

Phlebotomine sand flies (Diptera: Psychodidae: Phlebotominae) in urban rainforest fragments, Manaus – Amazonas State, Brazil

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ABSTRACT

The non-flooded upland rainforest fragment in the Federal University of Amazonas Campus is considered one of the world's largest urban tropical woodland areas and Brazil's second largest one in an urban setting. It is located in the city of Manaus, State of Amazonas at 03° 04' 34" S, 59° 57' 30" W, in an area covering nearly 800 hectares. Forty-one (41) sand fly species belonging to genus *Lutzomyia* were found attaining a total of 4662 specimens collected. *Lutzomyia umbratilis* was the dominant species at all heights, followed by *Lutzomyia anduzei* and *Lutzomyia clautrei*. The fauna alpha diversity index showed to be 6.4, which is not much lower than that reported for areas of continuous forest in this Amazonian region. This data provides additional evidence on Phlebotomine sand flies found to transmit *Leishmania* and other trypanosomatids to humans and other animals circulating in this area. This is the first study being reported on sand flies collected in an urban rainforest fragment in Amazonia.

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1. Introduction

Manaus is a city located in the Amazonian tropical rainforest covering over 11,000 km², 97% of which comprising rural areas presenting 70% protection index, inserted in conservation units of diverse categories. The urban area presents an over 50% protected area index, mainly due to the Adolpho Ducke Forest Reserve, which makes part of the study area in the National Research Institute of Amazonas (INPA), which together with the Federal University of Amazonas – UFAM upland tropical rainforest fragment, are amongst the few tropical large-sized tropical rainforest remnants extant within a urban perimeter (Nery, 2003). Forest fragmentation is most times due to landscape unit continuity rupture anthropic processes, resulting in changes in fauna community composition and diversification. This process has brought about diverse effects, on natural ecosystems, such as diverse populations size reduction as well as disappearance of species requiring large-sized areas to survive (Bierregaard et al., 1992). Sand flies are a group that also

suffers influences from ongoing fragmentation effects and anthropic activity in these environments. Insects belonging to family Psychodidae present some vector species to diseases such as tegumentary leishmaniasis, endemic in Amazonia. Knowledge on distribution of sand flies collected in diverse arborous strata can help to identify and define the parasite hosts and transmitting cycle (Williams, 1970). The upper-story and ground bush of different forests can harbor specific habitats and microclimates. These environmental conditions coupled with flower and fruit availability can attract diverse arborous animals, such as primates and sloths. The distribution of the sand fly species found at various strata above of the ground can be a response to these physical and biological differences (Chaniotis et al., 1971). Several works in this area are being undertaken throughout Brazil, demonstrating the existence of a great variety of sand flies species, as well as their geographic distribution, seasonality, ecology and epidemiology (Biancardi et al., 1982; Silva and Grunewald, 1999; Andrade Filho et al., 2001). In Brazilian Amazonia several studies pertaining to vertical stratification have been carried out (Biancardi, 1981; Arias and Freitas, 1982; Barrett, 1993; Dias-Lima et al., 2002). Studies on this area enable determining human exposure risk if and when *Leishmania* vector species are found to in the region, as well as helping on the planning of the actions to be undertaken to control and prevent the disease. Due to the paucity of data concerning leishmaniasis, the diverse forms with which it presents itself and knowledge concerning its vectors and dynamics, an entomological study in different areas of occurrence of the disease becomes paramount. Hence, the knowledge of the population fluctuations, its habitats, the species diversity and abundance is fundamental so as to plan controlling

