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Ecological and Epidemiological Aspects of the Sand Fly (Diptera, Psychodidae) Fauna of the National Monument of Pontões Capixabas, State of Espírito Santo, Southeastern Brazil

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ABSTRACT We evaluated the ecological and epidemiological aspects of the sand fly fauna in an area of the Atlantic Forest biome with records of visceral and cutaneous leishmaniasis. Sand fly collections at three different localities at the National Monument of Pontões Capixabas, State of Espírito Santo, Southeastern Brazil, were conducted by using two Centers of Disease Control and Prevention automatic light traps in the peridomiciliary environment and eight Centers of Disease Control and Prevention automatic light traps in the forested environment. Collections occurred during four consecutive nights within each of the months and locations: São Luiz (December 2009, May 2010, July 2010, and December 2010), Córrego Palmital de Baixo (September 2010 and October 2010), and Córrego São Bento (February 2011 and May 2011). We collected 21,138 sand flies belonging to 31 species and 14 genera. Of this total, 12,412 sand flies were captured in the peridomiciliary environment and 8,726 in the forested environment. All of the vector species, *Lutzomyia longipalpis* (=*Lutzomyia longipalpis*, *sensu*; Young and Duncan), *Migonemyia migonei* (=*Lutzomyia migonei*, *sensu*; Young and Duncan), *and Nyssomyia intermedia* (=*Lutzomyia intermedia*, *sensu*; Young and Duncan), occurred in significantly higher numbers in the peridomiciliary environment than compared with the forested environment. Our results highlight the importance of conservation in the forest remains of the National Monument of Pontões Capixabas, because of higher species richness and diversity. Furthermore, they indicate the epidemiological role of *Lu. longipalpis* as the vector of *Leishmania infantum* within the study area, and the no evident role of *Mg. migonei*.

KEY WORDS Phlebotominae, Atlantic forest, *Lutzomyia longipalpis*

The Atlantic Forest is a major biodiversity hotspot, and one of the most fragmented and damaged forests in the world. Currently, the Atlantic Forest covers only 7% of its original area. Despite these disturbances, the Atlantic Forest remains extremely rich in biodiversity, sheltered in several conservations units along the Brazilian coast, with high endemism levels of tetrapods, avian species, insects, and other animals (Instituto de Pesquisas da Mata Atlântica [IPEMA] 2005, Mittermeier et al. 1998, Myers et al. 2000). The sympatric occurrence of animals acting as reservoirs and insects acting as vectors is a favorable scenario for the occurrence of vector-borne diseases such as yellow fever, malaria, and leishmaniasis.

Human leishmaniasis is a spectral disease (ranging from self-limiting cutaneous infections to more serious progressive mucocutaneous and visceral forms) caused by protozoan parasites of the genus *Leishmania* (Ross, 1903). The ecological system in which a *Leishmania* species is maintained in nature is usually composed of a single or a small number of phlebotomine sand flies (which serve as arthropod vectors) and a few vertebrate wild or domestic animals of several different mammalian orders (that serve as reservoir hosts; Peters and Killick–Kendrick 1987). The parasite is transmitted from animals to sand flies, and then from the insects to humans.

Cutaneous leishmaniasis (CL) caused by *Leishmania braziliensis* (Vianna, 1911) occurs throughout the distribution of the species in the Atlantic Forest region of the Espírito Santo state. The parasite is usually transmitted by *Nyssomyia intermedia* (Lutz and Neiva, 1912; =*Lutzomyia intermedia, sensu;* Young and Duncan, 1994), but other sand fly species such as *Nyssomyia neivai* (Pinto 1926; =*Lutzomyia neivai, sensu;* Young and Duncan, 1994), *Nyssomyia whitmani* (Antunes and Coutinho, 1939; =*Lutzomyia whitmani, sensu;* Young and Duncan, 1994), and *Migonemyia*

