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ECOSYSTEMS

Sandfly Fauna (Diptera: Psychodidae, Phlebotominae) of São José Farm, Carmo District, State of Rio de Janeiro, Brazil

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Abstract: Aiming to compare and update the sand fly fauna of São José farm, Carmo District, Rio de Janeiro State, Brazil, and considering the environmental changes occurred, the biology and ecology of the local sandfly species were examined twelve years later as a complementary study carried. Captures were made in the intra, peridomicile and in the woods, from 6 p.m. to 6 a.m. 1210 sandflies of fifteen species of the *Lutzomyia* were captured: *L. intermedia, L. whitmani, L. lenti, L. aragaoi, L. cortelezzii, L. quinquefer, L. carrerai carrerai, L. davisi, L. lanei, L. fischeri, L. monticola, L. ayrozai, L. sordellii*, *L. lutziana*, *L.* sp and two species of the *Brumptomyia* Kind*: B. brumpti* and *B. cardosoi.* In 1994 and 1995 were collected 4603 samples from six species of the former genus and three of the second. *Lutzomyia intermedia* was predominant, in the intra and in the peridomicile, in both periods. *B. bumpti*, collected only in the recent prevailed i n the woods. Six species implicated as vector of *Leishmania*: *L. intermedia*, *L. whitmani*, *L. ayrozai*, *L. fischeri*, *L. davisi*, *L. carrerai carrerai* and *L. migonei* have been collected in the area, however, this last only in the previous study.

Key words: Carmo, sandfly, São Jose farm, vector.

INTRODUCTION

About 544 species of sandflies are found in the Americas, of which 527 presently exist and 17 are fossils (Galati 2018).

In Brazil, sandflies (Diptera: Psychodidae, Phlebotominae) of the genus *Lutzomyia* França, 1924 act as the invertebrate hosts for the species of the genus *Leishmania* Ross, 1903 (Kinetoplastida: Trypanosomatidae) that cause leishmaniasis in humans and other mammals (Young & Duncan 1994).

In the southeast region, 125 species of sandflies have been recorded so far. According to Carvalho et al. (2014), 65 species are present in the state of Rio de Janeiro. *Lutzomyia* (*Nyssomyia*) *intermedia* (Lutz and Neiva, 1912) is the main vector of *Leishmania* (*Viannia*) *braziliensis* Vianna, 1911 that causes American tegumentary leishmaniasis (ATL) in this State (Alves 2007).

According to the Ministério da Saúde (2019), 218.281 confirmed cases of ATL were registered in whole of Brazil from 2007 to 2017. Of these, 702 cases were reported in the State of Rio de Janeiro.

The prevalence of *L. intermedia* over other species of sandflies was registered in different regions of the State of Rio de Janeiro (Menezes et al. 2002, Aguiar & Vieira 2018).

Studies indicate that the shelters for domestic animals in rural areas help in the colonization of sandflies as they find food in these places (Alves 2007).

Studies on the impact of environmental, natural or those resulting from anthropic changes in the ecology of sandflies have been carried out in different regions of the country (Forattini 1960, Lima et al. 1988, Rangel et al. 1990, Menezes et al. 2002).

In the district of Carmo, nine cases of tegumentary leishmaniasis were notified from 2000 to 2006, eight of them occurred in the rural area. The occurrence of the first human case in the central area of district was recorded by Alves (2007), being *L. intermedia* the predominant species.

In 1994, one person, from a family of four, had cutaneous leishmaniasis (CL), worked at home and had no activity at night. The description of place was made by Alves (2007).

In 2006, only one couple the man worked on the farm and the woman elsewhere. The property had no shelters with pets except a dog. Thus, the anthropic actions have been reduced over the years.

In the peridomicile there are eight fruit trees. All these trees have been preserved since 1994, which was recorded by Alves (2007) (Figures 1 and 2).

The inhabitants reported that animals such as anteaters, lizards, monkeys, armadillos and snakes occasionally appeared in the peridomicile, which was not the case with previous work.