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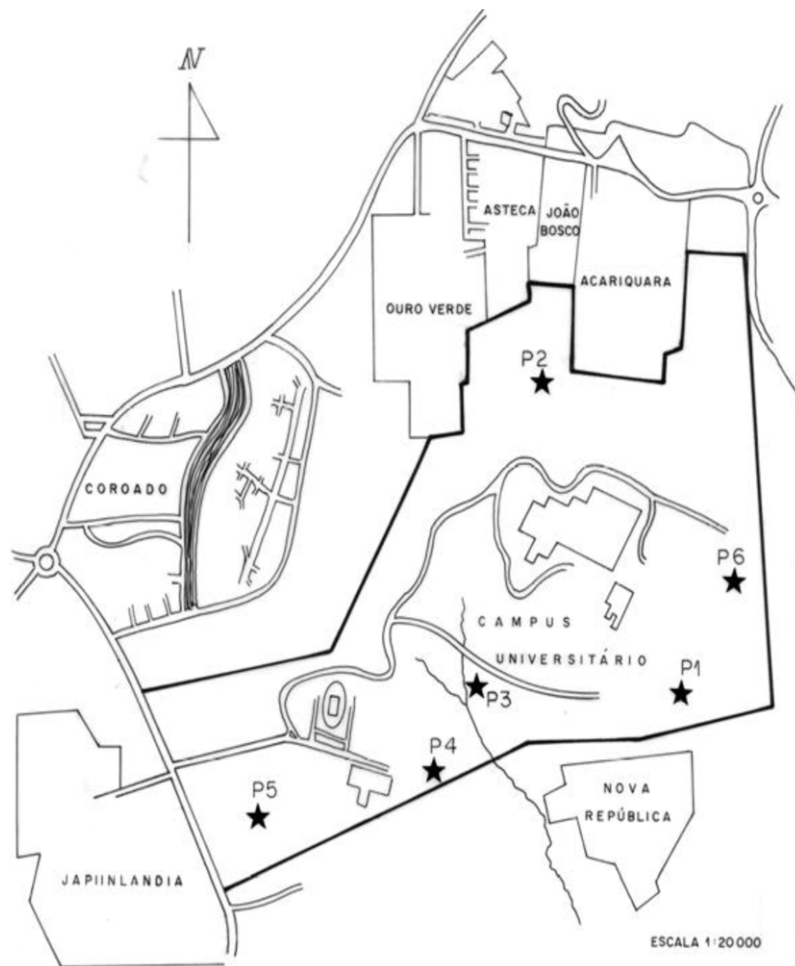


Fig. 1. The campus of UFAM showing: points available within the environment with lower (P1–P3) and increased anthropical alteration (P4–P6).

actions in order to break up the transmission of this disease to man (Biancardi, 1981). Based on the displayed data and the absence of information as to the phlebotomine sand fly fauna in the Federal University of Amazonas (UFAM) urban forest fragment, this study was carried out aiming to ascertain its fauna composition and sand fly vector occurrence and observe different levels of anthropic influence brought about by human being intense circulation in the areas surrounding it.

2. Materials and methods

2.1. Study area

Specimens were collected in the Federal University of Amazonas, upland tropical rainforest fragment, considered one of the world's largest urban tropical rainforest areas and Brazil's largest urban forest fragment. It is located in the city's eastern zone, Manaus, Amazonas (03° 04' 34" S and 059° 57' 30" W) and it comprises an area of near 800 ha. The Campus forested area encloses 594 hectares holding 25% of all public and Institutional forested areas in the city of Manaus. It is one of the few large-sized rainforest remnants in an urban perimeter. This area presents different types of vegetation. The photo-interpretation survey indicates the occurrence of dense and open ombrophilous forests, as well as grassland. These vegetation types are distributed throughout plateaus, slopes and lowlands. The dense ombrophilous forest may be said to be the proper jungle itself, representing nearly 40% of the covering. This jungle has been and keeps on being heavily exploited by selective

