FORAGING ACTIVITY OF *Polistes lanio lanio* (FABR.) (HYMENOPTERA: VESPIDAE)

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ABSTRACT

There is a well-marked difference in the intensity of foraging of *Polistes lanio lanio* (Fabr.) between wet and warm, and dry and cold seasons, suggesting a kind of metabolic adjustment to seasonal temperature and relative humidity changes. Nectar was the principal food collected by the foragers either during the day or along the season, and it is available for both adults and larvae. Data on duration of the foraging trips are given. The foragers are not specialized in a given task: the same individual could collect more than one kind of material. Active colonies occur throughout the year. This combined to their natural dependence on several noxious insects may suggest their use as a potential biological control agent.

KEY WORDS: Insecta, biological control, food, prey, social wasps.

RESUMO

Atividade Forrageadora de *Polistes lanio lanio* (Fabr.) (Hymenoptera: Vespidae)

Foram observadas diferenças marcantes na intensidade da atividade forrageadora de *Polistes lanio lanio* (Fabr.) quando se considerou uma estação úmida e quente e outra seca e fria, sugerindo uma forma de ajuste metabólico às mudanças sazonais de temperatura e umidade relativa. A maior parte do material coletado pelas vespas durante a atividade diurna, no decorrer das estações do ano, foi constituída de néctar, que é um alimento utilizado por adultos e larvas. Foram fornecidos dados de duração das viagens de coleta. As forrageadoras não são especializadas numa determinada tarefa: o mesmo indivíduo pode coletar mais de um tipo de material. Devido à ocorrência de colônias ativas durante todo o ano e ao fato de ser um inimigo natural generalista de uma série de pragas, pode-se considerar esta espécie potencialmente utilizável como um agente de controle biológico.

PALAVRAS-CHAVE: Insecta, controle biológico, alimento, presa, vespas sociais.

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INTRODUCTION

Polistes wasps are well-known insect hunters, preying mainly on caterpillars. Some studies have been carried out to verify their potential as predators in biological control programs (Rabb & Lawson 1957, Rabb 1960, Gillaspy 1971, 1979, Nakasuji *et al.* 1976, Yamasaki *et al.* 1980, Gould & Jeanne 1984, Butignol 1992). *Polistes lanio lanio* (Fabr.) is a large red-brown wasp, known as "marimbondo-caboclo" or "marimbondo-cavalo" whose nests are very common around human habitations. The latin name *lanio* signifies executer or butcher, and Fabricius (1775 *apud* Richards 1978) must be refering to its cruel hunting methods when he named it. When searching for prey the wasp does not utilize its sting: instead, it kills the prey with its mandibles and they are entirely or in part malaxated into a rounded ball. For this it uses the front tarsi for gripping and turning. Then the ball is carried to the nest, where it may be further malaxated and shared with other adults before being offered to a succession of larvae. Only a portion of a large prey is carried to the nest at one time, and a wasp may return to the carcass for additional loads (Rabb & Lawson 1957, Gillaspy 1971), but there is no evidence of some kind of recruitment among *Polistes* foragers (Kasuya 1984). Stamp & Bowers (1988, 1991) verified that besides the direct effect on the caterpillars survivorship, *Polistes* may have an indirect effect on them as a consequence of a reduction in growth rate of the prey, by forcing caterpillars into cooler microhabitats of the hostplant, where leaves are of lower quality.

Adult Vespidae wasps feed primarily on liquids: nectar, plant juices, homopteran exudates or larval saliva, which is a labial gland secretion absorved by attendant adults (Hunt *et al.* 1982).

The name "paper wasp" attributed to Vespidae wasps is due to the fact that their nests are built with plant fibers. The wood pulp loads carried by foragers are malaxated and added to the nest. Water collections are related to the maintenance of an ideal temperature for rearing brood and probably to the building activities.

In this work we observed the foraging activities of *P. lanio lanio*: schedules of activity and their seasonality, prey captured and the use of the diverse loads carried to the nest.

