Characterization of the Social Wasp Guild (Hymenoptera: Vespidae) Visiting Flowers in the Caatinga (Itatim, Bahia, Brazil)

by

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ABSTRACT

Thirteen species of flower-visiting social wasps were collected from 39 plant species. The number of wasp species did not vary significantly. On the other hand, the number of individuals varied significantly during the data collection period. Four of the wasp species (*Mischocyttarus lanei*, *Polybia ignobilis*, *Polybia occidentalis,* and *Polybia sericea)* showed changes in body size over the year. The total wasp biomass and the number of plants visited monthly by wasps had a positive significant correlation. Wasp body size varies with food availability for adults (flowering plants) and wasp species are affected differently by seasonal changes in the 'caatinga'

Keywords: Polistinae, guild, biomass, dry forest.

INTRODUCTION

Several biotic and abiotic factors influence population dynamics and community structures (Majer *et al.* 1994; Santos & Gobbi 1998), and allow the ecological theory about communities to be applied with different focuses (Lewinsohn 1990). To the present, diversity in natural communities has been assessed by diversity indexes based on two main concepts: richness and relative abundance of species (Magurran 1988). Studies on flower visitors are appropriate for characterizing communities because they provide much comparable and measurable data (Heitaus 1979). Using number of specimens as the only variable in studies of insect communities, however, can lead to over- or underestimates of the ecological importance of a given species. On the other hand, parameters related to individual body size or population size, such as biomass, can be appropriate. These parameters allow evaluations based

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on abundance of each species and inferences concerning the importance of each species for the community nutrient cycle and energy flow. Santos *et al.* (1998) showed the importance of body size for the diet choice of social wasps. The environmental fidelity of these insects and their double-placement in the food chain (primarily as carnivore immature and herbivore adult) lead to their peculiar way of participating in food webs of the ecosystems where they live; these organisms are, therefore, appropriate for studies on guild structure and community standards (Gess & Gess 1993).

In our study, we aimed to analyze the structure of the social wasp guild visiting flowers in a "caatinga" area as basis for further ecological studies on these insects.

MATERIALS & METHODS

Samples of a community of social wasp visiting flowers were collected in Itatim (12º 42'S; 39º 46'W), State of Bahia, Isolated rocky formations (sugar-loafs, inselbergs*)* dominate the local landscape, which belongs to the "caatinga" morphoclimatic dominium. The "caatinga" or steppe is the predominant phytogeographic component of the natural vegetation in Northeastern Brazil (Ab'Saber 1969; 1977). It is a complex variety of open and dry vegetational physionomy (Gonçalves & Orlandi 1981) occurring in typical "drought" areas. The core of this vegetation is defined by the limits of the Semi-Arid morphoclimatic dominium, which is related to the critical rainfall limits (Aouad 1986). The study area is a mosaic of semi-deciduous arboreal "caatinga" associated with inselbergs and a shrubby "caatinga" that dominates the areas around the inselbergs. A detailed description of the vegetation physionomy and floristic composition can be found in França *et al.* (1997).

Samples were collected near the inselberg "Morro do Agenor", from November 1996 through November 1997. Every 30 days, we visited a 3 km long by 20 m wide transect. During the visits, two data collectors carefully and simultaneously inspected each flowering plant, with or without wasps, for 5 minutes. Pre-fixed sampling times aimed to sample all plant species with similar intensities. Several researchers, such as Sakagami *et al.* (1967), Martins (1995), Aguiar & Martins (1997) and Aguiar & Zanella (2005) used the

same procedure for their studies on flower-visiting bees. Each monthly data collection was taken on two consecutive days (12:00 a.m. to 6:00 p.m. on the first day and 6:00-12:00 a.m. on the second), totaling 180 sampling hours.

We based the analysis of the social wasp guild visiting flowers on frequency, constancy (Silveira Neto *et al.* 1976), and dominance (Laroca 1995) of each wasp species. Faunistic indexes were based on number of individuals and body size of each collected species, dry weight being an indication of body size. Iglessias (1988) obtained satisfactory results when using this methodology.

RESULTS & DISCUSSION

Thirteen species of flower-visiting social wasps were collected from 39 plant species in Itatim (Table 1). In general, the number of wasp species did not vary significantly during the data collection period. On the other hand, the number of individuals varied significantly, with peaks in December 1996, in January and in June 1997 (Table 2).