removal of timber and small-sized trees, in addition to palm tree leaves and fruits, yet, it is still possible to find a large number of palm trees, such as bacaba, buriti and inajá. The open ombrophilous forest is represented by secondary vegetation (regrowth in various growing stages), which represents nearly 50% of the covering, along with the remaining grassland. Some cultivated plants such as cupuaçu, Brazil nut, graviola, biribá and Pau Brazil, can also be found. One observes a lot of places with no vegetation due to the compacting of the soil (information furnished by the botanist A. Webber, personal communication). Several representatives of the Amazonian fauna can be found, such as edentates (*Bradypus tridactylus*, *Choloepus didactylus*, *Dasyprocta novemcinctus*, *Tamandua tetradactyla* and *Cyclopes didactylus*), primates (*Pithecia pithecia*, *Saimiri sciureus* and *Saguinus bicolor bicolor* in extinction), rodents (*Sciurus* sp., *Dasyprocta agouti*, *D. fuliginosa* and *Myoprocta acouchy*) and carnivores as *Nasua nasua*. Apart from man there are no natural sloth predators in the area (Carmo, 2002). For many years this rainforest fragment has been subjected to exploitation carried out by the neighboring population in order to be able to find timber for building their houses, and to do this they mainly look for small-sized trees. Hunting still occurs sporadically, and the hunters eventually capture sloths (*B. tridactylus*) to eat them. There are four large city zones surrounding the UFAM rainforest fragments easy for their population to circulate in the area. Six 100 × 200 m (2 ha), upland forest areas were sampled within this rainforest fragment, three of them were in a forested area presenting higher anthropical alteration (open ombrophilous forest presenting vegetation in an advanced regeneration stage and up to 20 m high trees,

Table 1

Total number of sand flies species collected from the urban forest fragment at Amazonas Federal University, Manaus, Amazonas, Brazil.

Subgenus/group/species	Specimens number	Subgenus/group/species	Specimens number
Evandromyia		Psychodopygus	
<i>Lutzomyia bourrouli</i>	01	<i>L. amazonensis</i> ^a	07
<i>L. georgii</i> ^a	42	<i>L. ayrozai</i> ^a	05
<i>L. inpai</i> ^a	09	<i>L. clautrei</i> ^a	455
<i>L. monstrosa</i>	03	<i>L. davis</i> ^a	205
<i>L. (Evandromyia) sp.</i>	01	<i>L. geniculata</i> ^a	106
<i>L. tarapacaensis</i>	01	<i>L. hirsuta</i> ^a	01
		<i>L. paraensis</i> ^a	22
Lutzomyia		Trichophoromyia	
<i>L. falcata</i>	34	<i>L. eurypyga</i> ^a	166
<i>L. spathotrichia</i> ^a	185	<i>L. ruii</i> ^a	05
		<i>L. ubiquitous</i> ^a	88
Micropygomyia		Trichopygomyia	
<i>L. micropyga</i>	02	<i>L. ratcliffei</i> ^a	01
		<i>L. trichopyga</i> ^a	49
Nyssomyia		Viannamyia	
<i>L. anduzei</i> ^a	722	<i>L. furcata</i> ^a	31
<i>L. antunesi</i> ^a	68	<i>L. tuberculata</i> ^a	03
<i>L. flaviscutellata</i> ^a	38		
<i>L. umbratilis</i> ^a	1.744	Grupo aragaoi	
<i>L. olmeca nociva</i> ^a	09	<i>L. aragaoi</i> ^a	07
Pintomyia		<i>L. inflata</i> ^a	04
<i>L. damascenoi</i>	01		
Pressatia		Grupo oswaldoi	
<i>L. trispinosa</i> ^a	03	<i>L. rorotaensis</i> ^a	301
		Grupo migonei	
Psathyromyia		<i>L. sericea</i> ^a	01
<i>L. dendrophyla</i> ^a	78	<i>L. williamsi</i> ^a	02
<i>L. scaff</i> ^a	25		
<i>L. shannoni</i> ^a	13	Sciopemyia	
<i>L. abbonenci</i>	05	<i>L. nematoducta</i> ^a	01
		<i>L. sordellii</i> ^a	19
Sub-total	2984		1479
Total			4.463

^a Species collected with CDC light trap.

and paths used by the population inhabiting the neighboring city zones) and three others in a forest area subjected to lower anthropic alteration (forest areas characterized by dense ombrophilous forest presenting, in its structure, a vegetation with emergent trees reaching up to 25 m high as well as small mammals which attract hunters to these areas). All areas were composed by ten, 5 m apart, 200 m longitudinal paths intercepted by four, 50 m apart, crossing paths (Fig. 1).