The present study aimed to observe the changes in the sand fly fauna and in the of *Leishmania* spp. in a São José Farm, district of Carmo, considering the environmental changes where it took place. To do that, results of captures carried out in the 1994 and 1995 by Alves (2007) and those between 2006 and 2007 in the same district were compared.

Figure 1. The house and the peridomicile where the first autochthonous cases of leishmaniasis occurred in 1994.

Figure 2. The house of 1994 in 2006, when started the second period of research of sand flies fauna of São José farm, Carmo county, RJ, Brazil.

MATERIALS AND METHODS

Study area

The district of Carmo is located at 21º 56` 04`` S and of 42º 36` 31`` W in the physiographic zone of the Rio Paraiba do Sul marginal, bordering the districts of Cantagalo, Duas Barras, Sapucaia, Sumidouro and the State of Minas Gerais (Fig. 3).

According to Köppen-Geiger classification (2016), adapted to Brazil, the region of Carmo is Aw (high temperatures rains in the summer), with an average temperature between 19°C and 28°C and the average of rainfall inferior to 2000 mm/per year. The vegetation which covers the district is likewise those found in Mata Atlântica (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, [IBGE] 2016).

Collection of specimens

Sandflies were collected at São José farm, at the same location as that in the first study (1994/1995), and the same methodology was used in both studies by Alves (2007). For clarification and mounting of the specimens, the technique of Young & Perkins (1984), modified by Aguiar et al. (1993), was used. The identification of the species of the *Lutzomyia* França, 1924 and *Brumptomyia* França & Parrot, genera was undertaken in accordance with Young & Duncan (1994) and Forattini (1973), respectively.

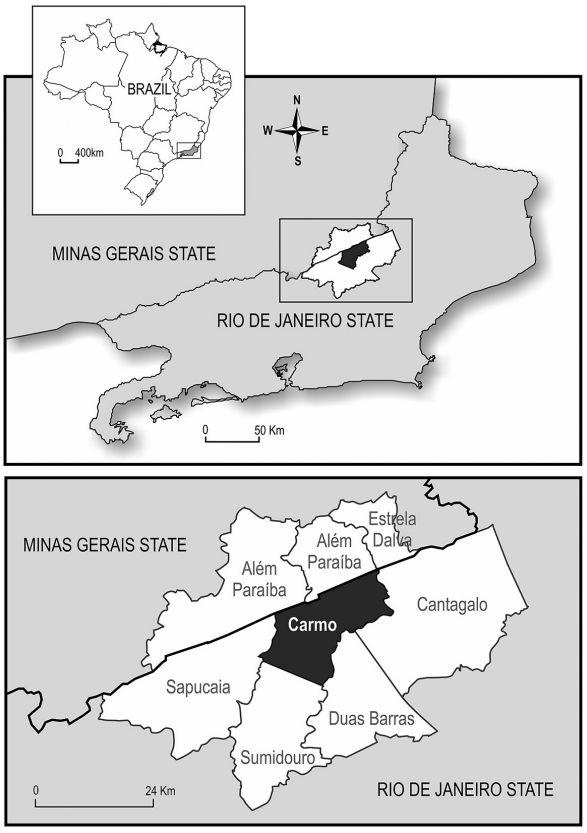

Figure 3. Localization of Rio de Janeiro State, Brazil and Carmo County with its neighboring municipalities.

Statistical analysis

We used the diversity indexes of Shannon and Simpson and applied the tests to identify significant differences between the two study periods (Rodrigues 2014). The analysis of the data was performed using the (ISA) and the standardized species abundance index (SISA), (Roberts & Hsi 1979) to classification based on the absolute abundance ISA and SISA were calculated using Microsoft Excel 2013 (Microsoft Corp., Redmond, WA, USA) and converted values between 0 and 1 (SISA), based on the following equations:

$$ISA = (a + RJ) / k$$

SISA = (c- ISA) / (c-1) where: K = capture number

a = value obtained by multiplying the species absence number (NAE) in k catches per c.

c = value of the highest position of the species in k catches plus 1.

RJ = sum of classifications in each species

The species were considered highly abundant when the SISA value was near to 1.0. This calculation was applied to all captured sandflies and to each type of collection performed in both periods.

