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Fauna of phlebotomine sand flies (Diptera, Psychodidae) in areas with endemic American cutaneous leishmaniasis in the State of Mato Grosso do Sul, Brazil

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ABSTRACT. Fauna of phlebotomine sand flies (Diptera, Psychodidae) in areas with endemic American cutaneous leishmaniasis in the State of Mato Grosso do Sul, Brazil. The aim of this study was to investigate the ecological aspects of the main vectors of American cutaneous leishmaniasis (ACL) in four monitoring stations situated in the municipalities of Naviraí, Nova Andradina, Novo Horizonte do Sul and Rio Verde de Mato Grosso. For each monitoring station, the captures of sand flies were undertaken each month from July 2008 to June 2010 using CDC and Shannon traps. The CDC traps were installed simultaneously for three consecutive nights in three collection sites: intradomicile, peridomicile and edge of the forest. A Shannon trap was installed from dusk to 10 pm, inside the forest, one night per month. A total of 7,651 sand flies belonging to nine genera and twenty-nine species were captured. *Nyssomyia neivai* (52.95%), *Psathyromyia hermanlenti* (10.91%), *Psathyromyia runoides* (9.16%), *Nyssomyia whitmani* (7.95%), *Psathyromyia aragaoi* (4. 89%), *Nyssomyia antunesi* (3.14%) and *Evandromyia bourrouli* (2.20%) were the most frequent species. Approximately 65% of the sand flies were collected in the forest environment. The municipalities presented significantly different indexes of species diversity. Naviraí presented the lowest species diversity index, however, it showed the highest abundance. Novo Horizonte do Sul had the highest species diversity index, but the lowest abundance (< 5%). It is noteworthy the occurrence of vector species of *Leishmania* in the areas studied, especially in Naviraí, where *Ny. neivai* presented high frequencies which may explain the increased number of ACL cases in this municipality.

KEYWORDS. Insecta; Neotropical; Phlebotominae; species diversity.

Knowing the main vector species found in an area of transmission of American cutaneous leishmaniasis (ACL) is very important in order to understand how the disease is transmitted and thus guide the measures of prevention and control, as well as to evaluate their effectiveness (Ministério da Saúde 2007). In Brazil, there are few studies on the diversity of sand fly species that are vectors of ACL *Leishmania*. However, bio-ecological studies on suspected or incriminated vector species can contribute to the development of indicators for disease risk assessment.

The sand fly fauna of Mato Grosso do Sul is relatively well known and currently consist of 59 species (Young & Duncan 1994; Galati *et al.* 2006; Oliveira *et al.* 2006; Almeida *et al.* 2010). Regarding the vectors of ACL agents in Mato Grosso do Sul, studies in the municipality of Corguinho and in the Bodoquena area demonstrated the presence of *Nyssomyia whitmani* (Antunes & Coutinho, 1939) (Galati *et al.* 1996; Galati *et al.* 2003) and *Nyssomyia neivai* (Pinto, 1926) in six municipalities of Mato Grosso do Sul (Almeida *et al.* 2010), which are important species involved in the transmission of ACL leishmaniasis in Brazil (Luz *et al.* 2000; Andrade Filho *et al.* 2007; Costa *et al.* 2007; Saraiva *et al.* 2010). Recently, in the municipalities of Bela Vista and Bonito the presence of *Bichromomyia flaviscutellata* (Mangabeira, 1942) in areas with occurrence of *Leishmania* (*Leishmania*) *amazonensis* was confirmed (Nunes *et al.* 2008; Dorval *et al.* 2010).

Between January 2008 and July 2010, the SINAN (*Sistema de Informações de Agravos de Notificação*), Epidemiological Surveillance Service of the Mato Grosso do Sul State Health Secretariat confirmed 388 cases of ACL in 60 municipalities, among them Naviraí, Nova Andradina, Novo Horizonte do Sul and Rio Verde de Mato Grosso. This study aimed to assess: 1) the sand fly fauna, and 2) the ecological aspects of the main vectors of ACL agents in Naviraí, Nova Andradina, Novo Horizonte do Sul and Rio Verde de Mato Grosso municipalities, where the prevalence of ACL is high.