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migonei (França, 1920; =*Lutzomyia migonei, sensu;* Young and Duncan, 1994) may be involved in some transmission cycles (Azevedo et al. 1990a,b; Ferreira et al. 2001; Lainson and Shaw 1998; Luz et al. 2000; Rangel and Lainson 2003; Pita–Pereira et al. 2005, 2009). Visceral leishmaniasis (VL) resulting from zoonotic transmission of *Leishmania infantum* (Nicolle, 1908) is also found in some northern areas of the Atlantic Forest biome of the State of Espírito Santo, and it seems to be transmitted by *Lutzomyia longipalpis* (Lutz and Neiva, 1912; =*Lutzomyia longipalpis, sensu;* Young and Duncan, 1994; Pinto et al. 2012a). The habit of keeping dogs and other domestic animals inside the house is thought to promote human infection, because dogs are peridomestic hosts of the parasite and attract phlebotomine sand flies, especially *Lu. longipalpis.* The population density of *Lu. longipalpis* can reach very high levels inside houses and in peridomestic settings (Deane 1956, Deane and Deane 1962, Lainson and Shaw 1998, Rangel and Lainson 2003). Molecular studies focusing on VL have shown that other sand fly species such as *Mg. migonei* (Carvalho et al. 2010) and *Lutzomyia almerioi* (Galati and Nunes, 1999; =*Lutzomyia almerioi, sensu;* Young and Duncan, 1994; Savani et al. 2009) can be naturally infected by the *Leishmania* parasite and can be acting as secondary vectors.

The predominant source of periodic fluctuations in the incidence of leishmaniasis is considered linked to the abundance of sand flies. To enable accurate timing of control measures, further studies on the dynamics of sand fly species vectors are required (World Health Organization [WHO] Expert Committee 2010). In the current study, we therefore evaluated the ecological and epidemiological aspects of the sand fly fauna of the National Monument of Pontões Capixabas (NMPC), State of Espírito Santo, Brazil. Our objectives were: 1) to assess the abundance and diversity of sand flies across the Atlantic Forest biome, 2) to investigate the population dynamics of potential vectors in peridomiciliary and forested environments within the NMPC, and 3) to identify the putative vectors of leishmaniasis within the study area.

Materials and Methods

Study Area. In Brazil, the "National Monument" category is applied to conservation units where the human population can live inside the geographical boundaries without expropriation of the land. Currently, ≈400 families live inside the boundaries of the NMPC. The NMPC is situated in the central region of the Atlantic Forest, above the Doce River, and covers an area of ≈174.96 km^2, including several Atlantic Forest remains and, predominantly, areas of farming and livestock. The NMPC is divided into two distinct areas: one belonging to the municipality of Pancas, and the other to the municipality of Águia Branca. Both of these areas are situated in the northwestern portion of the State of Espírito Santo, southeastern Brazil. The Brazilian name "Pontões" refers to the rocky outcrops that are very common along the NMPC, and are the main characteristic of the region's landscape. The Köppen–Geiger climate classification defines the NMPC as tropical monsoon (Peel et al. 2007), with low elevations (<500 m [a.s.l.]), low annual rainfall (<1,000 mm; with the wet season from November to April and the dry season from May to October), and no marine influence (Feitoza 1986, Secretaria de Estado de Meio Ambiente e Recursos Hídricos [SEAMA] 2008).

The portion of the NMPC belonging to the municipality of Pancas is an endemic area of VL and CL. Based on the occurrence of leishmaniasis, we conducted sand fly captures in three selected localities (Fig. 1). The first locality, Córrego São Luiz (19° 10′25″ S; 40° 51′08″ W), has recent records of VL and ancient records of CL. The second locality, Córrego Palmital de Baixo (19° 12′47″ S; 40° 47′20″ W), has records of VL 10 yr ago (2003), but no recent records of VL, and no records of CL. The third locality, Córrego São Bento (19° 13′44″ S; 40° 45′31″ W), has ancient records of CL, but no records of VL.