RESULTS

From August 2006 to July 2007, 17 sandfly species were captured at São José farm, of which 15 belonged to the genus *Lutzomyia* and 2 species were from the genus *Brumptomyia*. The species list was published by Carreira-Alves (2008).

L. intermedia was the predominant species in all of the locations (93.3%). The manual aspiration, 38.6% of the specimens were collected in the intradomicile and 61.4% in the peridomicile (22.3% from the external of the residence, 39.1% in the tree trunks). In the forest, where the number of female specimens were slightly higher than of males, only four. In the collections with Castro aspirator, in both periods, the male was predominant. In 1994/95, the proportion of male / female specimens was 1.9: 0.52 and 1.14: 0.87 in 2006/07. It is observed that the number of males was more significant in the first period, while that of females was in the second period. In relation to the peridomicile, we found the highest value among males 17.7, while the lowest was among females (0.06) in 1994/95. In 2006/07, the ration between, the female / male ratio was higher (0.19) and the male / female ratio, lower (5.28) (Table I).

In the collections with CDC trap in the peridomicile the highest male / female ratio

Table I. Number of sand flies species collected with Castro captor and CDC light trap on São José farm, District of Carmo, State of Rio de Janeiro, Brazil, from August to July in the periods of 1994/1995 and 2006/2007.

Species	Manual Gathering *				CDC Trap *					Manual Gathering **				CDC Trap **				
	Intradomicile		Peridomicile		Peridomicile		Woods		M/F	Intradomicile		Peridomicile		Peridomicile		Woods		M/F
	M	F	M	F	M	F	M	F	%	M	F	M	F	M	F	M	F	%
Lutzomyia intermedia	480	248	2871	162	406	341	24	22	98.9	105	92	264	50	362	232	9	15	93.3
Brumptomyia brumpti														1		15	14	2.5
L. aragaoi																8	7	1.2
L. cortelezzii															3		4	0.6
L. whitmani	2		10		3		4		0.4	1				2		2		0.4
L. . ayrozai				1					0.02							2	2	0.3
L. davisi																4		0.3
L. fischeri																	3	0.2
L. monticola														1		2		0.2
L. lanei																	2	0.2
L. quinquefer			1						0.02						2			0.2
L. carrerai carrerai														1				0.1
L. lenti		3	2	1	4	2			0.3						1			0.1
L. lutziana																1		0.1
L. sordellii																1		0.1
L. migonei.			2		4	1		1	0.2									
Lutzomyia sp.																	1	0.1
B. avellari					2		4		0.13									
B. cardosoi																1		0.1
B. guimaraesi								1	0.02									
B. nitzulescui							1		0.02									
Total	**482**	**251**	**2886**	**164**	**419**	**344**	**33**	**24**	**100**	**106**	**92**	**264**	**50**	**367**	**238**	**45**	**48**	**100**

M = Male; F = Female.
*** = 1994/1995; ** = 2006/2007.**

occurred in 2006/07 (1.56), while the lowest (0.6) occurred in the forest in this same period, when the females were more numerous than males, while for *B. brumpti* the most collected species was 1.07: .69. In total, the forest collections were balanced (0.9: 1.0). In the intradomicile, *L. intermedia* was the most common species with a frequency of 99 % which reached a peak in March 1995 and August 2006, when the temperature was of 25°C and 24°C, respectively (Fig. 4). The second *L. intermedia* peak occurred in September, from both periods, with 30 and 18 sandflies collected in each of them, with a temperature of 21º C and 20º C. In 1994/95, there was a higher frequency in the hot and wet period (January, February and March) with 158 sandflies, representing 63.7 % of the total and the lowest occurred in cold and dry months (June, July and August) with 16 sandflies (6.45%). In 2006/07, the highest frequency was recorded in the cold