2.2. Sand fly Collections

Sand flies were collected from March to October 2002, using light traps (CDC “miniature” – Hausherr Machine Works, New Jersey, USA), Disney traps (with animal bait, *B. tridactylus* and *C. didactylus*/Ibama license in. 36/2001/process in. 02005.002979/01-36) and aspiration in base of tree with modified CDC. At each place, twelve light traps were distributed in four trees, and lighted up from 18:00 overnight to 8:00 h, once a month. The Disney traps (Disney, 1966) were placed 10 m above the CDC traps on the same days and at the same times so as to collect sand flies with zoophilic habit. The collection made in the base of the tree, was done, in the morning, by aspiration with modified CDC, on the same day and at the same time the modified light traps were removed. This method's collecting effort lasted for one and a half hour (8:00–9:30 h). All the material collected through these methodologies was separated in the Leishmaniasis laboratory (CPCS/INPA) kept in 70% alcohol, clarified in NaOH (VETEC) and diafanized in phenol (VETEC) to be identified according to Young and Duncan classification (1994).

3. Results

3.1. Species richness

During the eight months it took to complete this study, a total of 4463 sand fly specimens were collected from the UFAM rainforest fragment. They were distributed in 41 species of 11 subgenera and five groups (Table 1). Different collecting methods were used so as to attain a comprehensive survey including the largest number of species that could be found in two areas with distinct levels of alteration. 1958 insects were caught in light traps, 2040 were collected by aspiration at tree bases and 465 in Disney traps (Table 2). *Psychodopygus* (seven species) was the subgenus presenting the largest number of species followed by subgenera *Evandromyia* (six), *Nyssomyia* (five), *Psathyromyia* (four), *Trichophoromyia* (three), *Lutzomyia*, *Sciopemyia*, *Trypophyomyia*, *Viannamyia*, Groups *aragaoi* and *migonei* (two) *Micropygomyia*, *Pintomyia*, *Pressatia* and Group *oswaldoi* (one). The UFAM calculated diversity index showed to be 6.4. The similarity rate presented a percentage of 73% between the two considered areas (greater and lesser anthropic alteration). A total of 33 species were collected in light traps, yet, *Lutzomyia scaff*, *Lutzomyia hirsuta*, *Lutzomyia inflata*, *Lutzomyia nematoducta*, *Lutzomyia sericea* and *Lutzomyia ratcliffei* species were not found in the areas presenting greater anthropic alteration. Out of all 1958 individuals, 833 came from more disturbed areas and 1125 from the area presenting lower anthropic alteration. Most species were found to be more abundant in the less disturbed environment (Table 3).

Table 2
Survey of sand flies species using various collection methods in urban forest fragment – Manaus, AM.

Species	Collection methods				Animal bait		Total
	Light trap				B	C	
	5 m	10 m	15 m				
<i>L. umbratilis</i>	106	77	169	1.382	8	2	1.744
<i>L. anduzei</i>	115	73	65	20	93	356	722
<i>L. clautrei</i>	247	157	41	8	2	–	455
<i>L. rorotaensis</i>	33	6	13	249	–	–	301
<i>L. davisi</i>	158	36	9	2	–	–	205
<i>L. spathotrichia</i>	4	1	4	175	1	–	185
<i>L. eurypyga</i>	142	17	7	–	–	–	166
<i>L. geniculata</i>	70	26	10	–	–	–	106
<i>L. ubiquitous</i>	53	9	6	20	–	–	88
<i>L. dendrophyla</i>	2	2	–	74	–	–	78
<i>L. antunesi</i>	19	7	1	41	–	–	68
<i>L. trichopyga</i>	38	6	5	–	–	–	49
<i>L. georgii</i>	39	1	2	–	–	–	42
<i>L. flaviscutellata</i>	28	6	2	2	–	–	38
<i>L. falcata</i>	–	–	–	34	–	–	34
<i>L. furcata</i>	17	10	3	1	–	–	31
<i>L. scaffi</i>	1	–	3	20	1	–	25
<i>L. paraensis</i>	15	1	6	–	–	–	22
<i>L. sordellii</i>	16	1	2	–	–	–	19
<i>L. shannoni</i>	3	2	2	4	2	–	13
<i>L. inpai</i>	9	–	–	–	–	–	9
<i>L. olmeca nociva</i>	7	2	–	–	–	–	9
<i>L. amazonensis</i>	6	1	–	–	–	–	7
<i>L. aragaoi</i>	6	1	–	–	–	–	7
<i>L. abbonenci</i>	1	1	–	3	–	–	5
<i>L. ayrozai</i>	5	–	–	–	–	–	5
<i>L. ruii</i>	4	1	–	–	–	–	5
<i>L. inflata</i>	4	–	–	–	–	–	4
<i>L. monstrosa</i>	3	–	–	–	–	–	3
<i>L. trispinosa</i>	1	2	–	–	–	–	3
<i>L. tuberculata</i>	2	–	–	1	–	–	3
<i>L. micropyga</i>	–	–	–	2	–	–	2
<i>L. williamsi</i>	–	–	2	–	–	–	2
<i>L. (Evandromyia) sp.</i>	1	–	–	–	–	–	1
<i>L. bourrouli</i>	–	–	–	1	–	–	1
<i>L. damascenoi</i>	–	–	–	1	–	–	1
<i>L. hirsuta</i>	1	–	–	–	–	–	1
<i>L. nematoducta</i>	1	–	–	–	–	–	1
<i>L. ratcliffei</i>	1	–	–	–	–	–	1
<i>L. sericea</i>	1	–	–	–	–	–	1
<i>L. tarapacaensis</i>	1	–	–	–	–	–	1
Total	1.160	446	352	2.040	107	358	4.463

