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Occurrence of Social Wasps (Hymenoptera: Vespidae) in a Sugarcane Culture

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Abstract

Predation of Lepidoptera caterpillars - including agricultural pest species - is one of the main ways through which social wasps gather proteinaceous resources. The presence of social wasps was sampled through active search and bait traps through a sugarcane culture cycle, totaling 12 months. Our aim was to record the presence of these insects during the sugarcane development cycle in order to obtain data to support alternative pest control strategies. A total of 1091 individuals in seven genera and 20 species of social wasps were collected, including the swarm-founding *Agelaia vicina* and *Polybia sericea* (Hymenoptera: Vespidae). Social wasp richness and abundance were not correlated with climatic variables (temperature, humidity and precipitation). However, richness was negatively correlated to the sugarcane plants' height (r= -0.4360, p= 0.05). The presence of social wasps during the plant's cycle shows their potential as predators in sugarcane culture pest management.

Introduction

Insect pests in sugarcane cultures have been controlled with phytosanitary products which, although necessary to ensure productivity, may reduce biological diversity and environmental quality, thus making necessary the search for methods that are less aggressive towards the environment and the human health (Rodrigues, 2004). Brazil is the greatest worldwide producer of sugarcane with approximately nine million cultivated hectares that produce over 607 million tons per year, with Minas Gerais being one of the most productive states in the Southeast region (UNICA, 2017).

Biological control through insects is an effective tool for pest management (Parra & Zucchi, 1997). Social wasps were reported as predators of herbivores in cultivated plants such as jaboticaba (De Souza et al., 2010), guava tree (Brugger et al., 2011), Spanish prune (Prezoto & Braga, 2013), mango (Barbosa et al., 2014) and also in forest plantations (Elisei et al., 2010; De Souza et al., 2012). These insects show a generalist and opportunistic alimentary behavior in the search for carbohydrates and proteinaceous resources used in larvae nutrition (Hunt, 2007; Elisei et al., 2010; Clemente et al., 2012). Thus, they prey on sugarcane pest insects such as *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae), *Mocis latipes* (Guen, 1852) (Lepidoptera: Noctuidae) and *Spodoptera frugiperda* (Smith, 1797) (Lepidoptera: Noctuidae) and are important for integrated pest management programs (Giannotti et al., 1995; Prezoto et al., 2008; Prezoto et al., 2016).

Social wasps have been understudied regarding the management of agricultural pests, in spite of *Polistes simillimus* Zikán, 1951 (Hymenoptera: Vespidae) has being shown to increase productivity in corn plantations infested with *S. frugiperda* caterpillars (Prezoto & Machado, 1999a) and *Polistes versicolor* (Olivier, 1791) being recorded foraging in eucalyptus leaf-eating caterpillars (Elisei et al., 2010).

The aim of this study was to record the presence of these insects during the sugarcane development cycle in order to obtain data to support alternative pest control strategies.

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Material and Methods

The study was carried out in Juiz de Fora (21° 47' 21.19" S, 43°25' 34.58" W, altitude: 678 m), Minas Gerais state, Brazil in a sugarcane culture with 1.5 ha (*Saccharum* sp. Variety RB867515) (Fig 1) bordered by a pasture, an orchard and an Atlantic Forest fragment. This region has humid subtropical climate, type Cwa (mesothermic with hot rainy summers) (Sá Júnior et al., 2012).

Wasps were collected at a monthly basis from July 2010 to June 2011 in 420 hours of field work. Sampling was carried out through active search from 10:00 to 17:00 during five days in a row each month in random transects within and around the culture. Bait traps were also used, consisting of two-liter polystyrene bottles with three triangular holes (2x2x2 cm) cut at 15 cm from the base, the baits were made from passion fruit juice, honey water or sardine broth (Souza & Prezoto, 2006; Souza et al., 2015). Thirty-six traps were set each month in two transects (East and West) with 18 bottles each (six with sardine broth, six with passion fruit juice and six with honey water). Traps were set at a 1.5 m height from the ground and at 10 meters apart from each other for five days. Captured wasps were separated in the study area and kept in 100 ml sampling vials with ethanol 70%.

