Ecology of Sand Flies (Diptera: Psychodidae: Phlebotominae) in the North of the State of Mato Grosso, Brazil

Alfredo CR Azevedo/+, Nataly A Souza, Cláudio RV Meneses, Wagner A Costa, Simone M Costa, José B Lima*, Elizabeth F Rangel

Laboratório de Transmissores de Leishmanioses, Departamento de Entomologia, Instituto Oswaldo Cruz-Fiocruz, Av. Brasil 4365, 21045-900 Rio de Janeiro, RJ, Brasil *Instituto de Biologia do Exército, Rio de Janeiro, RJ, Brasil

Peixoto de Azevedo is located in the north of State of Mato Grosso, where environmental alterations led to an outbreak of American cutaneous leishmaniasis in the 80s. The parasite from patients was characterized as Leishmania (V.) braziliensis. *The aim of this study is to contribute to the sand fly ecology of Central-West Brazil. Captures were carried out monthly using CDC light traps. Twenty-six species of sand fly were characterized; among which* Lutzomyia (Lutzomyia) spathotrichia, L. runoides *and* L. (Psychodopygus) llanosmartinsi *were recorded in the State of Mato Grosso for the first time.* L. (Nyssomyia) whitmani, L. (N.) antunesi, L. (L.) spathotrichia, L. (P.) c. carrerai, L. (P.) complexa, L. (P.) lainsoni *and* L. (N.) umbratilis *constituted 92.4% of the local fauna, among which* L. (N.) whitmani *and* L. (N.) antunesi, *accounting for about 53% of the fauna at the stations of capture. On the vertical distribution of sand flies on the Beira-Rio Farm,* L. (N.) whitmani *and* L. (N.) antunesi *prevailed at ground level and in the canopy, respectively, whereas on the BR-080,* L. (P.) llanosmartinsi *was prevalent on the ground and* L. (P.) c. carrerai, *in the canopy. It is suggested that* L. (N.) umbratilis *is the local vector.*

Key words: *Lutzomyia umbratilis* - *Leishmania braziliensis* - Phlebotominae - Mato Grosso - Brazil

Environmental alterations in different regions of Brazil have been modifying the epidemiological profile of leishmaniasis for some decades. These changes have created high-risk areas for *Leishmania* infection (Lainson 1988, 1989, Walsh et al. 1993, Rangel 1995).

The migration movements toward the Amazon Region that have taken place in the last three decades have been directly or indirectly supported by the Federal Government through colonization projects and road construction. Those migratory currents have produced considerable alterations in the environment and they have given rise to haphazard colonization models. Such environmental changes and new associations between man and nature have created new focuses of human disease: malaria and, especially of cutaneous leishmaniasis. Peixoto de Azevedo country, in the north of the State of Mato Grosso, is an area where such a chain of events has been recorded.

The region was covered by primitive forest 25 years ago, but now there are over 100,000 inhabitants in the area, and their main interests have been agriculture and mining. These two activities account for the regions thriving economy followed by wood extraction and cattle raising. The economic development of the region has contributed to the changing in the environment and has brought the population into contact with vector sand flies and could explain the increase in the number of cases of cutaneous leishmaniasis from of the mid-80s, according to data supplied by the Health National Foundation, Cuiabá, State of Mato Grosso. In the region, the disease manifests as a single ulcerated lesion, together with smaller or multiple ulcerated lesions.

Preliminary studies have revealed the presence of the sand fly vectors *L. (Nyssomyia) whitmani*, *L. (N.) umbratilis* and *L. (N.) flaviscutellata* (Rangel et al. 1998a) not only in the forest but also in the miners' camping areas and in domestic animal shelters. Both *L. (N.) umbratilis* and *L. (Psychodopygus) davisi* were found naturally infected by trypanosomatids, prossibly *Leishmania* that belong to the Peripilaria section (Lima et al. 1997). The parasite found in *L. (N.) umbratilis* was later characterized as *L. (Viannia) braziliensis* (T Pereira, pers. commun.).

This study aims to contribute to present knowledge on phlebotomine sand fly ecology the in the Central-West Region of Brazil.

