Community Structure of Social Wasps (Hymenoptera: Vespidae) in Riparian Forest in Batayporã, Mato Grosso do Sul, Brazil

by

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ABSTRACT

Reduction and destruction of riparian forests are harmful to the biota, especially the social wasps. This study analyzed the species constancy and the structure of the polistine wasp community associated with fragments of riparian forest in the municipality of Batayporã, state of Mato Grosso do Sul. Eighteen species of social wasps were collected, by the methods of active searching and traps baited with honey and sardine. Eight species were classified as infrequent, five as very frequent, and five as of intermediate frequency. The community structure, as represented by species richness, showed a significant negative correlation with the Berger-Parker dominance index, and no significant correlation with the width of the fragments and with the structural complexity of the vegetation, suggesting that the community, in this case, must be structured by the tolerance of the species and not by the vegetation characteristics, which did not limit the dispersal of the social wasps.

Keywords: Polistinae, species richness, dominance index.

INTRODUCTION

The term riparian forest (gallery forest; in Portuguese "mata ciliar") is synonymous with the official nomenclature (IBGE 1992) of "seasonal semideciduous alluvial forest". In spite of their importance and although they are legally preserved in Brazil, as Areas of Permanent Preservation, these forests are under anthropogenic pressures, with conflicting interests for use and occupation of the land, which have led to their destruction along entire watercourses for

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farming or logging (Vestena & Thomaz 2006). Reduction and destruction of riparian forests are harmful to the biota, because these systems form ecological corridors, act to maintain the microclimate and biodiversity, and provide habitat, shelter, food and water to the fauna (Kageyama *et al.* 2001).

The family Vespidae contains approximately 4,600 species, with one extinct subfamily and six current monophyletic subfamilies (Carpenter & Rasnitsyn 1990): Euparagiinae, Masarinae, Eumeninae, Stenogastrinae, Vespinae and Polistinae. Social species occur in the last three subfamilies. These species share a series of characteristics, including cooperation in the care of the offspring until the emergence of the adult, gradual provision, reuse of the reproductive cells, nest sharing between different generations, trophallaxis between adults, and division of labor (Carpenter 1991).

The only eusocial subfamily that occurs in Brazil is the Polistinae, represented by the tribes Polistini, Mischocyttarini and Epiponini (Carpenter & Marques 2001). The Polistinae is a diverse group and it taxonomy is relatively well known, so that many species can be identified with precision through published keys (Carpenter & Marques 2001; Garcete-Barrett 1999; Richards 1978).

Some species of wasps possess wide ecological valence; that is, they vary their habits of nest building as a function of the substrate and the environmental conditions (Marques *et al.* 1993; Santos & Gobbi 1998). Other species have relatively narrow ecological valence and only nest in sites with specific conditions (Santos *et al.* 2007; Santos *et al.* 2009; Silva-Pereira & Santos 2006), selected for the type and density of the vegetation, the arrangement and shapes of leaves, and other plant structures (Dejean *et al.* 1998; Diniz & Kitayama 1994; Santos & Gobbi 1998).

A few recent studies have examined the community structure or the constancy of species of social wasps, in particular the work of Santos *et al.* (2007) in Atlantic Forest, restinga, and mangrove ecosystems, and of Silva-Pereira & Santos (2006) in montane savannah (Portuguese "campo rupestre"); however, published studies on this subject are still few. The present study evaluated the constancy of the species and the relationship of the structure of the community of polistine wasps to the size and structural complexity of the vegetation, and to the dominance index associated with different fragments of riparian forest.

MATERIAL AND METHODS

Social wasps were collected in ten fragments of riparian forest near the municipality of Bataypora͂, Mato Grosso do Sul (22°18'00"S, 53°15'97"W). Point 1: (22°15'80"S, 53°11'21"W); point 2: (22°14'82"S, 53°12'73"W); point 3: (22°20'98"S, 53°20'53"W); point 4: (22°13'86"S, 53°03'86"W); point 5: (22°14'58"S, 53°09'98"W); point 6: (22°18'78"S, 53°14'11"W); point 7: (22°18'59"S, 53°17'61"W); point 8: (22°11'93"S, 53°10'61"W); point 9: (22°20'89"S, 53°15'38"W); and point 10: (22°19'47"S, 53°19'22"W). In each fragment, 2,000 m^2 of riparian forest was selected, for a total study area of 20,000 m^2. The climate of Mato Grosso do Sul is humid subtropical, with a warm rainy period from November through April, and a cooler dry period from May through October (Zavatini 1992).