MATERIAL AND METHODS

Study area. For each municipality, a Monitoring Station (MS) was selected, considering the number of autochthonous human cases of ACL in recent years and the absence of previous researches about the sand flies fauna in these areas.

Naviraí (23°03'54"S and 54°11'26"W, 362 meters altitude) with an area of 2,193.83 km^2 is located in the southwestern region of the state, 350 km from Campo Grande, the State capital. Its population consists of 46,355 inhabitants (IBGE, 2011). The municipality borders the state of Paraná and the original vegetation was seasonal semi-deciduous forest. The agriculture and commerce are the major economic resources of the municipality. The main crops are sugar cane, beans, lemon, corn and wheat. In this municipality, the entomological survey was conducted near "Usinavi", a sugar cane mill, situated at the farm *Santa Maria*.

Nova Andradina (22°14'00"S and 53°20'35"W, 380 meters altitude) with an area of 4,776.09 km^2 is located in the southeastern region, 288 km from Campo Grande. Its population consists of 45,599 inhabitants (IBGE, 2011). The municipality is part of the Paraná river basin and its original vegetation was seasonal semi-deciduous forest. Livestock (mainly buffalo) and commerce are the major economic resources of the municipality. The main crops are sugar cane and cassava. The CDC light traps were installed in the farm *Três Irmãos* and the Shannon trap, in a forest fragment, near the neighborhood "COHAB III".

Novo Horizonte do Sul (22°39'11"S and 53°51'21"W) with an area of 849.11 km^2 is also located in the southwest region, 303 km from Campo Grande. The population consists of 4,944 inhabitants (IBGE, 2011). It is also situated in the Paraná river basin and the original vegetation was characterized by seasonal semi-deciduous forest and livestock is the major economic activity of the municipality. The rearing of silkworms and cassava plantations are also widespread in the municipality. The survey was undertaken in an area known as *Linha Volta Redonda*.

Rio Verde de Mato Grosso (18°55'05"S and 54°50'39"W, 330 meters altitude) with an area of 8,151.97 km^2, is located in the Pantanal, in the north of the State, 201 km from Campo Grande, its population consisting of 18,892 inhabitants (IBGE 2011). The municipality is located in the Paraguay river basin with a dominant vegetation of Cerrado and Pantanal. Trade and farming are major economic activities in the municipality. Cattle, sheep, horses, wool production and orange, coconut and guava plantations are widespread around the city. The survey was conducted in the *Serra Grande* Farm resort.

Collection of the sand flies. The survey was conducted from July 2008 to June 2010. In each monitoring station, four locations were sampled: 1) intradomicile; 2) peridomicile; 3) edge of the forest and 4) inside the forest. Sand fly collections were carried out with automatic light traps during three consecutive nights on the first, second and third sites, monthly. The Shannon trap was installed from dusk to 10 pm, one night per month in the fourth point (forest). The field methodology followed the guidelines of the Manual for the Surveillance of ACL (Ministério da Saúde 2007). Species were identified in the *Laboratório Regional de Entomologia de Dourados*/SES-MS according to Galati's classification (2003). Abbreviations for the genera follow that proposed by Marcondes (2007).

Analysis of the data. The characteristics of the population studied were described using a single frequency through percentages, tables and graphs. Furthermore, the data were stratified by municipality and point of capture to check the diversity index and proximity among the descriptors, through correspondence analysis (Mingoti 2005).

In order to assess the diversity of the phlebotomine species in the four sites of capture, in each municipality, the Shannon-Wiener index was used (with correction factor and the natural logarithm) according to the number of species occurrences. The *t* test was used to compare the diversity index. The level of significance was 0.83%, which corresponds to 5% divided by the number of multiple comparisons (six).