L, *Lutzomyia*; B, *Bradypus tridactylus*; C, *Choloepus didactylus*.

3.2. Relative abundance

Out of all collected sand flies (4463) *Lutzomyia umbratilis* 39% (1744) shows to be the species presenting the highest abundance, followed by *Lutzomyia anduzei* 16% (722), *Lutzomyia clautrei* 10.1% (455) and *Lutzomyia rorotaensis* 6.7% (301). Out of the total, 42% (1890) were female. When these insects were captured and analyzed, *L. clautrei* was found to be predominant in light trap (CDC), whereas, there was a higher number of *L. umbratilis* found at tree base and *L. anduzei* in animal bait trap (sloth/*Choloepus didactylus*) showed greater representation (Table 2). Species *L. umbratilis*, *L. anduzei*, *L. clautrei*, *L. spathotrichia*, *L. scaffi* and *L. shannoni* were collected by Disney traps, being that only *L. umbratilis* (02/465) and *L. anduzei* (356/465) in traps using *C. didactylus* and the other species in traps using *B. tridactylus* as baits, respectively. Amongst the insects of the *Evandromyia* subgenus an incomplete male specimen was found that in accordance with its morphological characteristics appears to be a new species of this group. This specimen was collected in light trap at the UFAM's most disturbed rainforest fragment. The captured specimen was similar to *Lutzomyia pinottii* (Damasceno and Arouck, 1956).

4. Discussion

Sand fly fauna recorded in UFAM Campus shows to be very diverse, it presents a diversity index of around 6.4, belongs to different groups with distinct distribution patterns, being within that observed in the region's continuous forest areas. Freitas et al. (2002) working in Amapá (Porto Grande Municipality) reported a 6.8 diversity index. Based on data reported on studies by Castellón et al. (1989), Arias and Freitas (1982), Castellón et al. (1989) in Roraima, Arias and Freitas (1982) in Amazon and Dias-Lima et al. (2002) in Amazonia, all of them performed in upland forest sites, we were able to attain these areas' diversity index (7.8; 7.3 and 6.2, respectively). In surveys related to the fauna of these insects in the Brazilian Amazonia's primary forest, diverse authors (Lainson et al., 1973; Arias and Freitas, 1982; Ready et al., 1983; Rebêlo et al., 2000; Cabanillas et al., 2001), verified that species of the *Psychodopygus* subgenus were the most abundant, just as it was observed at the UFAM's area. Silveira et al. (1991) isolated *Lutzomyia* (*Viannia*) *naiffi* from two species of this subgenus (*Lutzomyia paraensis* and *Lutzomyia ayrozai*), incriminating *L. ayrozai* for transmitting this parasite to armadillos. Lainson et al. (1973) incriminated *Lutzomyia*

Table 3

Vertical distribution of sand flies collected with light trap in areas with different levels of change in the forest of UFAM, Amazonas, BR.