Biomass of most species varied along the year (Table 3). Four of the wasp species (*Mischocyttarus lanei*, *Polybia ignobilis*, *Polybia occidentalis,* and *Polybia sericea)* showed changes in body size over the year (Table 3; $p < 0.05$ by the non-parametric Kruskal-Wallis test). According to the Pearson Matrix Cor-

Table 1. Frequency, Constancy and number of plant species visited by social wasp species in the "caatinga" in Itatim, State of Bahia.

Species	Number of plant species visited	Frequency (%)		Constancy (%)
		Number of Individuals	Biomass	
Brachygastra lecheguana	12	17. 23	10. 22	100. 00
Mischocyttarus lanei	06	2. 43	1. 10	46. 15
Mischocyttarus cerberus	01	0. 19	0. 06	7. 69
Polistes biliardieri	01	0. 19	0. 29	7. 69
Polistes cinerascens	01	0. 19	0. 44	7. 69
Polistes canadensis	17	8. 80	30. 65	92. 31
Polistes versicolor	01	0. 19	0. 35	7. 69
Polybia ignobilis	18	17. 04	14. 47	84. 62
Polybia paulista	11	8. 24	2. 99	92. 31
Polybia occidentalis	13	6. 93	2. 19	76. 92
Polybia sericea	15	26. 78	33. 44	100. 00
Protonectarina sylveirae	10	10. 86	3. 68	76. 92
Protopolybia exigua	04	0. 94	0. 13	23. 08
TOTAL	41	100	100	-----

Table 2. Number of individuals of the social wasp species visiting flowers in Itatim, State of Bahia.

SPECIES	1996 NOV	DEC	1997 JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	TOTAL
Brachygastra lecheguana	05	03	18	06	03	05	06	15	07	14	03	05	02	92
Mischocyttarus lanei	---	01	---	---	---	01	03	02	03	---	03	---	---	13
Mischocyttarus cerberus	---	---	---	---	---	---	01	---	---	---	---	---	---	01
Polistes biliardieri	---	---	---	---	---	01	---	---	---	---	---	---	---	01
Polistes cinerascens	---	---	---	---	---	---	---	01	---	---	---	---	---	01
Polistes canadensis	02	06	03	02	04	11	05	05	01	06	01	01	---	47
Polistes versicolor	---	---	---	---	01	---	---	---	---	---	---	---	---	01
Polybia ignobilis	---	23	10	07	01	11	12	14	07	---	03	01	02	91
Polybia occidentalis	---	01	15	01	01	03	---	09	---	03	02	01	01	37
Polybia paulista	02	09	14	02	03	02	01	03	---	02	04	01	01	44
Polybia sericea	04	48	06	11	05	06	09	17	07	17	10	01	02	143
Protonectarina sylveirae	---	10	20	01	---	02	03	10	02	06	02	---	02	58
Protopolybia exigua	03	---	---	01	---	---	---	01	---	---	---	---	---	05
Total	16	101	86	31	18	42	40	77	27	48	28	10	10	534

relation analysis, *Mischocyttarus lanei* and *Polybia ignobilis* had a negative correlation between body size and temperature (respectively, r = - 0.70; p < 0.05 and r = - 0.65; p < 0.05). The body size of *P. ignobilis* was positively correlated with relative humidity of the air (r = -0.70; p < 0.05).

Four of the 13 species collected had only one specimen during the sampling period. Relative frequency data for number of individuals visiting flowers ranged from 0.19-26.78%, while relative frequency data for species biomass (total weight for each species) ranged from 0.09-33.4%. The guild structure of social wasps that feed on flowers in the "caatinga" changes if it is analyzed from the number of specimens or from biomass. In both situations, *Polybia sericea* had the highest frequency in the community (Fig. 1). On the other hand, in the analysis based on biomass, the frequency of *Brachygastra lecheguana* was lower than in the analysis based on the number of specimens, while species such as *Polistes canadensis* increased its frequency (Fig. 1).