We carried out ten collections in 30 days of fieldwork, in the period from October 2008 through March 2009. The collections were made by the methods of active searching and baited traps. Active searching was carried out during the time of day when the wasps are most active, from 09:00 to 15:00 h (Andrade & Prezoto 2001; Elisei *et al.* 2005; Lima & Prezoto 2003). We used a liquid bait, composed of a solution of sucrose (1:5, commercial sugar: water) and 2 cm^3 of salt for each liter of solution, sprayed on the vegetation; and captured the wasps with an entomological net (Noll & Gomes 2009). In each forest fragment, we walked parallel to the watercourse at different distances from it, for six hours, totaling 60 hours of fieldwork for this method.

In each fragment, we installed 40 baited traps, 20 containing a mixture of honey and water, and 20 containing a mixture of sardines and water, in 2 liter plastic bottles with side openings, as described by Souza & Prezoto (2006). In each forest fragment, the traps were attached 1.50 m above the ground, every 10 m along a 200 m transect, parallel to and about 5 m distant from the stream, and were removed after one week (Elpino-Campos *et al.* 2007; Souza & Prezoto 2006). This constituted a sampling effort of 60 baited traps.

The specimens collected were identified by dichotomous keys proposed by Carpenter & Marques (2001), Garcete-Barrett (1999) and Richards (1978) and by comparison with specimens of social wasps deposited in the Comparative Biology Laboratory of Paraná Federal University. Vouchers were deposited in the Museu de Entomologia of the Universidade Federal da Grande Dourados, UFGD.

Constancy was calculated by the frequency of occurrence of each species. Very frequent species were considered to be those that occurred in more than 50% of the fragments; of intermediate frequency, species that occurred in 25 to 50%; and as infrequent, species that were present in less than 25% of the fragments.

To evaluate the existence of a correlation between dominance and the community structure, represented by the species richness, the Berger-Parker dominance index was calculated for each collection point. This index considers the highest ratio of the species with the largest number of individuals (Rodrigues 2007), expressing the dominance of one or more species in a community, based on the importance value of each species. After the dominance index was calculated, an analysis of linear correlation was carried out, with a level of significance (α) of 0.05 between these parameters.

The widths of the fragments of riparian forest, including both banks of the watercourse, were measured with the aid of a measuring tape. The structural complexity of the vegetation was evaluated by counting trees, saplings, shrubs, lianas, seedlings, and the thickness of the leaf litter. The counts were made in a sample plot of 4 m^2, at each collection point. To obtain the vectors associated with these variables, a Principal Components Analysis was used (PCA). To give the same importance to these variables, the value of each was divided by the square root of the total sum of squares (Vieira *et al.* 2008).

To evaluate if there was a significant correlation between the structure of the community and the width of the fragments, and between the structure of the community and the structural complexity of the vegetation, the Linear Correlation Analysis was used, with a level of significance (α) of 0.05.

RESULTS AND DISCUSSION

We collected 18 species of social wasps (Table 1) belonging to six genera, with representatives of the tribes Polistini, Mischocyttarini and Epiponini. Tribe Epiponini was most important, with 10 species (56%), followed by Polistini with 7 (39%), and Mischocyttarini with only 1 (5%).

Of the total of 529 individual wasps caught, 456 (86%) were members of the tribe Epiponini, 46 (9%) Polistini, and only 27 (5%) Mischocyttarini. The predominance of epiponine wasps can be explained by the large numbers of individuals found in their colonies, in particular, the genus *Agelaia*, which in

Table 1. Constancy of the species of social wasps, as a function of the relative frequency of occurrence in the fragments of riparian forest in Batayporã, Mato Grosso do Sul state, Brazil.

Species		Frequency %	Constancy (C)
1	*Apoica pallens* (Fabricius)	30%	Intermediate Frequency
2	*Agelaia pallipes* (Olivier)	70%	Very Frequent
3	*Brachygastra augusti* de Saussure	30%	Intermediate Frequency
4	*Polybia jurinei* de Saussure	10%	Infrequent
5	*Polybia ignobilis* (Haliday)	50%	Intermediate Frequency
6	*Polybia sericea* (Olivier)	30%	Intermediate Frequency
7	*Polybia chrysothorax* (Lichtenstein)	20%	Infrequent
8	*Polybia paulista* (H. Von Ihering)	70%	Very Frequent
9	*Polybia ruficeps* Schrottky	20%	Infrequent
10	*Polybia occidentalis* (Olivier)	70%	Very Frequent
11	*Polistes subsericeus* de Saussure	60%	Very Frequent
12	*Polistes versicolor* (Olivier)	40%	Intermediate Frequency
13	*Polistes simillimus* Zikán	10%	Infrequent
14	*Polistes brevifissus* Richards	20%	Infrequent
15	*Polistes billardieri* (Fabricius)	20%	Infrequent
16	*Polistes cinerascens* de Saussure	10%	Infrequent
17	*Polistes geminatus* (Fox)	10%	Infrequent
18	*Mischocyttarus drewseni* de Saussure	60%	Very Frequent

some species such as *Agelaia vicina* (Saussure 1854) may have up to a million adults in a single colony (Zucchi *et al.* 1995).