RESULTS AND DISCUSSION

A total of 7,651 sand flies were captured, belonging to nine genera and twenty-nine species. The most frequent species were: *Nyssomyia neivai* (52.9%), *Psathyromyia hermanlenti* (Martins, Falcão & Silva, 1970) (10.9%), *Psathyromyia runoides* (Fairchild & Hertig, 1953) (9.2%), *Nyssomyia whitmani* (8.0%), *Psathyromyia aragaoi* (Costa Lima, 1932) (4.9%), *Nyssomyia antunesi* (Coutinho, 1939) (3.1%), and *Evandromyia bourrouli* (Barretto & Coutinho, 1941) (2.2%). The other species totalized 8.8% of the captured sand flies (Table I).

Naviraí presented a high frequency of *Ny. neivai* (99.6%). The other species accounted for less than 1% of the total. *Nyssomyia whitmani* was only captured at the edge of the forest (Table II). Both species are involved in the transmission of *Leishmania* protozoa in Brazil (Andrade Filho *et al.* 2007; Pita-Pereira *et al.* 2009; Marcondes *et al.* 2009; Saraiva *et al.* 2009).

A total of 65.0% of the sand flies were collected inside the forest, unlike other studies, in which most specimens were found in anthropic environments (Saraiva *et al.* 2008; Galati *et al.* 2010). This fact may be due to the use of a Shannon trap in the forest and CDC light traps in the other environments, which demonstrates the importance of using more than one type of trap in studies of sand fly fauna.

The seasonal variation of *Ny. neivai* in Naviraí is showed in Fig. 1. The highest frequency of the species occurs in the months that follow periods of heavy rain. This period coincides with the late winter and spring. This result is different than that showed by Galati *et al.* (2010) in the Iporanga municipality, São Paulo state, where the predominance of the species occurs in the summer, however, it corroborates the observations of Odorizzi & Galati (2007) in the northwestern region of São Paulo state.

In Nova Andradina, the species *Evandromyia lenti* (Mangabeira, 1938) showed the highest frequency (47.0%), followed by *Evandromyia termitophila* (Martins, Falcão & Silva, 1964) (19.3%). *Brumptomyia brumpti* (Larrouse, 1920), *Psathyromyia campograndensis* (Oliveira, Andrade Filho, Falcão & Brazil, 2001), *Sciopemyia sordellii* (Shan-

Table I. Phebotominae species collected in four municipalities of the Mato Grosso do Sul state, with CDC and Shannon traps, from July 2008 to June 2010, and the multiple comparison among the municipalities.

Species	Municipalities				Total	Relative Frequency (%)
	Naviraí	Nova Andradina	Novo Horizonte do Sul	Rio Verde de Mato Grosso		
Bichromomyia flaviscutellata	0	0	0	20	20	0.26
Brumptomyia avellari	1	2	23	50	76	0.99
Brumptomyia brumpti	0	5	0	9	14	0.18
Brumptomyia pintoi	0	2	0	3	5	0.06
Evandromyia bourrouli	0	0	4	164	168	2.20
Evandromyia carmelinoi	0	1	0	0	1	0.01
Evvandromyia cortelezzii	0	0	2	1	3	0.04
Evandromyia lenti	0	39	24	54	117	1.53
Evandromyia sallesi	0	0	2	0	2	0.03
Evandromyia teratodes	0	1	0	1	2	0.03
Evandromyia termitophila	1	16	5	1	23	0.30
Lutzomyia longipalpis	0	0	0	38	38	0.50
Micropygomyia acanthopharynx	0	0	0	3	3	0.04
Micropygomyia peresi	0	0	0	17	17	0.22
Nyssomyia antunesi	0	0	0	240	240	3.14
Nyssomyia neivai	4,002	2	41	6	4,051	52.95
Nyssomyia whitmani	15	0	28	565	608	7.95
Pintomyia christenseni	0	0	46	1	47	0.61
Psychodopygus davisi	0	0	0	2	2	0.03
Pintomyia misionensis	0	0	0	2	2	0.03
Pintomyia pessoai	0	1	26	0	27	0.35
Psathyromyia aragaoi	1	0	26	347	374	4.89
Psathyromyia brasiliensis	0	0	0	53	53	0.69
Psathyromyia campograndensis	0	5	4	59	68	0.89
Psathyromyia hermanlenti	0	0	2	833	835	10.91
Psathyromyia punctigeniculata	0	4	4	4	12	0.16
Psathyromyia runoides	0	0	0	701	701	9.16
Psathyromyia shannoni	0	0	98	17	115	1.50
Sciopemyia sordellii	0	5	12	10	27	0.35
Total	4,020	83	347	3,201	7,651	100.00
%	52.54	1.08	4.54	41.84	100.00	–
Shannon-W Index	0.310	1.689	2.333	2.075	–	–