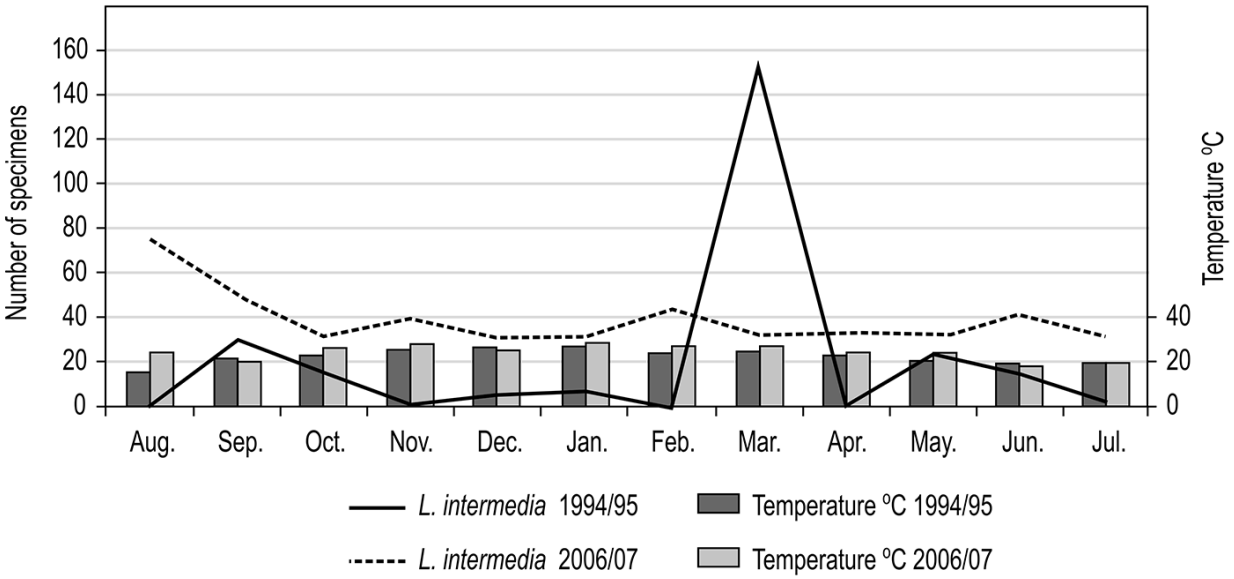

Figure 4. Total of females' specimens of *L. intermedia* collected with Castro captor, in relation to the temperature from August to July 1994/95 and 2006/07 on the São José farm, Carmo county, RJ, Brazil.

and dry period, with 53 sandflies (57.6%) and the lowest in the warmer and wetter months, with only 12 (13%) specimens. *B. brumpti* was the second most common species, with a recorded of 2.5%, when all the sites of capture were observed. In the frequency of this species was of 31.2%, followed by *L. intermedia* with 25.8%.

Comparing the years 1994/95 and 2006/07, it was found that *L. intermedia* remained with the largest number of specimens, which in previous years was even higher 98.9%. *L. migonei* representing 0.2% was not found in this posterior phase study (Table II).

As seen in Table III, a total of specimens were collected in 1994/95 and 2006/07 using a Castro aspirator, presenting a SISA of 0.875 and specimens collected in 1994/95 and banana tree with an abundance of 200 specimens being captured in 2006/07, followed by *L. whitmani*, which was only collected in 2006/07 inside the house, with a very low index (0.021) and only one specimen collected. *L. intermedia* was predominant in all locations and periods of collection, but was more abundant in 1994/95 than in 2006/07.

Analyzing the statistical results of internal and external walls of the residence, we observed that *L. intermedia* was more abundant in the interior of the wall (0.833) and in the external (0.604) in 1994/95.

In Table IV, a total of 1.511 specimens were collected using light traps. *L. intermedia* was the more abundant species in all locations of collection, especially in the peridomicile and stye (0.701 and 0.618, respectively), followed by *B. brumpti* (0.324). *L. aragaoi* (0.167) and *L. davisi* (0.106) in the forest. *L. migonei*, which was collected in 1994/95 in the stye and forest, 0.014.