Eight species (44%) were classified as infrequent, five (28%) as intermediate, and five (28%) as very frequent (Table 1).

The infrequent species were captured in less than 25% of the fragments. This may be related to the wide radius of action of the wasps during foraging. For example, *Polistes versicolor* (Olivier 1791) shows a 200 m effective radius of action (Gobbi 1978), and *Polistes simillimus* (Zikán 1951) a 150 m radius of action (Prezoto & Gobbi 2005). This capacity of movement results in many captures of infrequent species in locations other than their permanent habitat. Diniz & Kitayama (1998) and Silva-Pereira & Santos (2006) observed that some wasps can construct their nests in one environment and forage in locations distant from that environment. Considering that the environment that surrounds the fragments studied here consists of Cerrado, the riparian forest may represent only part of the foraging area for those species that use the Cerrado as a permanent habitat.

Supporting this hypothesis, *Polistes simillimus*, for example, prefers to nest in dry habitats, and *Polistes geminatus* (Fox 1898), *Polistes billardieri* (Fabricius 1804) and *Polybia chrysothorax* (Lichtenstein 1796) prefer the Cerrado (Garcete-Barrett 1999). Therefore, riparian forest would be a transitory environment for many of these species. Santos *et al.* (2007) also found the species *Polistes carnifex* (Fabricius 1775) and *Synoeca cyanea* (Fabricius 1775) foraging in mangrove areas, apparently a transitory environment for them, but their nests are restricted to the Restinga and Atlantic Forest. Santos *et al.* (2009) also observed the occurrence of *Protonectarrina sylveirae* (de Saussure 1854), *Parachartergus pseudoapicalis* (Willink 1859) and *Synoeca cyanea* in agricultural systems other than their nest sites.

The species with intermediate frequency can be considered as tolerant, changing their nest building habitats according to ambient conditions and the available substrata. *Apoica pallens* (Fabricius 1804), *Polybia ignobilis* (Haliday 1836) and *Polybia sericea* (Olivier 1791) are known to be tolerant (Santos 2000) and both *Brachygastra augusti* (de Saussure 1834) and *Polistes versicolor* (Olivier 1791) can also be found in forests and the Cerrado (Garcete-Barrett 1999).

In contrast, *Agelaia pallipes* (Olivier 1791), *Polybia paulista* (Von Ihering 1896), *Polybia occidentalis* (Olivier 1791), *Polistes subsericeus* (Saussure 1854) and *Mischocyttarus drewseni* were very frequent in this study, probably because of their numerous colonies (Zucchi *et al.* 1995), or because they found in the riparian forest fragments a more favorable environment than the Cerrado. In particular, *M. drewseni* shows a clear preference for more humid environments (Garcete-Barrett 1999).

The width of the fragments of riparian forest varied at the different collection points, from 26 to 650 m (Table 2). No significant correlation between the width and the community structure in the fragments, represented by species richness, was found ($r = 0.0476$; $t = 0.1347$; $p= 0.8962$ and $GL= 8$). It can be suggested that the fragments of riparian forest do not represent islands for the polistines, and that the surrounding areas of Cerrado do not represent a barrier to the dispersal of these species.

Table 2. Dominance index, species richness, width of the fragments of riparian forest, and values of axes 1 and 2 of the Principal Components Analysis (PCA) representing the vegetation complexity of the sampling points.

Collection Points	Berger-Parker Dominance	Dominant Species	Species Richness	Width (m)	Vegetation Complexity PCA 1	PCA 2
1	0.63	*Polistes versicolor*	6	300	-16.290	21.122
2	0.86	*Polybia paulista* and *Polybia occidentalis*	3	26	-0.7003	-17.453
3	0.57	*Apoica pallipes*	8	650	42.221	0.4993
4	0.73	*Polybia occidentalis* and *Agelaia pallipes*	6	520	0.0288	0.4091
5	0.52	*Agelaia pallipes*	8	30	0.1297	-0.7871
6	0.53	*Polybia paulista* and *Polybia sericea*	8	55	-0.6588	-18.211
7	0.98	*Agelaia pallipes*	3	180	-0.2916	13.790
8	0.49	*Polybia paulista*	11	50	-12.265	0.2321
9	0.75	*Mischocyttarus drewseni*	5	100	-0.6985	0.0544
10	0.54	*Agelaia pallipes*	5	150	0.8240	-0.3326