In this wasp community, 4 species were dominant: *Polybia sericea, Brachygastra lecheguana, P. ignobilis* and *Protonectarina sylveirae* (dominance calculated by number of individuals) and *Polybia sericea, Polistes cannadensis* and *Brachygastra lecheguana* (dominance calculated by biomass). The value of the Dominance Index was highest for *P. sericea,* in number of individuals and in biomass (Fig. 1). Among the dominant species, *P. sericea* and *P. ignobilis* have been cited as pest control agents in agriculture, showing the importance of these species. If dominance was calculated based on biomass, minimum and maximum frequency limits were narrow for all species and there were some changes in the dominance hierarchy (Fig. 1). Calculating dominance only based on the number of individuals, under-counts the dominance of big size species such as *Polistes canadensis* and over-counts small size species such as *Protopolybia sylveriae.*

Studies based on number of individuals give excessive importance to small organisms, whereas studies based on biomass emphasize large organisms (Odum 1988). Using biomass is advantageous because of its role in the community nutrient cycles and energy

Table 3. Monthly biomass (g) of social wasp species collected while visiting "caatinga" flowers in Itatim. State of Bahia.

SPECIES	1996 NOV	DEC	1997 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
Brachygastra lecheguana	0.0581	0.0329	0.2100	0.0682	0.0315	0.0615	0.0643	0.1726	0.0772	0.1428	0.0283	0.0548	0.0248	1.0270
Mischocyttarus lanei	---	0.0081	---	---	---	0.0056	0.0294	0.0207	0.0202	---	0.0256	---	---	0.1096
Mischocyttarus cerberus	---	---	---	---	---	---	0.0061	---	---	---	---	---	---	0.0061
Polistes billardieri	---	---	---	---	---	0.0290	---	---	---	---	---	---	---	0.0290
Polistes cinerascens	---	---	---	---	---	---	---	0.0435	---	---	---	---	---	0.0435
Polistes canadensis	0.1246	0.4306	0.1915	0.1035	0.2373	0.7649	0.3049	0.3207	0.0642	0.4226	0.0636	0.0507	---	3.0791
Polistes versicolor	---	---	---	---	0.0351	---	---	---	---	---	---	---	---	0.0351
Polybia ignobilis	---	0.3766	0.1512	0.1020	0.0134	0.1714	0.1996	0.2309	0.1166	---	0.0449	0.0105	0.0371	1.4542
Polybia paulista	0.0177	0.0592	0.1017	0.0127	0.0204	0.0141	0.0075	0.0170	---	0.0147	0.0242	0.0053	0.0052	0.2997
Polybia occidentalis	---	0.0041	0.0945	0.0054	0.0064	0.0178	---	0.0505	---	0.0189	0.0122	0.0042	0.0055	0.2195
Polybia sericea	0.1029	1.1311	0.1288	0.2711	0.1157	0.1413	0.2224	0.4385	0.1698	0.3631	0.2077	0.0190	0.0480	3.3594
Protonectarina sylveirae	---	0.0645	0.1198	0.0057	---	0.0142	0.0207	0.0660	0.0130	0.0383	0.0126	---	0.0150	0.3698
Protopolybia exigua	0.0080	---	---	0.0025	---	---	---	0.0024	---	---	---	---	---	0.0129
Total	0.3113	2.1071	1.0228	0.5711	0.4598	1.2198	0.8549	1.3628	0.4610	1.0004	0.4191	0.1445	0.1356	10.0449