MATERIALS AND METHODS

Area studied - Peixoto de Azevedo, a large country covering an area of 14,383 km^2 is located 661 km from Cuiabá, in the north of the State of Mato Grosso, at latitude 10^{o}13'23"S and longitude 54^{o}58'47"W (Fig. 1). The weather is hot and humid, with three dry months (equatorial climate), with an average yearly temperature of 26^{o}C, and annual rainfall ranging from 2,000 to 3,000 mm. The relief of the area presents a complex base made up of southern Amazon Plateau Residuals. Those plateaus, that interfluves with slopes at heights above 400 m are included in the Peripheral Amazon Basin, which also features mountain ridges carved in volcanic, sub-volcanic and metamorphic Precambrian rocks. The local vegetation is composed by an ecologically tense region, a small spot where two different vegetation types occur (Ama-

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+Corresponding author: Fax:+55-21-2573.4468 E-mail: alcaraze@ioc.fiocruz.br
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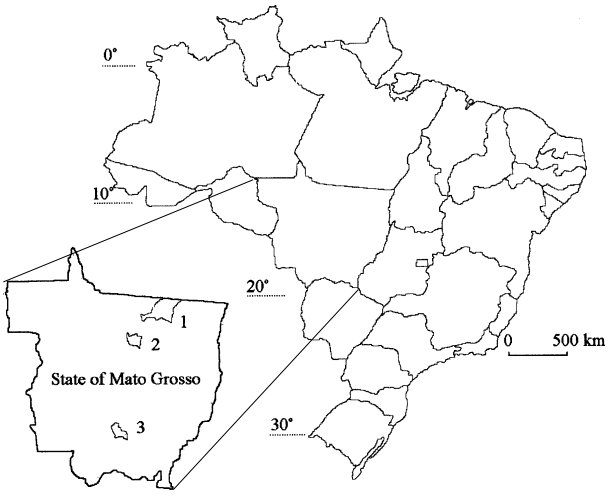

Fig. 1: municipality of Peixoto de Azevedo, State of Mato Grosso, Brazil. 1: Peixoto de Azevedo; 2: Sinop; 3: Cuiabá

zon Forest and savanna) (IBGE 1996). This region has been influenciated by human modifications (anthropic action). The local economy now is based on agricultural production (rice, corn, beans), cattle raising, timber extraction (cinnamon, jatobá and cedar), and lately, in less proportion on gold prospecting.

Sand fly collections - In order to establish the two collection sites, some captures with Shannon trap were done. The station Beira-Rio Farm was approximately 22 km apart from station BR-080 (primary Forest). Sand fly collections were carried out monthly between 6:00 p.m. and 6:00 a.m. from May 1997 to October 1998. The captures were made at the tree canopy (18 m), at an intermediate level (10 m) and near the ground (50 cm) by means of CDC light traps (Sudia & Chamberlain 1962).

Species identification - The sand flies were preserved in 70% alcohol, and later processed for mounting between slide and cover glass, with the use of Canada balsam. The species identification was made according to the classification adopted by Young and Duncan (1994).

The index of species abundance (ISA) (Roberts & His 1971) was applied in order to evaluate the abundance of species of Peixoto de Azevedo.