Sand Fly Collection Methods. In each locality, we conducted at least two sand fly captures as follows: São Luiz (December 2009, May 2010, July 2010, and December 2010), Córrego Palmital de Baixo (September 2010 and October 2010), and Córrego São Bento (February 2011 and May 2011). We used two Centers of Disease Control and Prevention automatic light traps in the peridomiciliary environment and eight Centers of Disease Control and Prevention automatic light traps in the forested environment, during four consecutive nights within each of the months listed earlier. Ten light traps were used for each night. In the peridomiciliary environment, the traps were placed close to domestic animal shelters. In the forest environment, the traps were placed randomly, at a distance of 30 m from each other and at least 50 m from the forest edge. The traps remained in operation throughout the night (1800–0600 hours). In total, 768 collection hours were amassed in the peridomestic environment, and 3,072 collections hours in the forest environment. A small container (220 ml) with 80% ethanol was connected to the trap to store insects after the capture, instead of the meshed cages provided by the manufacturer. At the end of each night, we removed the containers, filled them with 80% ethanol, and transported them to the Laboratory of Parasitology, Universidade Federal do Espírito Santo. The sand flies were screened and mounted on glass slides, according to the technique proposed by Barreto and Coutinho (1940). We identified sand flies based on morphological characters (Galati 2003a), following the phylogenetic classification of Galati (1995, 2003b) and the generic name abbreviations of Marcondes (2007). Because the phylogenetic classification of Galati (1995, 2003b) still remains controversial outside of Brazil, we used the classification of Young and Duncan (1994) in parentheses after the species' name and author. Sand fly vouchers were deposited in the Phlebotomine Collection of the Centro de Pesquisas René Rachou, FIOCRUZ, municipality of Belo Horizonte, State of Minas Gerais.

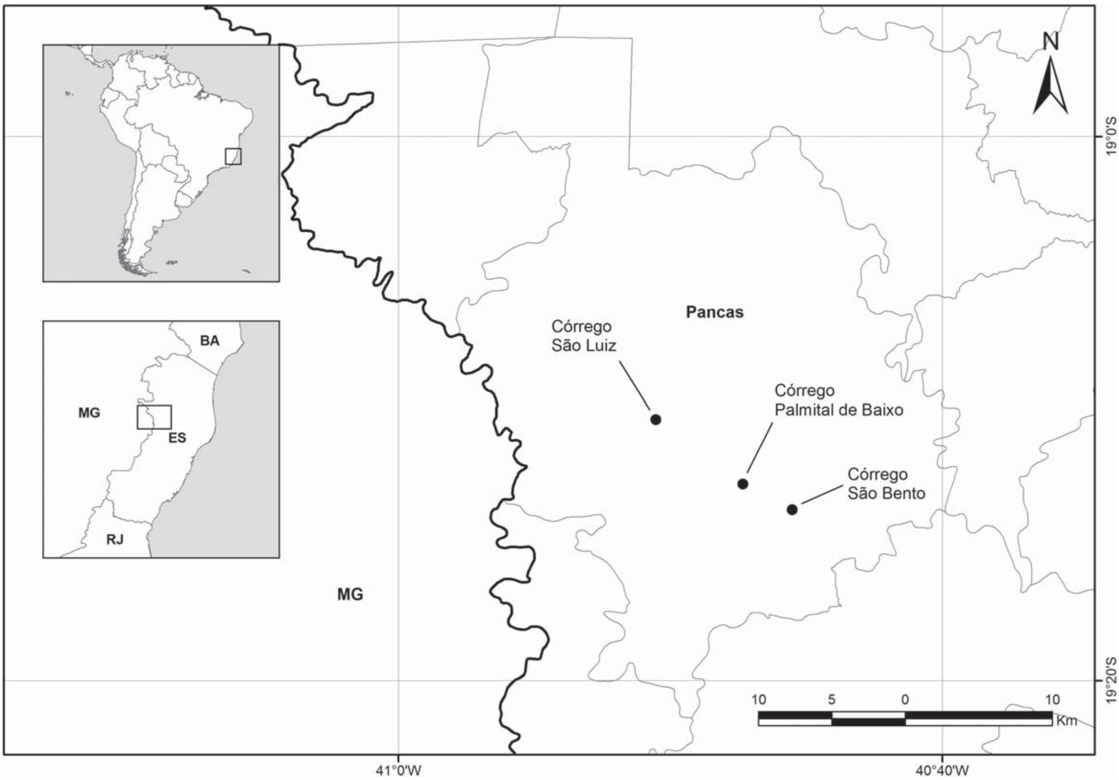

Fig. 1. Map showing collecting localities of sand flies at the National Monument of Pontões Capixabas, municipality of Pancas, State of Espírito Santo, southeastern of Brazil.

Statistical Analyses. We used the program PAST (Hammer et al. 2001) to calculate the species richness (S), and the equitability (J) and Shannon diversity (H) indices.