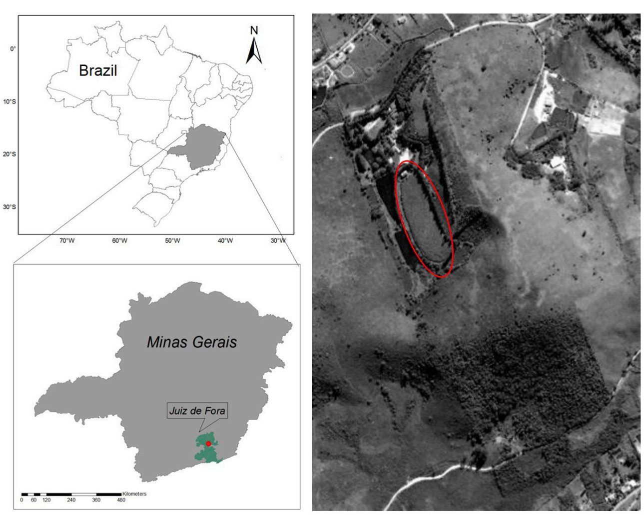

Fig 1. Geographical representation of the sugarcane culture area in Juiz de Fora, Minas Gerais state, southeastern Brazil.

Collected wasps were identified through keys for genera and species (Richards, 1978), and comparisons with specimens from the entomological collection of the Laboratório de Ecologia Comportamental e Bioacústica (LABEC) of the Universidade Federal de Juiz de For a in Juizfor aFora, Minas Gerais, Brazil.

The development phases of the sugarcane were identified through the plants' height according to the Kujiper system (Van Dillewijn, 1952), with the first top-to-bottom leaf presenting fully visible insertion in auricle (leaf collar) being designated as +1. Leaves under it were numbered +2, +3, etc., and the ones above it were numbered as 0, -1, -2, -3, etc. The leaf +3 was standardized as reference for samples. Five sugarcane plants were randomly measured each sampling month and the calculated mean of these measures was used.

Temperature (°C), relative air humidity (%) and precipitation (mm) data were obtained at the Laboratório de Climatologia e Análise Ambiental (LabCAA) in the Departamento de Geociências do Institutos de Ciências Humanas of Universidade Federal de Juiz de Fora.

Maximum attainable species richness from each study site was estimated through the use of the 1st order Jacknife non-parametric estimator, in the statistical software DivEs v 3.0. Constancy was obtained through the formula: C=Px100/N (Bodemheimer, 1955). Species that were present in more than 50% of the samples were considered constant, from 25% to 50% were considered as accessory and in less than 25% were considered accidental.

Correlation between species richness/ abundance and the variables temperature (°C), humidity (%), precipitation (mm) and sugarcane plant height was calculated through the use of the coefficients of Spearman (rs) and Pearson ®.