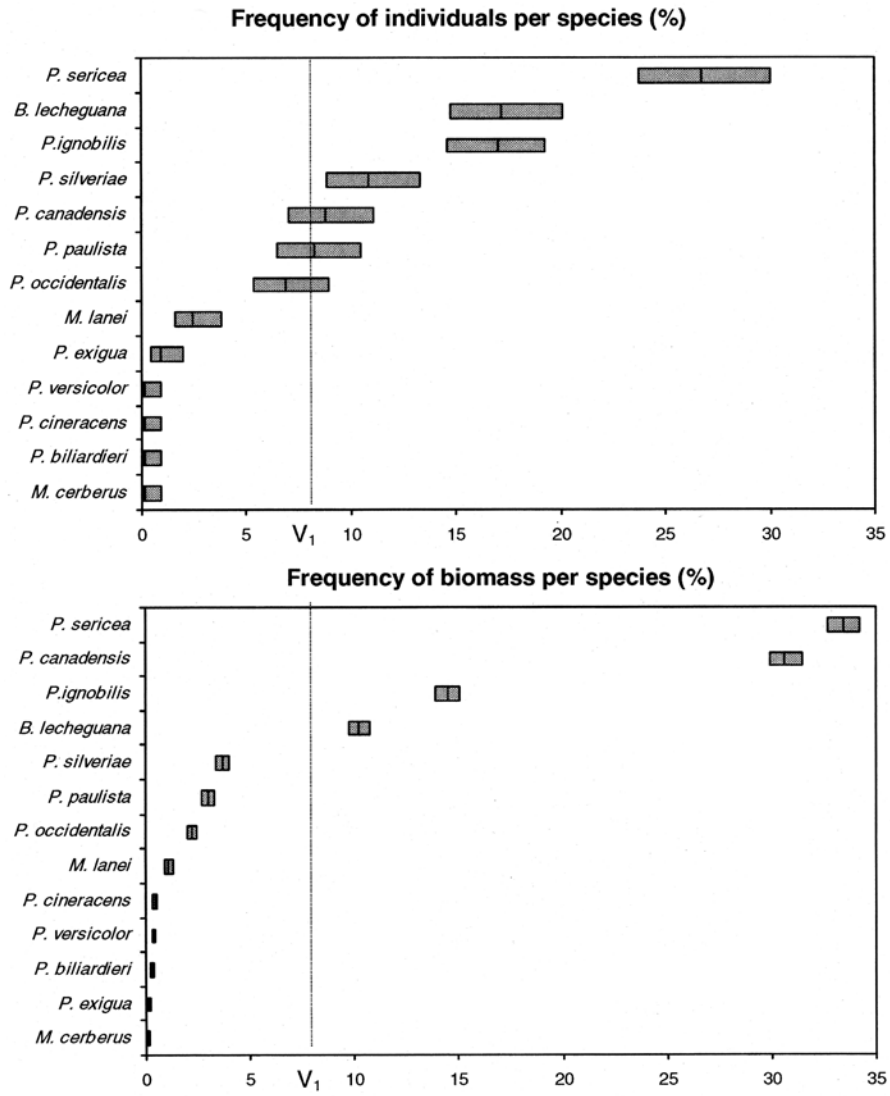

Fig. 1. Dominance hierarchy in the community of social wsps visiting flowers in Itatim. Left and right bar edges are the lower and upper occurrence limits respectively. The medium line is the frequency observed for each species (V1=7.69%).

flow (Iglessias 1988, 1990). Populations with higher biomass use more food resources; however, this information is lost if community analysis does not consider the body size of specimens. According to biomass values obtained in our study, *Polistes canadensis* probably uses approximately 10 times more

Table 4. Summary of the statistical analysis of the variables studied at the community of social wasps visiting "caatinga" flowers Itatim, BA. (November 1996 to November 1997) (Pearson Matrix Correlation).

	Number of species	Number of individuals	Total Biomass	Number of plants visited[1]
Number of Species	-----			
Number of Individuals	Ns	-----		
Biomass	r = 0.60 p=0.05	r = 0.91 p=0.01	-----	
Number of Plants Visited	r = 0.71 p=0.01	r = 0.65 p=0.05	r = 0.65 p=0.05	-----
Temperature	Ns	Ns	Ns	r = -0.60 p=0.05
Relative Humidity	Ns	Ns	Ns	r = 0.60 p=0.05

[1]Only plants visited by more than two individuals during the 13 sampling months were considered.

food than *Polybia paulista*. However, we collected 47 specimens of *Polistes canadensis* and 44 of *Polybia paulista*. In this example, therefore, we can observe the importance of specimen body size for community studies, particularly studies on food guilds.

Iglessias (1988) showed a discussion on body size and energy flow within communities and emphasized the need for improving quality of the data collected in the natural environment. Brown & Maurer (1989) and Talyor & Gotelli (1994), studied correlation patterns between body size and environmental needs, and found different conclusions. The first pattern was that the larger the body size, the higher the consumption of resources. The second was that small organisms tend to have large populations. Therefore, small sized species can reach large biomass, increasing the consumption of resources. That debate, that has been usually concentrated on the role of the area used by each species related to body size (Gaston 1988; Gaston & Lawton 1988, Gaston 1990), emphasizes the importance of analyzing parameters such as body size and population biomass in studies on community structure.