When we compare the diversity of the phlebotomine fauna captured in the forest, we can establish that: In 1994 and 1995, sand flies were collected during four months, totalizing five species. In October, a peak of *L. whitmani* occurred with four specimens, followed by *L. migonei* in a unique way, at a temperature of 23º C. We were struck by the fact that during the other three months only phlebotomines

Table II. Quantitative comparison and composition of the sandfly fauna of São José farm, District of Carmo, State of Rio de Janeiro, Brazil, from August 1994 to July 1995 and August 2006 to July 2007.

Species/Year	1994/1995	%	2006/2007	%
Lutzomyia intermedia	4554	98.9	1129	93.3
Brumptomyia brumpti			30	2.5
L. aragaoi			15	1.2
L. whitmani	19	0.4	5	0.4
L. lenti	12	0.3	1	0.1
L. migonei	8	0.2		
L. cortelezzii			7	0.6
B. avellari	6	0.1		
L. ayrozai	1	0.02	4	0.3
L. davisi			4	0.3
L. fischeri			3	0.2
L. monticola			3	0.2
L. quinquefer	1	0.02	2	0.2
L. lanei			2	0.2
L. carrerai carrerai			1	0.1
L. lutziana			1	0.1
L. sordellii			1	0.1
B. guimaraesi	1	0.02		
B. nitzulescui	1	0.02		
Lutzomyia sp.			1	0.1
B. cardosoi			1	0.1
Total	**4603**		**1210**	

of the genus *Brumptomyia* were collected. In September and May *B. avellari* were collected, with one specimen, in the first month and three in the other, with 21º C and 20º C in both months respectively, while in July, *B. nitzulescui* and *B. guimaraesi* were collected with a single specimen of each and with the lowest temperature (19º C) during all four months. This demonstrates a preference for cold and dry weather for species of this genus. It is also observed that in August at a temperature of 15º C, no phlebotomes were captured.

In 2006 and 2007, phlebotomes were registered during nine months, with a finding of twelve species, being ten of them of the genus *Lutzomyia* and two of them of *Brumptomyia*. It is worth pointing the fact that *B. brumpti* and *L. aragaoi* were found in eight and five months each species. Besides, *B. brumpti* presented two peaks, both with eight phlebotomes, in February and June, at a temperature of 27º C and 18º C respectively, in the hot and humid as well as cold and dry periods, followed by a third peak, with six specimens, in April, with a temperature

Table III. Total (T) of sand flies by places of captures with Castro captor in inner and outer wall of the house, in tree trunk, banana tree and sty. Standartized index of species Abundance (SISA) and Rank (R) in São José farm, municipality of Carmo, State of Rio de Janeiro, Brazil, from August to July in the periods of 1994/1995 and 2006/2007.

	Inner of the house*			**Outer of the house***			**Tree trunk***			**Sty***		
Species	T	SISA	R	T	SISA	R	T	SISA	R	T	SISA	R
L. intermedia	728	0.833	1	258	0.604	1	1432	0.875	1	1343	0.771	1
L. lenti	3	0.042	2	1	0.021	2	2	0.042	3	1	0.042	2
L. whitmani	2	0.021	3	1	0.021	2	9	0.083	2	˝	˝	˝
L. migonei	˝	˝	˝	˝	˝	˝	1	0.028	4	1	0.021	3
L. ayrozai	˝	˝	˝	˝	˝	˝	˝	˝	˝	1	0.021	3
Total	**733**			**260**			**1444**			**1346**		
	Inner of the house**			Outer of the house**			Banana Tree**					
Species	T	SISA	R	T	SISA	R	T	SISA	R			
L. intermedia	197	0.167	1	114	0.542	1	200	0.667	1			
L. whitmani	1	0.021	2	˝	˝	˝	˝	˝	˝			
	931			**374**			**1644**					
* =1994/1995; ** = 2006/2007.												

of 24º C. It was also recorded that in January and November (28ºC) was the highest temperature of this period, and two specimens of *B. brumpti,* were captured in both months.

L. aragaoi showed a peak in April, with eight phlebotomes and in February with three phlebotomes, with 24º C and 27º C, in each month. It was captured uniquely in January, when the highest temperature (28ºC) was recorded. In September, at the lowest temperature (20ºC), two specimens of *L. aragaoi* were captured. It is suggested this species is adapted to low and high temperature in the forest environment of the studied area.