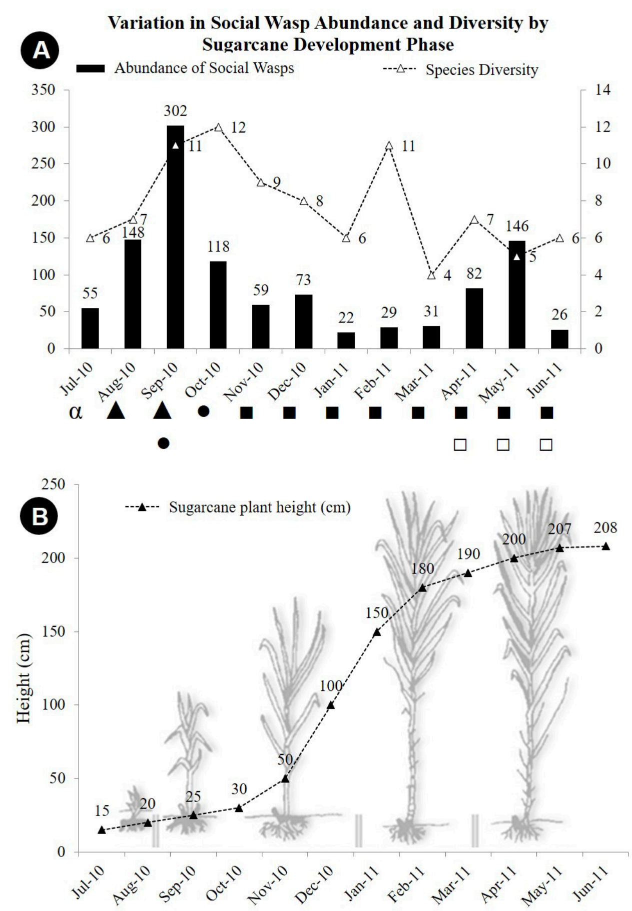

Fig 2. Social wasp species richness and abundancy (A) through the sugarcane development phases. Phase 0 (α): sugarcane cut, 1st phase (▲): budding and establishment (duration of ≈20-30 days after planting), 2nd phase (●): tillering (duration of ≈20-30 days after the emergence of the primary stem), 3rd fase (■): stem growth (beginning ≈ 4 months after planting), 4th phase (□): maturation (beginning ≈ 10 after planting) and B: height variation in sugarcane plants (cm) per month in the city of Juiz de Fora, Minas Gerais, Brazil.

The Chi-square test (x^2) was used to verify the existence of differences between seasons (hot/rainy, cold/dry), wasp abundance and richness in the software BioEstat 5.0.

Results

A total of 1,091 social wasps were captured from 20 species in seven genera, with 861 individuals belonging to *Agelaia vicina* (de Saussure, 1854). Thirty percent of the species were constant, 20% were accessory and 50% were accidental. Half of the constant species were swarm-founding wasps.

The 1st order Jacknife index estimated 21 species for the studied area. This confirms the efficiency of the method used, given that 20 species were found (95% of the estimated total). Social wasp richness was higher in the hot/rainy season (Oct 2010 to Apr 2011), peaking in October 2010 with 12 species. However, it didn't correlate to temperature (r=0.2379, p= 0.4566), relative humidity (r= -0.5208, p= 0.0825) or precipitation (r= 0.0860, p= 0.7905). Social wasps were collected through the whole sugarcane cycle, and species richness was correlated to the plants' height (r= -0.4360, p= 0.05) (Fig 2).

Wasp abundance was not correlated to temperature (rs= -0.3713, p= 0.2347), relative humidity (rs= -0.4476, p= 0.1445) or precipitation (rs= -0.3916, p= 0.2080). Nests of *Mischocyttarus drewseni* Saussure, 1857, *Polistes simillimus* Zikán, 1951, *Polistes versicolor* (Olivier, 1791), *Polybia occidentalis* Olivier, 1791 and *Polybia platycephala* Richards 1951 (Hymenoptera: Vespidae) were found within the planted area. Nests from the other 10 species were found up to 100 meters away from the culture.

Discussion

Social wasp species richness can be considered high in the studied environment, being greater than that found in orchards (Santos 1996; Silva et al., 2013), eucalyptus plantations (De Souza et al., 2012) and silvipasture areas (Auad et al., 2010), even with the last two showing higher plant diversity than sugarcane cultures. This can be explained by the environmental diversity around plantations, with a great variety of resource sites for herbivore insects and, consequently, their predators.

Table 1. Species, percentage of individuals per species captured through active search (Search) and through bait traps with sardine, passion fruit and honey water and constancy (Const.) of social wasps in a sugarcane culture from July 2010 to June 2011. City of Juiz de Fora, Minas Gerais, Brazil.