Brachygastra lecheguana and *Polybia sericea* were the only species found

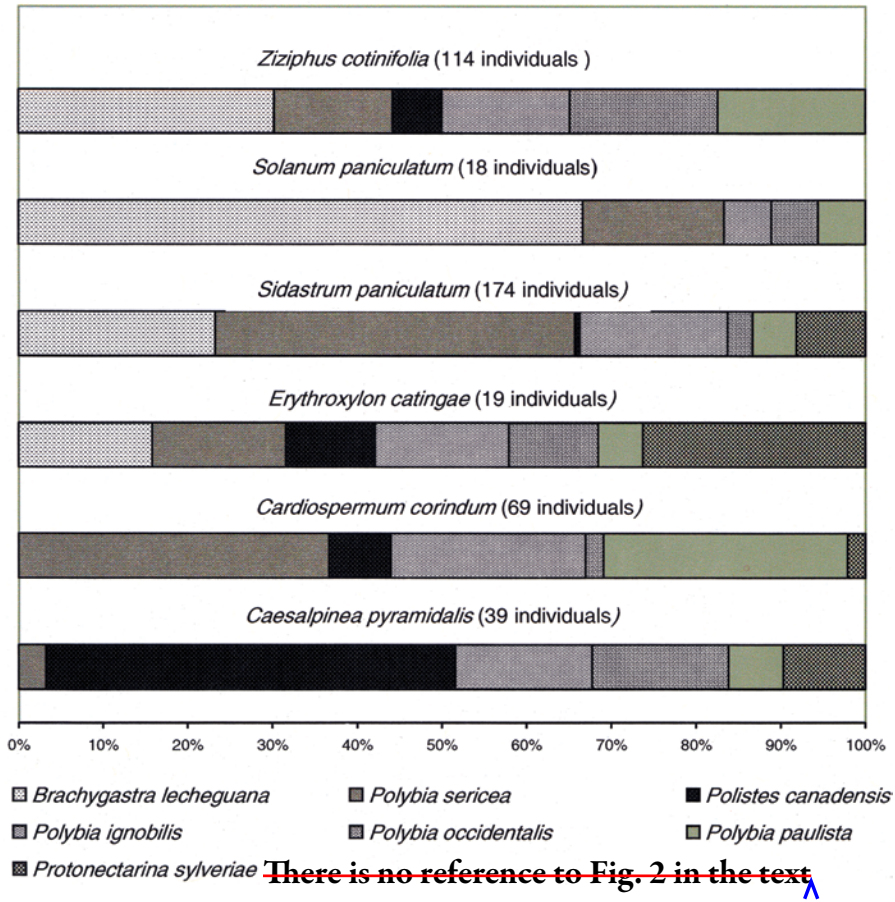

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Fig. 2. Wasp visits to the main plant species for the social wasp guild visiting fowers in Itatim (only wasp species with F < 0.05 were represented).

throughout the study. The large number of species ranked as accessorial or accidental in the study can indicate an unstable environment. The species of Mischocyttarini were not ranked as constant; only one of them was accessorial and found in 46% of the samples (6 of 13); one species was accidental and found in 7.69% of the samples (1 of 13) (Table 1). Of all Polistini, only *Polistes canadensis* was constant and found in 92.31% of the samples (12 of 13). The other three species were accidental and observed in only 7.69% of the samples (1 of 13). The Epiponini had only one species ranked as accidental, observed in 23.08% of the samples (3 of 13); all other six species were

Table 4. Plant species visited by social wasps during sampling months in Itatim, BA, November 1996 to November 1997.