Multiple comparisons among the municipalities	t	g.l.	p-value	Sig.
Naviraí x Nova Andradina	-12.959	83.42	< 0.001	*
Naviraí x Novo Horizonte do Sul	-46.316	360.15	< 0.001	*
Naviraí x Rio Verde do MT	-105.76	4005.6	< 0.001	*
Nova Andradina x Novo Horizonte do Sul	-3.993	106.6	< 0.001	*
Nova Andradina x Rio Verde do MT	-2.990	86.5	< 0.004	*
Novo Horizonte do Sul x Rio Verde do MT	3.126	457.5	< 0.002	*

* Significant with $p < 0.0084$.

non & Del Pont, 1927), all with 6.0%, and *Psathyromyia punctigeniculata,* with 4.8%, presented distinct frequencies from the other species, which together accounted for 10.9% of the species captured (Table III). *Evandromyia lenti* was found naturally infected with *Leishmania braziliensis* in Minas Gerais (Margonari *et al.* 2010), and Sherlock (1996) suggests that this species may be involved in the transmission of canine visceral leishmaniasis in the State of Bahia.

Psathyromyia shannoni (Dyar, 1929) was the species with the greatest abundance (28.2%) in Novo Horizonte do Sul, followed by *Pintomyia christenseni* (Young & Duncan, 1994) (13.3%), *Ny. neivai* (11.8%), *Ny. whitmani* (8.1%), *Pa. aragaoi* and *Pintomyia pessoai* (Barretto & Coutinho, 1940), both with 7.5%, *Ev. lenti* (6.9%) and *Brumptomyia avellari* (Costa Lima, 1922) (6.6%). The other species accounted for the remaining 10.1%. *Psathyromyia shannoni* was predominant inside the forest. This species has been found naturally infected in several countries (Young & Duncan 1994) and may be involved in the transmission of *Leishmania mexicana* in Mexico (Sanchéz-García *et al.* 2010). It is also important to empha-

Table II. Phebotominae species collected in four municipalities of the state of Mato Grosso do Sul, with CDC and Shannon traps, from July 2008 to June 2010, and multiple comparison among the four collection sites.