Results

We collected 21,138 sand flies belonging to 31 species and 14 genera (J = 0.54, H = 1.86). Of this total, 12,412 sand flies were captured in the peridomiciliary environment (S = 19, J = 0.48, H = 1.42) and 8,726 in the forested environment (S = 30, J = 0.59, H = 2.03). We excluded sand flies belonging to *Brumptomyia* spp. (=*Brumptomyia* spp., *sensu;* Young and Duncan, 1994), *Evandromyia* spp. (=*Lutzomyia* spp., *sensu;* Young and Duncan, 1994), and *Pressatia* spp. (=*Lutzomyia (Pressatia)* spp., *sensu;* Young and Duncan, 1994) from our analysis of equitability and diversity. In decreasing order, the three most captured species were *Mg. migonei*, *Pressatia choti* (Floch and Abonnenc, 1941; =*Lutzomyia choti, sensu;* Young and Duncan, 1994), and *Lu. longipalpis* in the peridomiciliary environment, and *Pr. choti*, *Micropygomyia ferreirana* (Barretto, Martins and Pellegrino, 1956; =*Lutzomyia ferreirana, sensu;* Young and Duncan, 1994), and *Mg. migonei* in the forested environment. We collected no specimens of *Lu. longipalpis* in the locality of Córrego Palmital de Baixo, and only a single specimen in the locality of Córrego São Bento (captured in the forested environment). The species *Mg. migonei* and *Ny. intermedia* were collected in both kinds of environment, and in all three localities. The sand fly species *Evandromyia termitophila* (Martins, Falcão and Silva, 1964; =*Lutzomyia termitophila, sensu;* Young and Duncan, 1994) was captured only in the peridomiciliary environment. *Brumptomyia avellari* (Costa Lima, 1942; =*Brumptomyia avellari, sensu;* Young and Duncan, 1994), *Brumptomyia figueiredoi* (Mangabeira and Sherlock, 1961; =*Brumptomyia figueiredoi, sensu;* Young and Duncan, 1994), *Evandromyia sallesi* (Galvão and Coutinho, 1939; =*Lutzomyia sallesi, sensu;* Young and Duncan, 1994), *Evandromyia sericea* (Floch and Abonnenc, 1944; =*Lutzomyia sericea, sensu;* Young and Duncan, 1994), *Martinsmyia gasparviannai* (Martins, Godoy and Silva, 1962; =*Lutzomyia gasparviannai, sensu;* Young and Duncan, 1994), *Micropygomyia capixaba* (Dias, Falcão, Silva and Martins, 1987; =*Lutzomyia capixaba, sensu;* Young and Duncan, 1994), *Pintomyia mamedei* (Oliveira, Afonso, Dias and Brazil, 1994; =*Lutzomyia mamedei, sensu;* Young and Duncan, 1994), *Psathyromyia lutziana* (Costa Lima, 1932; =*Lutzomyia lutziana, sensu;* Young and Duncan, 1994), *Psathyromyia pascalei* (Coutinho and Barretto, 1940; =*Lutzomyia pascalei, sensu;* Young and Duncan, 1994), *Psychodopygus hirsutus* (Mangabeira, 1942; =*Lutzomyia hirsuta, sensu;* Young and Duncan, 1994), *Sciopemyia microps* (Mangabeira, 1942; =*Lutzomyia microps, sensu;* Young and Duncan, 1994), and *Trichopygomyia longispina* (Mangabeira, 1942; =*Lutzomyia longispina, sensu;* Young and Duncan, 1994) were captured only in the forested environment. We recorded the presence of *Pi. mamedei* in the State of Espírito Santo for the first time.

Tables 1 and 2 show the numbers of sand fly specimens, according to species and sex, captured during each collection month and in each one of the three localities, from the peridomiciliary environment and the forested environment. The tables also show the sex ratio, species richness, and equitability and Shannon diversity indices for each collection month. The ratio of males to females was at least two times higher in the peridomiciliary environment than in the forested environment. The success rates of capture were 16.16 sand flies per hour per trap from the peridomiciliary environment and 2.84 sand flies per hour per trap from the forested environment.