MATERIAL AND METHODS

Preliminary studies were carried out in Rio Claro, SP, in 1988. Two daylight periods of foraging quantification were made in March 30 and May 26 in two different colonies. We have also carried out some behavioral observations on the foraging of six colonies of *P. lanio lanio*: time spent for carrying prey, nectar, water and wood pulp; and the behavioral patterns performed by the wasps when arriving to the nest. Adults of six colonies were marked with model airplane enamel for individual identification. Five more periods of foraging quantification were made in Piracicaba, SP, in 1993-1994 in five different active nests, in May 1, July 5, September, 29, November 1, 1993 and February 17, 1994. These Piracicaba nests were located in a abandoned building next to sugar-cane, corn and bean fields. The way outs and the returns of the foragers were quantified and identified. Return with nectar was so considered when a forager made a trophallaxis with an adult or larva; with water when it arrived and deposited a drop directly on the cell walls; and without load when it arrived and performed none of these behaviors. Loads of prey and wood pulp were easily distinguished by the size and texture of the material carried to the nest. We considered the year divided in a wet and warm season (from September to April), and in dry and cold season (from May to August), according to Koeppen's climatic classification (climate kind Owa).

Fifteen collections of solid loads carried by the foragers were made in March-April 1993 for identification and weighing of the material. Some foragers arriving with prey or wood pulp were also captured with a net and fixed in alcohol 70%.

An efficiency index of foragers was calculated as: efficiency index = foragers arriving with load x 100/total number of foragers arriving. The Spearman correlation coefficient was calculated using data on the number of foragers per hour x temperature and relative humidity, water collection x temperature and relative humidity, and wood pulp x water collections.

RESULTS AND DISCUSSION

There was a well-marked difference in the intensity of foraging of *P. lanio lanio* between the wet and warm, and the dry and cold seasons (Figs. 1 and 2). In the wet and warm season, the foragers started flying earlier (5:58 AM) and finish later (6:46 PM), with more wasps foraging/hour than in the dry and cold season (from 8:03 AM to 5:14 PM). In the wet and warm season the peak of foraging was between 10:00 and 11:00 AM, at 28,4°C and 63.0% of relative humidity, and in the dry and cold season it was between 12:00 and 1:00 AM, at 24.5°C and 62.2% of relative humidity. Temperature, relative humidity and sunlight period (and probably other non-measured variables, as luminosity, air pressure and wind) influenced the foraging of these wasps so that warm long sunlight days are more favourable to flight than cold short sunlight days. Osgood (1974, *apud* Leren *et al.* 1982) suggests that *Trigona hyalinata* Lepeletier starts foraging in the morning influenced by the temperature, but the end of the activities in the afternoon depends on the luminosity.

Our observations suggest different rhythms of foraging in *P. lanio lanio* as a form of metabolic adjustment to seasonal temperature changes and in accordance to the needs of the colonies. Hebling-Beraldo & Machado (1987) studying the comparative respiratory metabolism of *P. simillimus* Zikán in the winter and summer, verified that temperature coefficients (Q_{10} values), based on average respiratory rates, were higher at low temperatures and reached minimum values between 20 and 30°C in the winter, and 25 and 35°C in the summer. The lower values of Q_{10} at higher temperatures reflect the thermal ranges of better physiological adjustment during the winter and summer for *P. simillimus* wasps. Our field data on foraging of *P. lanio lanio* agree with these temperature intervals.

The Spearman correlation coefficient for the variables number of foragers x temperature was $r_e = 0.63$ ($t = 2.82$, significant at 0.02 level), and number of foragers x relative humidity was $r_e = -0.55$ ($t = 2.28$, significant at 0.05 level) in the wet and warm season, but these values were not significant in the dry and cold season ($r_e = 0.25$, $t = 0.82$; and $r_e = 0.13$, $t = 0.42$, respectively). Three factors could explain the absence of correlation between these variables in the dry and cold season: the small number of wasps foraging, the greater variability of the average temperature and relative humidity per hour, and the lack of relationship between the number of foragers and temperature and relative humidity after 1:00 PM (Fig. 2).