In order to continue evaluating the diversities collected in the peridomicile with CDC trap in 1994/1995 and 2006/2007 on the São José farm, we highlight that:

In 1994/95, the CDC trap was placed in the pig pen for seven months, *L. lenti*, *L. migonei*, *L. whitmani* and *B. avellari* were collected. *L. lenti* was the most abundant species of all, with a peak in January, when the highest temperature (27º C) of the period was recorded. This species was ticked in February, too. In this month, the predominant species was *L. migonei*, being recorded the temperature of 25º C.

L. whitmani was also collected in January, but with two specimens. During the months of March, August, September, October and November, only one species of each was collected. In August and September, the coldest and dryest ones with 15º C and 21º C, respectively, *B. avellari* were collected, while *L. migonei* occurred in March and November, with one and two phlebotomes in each month, at 25º C and 26º C. In October, at a cooler temperature, 23° C, *L. whitmani* was collected.

In 2006/2007, in the peridomicile and with CDC trap four species were collected, two

Table IV. Total (T) of sand flies by places of captures with CDC light traps in Sty, Forest and Peridomicile. Standarsed Index of species abundance (SISA) and Rank (R) in São José farm, municipality of Carmo, State of Rio de Janeiro, Brazil, from August to July in the periods of 1994/1995 and 2006/2007.

	CDC light Sty*			CDC light Forest*			CDC light Peridomicile**			CDC light Forest**		
Species	**T**	**SISA**	**R**	**T**	**SISA**	**R**	**T**	**SISA**	**R**	**T**	**SISA**	**R**
L. intermedia	747	0.618	1	46	0.25	1	585	0.701	1	24	0.394	1
L. lenti	6	0.049	4	˝	˝	˝	1	0.035	5	˝	˝	˝
L. migonei	5	0.103	2	1	0.014	6	˝	˝	˝	˝	˝	˝
L. whitmani	3	0.028	6	4	0.056	4	2	0.049	4	2	0.032	11
L. cortellezzii	˝	˝	˝	˝	˝	˝	3	0.063	3	4	0.065	6
L. quinquefer	˝	˝	˝	˝	˝	˝	2	0.049	4	˝	˝	˝
L. carrerai carrerai	˝	˝	˝	˝	˝	˝	1	0.021	7	˝	˝	˝
L. monticola	˝	˝	˝	˝	˝	˝	1	0.083	2	2	0.032	11
B. brumpti	˝	˝	˝	˝	˝	˝	1	0.028	6	29	0.324	2
B. avellari	2	0.083	3	4	0.083	2	˝	˝	˝	˝	˝	˝
B. guimaraesi	1	0.033	5	2	0.075	3	˝	˝	˝	˝	˝	˝
B. nitzulescui	˝	˝	˝	1	0.035	5	˝	˝	˝	˝	˝	˝
L. aragaoi	˝	˝	˝	˝	˝	˝	˝	˝	˝	15	0.167	3
L. davisi	˝	˝	˝	˝	˝	˝	˝	˝	˝	4	0.106	4
L. fischeri	˝	˝	˝	˝	˝	˝	˝	˝	˝	4	0.074	5
L. lanei	˝	˝	˝	˝	˝	˝	˝	˝	˝	2	0.046	7
L. ayrozai	˝	˝	˝	˝	˝	˝	˝	˝	˝	4	0.042	8
L. lutziana	˝	˝	˝	˝	˝	˝	˝	˝	˝	1	0.042	8
L. sordellii	˝	˝	˝	˝	˝	˝	˝	˝	˝	1	0.042	8
B. cardosoi	˝	˝	˝	˝	˝	˝	˝	˝	˝	1	0.023	13
Total	**764**			**58**			**596**			**93**		

*** = 1994/1995; ** = 2006/2007; *L. = Lutzomyia; B.= Brumptomyia.***

of them in the cold and dry period (June and August), another during the hot and humid period (February) and the last one in November.