Discussion

In the current study, the species richness recorded in the peridomiciliary environment (i.e., the least conserved area) of the NMPC was in accordance with those of previous observations in the peridomiciliary environment of the Atlantic Forest, State of Espírito Santo (Pinto et al. 2010a, 2012a; Virgens et al. 2008). However, when we included in our analyses, specimens captured in the forested environment (i.e., the most conserved area) of the NMPC, the species richness increased significantly. In this regard, our results are in agreement with those of Bock et al. (2007), who demonstrated that correlations between species richness, evenness, and abundance for certain animals and plants supported the validity of species richness as an indicator of overall conservation value of an area (i.e., places with particular conservation value should include those with high species richness, but also those where desirable, e.g., generally rare or threatened, species or groups of species are especially abundant).

The high value of species richness found in the NMPC is also in accordance with those of previous studies that have identified the Central Corridor Region of the Atlantic Forest as a major biodiversity hotspot of the world (Orme et al. 2005). Carnaval et al. (2009) further recognized the Central Corridor Region as a hotspot within the Atlantic Forest hotspot, and a refuge for biodiversity during the climatic extremes of the Late Pleistocene. Based on species richness alone, our data also suggest the Central Corridor Region as a biodiversity hotspot within the Atlantic Forest, because the overall species richness of the NMPC was considerably higher than that of the south region (São Paulo refugium; Galati et al. 2010a,b; Marcondes et al. 2001), and that of the north region (Pernambuco refugium; Andrade et al. 2005, Cortez et al. 2007, Guimarães et al. 2012), of the Atlantic Forest. Considering only the Atlantic Forest within the State of Espírito Santo, the species richness was also the highest recorded (Pinto et al. 2010b, 2012b). It is possible that the high sand fly species richness in the central region of the Atlantic Forest is associated with the high diversity of vertebrates in the area (Costa et al. 2000, Myers et al. 2000, Pinto et al. 2009, Tonini et al. 2010), because many sand fly species show some species-specific preference for the host that provides them with a bloodmeal (Falqueto 1995).

Many previous studies have used species richness as the sole measure of diversity (Harper and Hawksworth 1994, Ricklefs and Schluter 1993). However, other studies have indicated that diversity can change with ecological processes such as competition, predation, and succession. Each of these processes alters the diversity through changes in evenness, without any change in species richness (Stirling and Wilsey 2001, Wilsey and Potvin 2000). In the current study, we therefore also evaluated the Shannon diversity index, which provides diversity information that unites species richness and relative species abundance. In addition, we calculated the Shannon diversity index for previous studies that had not considered species diversity to conduct the comparisons between different areas. In contrast to species richness, we detected no relationship between a high Shannon diversity and hotspots within the Atlantic Forest biome, because of variations in evenness. Nevertheless, the presence of rare species (e.g., *Ev. sericea*, *Pi. mamedei*, and *Mt. gasparviannai*) highlights the conservation value of the NMPC, because rare species can be used as indicator groups for conservation planning (Lawler et al. 2003). We further revealed that, similar to species richness, sand fly diversity in forested environments is clearly higher than that in peridomiciliary areas, even within the same study area (Galati et al. 2010a,b; Pinto et al. 2012a,b).

Our present data therefore indirectly support the hypothesis that high species richness and diversity of sand flies may be associated with high genetic diversity of *Leishmania* parasites. Souza–Rocha et al. (2010) studied natural infection by *Leishmania* in sand fly species collected in the State of Espírito Santo and observed a relationship between high species richness of sand flies and high genetic diversity of *Leishmania* parasites. In addition, Cupollilo et al. (2003) studied the genetic diversity of *Leishmania braziliensis* from different regions of Brazil and observed that parasites isolated from the State of Espírito Santo belonged to two distinct groups: 1) isolates from urban areas clustered with isolates from the State of Rio de Janeiro (lower genetic diversity), and 2) isolates from rural areas clustered with isolates from the State of Pernambuco (higher genetic diversity). The first group is composed of parasites isolated from the municipality of Viana and neighboring municipalities, and the second group consists of parasites isolated from municipalities bordering the NMPC. Indirectly, our data support this hypothesis because the values of species richness and diversity of sand flies that we recorded from the NMPC (second group) were higher than the values recorded from Viana and neighboring municipalities (first group; Barros et al. 1985, Pinto et al. 2010b).

