Foraging Behavior of the Swarm-Founding Wasp, *Polybia* (*Trichothorax*) *sericea* (Hymenoptera, Vespidae): Prey Capture and Load Capacity

by

Carlos Costa Bichara Filho[1], Gilberto M. de M. Santos[1,2], Janete Jane Resende[2], Jucelho Dantas da Cruz[1,2], Nivar Gobbi[3] & Vera Ligia L. Machado[3]

ABSTRACT

The main component of the protein diet of *P. sericea* was larvae of Lepidoptera (75.38 %), with predominance of the following Families: Noctuidae (30.99 %), Hesperiidae (19.01 %); Pyralidae (19.01 %) and Nymphalidae (11.98%). The average weight of the prey captured was 14.2 mg, a value equivalent to 24.7 % of the average wasp weight. The average glucidic food load was 28.61 mg, corresponding to approximately half the wasp weight (49.64%). The weight of the load transported in the crop varied according to the food density, which, in turn, influenced the time spent in its collection (Pearson: $n=64; r=0.64; p<0.05$). *Polybia sericea* showed predatory interactions against Lepidopteran caterpillars, who are known to be agricultural pests. *P. sericea* has potential to be used in Integrated Pest Management.

Keywords: social wasps, Polistinae, biological control, prey.

INTRODUCTION

An important review of social wasp foraging behavior, carried out by Raveret-Richter (2000), evidenced a great variability in the strategies to collect water, prey, and carbohydrate used by these wasps, both within the same and in different species. The swarm-founding wasps' diet is extremely assorted: nectar, fruit juices, honeydew, and sugary human food are the basis of the adult diet (Evans & West-Eberhard 1970; Hunt *et al.* 1987), being also important sources of energy for wasps in their early stage of development (Akre *et al.* 1980). Lepidoptera larvae are the main source of protein

[1]Laboratório de Entomologia, Departamento de Ciências Biológicas, Universidade Estadual de Feira de Santana, 44.031-460, Feira de Santana, Bahia, Brazil. Email: gmms.uefs@gmail.com
[2]Programa de Pós Graduação em Zoologia Universidade Estadual de Feira de Santana
[3]Instituto de Biociências - Depto. de Ecologia - UNESP, 13.506-900, Rio Claro - SP, Brasil

for social wasps in their early developmental stages (Evans & West-Eberhard 1970), but their diet may also include vertebrate and invertebrate carcasses, Anura eggs and tadpoles, human food, and a large variety of small arthropods (Raveret-Richter 2000).

The opportunistic behavior of the social wasps impels them to hunt the most abundant resources available in the environment. Therefore, like other generalist predators, they contribute to the control of populations of several pests insects (Marques 1989). Despite their potential to reduce agricultural pest populations in biological control programs (Martin & Arias 1983; Prezoto 1999), the use of social wasps as biological controllers of pests is still fairly uncommon.

Knowledge of several aspects of wasp behavior and ecology, such as the effect of agricultural pesticides on wasps (Hebling-Beraldo *et al.* 1982; Picanço *et. al* 1998; Santana-Reis *et al.* 2002; Santos *et al.* 2003), flight capacity (Gobbi 1978; Santos *et al.* 1994 2000), daily activity (Andrade & Prezoto 2001; Resende *et al.* 2001), diet (Gobbi *et al.* 1984; Gobbi & Machado 1985 1986; Machado *et al.* 1987,1988; Prezoto *et al.* 1994) and load-carrying capacity (Malaspina *et al.* 1991) is required to use social wasps in integrated pest management systems. In this work, we aimed to determine the load-carrying capacity and identify the prey captured by *Polybia* (*Trichothorax*) *sericea* (Olivier).

MATERIAL & METHODS

Area of study

The study was carried out at the Campus of the Universidade Estadual de Feira de Santana, placed in the municipality of Feira de Santana (12° 16'S; 38° 58'W), State of Bahia, Brazil. This area is inserted in the vegetation of the "Caatinga," a kind of dry and deciduous shrubby vegetation. The climate in this region is dry to subhumid, with an annual average of 867 mm of rain.

Data collection and analysis

From June 2000 to April 2001, we followed a colony of *P. sericea* from colony-founding until declination and nest abandonment. In order to evaluate their diet, twenty wasps were captured every week when returning to the nest with their prey. We weighed the captured prey using an analytical digital balance (Sartorius VP221S), with 0.00001g precision to calculate *P.*

sericea capacity to carry prey. The captured prey were kept in ethanol and were identified later. The high degree of fragmentation of some samples made it impossible to identify the prey to a lower taxonomic level. The Dice similarity coefficient was used to compare the diets of wasp species from different places with the diet found in this study for *P. sericea*.