In February, three species were collected: *L. lenti, L. cortelezzii* and *L. whitmani*, being one specimen of the first and two of the latter, in November it was one specimen of *L. carrerai carrerai* and two of *L. quinquefer*, while in June and August one of *B. brumpti* and *L. monticola* in each. *L. lenti* was caught in both periods and in February, as so was *L. whitmani*, however in January and October at that time. Considering the temperature, the lowest one was 18º C registered in June, being *B. brumpt* to be collected and the highest 28 ° C in November with *L. carrerai carrerai* and *L. quinquefer* collected (Fig. 5).

The index of total abundance showed that *L. intermedia* was the most abundant species in 1994/95 (0.917) and 2006/07 (0.906) (Fig. 6).

The student test revealed significant differences between the predominance of *L. intermedia* in 1994/95 and 2006/07 in all locations of collection, except for the external wall (t = 2.014; p = 0.050042; v (GL) = 45).

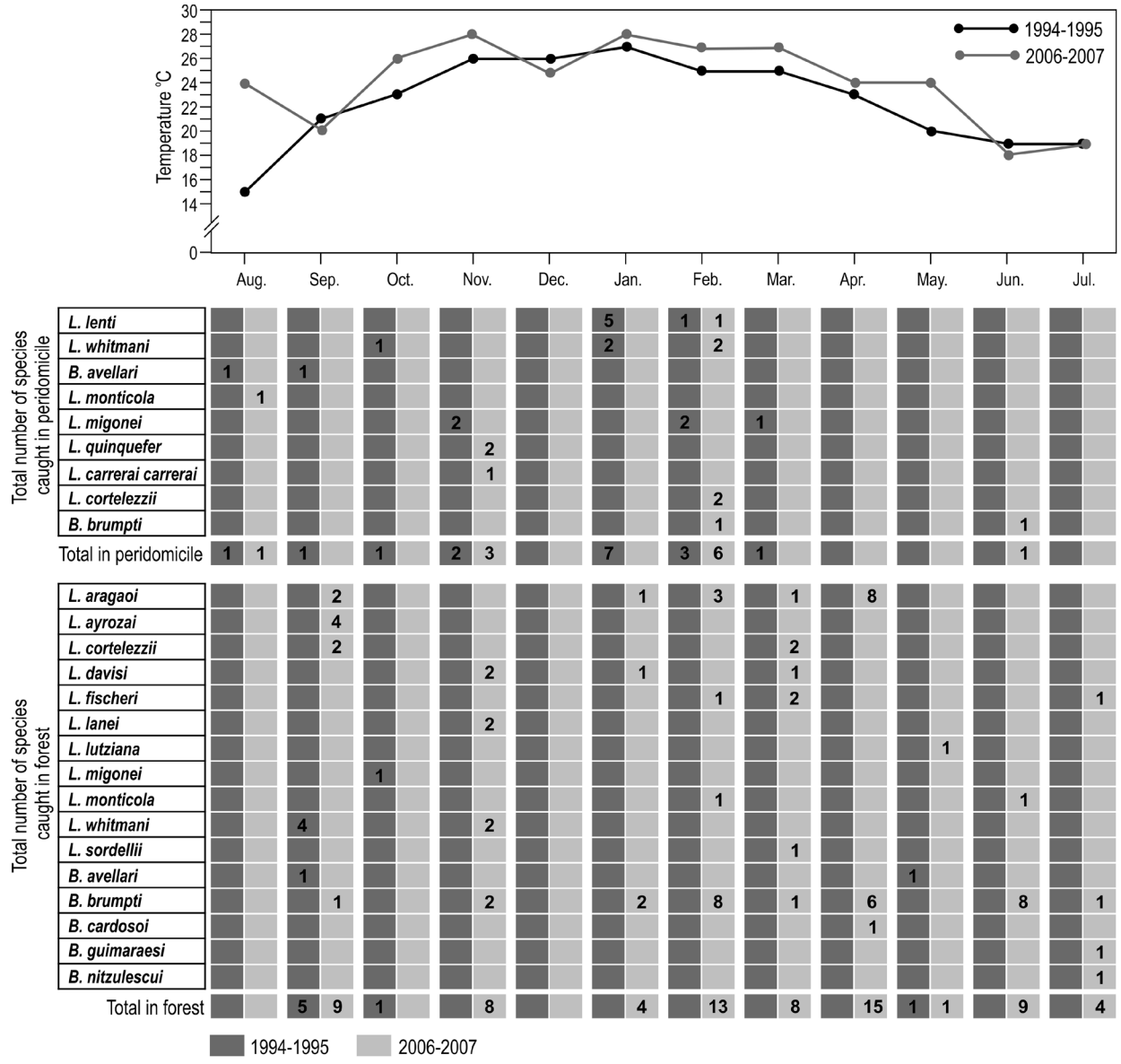

Figure 5. Total of diversity of species collected with CDC traps, in relation to the temperature, in peridomicile and in the forest from August to July 1994/95 and 2006/07 on the São José farm, Carmo county, RJ, Brazil.

DISCUSSION

The highest richness of species occurred in the woods, however, the greatest number of species occurred in the peridomicile. According to Ximenes et al. (2007), the greatest diversity of sandflies found in Alto Apodi in the State of Rio Grande do Norte, is probably due to the lowest level of environmental degradation in the mountain areas.