Species	Collection sites				Total	Relative Frequency (%)
	Intra domicile	Peri domicile	Edge of the forest	Inside the forest		
Bi. flaviscutellata	0	6	14	0	20	0.26
Br. avellari	1	20	42	13	76	0.99
Br. brumpti	0	3	8	3	14	0.18
Br. pintoi	0	0	4	1	5	0.06
Ev. bourrouli	0	46	116	6	168	2.20
Ev. carmelinoi	0	0	1	0	1	0.01
Ev. cortelezzii	1	0	2	0	3	0.04
Ev. lenti	21	39	44	13	117	1.53
Ev. sallesi	0	0	0	2	2	0.03
Ev. teratodes	0	2	0	0	2	0.03
Ev. termitophila	2	20	1	0	23	0.30
Lu. longipalpis	4	8	12	14	38	0.50
Mi. acanthopharynx	1	2	0	0	3	0.04
Mi. peresi	0	3	14	0	17	0.22
Ny. antunesi	4	54	179	3	240	3.14
Ny. neivai	290	539	607	2615	4,051	52.95
Ny. whitmani	9	173	342	84	608	7.95
Pi. christenseni	2	5	17	23	47	0.61
Ps. davisi	0	0	2	0	2	0.03
Pi. misionensis	0	0	0	2	2	0.03
Pi. pessoai	1	1	9	16	27	0.35
Pa. aragaoi	5	84	274	11	374	4.89
Pa. brasiliensis	1	24	28	0	53	0.69
Pa. campograndensis	3	18	34	13	68	0.89
Pa. hermanlenti	25	164	618	38	835	10.91
Pa. punctigeniculata	1	1	2	8	12	0.16
Pa. runoides	22	146	521	12	701	9.16
Pa. shannoni	11	5	15	84	115	1.50
Sc. sordellii	1	9	13	4	27	0.35
Total	405	1,362	2,919	2,965	7,651	100
%	5.29	17.80	38.15	38.75	100	–
Shannon-W Index	1.221	2.060	2.171	0.635	–	–
Multiple comparisons among the sites			T	g.l.	p-value	Sig.
Intra x Peri			-10.108	558.50	< 0.001	*
Intra x Edge of forest			-12.082	452.79	<0.001	*
Intra x Forest			7.247	507.49	<0.001	*
Peri x Edge of forest			-2.966	2,265.30	< 0.004	*
Peri x Forest			34.028	3,148.80	<0.001	*
Edge of forest x Forest			47.610	5,256.70	<0.001	*

* Significant with $p < 0.0084$.

size the predominance of *Ny. neivai* in the intradomicile environment.

In Rio Verde do Mato Grosso, the species with the highest frequency was *Pa. hermanlenti* (26.0%), followed by *Pa. runoides* (21.9%), *Ny. whitmani* (17.7%), *Pa. aragaoi* (10.8%), *Ny. antunesi* (7.5%), *Ev. bourrouli* (5.1%), *Pa. campograndensis* (1.9%) and *Ev. lenti* (1,7%). The other species totalized 7.4%. The majority of specimens were collected at the edge of the forest (68.4%). *Psathyromyia hermanlenti* and *Pa. runoides* were more frequent in the intradomicile environment (Table III). This is the first report of *Pa. runoides* in the Mato Grosso do Sul state. The vectors species of *Leishmania* (*Viannia*) spp. collected in Rio Verde do Mato Grosso were *Ny. whitmani* and *Ny. antunesi*, the latter presenting a highly anthropophilic behavior (Andrade Filho *et al.* 2001) and they were found naturally infected by flagellates in the State of Pará (Ryan *et al.* 1984; Silveira *et al.* 2002). *Bichromomyia flaviscutellata*, a species involved in the transmission of *Leishmania* (*Leishmania*) *amazonensis* in several regions of Brazil, including Mato Grosso do Sul (Lainson & Shaw 1968; Shaw & Lainson 1968; Dorval *et al.* 2010), was also captured.

Table III. Phebotominae species captured from July 2008 to June 2010, in the municipalities of Naviraí, Nova Andradina, Novo Horizonte do Sul and Rio Verde de Mato Grosso, in the state of Mato Grosso do Sul.