Species	Tree layer/ anthropical alteration					
	Minor alteration			Biggest alteration		
	5m	10m	15m	5m	10m	15m
<i>Lutzomyia anduzei</i>						
<i>L. clautrei</i>						
<i>L. davis</i>						
<i>L. eurypyga</i>						
<i>L. furcata</i>						
<i>L. geniculata</i>						
<i>L. paraensis</i>						
<i>L. rorotaensis</i>						
<i>L. trichopyga</i>						
<i>L. ubiquitalis</i>						
<i>L. umbratilis</i>						
<i>L. amazonensis</i>						
<i>L. antunesi</i>						
<i>L. dendrophyla</i>						
<i>L. flaviscutellata</i>						
<i>L. olmeca nociva</i>						
<i>L. ruii</i>						
<i>L. scaff</i>						
<i>L. shannoni</i>						
<i>L. sordellii</i>						
<i>L. spathotrichia</i>						
<i>L. aragaoi</i>						
<i>L. ayrozai</i>						
<i>L. georgii</i>						
<i>L. hirsuta</i>						
<i>L. inflata</i>						
<i>L. inpai</i>						
<i>L. nematoducta</i>						
<i>L. ratcliffei</i>						
<i>L. sericea</i>						
<i>L. tuberculata</i>						
<i>L. trispinosa</i>						
<i>L. williamsi</i>						

welcome as the main vector of *Lutzomyia* (V.) *braziliensis* in the Carajás Mountain range, Pará, Brazil, and Souza et al. (1996) indicated the participation of *Lutzomyia* complex in the transmission of this parasite in the same region's low altitude forests. *Evanromyia* was the second most species representative subgenus. In recent revision of this subgenus Freitas and Barrett (2002) pointed out it becomes of major medical importance. *Nyssomyia* was the third most species representative subgenus. On account of presenting LTA vector species in Amazonia this subgenus becomes the one with the greatest medical importance. Within this group, *L. umbratilis* species, which is predominantly found in this upland forest region, presenting high natural infection rates, is considered as the main vector of *Lutzomyia* (V.) *guyanensis* in the State of Amazonas, north of the Amazon River (Lainson et al., 1976; Ward and Fraiha, 1977; Arias and Freitas, 1978). Higher species richness was observed by using CDC light trap. Studies by Arias and Freitas (1982), Castellón et al. (1989, 2000), Fé et al. (1998), and Dias-Lima et al. (2002) in the Amazon forests using this method of capture demonstrated its efficiency, on a qualitative and quantitative viewpoint. However, three of our species could only be collected by the aspiration method at tree base, which led us to conclude that using a simultaneous, varied collecting methodology in species inventories, becomes more efficient since it covers

several habitats harboring these insects. Species similarity rate for the two study areas is 73% (27 species), pointing out that the environment disturbance action brought about by man in this urban forest fragment has not yet caused great alterations regarding these sand fly species distribution rates. The high prevalence of *L. umbratilis* at tree base sites in the morning period, at the same time the collections were being carried out, along with the fact of only having found flagellates in insects within this environment, may be accounted for, among other factors, by its biology, which shows its preference for tree base environments highlighted by the fact of the large number of naturally infected ones for the region. Our findings indicate *L. umbratilis* and *L. anduzei* females to be predominant at 15 m above the ground, and *Lutzomyia flaviscutellata* and *Lutzomyia olmeca nociva* to be more restricted to ground growth levels (data not showed). Memmott (1991) and Dias-Lima et al. (2002) related distribution type to these insects' food sources, that is, the distribution of the food source of these phlebotomine sand flies can restrict their occurrence in some levels, *L. umbratilis* and *L. anduzei* vectors of *L. (V.) guyanensis*, which go up the trees searching for food, *Lutzomyia flaviscutellata* and *L. olmeca nociva*, vectors of *Lutzomyia (L.) amazonensis* that take their blood meals from wild rodents such as *Proechimys* and *Oryzomys*, are found at ground levels where natural infection by leishmanias occurs