Species	Search	Sardine	Passion Fruit	Honey Water	Const.
*Agelaia vicina**	178 (16,32%)	644 (59,03%)	36 (3,30%)	3 (0,27%)	▲
*Mischocyttarus drewseni**+	28 (2,57%)	-	-	-	▲
Mischocyttarus rotundicollis	16 (1,47%)	-	-	-	▲
*Polistes simillimus**+	50 (4,58%)	-	-	-	▲
Polybia ignobilis	24 (2,20%)	2 (0,18%)	2 (0,18%)	-	▲
Polybia sericea	55 (5,04%)	-	-	-	▲
*Brachygastra lecheguana**	13 (1,19%)	-	-	-	■
*Mischocyttarus cassununga**	4 (0,37%)	-	-	-	■
Polybia jurinei	1 (0,09%)	-	3 (0,27%)	-	■
*Polybia platycephala**+	11 (1,01%)	-	-	-	■
Agelaia multipicta	-	3 (0,27%)	1 (0,09%)	-	●
*Apoica sp.**	-	-	1 (0,09%)	-	●
Polistes billardieri	1 (0,09%)	-	-	-	●
Polistes cinerascens	1 (0,09%)	-	-	-	●
Polistes subsericius	2 (0,18%)	-	-	-	●
*Polistes versicolor**	1 (0,09%)	-	-	-	●
Polistes sp.	1 (0,09%)	-	-	-	●
*Polybia occidentalis**+	1 (0,09%)	-	1 (0,09%)	-	●
*Polybia paulista**	3 (0,27%)	-	-	-	●
Protonectarina silveirae	2 (0.18%)	2 (0.18%)	1 (0.09%)	-	●
Total	392 (35.93%)	651 (59.67%)	45 (4.12%)	3 (0.27%)	-
Shannon Wiener (H')	0.79	0.03	0.36	0	-
Homogeneity	0.61	0.02	0.28	0	-
Heterogeneity	0.39	0.98	0.72	1	-

Species with nests up to 100 meters away from the culture (*), species with nests within the culture (+), species frequency and constancy (▲- constant (C>50%), ■ - accessory (C de 25% a 50%), ● - accidental (C<25%).

The great number of *A. vicina* individuals can be explained by the larger size of their colonies, which may reach one million adults each. This species' nests are built in termitaries, hollow trunks and even inside buildings (Zucchi et al., 1995; Oliveira et al., 2010). This species can prey on insects from 10 different orders, including Coleoptera, Diptera, Hymenoptera, Hemiptera and Lepidoptera. Many of these may include pest species such as the corn leafhopper (Oliveira et al., 2010).

Swarm-founding species such as *Polybia sericea* (Olivier, 1791), which were classified as constant in this study, have 75.4% of their protein forage composed of Lepidoptera caterpillars, including *S. frugiperda* (Bichara et al., 2009). The presence of *P. simillimus* colonies within the sugarcane plantations is valuable, since the species foraging behavior in corn plantations have shown the species' potential for pest management and the translocation of their colonies to artificial shelters in cultures reduces *S. frugiperda* populations (Prezoto et al., 1994; Prezoto & Machado 1999a, b).

Finding no relation between climatic factors and wasp abundance and richness contrasts with most published studies. However, it is clear that this particular situation occurs in anthopized environments, as shown by Ribeiro-Junior (2008), Auad et al. (2010) and Barbosa (2015). This might explain the results reported here, since our study also took place at an environment altered by man.

Despite social wasps being present through the whole sugarcane cycle, different plant stages modified the size of planted area, decreasing the area available for insect flight and influencing in their abundance and richness. Besides air viscosity and wind speed, vegetation density can also influence on the flight of insects (Unwin, 1980; Hilário et al., 2007).

Aside from the continuous presence of wasp colonies both in the surrounding vegetated areas and within the sugarcane plantation, the generalist diet is an indicative of their potential for controlling pests such as *D. saccharalis, M. latipes* e *S. frugiperda*, responsible for losses in sugarcane culture.

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