Species	Collection sites				Total	Relative Frequency (%)
	Intra domicile	Peri domicile	Edge of the forest	Inside of the forest		
Naviraí						
Br. avellari	0	1	0	0	1	0.03
Ev. termitophila	1	0	0	0	1	0.03
Ny. neivai	274	29	592	2,607	4,002	99.55
Ny. whitmani	0	0	15	0	15	0.36
Ps. aragaoi	1	0	0	0	1	0.03
Total	276	530	607	2,607	4,020	100.00
%	6.87	13.18	15.10	64.85	100.00	–
Nova Andradina						
Br. avellari	0	0	0	2	2	2.41
Br. brumpti	0	1	1	3	5	6.02
Br. pintoi	0	0	1	1	2	2.41
Ev. carmelinoi	0	0	1	0	1	1.21
Ev. lenti	4	11	14	10	39	46.99
Ev. teratodes	0	1	0	0	1	1.21
Ev. termitophila	1	15	0	0	16	19.27
Ny. neivai	0	0	1	1	2	2.41
Pi. pessoai	0	1	0	0	1	1.20
Pa. campograndensis	1	0	0	4	5	6.02
Pa. punctigeniculata	0	0	0	4	4	4.82
Sc. sordellii	0	2	0	3	5	6.02
Total	6	31	18	28	83	100.00
%	7.23	37.35	21.69	33.73	100.00	–
Novo Horizonte do Sul						
Br. avellari	1	2	17	3	23	6.63
Ev. bourrouli	0	1	3	0	4	1.15
Ev. cortelezzii	1	0	1	0	2	0.58
Ev. lenti	9	9	5	1	24	6.92
Ev. sallesi	0	0	0	2	2	0.58
Ev. termitophila	0	4	1	0	5	1.44
Ny. neivai	15	9	11	6	41	11.82
Ny. whitmani	4	4	10	10	28	8.07
Pi. christenseni	2	5	16	23	46	13.26
Pi. pessoai	1	0	9	16	26	7.49
Pa. aragaoi	1	7	16	2	26	7.49
Pa. campograndensis	0	0	2	2	4	1.15
Pa. hermanlenti	0	2	0	0	2	0.58
Pa. punctigeniculata	0	0	0	4	4	1.15
Pa. shannoni	10	3	8	77	98	28.24
Sc. sordellii	0	5	6	1	12	3.46
Total	44	51	105	147	347	100.00
%	12.68	14.70	30.26	42.36	100.00	–
Rio Verde de Mato Grosso						
Bi. flaviscutellata	0	6	14	0	20	0.63
Br. avellari	0	17	25	8	50	1.56
Br. brumpti	0	2	7	0	9	0.28
Br. pintoi	0	0	3	0	3	0.09
Ev. bourrouli	0	45	113	6	164	5.12
Ev. cortelezzii	0	0	1	0	1	0.03
Ev. lenti	8	19	25	2	54	1.69
Ev. teratodes	0	1	0	0	1	0.03
Ev. termitophila	0	1	0	0	1	0.03
Lu. longipalpis	4	8	12	14	38	1.19
Mi. acanthophargynx	1	2	0	0	3	0.09

Continues

Table III. Continued.

Species	Collection sites				Total	Relative Frequency (%)
	Intra domicile	Peri domicile	Edge of the forest	Inside of the forest		
Mi. peresi	0	3	14	0	17	0.53
Ny. antunesi	4	54	179	3	240	7.50
Ny. neivai	1	1	3	1	6	0.19
Ny. whitmani	5	169	317	74	565	17.65
Pi. christenseni	0	0	1	0	1	0.03
Ps. davisi	0	0	2	0	2	0.06
Pi. misionensis	0	0	0	2	2	0.06
Pa. aragaoi	3	77	258	9	347	10.84
Pa. brasiliensis	1	24	28	0	53	1.66
Pa. campograndensis	2	18	32	7	59	1.85
Pa. hermanlenti	25	152	618	38	833	26.02
Pa. punctigeniculata	1	1	2	0	4	0.13
Pa. runoides	22	146	521	12	701	21.90
Pa. shannoni	1	2	7	7	17	0.53
Sc. sordellii	1	2	7	0	10	0.31
Total	79	750	2,189	183	3,201	100.00
%	2.47	23.43	68.38	5.72	100.00	–

During the two years of the study, the seasonal distribution of *Ny. whitmani* in Rio Verde de Mato Grosso showed a higher density in drier periods (fall and winter) (Fig. 1), as occurred in the Bodoquena and Corguinho municipalities, both in Mato Grosso do Sul state (Galati *et al.* 1996; Galati *et al.* 2003), and Maringá, in Paraná state (Teodoro *et al.* 2003).