The variation in the structural complexity of the vegetation among the collection points can be represented by the first two axes of a Principal Components Analysis (Table 2). These axes accounted for 70.57% of the variance (eigenvalues 2.687 for axis 1 and 1.548 for axis 2) of the original data for the numbers of trees, shrubs, lianas, seedlings, and thickness of the leaf litter; the first axis (PCA 1) explained 44.77% of this variance. For correlation analysis between the variable structural complexity of the vegetation (represented by PCA axes 1 and 2) and the community structure, represented by the species richness, significant correlations between PCA axes 1 ($r = 0.1114$; $t = 0.3171$; $p = 0.7593$ and GL = 8) and 2 ($r = -0.0601$; $t = -0.1703$; $p = 0.8690$ and GL = 8) with the community structure were also not found. Therefore, the results demonstrate that the occurrence of species of polistine wasps in these fragments is not correlated with the vegetation complexity. This result differs from the data of Santos *et al.* (2007), who found a direct correlation between the structural complexity of vegetation and the diversity of wasp species.

However, although the richness in a community can be influenced by the number of niches, which reflects the structural heterogeneity of the environment, it also can be partly determined by the tolerance of the species to the physical conditions (basic niche) and by interactions with other species (actual niche) (Giller 1984; Santos *et al.* 2007). Tolerant species also possess wide ecological valence (Marques & Carvalho 1993; Santos & Gobbi 1998).

The correlation analysis between the community structure, represented by species richness, and the Berger-Parker dominance index indicated a significant negative correlation (r = -0.8375; t = -4.3358; p = 0.0025 and GL = 8, Fig. 1); the richness decreased as the dominance increased. In particular, the analysis indicated the dominance of *Polybia paulista* (d= 0.49) at point 8, the co-dominance of *Polybia paulista* (d= 0.57) and *Polybia occidentalis* (d=

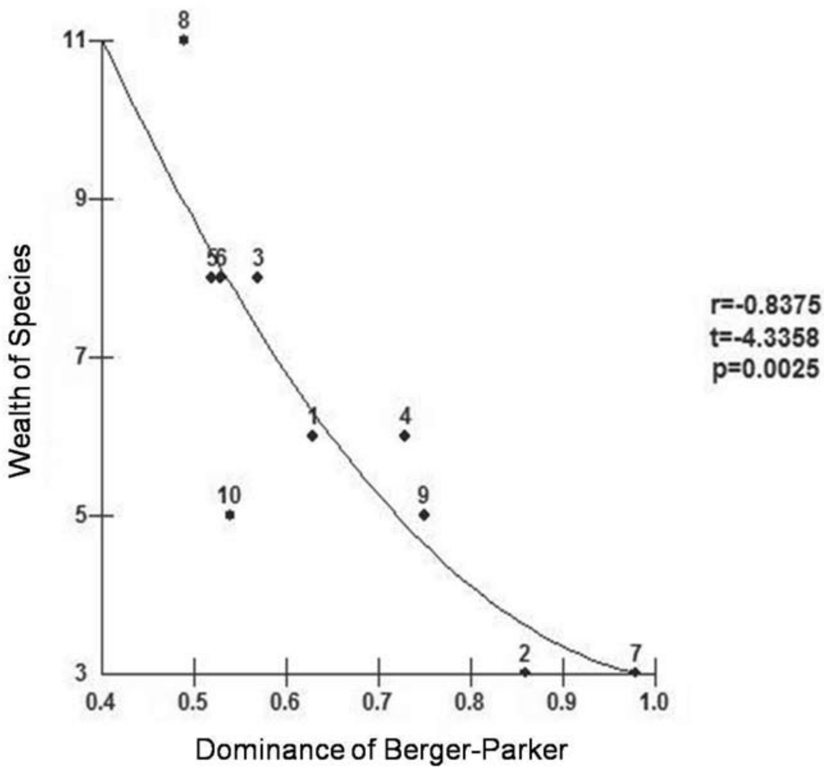

Figure 1. Correlation between species richness and the Berger-Parker dominance index ($\alpha = 0.05$; GL = 8). The numbers beside the points indicate the collection localities.

0.29) at point 2, the co-dominance of *Polybia paulista* (d= 0.29) and *Polybia sericea* (d= 0.24) at point 6, the co-dominance of *Polybia occidentalis* (d= 0.32) and *Agelaia pallipes* (d= 0.41) at point 4, the dominance of *Agelaia pallipes* at points 3, 5, 7 and 10, of *Polistes versicolor* at point 1, and of *Mischocyttarus drewseni* at point 9.

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