Table 1. Sand flies species collected in peridomiciliary (P) and forest (F) ambients from the localities of Córrego São Luiz, National Monument of Pontões Capixabas, municipality of Pancas, State of Espírito Santo, southeastern of Brazil

Species	Córrego So Luiz										
	2009		2010						Total		
	Dec.		May		July		Dec.				
	P	F	P	F	P	F	P	F	P	F	T
	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	
Brumptomyia figueiredoi (=*Brumptomyia figueiredoi*)		1/						2/		3/	3
Brumptomyia nitzulescui (=*Brumptomyia nitzulescui*)		14/		1/				18/		33/	33
Brumptomyia spp. (=*Brumptomyia* spp.)		/15		/5				/11		/31	31
Evandromyia callipyga (=*Lutzomyia callipyga*)		1/								1/	1
Evandromyia edwardsi (=*Lutzomyia edwardsi*)		/3						/1		/4	4
Evandromyia lenti (=*Lutzomyia lenti*)		/1								/1	1
Evandromyia spp. (=*Lutzomyia* spp.)		/85		/12		/4		/53		/154	154
Evandromyia tupynambai (=*Lutzomyia tupynambai*)		9/		2/	1/	3/		12/	1/	26/	27
Expapillata firmatoi (=*Lutzomyia firmatoi*)				/2				/3		/5	5
Lutzomyia alencari (=*Lutzomyia alencari*)		1/					1/		1/	1/	2
Lutzomyia longipalpis (=*Lutzomyia longipalpis*)	177/14	1/	27/5	1/3	3/3		936/147		1,143/169	2/3	1,317
Micropygomyia capixaba (=*Lutzomyia capixaba*)		5/11		3/15		/2		21/17		29/45	74
Micropygomyia ferreirana (=*Lutzomyia ferreirana*)		88/84	/3	82/111	1/	1/4	1/	47/27	2/3	218/226	449
Micropygomyia quinquefer (=*Lutzomyia quinquefer*)		8/13	/2	1/4					/2	9/17	28
Micropygomyia schreiberi (=*Lutzomyia schreiberi*)		9/4	/1	30/17	1/1	1/	1/1	5/14	2/3	45/35	85
Migonemyia migonei (=*Lutzomyia migonei*)		190/73	19/11	3/8	17/5	/1	1/2	25/40	37/18	218/122	395
Nyssomyia intermedia (=*Lutzomyia intermedia*)	2/1		16/1		38/2		5/5	1/1	61/9	1/1	72
Pintomyia fischeri (=*Lutzomyia fischeri*)		82/76	9/4	4/6	17/3	/1	/3	17/32	26/10	103/115	254
Pintomyia monticola (=*Lutzomyia monticola*)		2/8			/2	/2		/6	/2	2/16	20
Pressatia choti (=*Lutzomyia choti*)	11/	145/		4/		1/		147/	11/	297/	308
Pressatia equatorialis (=*Lutzomyia equatorialis*)	1/	3/						8/	1/	11/	12
Pressatia spp. (=*Lutzomyia* (*Pressatia*) spp.)	/2	/156		/2		/1	/2	/177	/4	/336	340
Psathyromyia lutziana (=*Lutzomyia lutziana*)		1/						/1		1/1	2
Psathyromyia pascalei (=*Lutzomyia pascalei*)		2/		10/6				8/		20/6	26
Psychodopygus hirsutus (=*Lutzomyia hirsuta*)								/1		/1	1
Sciopemyia microps (=*Lutzomyia microps*)		2/		2/3				2/1		6/4	10
Sciopemyia aff. microps (=*Lutzomyia aff. microps*)			/2	/1	/1			/9	/3	/10	13
Trichopygomyia longispina (=*Lutzomyia longispina*)		1/				1/				2/	2
Total	208	1,094	100	338	95	22	1,105	707	1,508	2,161	3,669
Sex ratio male/female	11.23	1.06	2.45	0.74	4.58	0.47	5.90	0.79	5.76	0.90	1.70
Specific richness	4	21	8	17	9	9	7	19	13	25	25
Equitability index	0.22	0.60	0.76	0.58	0.69	0.91	0.06	0.72	0.23	0.64	0.59
Shannon diversity	0.31	1.83	1.60	1.66	1.51	2.00	0.11	2.14	0.59	2.07	1.91

Brumptomyia spp., *Evandromyia* spp., and *Pressatia* spp. refer to females that cannot be morphologically separated within their genus.
We give the name in parentheses according to Young and Duncan (1994) for each species.
T, total.