RESULTS

Species identification - Twenty six phlebotomine species were identified at the two collection stations: *Brumptomyia brumpti* (Larrousse) 1920, *Lutzomyia* (*Lutzomyia*) *spathotrichia* Martins, Falcão & Silva 1963, *L.* (*Sciopemyia*) *sordellii* (Shannon & Del Ponte 1927), *L. migonei* (França 1920), *L. sericea* (Floch & Abonnenc 1944), *L. wilsoni* (Damasceno & Causey 1945), *L.* (*Viannamyia*) *furcata* (Mangabeira 1941), *L.* (*Psathyromyia*) *campbelli* (Damasceno, Causey & Arouck 1945), *L.* (*P.*) *dendrophyla* (Mangabeira 1942), *L. runoides* (Fairchild & Hertig 1953), *L. aragaoi* (Costa Lima 1932), *L. hermanlenti* Martins, Silva & Falcão 1970, *L.* (*Trichopygomyia*) *dasypodogeton* (Castro 1939), *L.* (*T.*) *rondonensis* Martins, Falcão & Silva 1965, *L.* (*Nyssomyia*) *flaviscutellata* (Mangabeira 1942), *L.* (*N.*) *antunesi* (Coutinho 1939), *L.* (*N.*) *whitmani* (Antunes & Coutinho 1939), *L.* (*N.*) *umbratilis* Ward & Fraiha 1977, *L.* (*N.*) *yuilli yuilli* Young & Porter 1972, *L.* (*Psychodopygus*) *lainsoni* (Fraiha & Ward 1974), *L.* (*P.*) *complexa* (Mangabeira 1941), *L.* (*P.*) *davisi* (Root 1934), *L.* (*P.*) *llanosmartinsi* (Fraiha & Ward 1980), *L.* (*P.*) *hirsuta hirsuta* (Mangabeira 1942), *L.* (*P.*) *ayrozai* (Barretto & Coutinho 1940), *L.* (*P.*) *carrerai carrerai* (Barretto 1946). Among the species listed, *L. (L.) spathotrichia*, *L. runoides* and *L. (P.) llanosmartinsi* are mentioned in the State of Mato Grosso for the first time. A total number of 6,449 specimens were collected, of which, *L. (N.) whitmani*, *L. (N.) antunesi*, *L. (P.) llanosmartinsi*, *L. (P.) c. carrerai*, *L. (P.) complexa*, *L. (P.) lainsoni* and *L. (N.) umbratilis* accounted for 92.4% of the local fauna. *L. (N.) whitmani* (ISA = 4.5) and *L. (N.) antunesi* (ISA = 4.8) were the most abundant species, accounting for 53.5% of the total (Table I).

Sand fly distribution per collecting area - A qualitative difference between sand fly species was observed when the collections from the two different stations were compared. Nineteen and 21 species were identified on the Beira-Rio Farm and at the BR-080 stations, respectively. Some species were exclusively detected at the BR-080 station: *L. runoides*, *L. (T.) dasypodogeton*, *L. (T.)*

TABLE I

Total, percentage and index of species abundance (ISA) of sand flies collected in Peixoto de Azevedo, State of Mato Grosso, Brazil, May 1997/October 1998

Species	Male	Female	Total	%	ISA
Brumptomyia brumpti	19	5	24	0.4	10.9
Lutzomyia spathotrichia	1	3	4	0.1	15.3
L. sordellii	14	1	15	0.2	15.3
L. migonei	10	6	16	0.2	15.3
L. sericea	28	26	54	0.8	9.6
L. wilsoni	4	1	5	0.1	15.8
L. furcata	2	1	3	0	16.6
L. campbelli	-	1	1	0	17.3
L. dendrophyla	-	1	1	0	17.3
L. runoides	6	-	6	0.1	16.8
L. aragaoi	26	14	40	0.6	12.1
L. hermanlenti	84	40	124	1.9	8.7
L. dasypodogeton	11	2	13	0.2	15.1
L. rondonensis	2	4	6	0.1	16.8
L. flaviscutellata	2	-	2	0	17.0
L. antunesi	400	768	1,168	18.1	4.8
L. whitmani	1,777	507	2,284	35.4	4.5
L. umbratilis	261	112	373	5.8	6.7
L. y. yuilli	6	1	7	0.1	15.3
L. lainsoni	81	328	409	6.3	7.8
L. complexa	59	470	529	8.2	8.6
L. davisi	89	55	144	2.2	10.0
L. llanosmartinsi	224	392	616	9.6	10.0
L. h. hirsuta	11	4	15	0.2	16.3
L. ayrozai	4	3	7	0.1	17.3
L. c. carrerai	33	550	583	9	10.0
Total	3,154	3,295	6,449	100	

rondonensis, *L. (N.) y. yuilli*, *L. (P.) llanosmartinsi*, *L. (P.) h. hirsuta* and *L. (P.) ayrozai*. Some other species were only detected on the Beira-Rio Farm: *L. (L.) spathotrichia*, *L. (S.) sordellii*, *L. (V.) furcata*, *L. (P.) campbelli*, *L. (P.) dendrophyla* and *L. (N.) flaviscutellata* (Table II). The species of the *Nyssomyia* sub-genus had a higher incidence on the Beira-Rio Farm (94.2%), and at that station the prevailing species, accounting for 67% of the total of specimens collected, was *L. (N.) whitmani* (Fig. 2A). The *Psychodopygus* sub-genus was prevalent at BR-080 (71.3%), of which *L. (P.) llanosmartinsi*, *L. (P.) c. carrerai*, *L. (P.) complexa* and *L. (P.) lainsoni* represented 92.8% (Fig. 2B).