Plant species	Social wasps collected		1996		1997											
	number of species	number of individuals	N	D	J	F	M	A	M	J	J	A	S	O	N	
Capparis jacobina	01	01	■													
Chamaecristia belamii	01	02	■													
Jatropha molissima	01	01	■													
Eugenia rosea	01	01	■													
Cereus peruvians	01	04		■												
Sideroxylon obtusifolium	03	08		■												
Peltogyni pauciflora	02	03	■		■											
Passiflora foetida	02	03			■											
Mullugu verticillata	01	01			■											
Lippia poherania	01	02			■											
Portulaca elator	02	03			■											
Poeppigia procera	01	01				■										
Cordia globosa	01	01				■										
Herissantia tiubae	01	01				■										
Oxalis sp	02	02					■									
Gomphrena holosericea	03	03				■	■									
Boerhavia coccinia	02	01					■									
Opuntia palmodora	03	03						■								
Sida purpurandus	03	03						■								
Herissantia crispa	02	02					■		■							
Chaetocalyx scandens	02	03						■	■							
Hydrocleis nymphaeoldes	01	01							■							
Mimosa arenosa	01	01							■							
Raphidon echinus	01	01							■							
Sida galheirensis	01	01							■							
Senna spectabilis	07	12					■		■	■						
Alternaria tenella	02	03						■		■						
Syagrus vagans	02	02							■	■						
Clorophora tinctoria	03	05						■	■	■						
Caesalpinea pyramidalis	10	39		■	■		■	■	■	■	■					
Cardiospermun corindum	06	69		■	■	■	■	■	■	■	■	■				
Erythroxylon catingae	07	19						■		■	■	■	■			
Capparis yco	05	10	■	■									■			
Stigmaphyllon auriculatum	01	02										■	■			
Sidastrum paniculatum	08	174	■	■		■	■	■	■	■	■	■	■	■		
Tecoma heptaphylla	02	02									■			■		
Echinodorus subalatus	03	03										■		■		
Ziziphus cotinifolia	09	109	■	■	■	■	■				■				■	■
Solanum paniculatum	05	18	■			■	■					■	■	■	■	■
Acacia bahiensis	02	03		■									■			■
Melochia betonicifolia	03	05			■					■						■

There are two Table 4s

constant and appeared in more than 50% of the samples.

Our data agree with those obtained by Heitaus (1979), who observed that 86% of the social wasps visiting flowers throughout the year in Costa Rica belong to the Epiponini tribe. Tropical social wasps store honey in hive cells, mainly during the dry season (White 1841; Rau 1933; Hunt *et al.* 1987). This resource can be a reserve for maintaining the colony throughout the year

and during the scarce food-supply season (Rossi & Hunt 1988). A possible explanation for constancy of the Epiponini species is related to their ability to produce honey, since these species store food resources more efficiently than the species of Polistini and Mischocyttarini (Rossi & Hunt 1988).

In this community of 13 social wasp species, we found abundance $\propto = 1.91$ and equitability J' = 0.77. The diversity indexes calculated were Shannon (H' = 1.98) and Simpson (L = 0.16). In the Simpson index, common species have more weight whereas in the Shannon index, rare species are valued higher. The Shannon (H') index is one of the most often used in community studies because it allows for comparison among communities even if samples are not standardized. Mechi (1996) studied two communities of social wasps visiting flowers in "cerrado" ecosystems, Jataí and Corumbataí. The social wasp diversity (H′) and richness (S) found in those areas of "cerrado" (H' = 2.18, S= 26 species and H' = 2.42, S= 25 species) was higher than the diversity and richness we found in the "caatinga".

In spite of the high richness of plant species visited by wasps in Itatim, most plants were visited by fewer than 1% of the individuals. Nineteen of the 41 plant species were visited by only one or two individuals, and 24 plant species were visited by only one or two social wasp species. Six plant species were predominantly visited by social wasps: *Ziziphus cotinifolia*, *Solanum paniculatum*, *Sidastrum paniculatum*, *Erythroxylon catingae*, *Cardiospermum corindum,* and *Caesalpinia pyramidalis*. These species together were visited by 81.08% of the visiting wasps. The species *Ziziphus cotinifolia* and *Sidastrum paniculatum* together had 53.93% of the social wasp visits, which highlights their importance in support the social wasp community (Table 4).

The total wasp biomass and the number of plants visited by wasps monthly had a positive significant correlation (p= 0.05, r= 0.65). In the 'caatinga', flowering is in general highly seasonal, following the rainy and dry seasons. A significant correlation was also observed between the number of plant species visited monthly, and the temperature and humidity data (Table 3). According to these data, wasp body size varies with food availability for adults (flowering plants) and wasp species are differently affected by seasonal changes in the 'caatinga'.

The most visited plant species did not show different floral morphology, but a common characteristic of them is the abundance of resources, which

supports the social wasps' status as opportunistic visitors. The structure of this social wasp community is characterized by a low number of dominant species, a large number species that are not frequently present and several plant species visited by few wasps. These patterns agree with the results obtained by Heithaus (1979) and Mechi (1996) for guilds of social wasps visiting flowers in other tropical ecosystems.

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