Most of the material collected in both seasons was nectar: 61.4% in the wet and warm season and 39.6% in the dry and cold season (Figs. 1 and 2). Indeed, nectar is a food available for both brood and adult wasps. Only the larvae feed on pray, and this consisted in 5.3% of the material captured in the wet and warm season, and 10.7% in the dry and cold season. Rabb (1960) has also observed a higher frequency of foraging for liquids than prey or wood pulp in

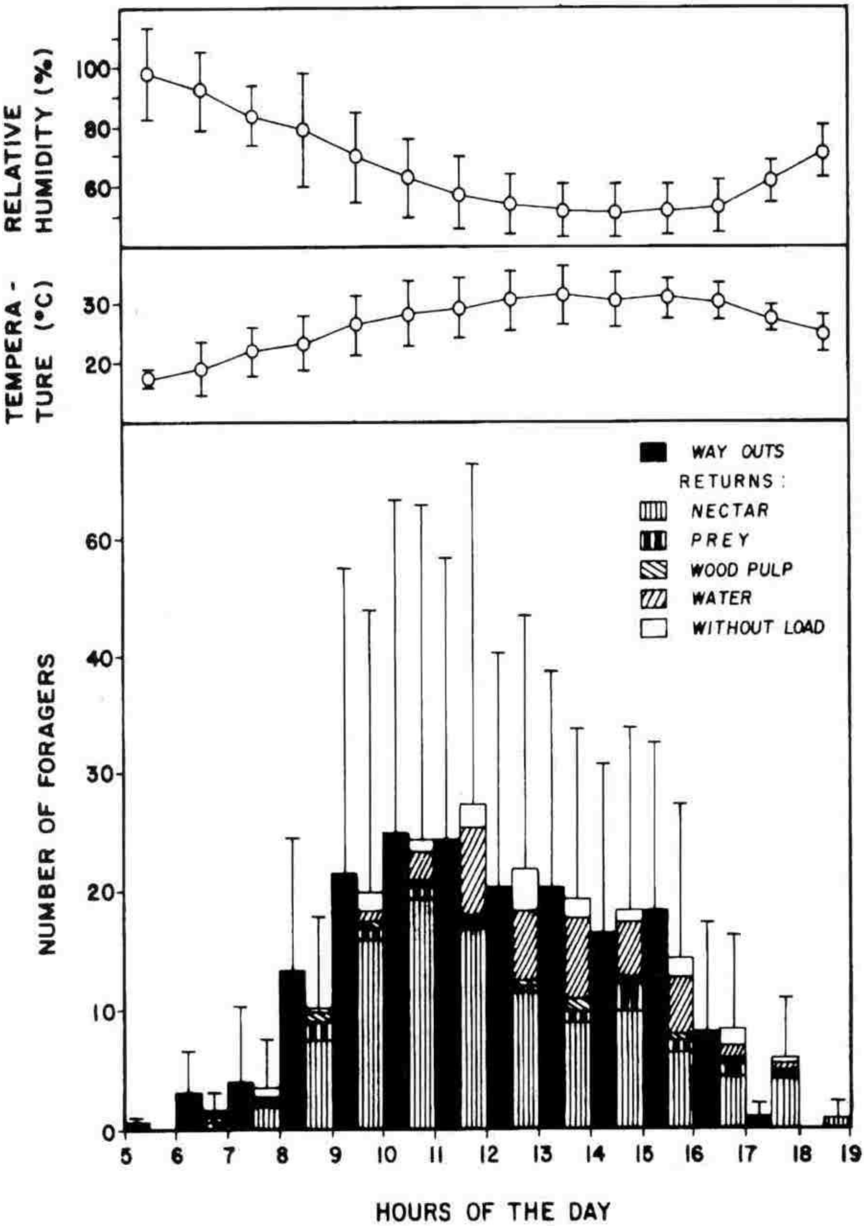

Figure 1. Schedule of foraging of *Polistes lanio lanio* during the wet and warm season: average number of foragers leaving and returning to the nest, with the respective proportional load carried, related to the temperature and relative humidity.