Sand fly stratification - As regards the seven species of highest occurrence it was observed that *L. (N.) whitmani*, *L. (N.) antunesi* and *L. (N.) umbratilis* were found at three different levels on the Beira-Rio Farm. There *L. (N.) whitmani* was prevalent on the ground (96.5%) and at 10 m (45.8%), while *L. (N.) antunesi* was found much more frequently in the canopy (48.3%) (Fig. 3A). On the BR-080, the seven species mentioned above were found on the three levels: *L. (P.) llanosmartinsi* was prevalent on the ground (29%) and at 10 m (38.7%), while *L. (P.) c. carrerai* was more frequently found in the canopy (20.1%) and, among the least numerous species, the presence of *L. (P.) davisi* on the ground (11.7%) is remarkable (Fig. 3B).

L. (N.) umbratilis was the seventh most abundant species, accounting for 5.7% of the specimens collected at both stations. The *L. (N.) umbratilis* captures were productive at the intermediate level (10 m) and in the canopy, where the total of specimens from the two levels totalled 94% (Beira-Rio Farm) and 98% (BR-080) (Fig. 4).

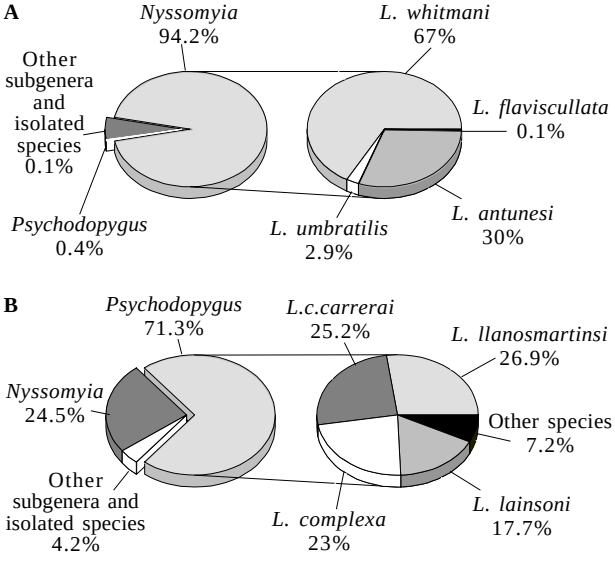

Fig. 2: the frequencies of the sub-genera *Nyssomyia* and *Psychodopygus* and the predominant sand fly species. Peixoto de Azevedo, State of Mato Grosso, Brazil (1997-1998). A: Beira-Rio Farm; B: BR-080

DISCUSSION

Peixoto de Azevedo is a municipality that has been undergoing a high level of environmental degradation over the years, as it has seen a remarkable increase in its population especially in areas where housing conditions favour the emergence of cutaneous leishmaniasis. The occupational disease profile seems to be well evident in the region, as most of the people affected work in agriculture and mining.

The light trap CDC type has been systematically used in studies on sand flies in forest areas and/or in areas where there is leishmaniasis transmission (Arias & Freitas 1982, Aguiar et al. 1985a, Gomes & Galati 1987, Dourado et al. 1989, Azevedo & Rangel 1991, Azevedo et al. 1993, Galati et al. 1996, Brazil et al. 2000, Barros et al. 2000). In spite of the fact that this kind of collection does not allow access to the great number of species, which may constitute the local fauna (Shaw & Lainson 1972) when undertaken at different capture sites, this type of collection can yield a representative sample of the sand fly fauna in a given area.