Table 2. Sand flies species collected in peridomiciliary (P) and forest (F) ambients from the localities of Córrego Palmital de Baixo and Córrego São Bento, National Monument of Pontões Capixabas, municipality of Pancas, State of Espírito Santo, southeastern of Brazil

Species	Córrego Palmital de Baixo							Córrego So Bento						
	2010		2011		Total			2011				Total		
	Sept.		Oct.					Feb.		May				
	P	F	P	F	P	F	T	P	F	P	F	P	F	T
	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀		♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	♂/♀	
Brumptomyia avellari (=*Brumptomyia avellari*)		1/		2/		3/	3							
Brumptomyia figueiredoi (=*Brumptomyia figueiredoi*)		7/				7/	7		1/				1/	1
Brumptomyia nitzulescui (=*Brumptomyia nitzulescui*)		52/		4/		56/	56	1/	4/	1/	17/	2/	21/	23
Brumptomyia spp. (=*Brumptomyia* spp.)	/1	/30	/1	/3	/2	/33	35	/2	/7	/1	/2	/3	/9	12
Evandromyia callipyga (=*Lutzomyia callipyga*)		1/	1/		1/	1/	2							
Evandromyia edwardsi (=*Lutzomyia edwardsi*)		/5	/1	/6	/1	/11	12		2/6		2/6		4/12	16
Evandromyia lenti (=*Lutzomyia lenti*)								3/3				3/3		6
Evandromyia sallesi (=*Lutzomyia sallesi*)		1/				1/	1							
Evandrmyia sericea (=*Lutzomyia sericea*)		/1				/1	1							
Evandromyia spp. (=*Lutzomyia* spp.)		/27		/25		/52	52		/8		/3		/11	11
Evandromyia termitophila (=*Lutzomyia termitophila*)			/1		/1		1							
Evandromyia tupynambai (=*Lutzomyia tupynambai*)		13/		11/		24/	24		2/				2/	2
Expapillata firmatoi (=*Lutzomyia firmatoi*)	/2	4/12			/2	4/12	18	/7	12/36		/3	/7	12/39	58
Lutzomyia alencari (=*Lutzomyia alencari*)	1/	2/2			1/	2/2	5							
Lutzomyia longipalpis (=*Lutzomyia longipalpis*)									/1				/1	1
Martinsmyia gasparviannai (=*Lutzomyia gasparviannai*)		/1				/1	1							
Micropygomyia capixaba (=*Lutzomyia capixaba*)		/3		/2		/5	5		1/11				1/11	12
Micropygomyia ferreirana (=*Lutzomyia ferreirana*)	24/16	557/690	/1	13/17	24/17	570/707	1,318		14/16	/1	6/11	/1	20/27	48
Micropygomyia quinquefer (=*Lutzomyia quinquefer*)		3/				3/	3	15/70	36/88		/2	15/70	36/90	211
Micropygomyia schreiberi (=*Lutzomyia schreiberi*)	5/	35/17	2/1	9/8	7/1	44/25	77	6/5	103/65		3/9	6/5	106/74	191
Migonemyia migonei (=*Lutzomyia migonei*)	5/4	32/43	281/139	10/8	286/143	42/51	522	3,586/1,309	248/233	90/41	5/47	3,676/1,350	253/280	5,559
Nyssomyia intermedia (=*Lutzomyia intermedia*)	21/7	25/9	348/205	/2	369/212	25/11	617	224/87	358/81	15/13	/1	239/100	358/82	779
Pintomyia fischeri (=*Lutzomyia fischeri*)	4/1	128/39	61/24	4/4	65/25	132/43	265	429/180	215/75	10/6	1/10	439/186	216/85	926
Pintomyia mamedei (=*Lutzomyia mamedei*)			/1		/1		1							
Pintomyia monticola (=*Lutzomyia monticola*)		/2	/1		/1	/2	3		/1				/1	1
Pressatia choti (=*Lutzomyia choti*)	32/	1,279/	263/	90/	295/	1,369/	1,664	2,093/	280/	118/	38/	2,211/	318/	2,529
Pressatia equatorialis (=*Lutzomyia equatorialis*)								3/				3/		3
Pressatia spp. (=*Lutzomyia* (*Pressatia*) spp.)	/15	/681	/144	/103	/159	/784	943	/828	/324	/141	/38	/969	/362	1,331
Psathyromyia lutziana (=*Lutzomyia lutziana*)				/2		/2	2		/2		/2		/4	4
Psathyromyia pascalei (=*Lutzomyia pascalei*)		42/14		3/1		45/15	60		2/1		2/1		4/2	6
Psychodopygus hirsutus (=*Lutzomyia hirsuta*)		6/2				6/2	8				1/3		1/3	4
Sciopemyia microps (=*Lutzomyia microps*)		3/7				3/7	10		1/		1/1		2/1	3
Sciopemyia aff. microps (=*Lutzomyia aff. microps*	/1	/3	/1	/1	/2	/4	6	/2	/4		/3	/2	/7	9
Trichopygomyia longispina (=*Lutzomyia longispina*)		/1				/1	1							
Total	129	3,780	1,476	328	1,615	4,108	5,723	8,853	2,238	437	218	9,290	2,454	11,744
Sex ratio	1.95	1.37	1.83	0.80	1.84	1.31	1.44	2.55	1.33	1.15	0.53	2.44	1.22	2.09
Specific richness	9	25	12	14	14	26	28	11	20	6	15	12	19	22
Equitability index	0.75	0.43	0.51	0.69	0.53	0.44	0.51	0.43	0.65	0.64	0.78	0.42	0.67	0.43
Shannon diversity	1.64	1.40	1.27	1.84	1.40	1.45	1.72	1.04	1.94	1.14	2.12	1.05	2.00	1.35