P. fuscatus (Fabr.). Every kind of load could be potentially carried along the day. Only water is more intensely carried between 11:00 to 16:00 due to the high temperatures and low relative humidity. There were singificant Spearman correlation coefficients (at 0.001 level) between water collection and temperature (r_e=0.84, t=5.4), and water collection and relative humidity (r_e = 0.78, t = 4.33) in the wet and warm season, but these values were not significant in the dry and cold season (r_e = 0.35, t = 1.18; and r_e = 0.30, t = 0.99, respectively). Indeed, the frequency of water collections in the dry and cold season is much smaller than in the wet and warm season. Foragers of the different observed colonies of *P. lanio lanio* have collected the diverse kind of loads. according to their imediate necessities. Returns without load were considered unsuccessful foraging attempts. The efficiency index of foraging was 89.3 in the wet and warm season and 68.8 in the dry and cold season. These values are indirect indicators of the food abundance along the seasons.

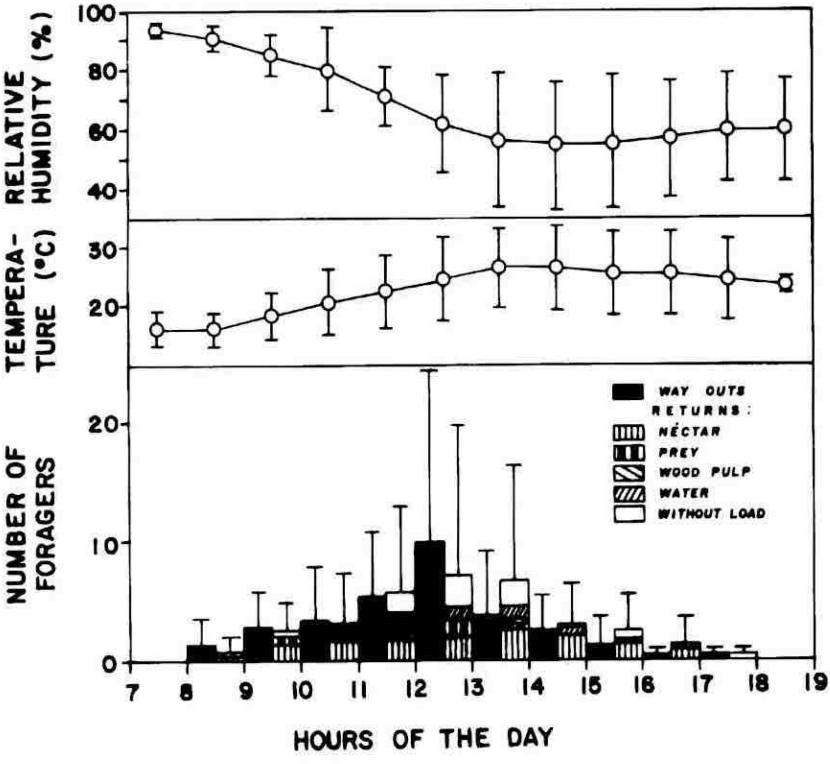

Figure 2. Schedule of foraging of *Polistes lanio lanio* during the dry and cold season: average number of foragers leaving and returning to the nest, with the respective proportional load carried, related to the temperature and relative humidity.

When a wasp foraged for prey it returned to the nest with a mass of prey held in mandibles and forelegs. The average duration of this trip was 41.3 ± 25.3 minutes (12 - 65). The forager could share or not the mass of prey with a nestmate (0 - 5 times); the prey was malaxated for 9.1 ± 4.5 minutes (2 - 15), depending on the size of the mass, and it was swallowed by the adult wasp. This wasp regurgitated the inglubial material to a succession of 5 to 10 larvae of different sizes. The average mass of the load of prey was 42.6 ± 28.4 mg (5.3 - 107.8) and of the forager was 306.4 ± 46.5 mg (243.0 - 368.6), being of 0.14 the ratio prey/forager mass. This value is

Table 1. List of prey captured by *Polistes lanio lanio* foragers in Piracicaba, SP.