Located in the southern Amazon Basin, Peixoto de Azevedo has sand fly fauna characteristic of the Amazon Region. Species that belong to the *Brumptomyia*, *Lutzomyia* genera (seven sub-genera) and six isolated species totalled 26. Except for *L. (L.) spathotrichia*, *L. runoides* and *L. (P.) llanosmartinsi*, the other species had already been registered in the State of Mato Grosso (EAB Galati & AL Falcão, pers. commun., Martins et al. 1978, Young & Duncan 1994).

The contrasts between preserved and modified areas in the region studied became evident when the sand fly fauna was qualitatively analyzed. The species distribution per collection and per stratified area showed variations according to the alterations that had taken place in the vegetation where the two collecting stations were located. The BR-080 station is located in an area where the environmental degradation rate is lower and the vegetation is typical of the southern Amazon Region. On the other hand, the area where the Beira-Rio Farm is located has been systematically exploited by different economic activities.

Studies of stratification in forested areas have made the description of phlebotomine feeding habits possible. Their preference for mammals whose habitat are on the ground or at canopy level has contributed with information about the different cycles of leishmaniasis transmission. In the primary Amazonian forest in the North of Brazil, the species of *Psychodopygus* and *Nyssomyia* prevail, on the ground and in the tree canopy, respectively (Arias & Freitas 1982, Azevedo et al. 1993). But this trend was not observed in Peixoto de Azevedo, for on the Beira-Rio Farm, *Nyssomyia* was prevalent on the ground and *L. (N.) whitmani* and *L. (N.) antunesi*, in the canopy. At BR-080, *Psychodopygus* was predominant, whereas *L. (P.) llanosmartinsi* had the highest rate on the ground and *L. (P.) c. carrerai*, in the canopy. This evidence may can corroborate the existence of a qualitative and quantitative imbalance in the regional phlebotomine fauna.

Among the local sand fly fauna, some species are referred to by Young and Duncan (1994) and Lainson and

TABLE II

Total and percentage of sand flies on Beira-Rio Farm and BR 080 in Peixoto de Azevedo, State of Mato Grosso, Brazil, May 1997/October 1998

	Beira-Rio Farm				BR-080			
Species	Males	Females	Total	%	Males	Females	Total	%
Brumptomyia brumpti	16	4	20	0.6	3	1	4	0.1
Lutzomyia spathotrichia	1	3	4	0.1	-	-	-	-
L. sordellii	14	1	15	0.5	-	-	-	-
L. migonei	1	6	7	0.2	9	-	9	0.3
L. sericea	7	14	21	0.6	21	12	33	1
L. wilsoni	4	-	4	0.1	-	1	1	0
L. furcata	2	1	3	0.1	-	-	-	-
L. campbelli	-	1	1	0.1	-	-	-	-
L. dendrophyla	-	1	1	0	-	-	-	-
L. runoides	-	-	-	-	6	-	6	0.2
L. aragaoi	1	-	1	0	25	14	39	1.2
L. hermanlenti	76	23	99	3.1	8	17	25	0.8
L. dasypodogeton	-	-	-	-	11	2	13	0.4
L. rondonensis	-	-	-	-	2	4	6	0.2
L. flaviscutellata	2	-	2	0.1				0
L. antunesi	326	587	913	28.2	74	181	255	7.9
L. whitmani	1,599	443	2,042	63.1	178	64	242	7.5
L. umbratilis	67	22	89	2.8	194	90	284	8.8
L. y. yuilli	-	-	-	-	6	1	7	0.2
L. lainsoni	1	2	3	0.1	80	326	406	12.6
L. complexa	3	-	3	0.1	56	470	526	16.4
L. davisi	1	1	2	0.1	88	54	142	4.4
L. llanosmartinsi	-	-	-	-	224	392	616	9.2
L. h. hirsuta	-	-	-	-	11	4	15	0.5
L. ayrozai	-	-	-	-	4	3	7	0.2
L. c. carrerai	2	3	5	0.2	31	547	578	18
Total	2,123	1,112	3,235	100	1,031	2,183	3,214	100

Shaw (1998) as having been naturally infected by *Leishmania*, with special emphasis on the vectorial importance of *L. (N.) flaviscutellata* and *L (N.) umbratilis*, in the North, *L. (N.) whitmani*, in the North, Northeast and Southeast and *Psychodopygus* species (*L. (P.) complexa*) in the North of Brazil.