Brumptomyia spp., *Evandromyia* spp. and *Pressatia* spp. refer to females that cannot be morphologically separated within their genus.
We give the name in parentheses according to Young and Duncan (1994) for each species.
T, total.

In the current study, we also evaluated the vector dynamics of leishmaniasis-endemic areas in the Atlantic Forest, which is relevant to the epidemiology of leishmaniasis. We revealed that the human population in the endemic area of NMPN is exposed to risk of infection by *Leishmania* throughout the year, because *Lu. longipalpis* was always captured in the peridomiciliary environment. Furthermore, we propose that infection occurs in the peridomiciliary environment, because sand flies vectors of all species were more abundant in this environment. Pinto et al. (2012a) also demonstrated a high abundance of sand fly vectors in the peridomiciliary environment of endemic areas of American VL, across the Central Atlantic Forest Biodiversity Corridor. Epidemiological surveys of human and canine visceral infections caused by *L. infantum* in rural areas of the municipality of Pancas have revealed similar findings (Falqueto et al. 2009). These surveys showed no significant differences in *L. infantum* infection rates within the human population according to gender or age, indicating that transmission occurs in the home and in the peridomestic setting. The occurrence of human infections caused by *Leishmania* in the peridomiciliary environment of the Atlantic Forest (Rangel 1995, Tolezano 1994) contrasts with the Amazon region, where almost all human infections caused by *Leishmania* are associated with wild environments (Guerra et al. 2011, Martins et al. 2004).

Based on the results of our current study, we believe that *Lu. longipalpis* is the main vector of *L. infantum* in the NMPC, and that *Mg. migonei* plays an no evident role. These assertions are supported by the absence of *Lu. longipalpis,* and the presence of *Mg. migonei,* in the peridomiciliary environments of areas with no recent records of *L. infantum* (Córrego Palmital de Baixo), and in areas where *L. infantum* has never been recorded (Córrego São Bento). By contrast, *Mg. migonei* acts as vector of *L. infantum* in an area of the State of Pernambuco, in the northern portion of the Atlantic Forest (Carvalho et al. 2010), and appears to act as vector in the City of La Banda, Argentina (Salomón et al. 2010).

In conclusion, we have demonstrated that species richness and diversity of sand flies is congruent with biodiversity hotspots of the Atlantic Forest. Furthermore, species richness and diversity of sand flies might be associated to the genetic diversity of the *Leishmania* parasite. Epidemiologically, we have reinforced the relationship between peridomiciliary and domiciliary environments, and the transmission pattern of *Leishmania* parasites in the Atlantic Forest. Finally, our data indicate *Lu. longipalpis* as the vector of *L. infantum* within our study area.

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