List of preys	n	%
Lepidoptera		
Noctuidae		
Spodoptera frugiperda	9	21.9
Anticarsia gemmatalis	2	4.9
Pseudaletia sequax	2	4.9
Psedoplusia includens	2	4.9
Heliothis sp.	1	2.5
Unidentified	2	4.9
Nymphalidae		
Chlosyne lacinia saundersii	3	7.3
Saturnidae		
Automeris sp.	3	7.3
Pyralidae		
Unidentified	3	7.3
Unidentified Lepidoptera	5	12.2
Unidentified fragments	9	21.9
Total	41	100.0

similar to 0.11 observed in *P. simillimus* (Prezoto *et al.* 1994). Table 1 shows a list of caterpillars captured by *P. lanio lanio* foragers. Some sugar-cane and corn pests: *Spodoptera frugiperda* (J.E. Smith), *Pseudaletia sequax* Franclemont and *Heliothis* sp., some bean pests: *Pseudoplusia includens* Walker and *Anticarsia gemmatalis* Hübner, besides *Chlosyne lacinia saundersii* Doubleday & Hewitson and *Automeris* sp. were identified. Rabb (1960) verified that more than 95% of the prey captured by *P. fuscatus*, *P. exclamans* Viereck and *P. annularis* (L.) in North Carolina (USA), consisted of caterpillars. Gobbi *et al.* (1984), Gobbi & Machado (1985, 1986), and Machado *et al.* (1987, 1988) have also observed that 36.5 - 77.3% of the prey captured by *P. occidentalis* (Olivier), *P. paulista* (Ihering), *P. ignobilis* (Haliday), *Agelaia pallipes* and *P. sericea* (Olivier), respectivelly, were lepidopteran larvae. Prezoto *et al.* (1994) have also observed a high proportion of caterpillar captured by *P. simillimus* (85.4%).

The average duration of a collection of nectar was 26.5 ± 22.7 minutes (5 - 105), and a forager returning with nectar in the crop performed the trophallaxis with 1 to 5 individuals (adults or larvae).

The average duration of wood pulp collection was 18.4 ± 14.9 minutes (5 - 60). Foragers returning with wood pulp could or not share the pulp ball with a nestmate (0 - 2 times); this material was malaxated for 5.0 minutes and used to enlarge a pre-existing cell or build a new one. The average mass of a load of wood pulp was 2.4 ± 1.0 mg (1.0 - 3.6), and the ratio wood pulp/forager mass was 0.008. This value for *P. simillimus* was 0.004 (Prezoto *et al.* 1994).

Water collections were made generally in sites around the nest and lasted only 1.5 ± 1.0 minutes (1 - 4); the forager arriving with water did not make trophallaxis with and nestmate and deposited the drop directly into the cells. Generally this forager made from 1 to 6 trips to the water site of the collection. There were not significant Spearman correlation coefficients between wood pulp and water collections, either in the wet and warm season ($r_e = 0.25$, $t = 0.89$) or in the dry and cold season ($r_e = 0.13$, $t = 0.41$). These results disagree with the hypothesis of a relationship between water collection and building activities for *P. lanio lanio*.

In a group of 16 foragers of *P. lanio lanio* 43.7% (n = 7) returned exclusively with nectar but 37.5% (n = 6) foraged for nectar and wood pulp, and 18.8% (n = 3) foraged for nectar and prey. So, we believe that there is not a specialization in foraging activities of the individual wasps. This behavioral plasticity is a benefic characteristic, because a same forager could be ready to supply the necessities of the colony.

The potential of the social wasps as biologic control agents of pests has been studied by Rabb & Lawson (1957): the introduction of *P. exclamans* and *P. fuscatus* colonies in a 670 m² tobacco field reduced in 68% the damages caused by *Protoparce sexta* (Johnson); Gould & Jeanne (1984) verified a reduction of 44% of the damages caused by *Pieris rapae* (L.) in a 1,296 m² cabbage field due to the introduction of *P. fuscatus* colonies. The occurrence of active colonies of *P. lanio lanio* during all year, and the fact that it is a general natural enemy of several pests, this species is potentially useful as a biological control agent.

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