L. (N.) flaviscutellata was found in low densities; and only collected on the Beira-Rio Farm. Having a nocturnal habit and being not very anthropophilic, it has been suggested that it is the vector of *L. (L.) amazonensis*, responsible for the anergic diffuse clinical form of tegumentary leishmaniasis in the Amazon Region. Apparently, this phlebotomine is not involved in the local leishmaniasis ecology at the two collecting station in Peixoto de Azevedo.

L. (N.) whitmani was present at both collecting stations; however, its density was lower at BR-080, than on the Beira-Rio Farm, where species of the sub-genus *Nyssomyia* prevailed.

The relationship between the primary forest and the density of the *Psychodopygus* species has also been observed in Bolivia (Le Pont & Desjeux 1986) and in Brazil (Biancardi et al. 1982, Aguiar & Soucasaux 1984, Aguiar et al. 1985b, Ready et al. 1986).

The highest density of the *Nyssomyia* species and especially of *L. (N.) whitmani* may be associated with modifications in the original vegetation cover and because of a better adaptation to the new environmental conditions.

Epidemiological study of cutaneous leishmaniasis carried out in the Corguinho, State of Mato Grosso do Sul (Nunes et al. 1995) isolated parasites identified as *L. (V.) braziliensis* in patients and Galati et al. (1996) have suggested *L. (N.) whitmani* as the likely vector, considering that this phlebotomine was found to be naturally infected by flagellate protozoan whose behaviour was similar that of the parasite mentioned and was also the most abundant species at almost all the different ecological sites where the captures were made. *L. (N.) whitmani* is often associated with the peridomicile in the cutaneous leishmaniasis transmission area in the Northeastern and Southeastern Regions of Brazil (Cuba-Cuba et al. 1985, Azevedo & Rangel 1991). In these regions the human population is concentrated on the hill slopes, which have often lost of their original vegetation cover due to the continuous sustenance agriculture. However, in Peixoto de Azevedo, this sand fly presents a behaviour pattern more similar to that observed of the population of the Northern Brazilian region, with sylvatic habits and not inclined to bite human being.

L. (N.) umbratilis is considered to be the main vector of *L. (V.) guyanensis*, responsible for most cases of cutaneous leishmaniasis in the Amazon Region. Studies on the stratification of this phlebotomines in the Northern region in Brazil have shown that its density is as high in the canopy as on the ground, where specimens can be collected right on the tree trunks and also during their anthropophilic activity in the first hours of daylight. They also feed on human blood at dusk (Arias & Freitas 1982, Lainson 1983, Ready et al. 1986).