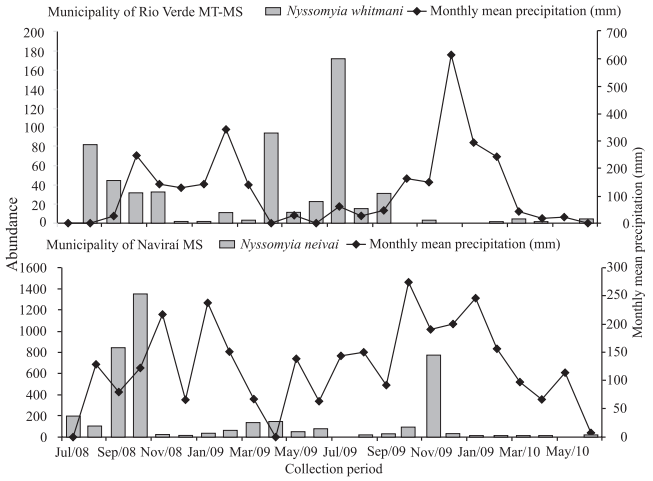

Fig. 1. Monthly variation of the abundance of *Nyssomyia whitmani* and *Nyssomyia neivai* in relation to the monthly mean precipitation in Rio Verde de Mato Grosso and Nivaraí municipalities, from July 2008 to June 2010.

The municipalities presented significantly different species diversity indexes (Table I), with Naviraí, which presented the highest frequency of specimens (52.6%), showing the lowest value, influenced by the abundance of *Ny. neivai* (Table III). Nova Andradina had less than 2% of specimens captured, and showed the second lowest diversity value (Table I, Fig. 2). Novo Horizonte do Sul had the highest species diversity, although its abundance was lower than 5% (Table I, Fig. 2) and Rio Verde do Mato Grosso presented the second highest diversity and abundance, with approximately 42% of the sand flies captured (Table I, Fig. 2).

The correspondence analysis (Fig. 2) revealed that the position of the different species is not close to the center, which means that their prevalence differs among the municipalities. The incidence is similar in Novo Horizonte do Sul and Nova Andradina. Naviraí had an incidence of few spe-

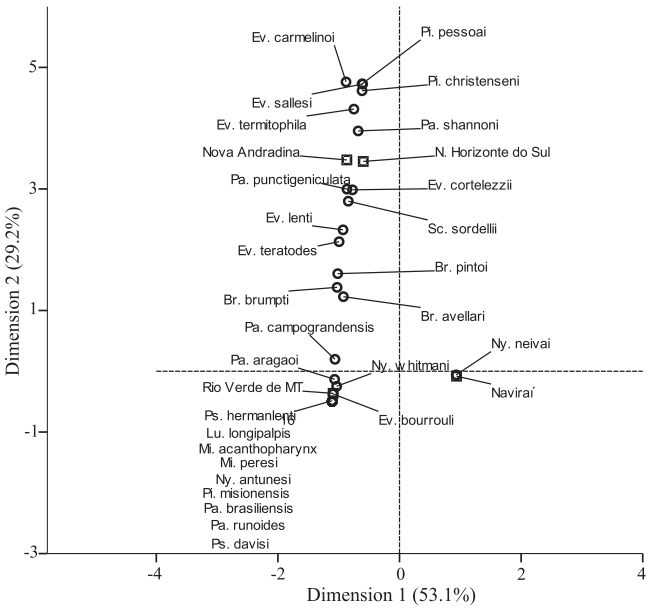

Fig. 2. Results of correspondence analysis among the phebotomine species and the municipalities of Naviraí, Nova Andradina, Novo Horizonte do Sul and Rio Verde de Mato Grosso from July 2008 to June 2010. (□) Municipality, (○) species.

cies, but is associated with the most abundant species, *Ny. neivai*. Rio Verde de Mato Grosso is associated with more species and greater abundance.