The capacity to carry glucidic food was determined according to a methodology developed by Neves-Fermiano & Stort (1985) for bees, later adapted by Malaspina *et al* (1990) for *Polybia paulista* (Iehring, 1896). Our study on glucidic food-carrying capacity was performed using wasps from three colonies. Wasps were trained to collect a glucose syrup (maize-syrup) solution in a container placed on the weighing tray of a Sartorius VP221S analytical digital balance with 0.00001g precision, placed about 2.5 m from the nest. We offered sugary solution in three different proportions of maize-syrup/water (1.3/1, 1.4/1 and 1.5/1). Time spent to collect glucidic food and the weight of the food collected by each wasp were recorded. We estimated the volume collected in each trip based on the weight recorded, in order to evaluate the fluid food-carrying capacity of *P. sericea*.

To identify the existence or absence of a significant difference in the load capacity between the colonies, the Kruskal-Wallis non-parametric test for average comparison was used. Pearson Linear Correlation was used, to check for correlation between the measured variables (weight of the wasp, of their prey, of the glucidic food, time spent to collect the food and concentration of the sugary solution).

RESULTS & DISCUSSION

Most of the material collected by *P. sericea* was composed of macerated and/or fragmented bodies of prey, thus making it impossible to identify them at lower levels. Three hundred and twenty one samples of materials transported by the workers of *P. sericea* were collected. Two hundred and forty nine samples were insects and they were identified to the Order level. We recorded an unquestionable preference for larvae of Lepidoptera (242 samples), corresponding to 75.38 % of the total number of samples.

From the total amount of captured Lepidopterans, 77.68 % were identified to the Family level; and we recognized the species of prey in 7.44 % of the samples. The following species were identified: *Alabama argillacea, Spodoptera*

Table 1. Prey captured by foragers of *Polybia sericea* in Feira de Santana, Bahia State, Brazil. June 2000 to April 2001.

LIST OF PREY	MATERIAL CAPTURED (N)			FREQUENCY (%)
	Juvenile forms	Adult insects	Macerated prey	
Hymenoptera	1	-	-	0.31
Diptera	1	-	-	0.31
Coleoptera	3	-	-	0.93
Homoptera	-	1	-	0.31
Heteroptera	1	-	-	0.31
Lepidoptera	206	-	36	75.40
Family Arctidae	1	-	-	-
Family Cythernidae	1	-	-	-
Family Geometridae	4	-	-	-
Family Hesperiidae	46	-	-	-
Family Noctuidae	75	-	-	-
Family Nynfalidae	29	-	-	-
Family Olethrentidae	1	-	-	-
Familia Pyralidae	46	-	-	-
Family Saturnidae	3	-	-	-
Family not identified	-	-	36	-
Other unidentified material	23	1	48	22.43
TOTAL	235	2	84	100

fugiperda, *Elasmopalpos lignosellus*, *Pseudoplusia includens*, and *Chlosynelacinia saundersii.* Noctuidae (30.99 %), Hesperiidae (19.01%); Pyralidae (19.01%) and Nymphalidae (11.98%) were the most frequent families in the samples (Table 1). Hesperiidae was the most consistently found family during the whole study, being present in all months of sampling; however, it was captured frequently only in the absence of other Lepidopteran families (Fig.1).

P. sericea showed replacement of prey during the study, corroborating the generalist and opportunist behavior of this species, who tended to hunt the more abundant prey. The constant presence and the high frequency of Lepidoptera larvae indicated a high hunting pressure exerted by social wasps on this group; during the study, it was common to see a repeated capture of the same prey species. Similar results were obtained for other species, such as *P. occidentalis occidentalis* (Gobbi *et al.* 1984), *P. paulista* (Gobbi & Machado 1985; *P. ignobilis* (Gobbi & Machado 1986), *Agelaia pallipes* (Machado *et al.* 1987), *Polistes simillimus* (Prezoto *et al.* 1994), *P. fastidiosuscula* (Tech 1987), *Polistes lanio* (Giannotti *et al.* 1995) and *Polistes versicolor* (Prezoto *et al.* 2006). All these works evidenced the importance of Lepidopterans in the diet of social wasps.

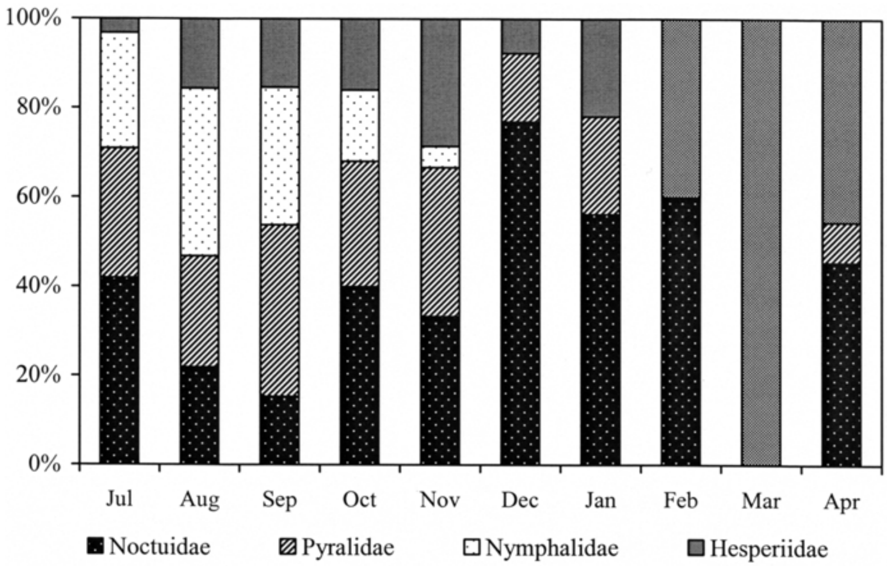

Fig. 1. Monthly changes in the abundance of the main prey families captured by *Polybia sericea* in Feira de Santana, Bahia State, Brazil. June 2000 to April 2001.