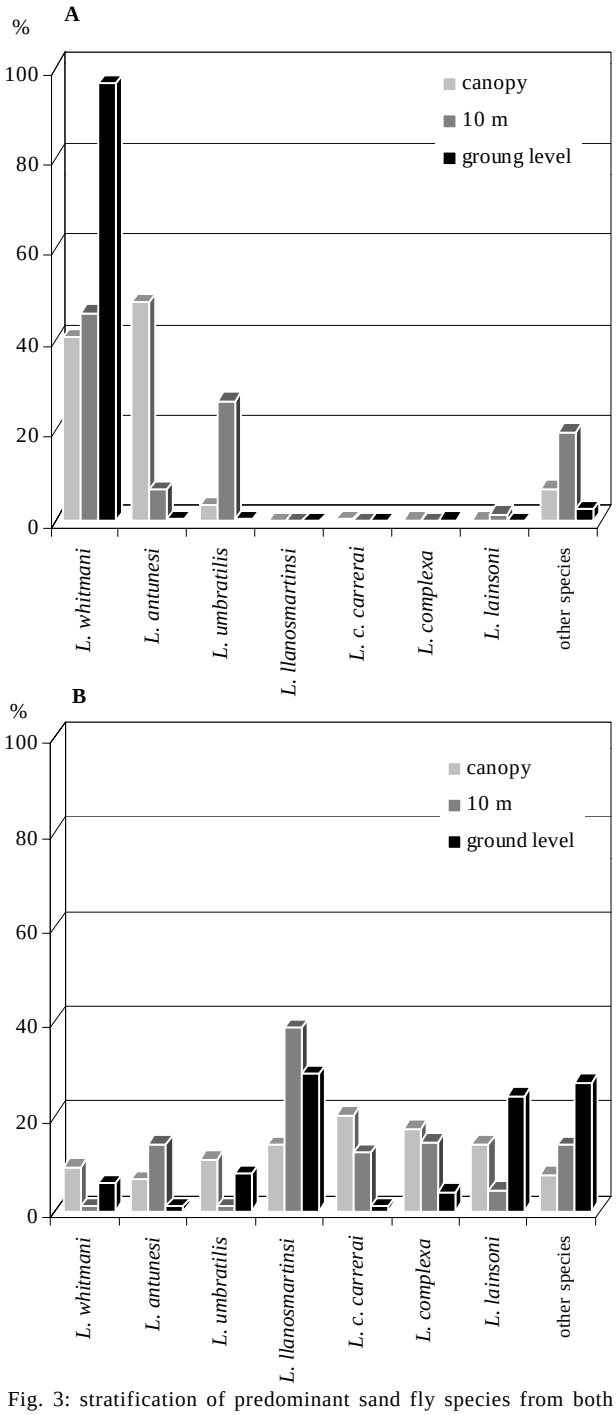

Fig. 3: stratification of predominant sand fly species from both captures stations. Peixoto de Azevedo, State of Mato Grosso, Brazil (1997-1998). A: Beira-Rio Farm; B: BR-080

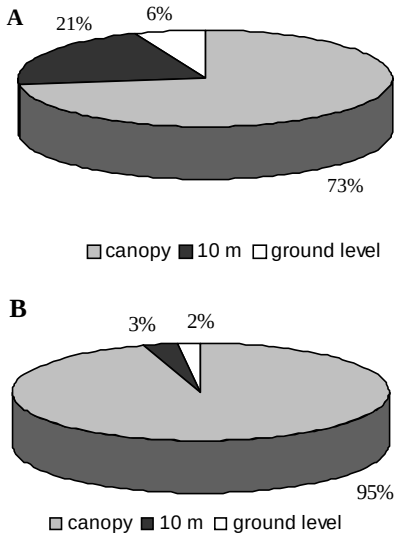

Fig. 4: stratification of *Lutzomyia (N.) umbratilis* at both captures stations. Peixoto of Azevedo, State of Mato Grosso, Brazil (1997-1998). A: Beira-Rio Farm; B: BR-080

In Peixoto de Azevedo, *L. (N.) umbratilis* was found at both stations, however, the BR-080 station showed the highest number of collected specimens (76.1%). *L. (N) umbratilis* was the most abundant species at the intermediate level and in the canopy of trees. Our observations confirm the habit of this species coexisting preferably in the canopy of threes. The same findings were previously described in the Amazonian region (Arias & Freitas 1982, Azevedo et al. 1993).

Previous studies on natural infection made in Peixoto de Azevedo have demonstrated a possible association of that phlebotomine with *L. (V.) braziliensis*, the same parasite that has been isolated from patients. Tissue samples from the borders of lesions were inoculated into the feet of hamsters. After development of the papulae, the material was transported and cultivated in enriched blood-agar medium (NNN) for *Leishmania*. One isolate was characterized as *L. (V.) braziliensis* by enzymatic profiles, using reference stocks of *L. (V.) braziliensis*, *L. (V.) guyanensis* and *L. (V.) amazonensis* (Rangel et al. 1998b). This suggests that *L. (N.) umbratilis* may be a local vector, bearing in mind that the use of the Shannon trap in some of the collections permitted the detection of degree of anthropophily for this specie (EF Rangel, pers. commun.).

Bearing in mind Lainson's hypothesis (1988) that *L. (N.) umbratilis* only infects *L. (V.) guyanensis* in the north of the River Amazon, this new evidence suggests the existence of a complex of species. It may also be admitted that genetically heterogeneous populations could also be associated with different cycles of leishmaniasis transmission in Brazil.

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