(Christensen et al., 1982; Talhari et al., 1988). The predominance of *L. anduzei* in captures with Disney traps, holding both *Choleopus* and *Bradypus* sloth genera, called our attention to the fact of when comparing literature reporting sloths to be the main blood meal source for *L. umbratilis* (Christensen et al., 1982), our study's findings confirm these observations not to be proper when concerning the UFAM Campus' area, since the *L. anduzei* preference for sloths was both confirmed by Disney traps and precipitin test and that *L. umbratilis* bit rodents preferentially, contradicting the information found in literature. *Psathyromyia* subgenus sand flies: *Lutzomyia dendrophyla*, *L. scaffi* and *L. shannoni* are seldom attracted by CDC light traps in Balbina, Amazonas, Brazil (Barrett, 1993), corroborating Dias-Lima et al. (2002) in the Experimental Station of the Tropical Silviculture (BR 174, Manaus – Boa Vista, km 45) and equally proven by the findings presented in this work. However, they were collected in larger numbers by aspiration performed at tree bases. *Leishmania* vectors found amongst the collected species: *L. ubiquitalis* is incriminated as *L. (V.) lainsoni* vector by Lainson et al. (1992), in the Pará State. *L. rorotaensis* species, captured in all environments, has been found infected with trypanosomatids, probably a parasite of reptiles (Lainson and Shaw, 1979). One *Leishmania* unknown type, integrant of the *Viannia* subgenus, was found in *L. tuberculata* (Killick-Kendrick, 1990). Amongst the sand flies found in Amazonia and collected at the studied areas, a group of probable vectors of leishmaniasis is cited: *L. furcata* (*L. (L.) deanei*), *L. ayrozai* and *L. paraensis* (*L. (V.) braziliensis*), *L. tuberculata* (*L. (V.) guyanensis*), *L. shannoni* (*L. (V.) panamensis*), *L. ayrozai* and *L. paraensis* (*L. (V.) naiffi*), according to Killick-Kendrick (1990). The *Psychodopygus* subgenus species, *L. davis* and *L. ayrozai* have been indicated as probable vectors of *L. (V.) naiffi*, causers of cutaneous leishmaniasis in Amazonia (Lainson and Shaw, 1989). Ready et al. (1985) found no differences pertaining to sand fly fauna composition and abundance in areas of recent human occupation in the city of Manaus when compared to not disturbed forest environments studied by other researchers (Arias and Freitas, 1982). Paes (1991) reported findings similar to those put forth by Ready et al. (1985), in areas of forests neighboring the city district named as Cidade Nova, yet verified some changes with *L. umbratilis*, as to the male: female ratio and population density values observed at the areas surrounding the houses, where they had found differences between earlier and more recently encroached areas. The capture of certain species in reduced number and present in only one of the studied areas, leads us to believe there might occur among sand flies, differentiated adaptability degrees in disturbed environments and isolated forest fragments due to urban expansion. It is possible that the numerical difference (density and diversity) of these sand flies found near urban areas be related to their feeding habit being more eclectic than that of the other species collected exclusively in non-disturbed forest areas. Further studies must be undertaken so as to evaluate the impact of the man-disturbed environment on the wild flora and fauna of these ecosystems, by considering aspects of behavior, physiology and dispersion of these insects, in order to elucidate the changes as to the dominance and composition of the entomological fauna observed in the present study. The alteration of a forest area influences the composition and abundance of vector species (Ready et al., 1983; Walsh et al., 1993). Soil types and tree trunk characteristics influence sand fly fauna composition (Rutledge and Ellenwood, 1975; Cabanillas et al., 1995). The findings presented in this study make up the first information regarding the sand fly fauna found in this forest fragment in the city of Manaus, and contribute to the knowledge on insect distribution, as well as to the better understanding of the leishmaniasis vector epidemiology in the Amazonian region. It also contributes to visualize the importance of maintaining these forest areas for the balance of the entomological populations and their interaction with the neighboring community.

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