The similarity analysis showed that the diet of *Polybia sericea* in Rio Claro (São Paulo State, Southest Brazil) is closer to that of other wasp species from the same region (*Polybia ignobilis* and *Agelaia pallipes*) than to the diet of *P. sericea* from Feira de Santana (Bahia State, Northeast Brazil) (Fig. 2). This means that the hunted species vary considerably from place to place, and that wasps hunt the most abundant prey more frequently. These data corroborate the facultative specialist behavior of the social wasp foragers. According to Raveret-Richter (1990, 2000), "individual social wasp foragers often return to hunt in sites of previous hunting success and may feed repeatedly on same species of prey, thus acting individually as facultative specialists."

Some studies performed under natural and controlled conditions have shown that social wasps develop strategies to maximize their hunting efficiency, including strategies against defense mechanisms of caterpillars (Marques *et al*. 2005; Raveret-Richter 1990). *Polybia sericea* behavior related to hunting strategies, location, manipulation, and protection of hunted prey against other predators were described by Raveret-Richter & Jeanne (1985, 1991).

In our study, the weight of the wasps ranged from 42.7 mg to 73.6 mg (average of 59.0 mg), while the weight of the transported prey ranged from 1.9 mg to 32.5 mg (average of 14.2 mg). Thus, these wasps can carry prey whose average weight is equivalent to 24.7 % of their own weight. *P. sericea*

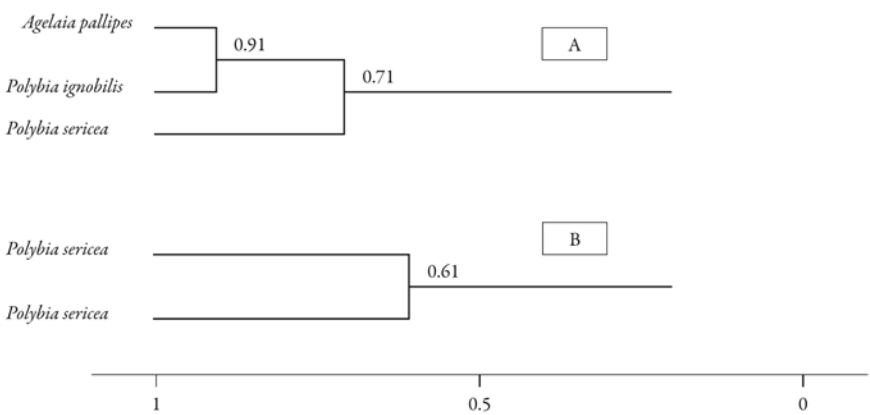

Fig. 2. A - Similarity in the diet of *Agelaia pallipes*, *Polybia ignobilis* and *Polybia sericea* from Rio Claro (São Paulo State, Brazil). B - Similarity in the diet of *Polybia sericea* from two different places in Brazil (Rio Claro, São Paulo State and Feira de Santana, Bahia State).

showed a prey-carrying capacity higher than *Polybia paulista*, which can transport prey weighting the equivalent of 7.1 % of its weight (Malaspina *et al.* 1990). Our data agree with previous studies that estimated the protein load transported to the nest by both *P. sericea* (522.6 mg/day, Machado *et al.* 1988) and *P. paulista* (108.9 mg/day, Gobbi & Machado 1985).

The load of glucidic food transported by *P. sericea* ranged from 19.11 mg to 22.63 mg (average weight of 28.61 mg). The average weight of that load corresponded to approximately half of the weight of an average wasp (49.64 %). Similar results were obtained for *Polybia paulista* and *Polybia ignobilis*, which had fluid load carrying capacities of 47.7 % and 53.5 % of their weight, respectively (Malaspina *et al.* 1990, 1991). These authors emphasized that crop volume is a limiting factor in the capacity of carrying fluid food.

We found a significant difference in the average weight of food collected by wasps from the three different densities of the sugary solution tested (Kruskal-Wallis Non-parametric test, $p<0.05$). The time spent collecting food ranged from 24 to 358 seconds (average of 135.25 seconds). The density of the solution influenced the time spent in the collection: food collection demanded more time when the density increased (Pearson Correlation matrices: $n= 64$; $r= 0.64$; $p<0.05$).

Our study shows that *Polybia sericea* has strong predatory interactions against Lepidopteran caterpillars, which are prominent agricultural pests. Therefore, *P. sericea* has the potential to be used in integrated pest management, helping in the maintenance of the equilibrium of the agroecosystems.

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