Nyssomyia neivai was the most frequent and abundant species. It was present in all ecotypes surveyed in the state of Mato Grosso do Sul. This observation confirms the results obtained by Massafera *et al.* (2005) and Silva *et al.* (2008) in the State of Paraná. In the state of São Paulo, Condino *et al.* (1998) also observed a higher density of *Ny. neivai* in the city of Teodoro Sampaio. In the city of Piçarras, in the state of Santa Catarina, Marcondes *et al.* (2005) observed the predominance of *Ny. neivai* in areas with occurrence of ACL.

Nyssomyia whitmani was the fourth most frequently captured species (Table I), occurring in Naviraí, Novo Horizonte do Sul and Rio Verde do Mato Grosso and was considered as a potential vector of *Leishmania braziliensis* in Mato Grosso do Sul (Galati *et al.* 1996). This species was more abundant in environments with anthropic modifications, such as peridomicile and the edge of the forest.

Despite the use of different traps, the diversity is distinct among the different collecting sites, being higher in the edge of the forest, followed by peridomicile and intradomicile. The lowest diversity was found inside the forest. The diversity index was statistically different for all comparisons between two environments (Table II). The diversity of sand flies of the four municipalities should be related, probably with peculiar characteristics of each, such as geographical location, vegetation and climate, important factors for the faunal composition.

The geometric proximity between the site of capture and species of sand flies is represented by Fig. 3. Dimension 1 explains almost all of the variation (92.7%), allowing the results to be read horizontally, from left to right. The species located to the left of the center are associated with the edge of the forest and peridomicile, and those located to the right of the center, with intradomicile and inside the forest and, therefore, they represent the most abundant species there. Near the center, indicating that there is no trend, i.e., the abundance is divided proportionally among the environments, few species appear in this location. *Lutzomyia longipalpis* (Lutz & Neiva, 1912) and *Pi. christenseni* appear closer to the center, being their frequencies proportional in all places of capture. On the other hand, the majority of species are found outside the center, showing that their incidence is not proportionally equal among the sites of capture.

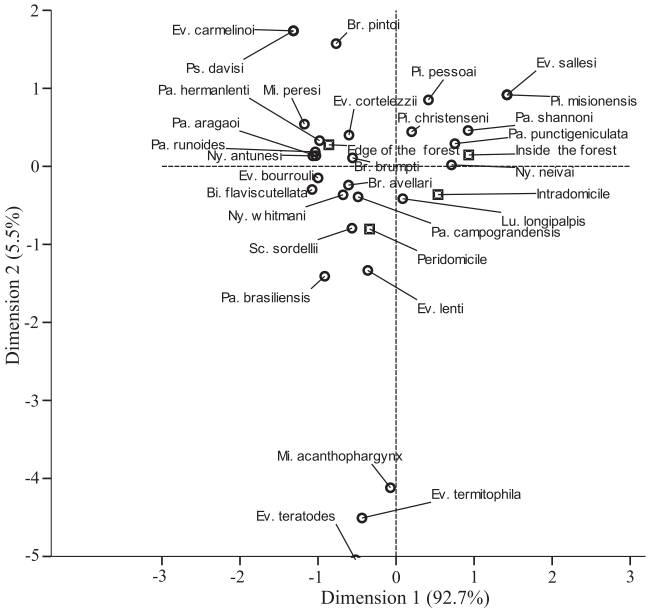

Fig. 3. Results of correspondence analysis among the phebotomine species and the environment in which they were collected in the municipalities of Naviraí, Nova Andradina, Novo Horizonte do Sul and Rio Verde de Mato Grosso, from July 2008 to June 2010. (□) Collection sites, (○) species.

From 2001 to 2010, Naviraí reported 82 cases of ACL, Nova Andradina reported 41, Novo Horizonte do Sul reported 48 and Rio Verde de Mato Grosso reported 51 cases (Sinan 2011). Important vector species of ACL agents were found in these municipalities, especially *Ny. neivai* in Naviraí, which may explain the high number of cases of ACL in this municipality, suggesting that this species may be responsible for the disease transmission in this region.

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