As observed by Alves (2007) and in the present study, *L. intermedia* is endowed with a great capacity of domiciliation and adaptation to the anthropic environment, at the same time that a smaller population continues to be present in a preserved area.

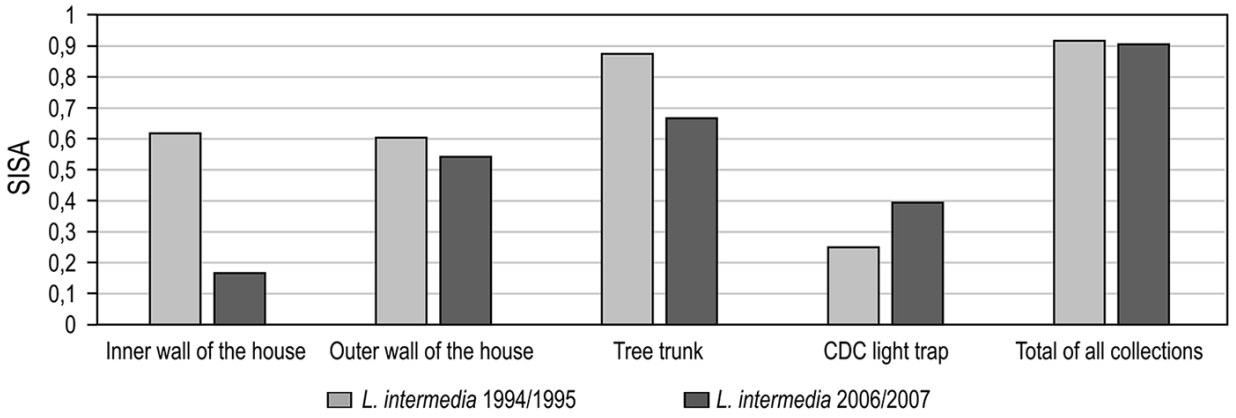

Figure 6. Comparation of Standarsed Index Species Abundance (SISA) for *L. intermedia* captured with Castro captor, CDC trap in the forest and the total of all collection in São José farm, in the periods of 1994/95 and 2006/07.

According to Teodoro et al. (2001a, b), the domestic animal shelters built close to the domicile and the absence of good hygiene conditions in the peridomicile, seem to favor the concentration of sandflies in this site of gathering. In our research, we observed that the frequency in both periods were basically the same, the data do not show there, because in the former period when there were animals in the peridomicile, *L. intermedia* was much more numerous.

In 1994/95, *L. intermedia* was more frequent in the summer and less frequent in winter. In 2006/07, we observed a higher frequency in winter and a lower frequency in the fall with featuring significant peaks in the months of February, August and November. This result suggests that *L. intermedia* managed to ideally adapt for its own reproduction, maintenance and survival.

Although *L. intermedia* had been collected in considerable amount and had been predominant during all the period, its frequency was not regular, corroborating observation of Forattini et al. (1976) and Santos-de-Marco et al. (2002).

It was evident that the seasonality did not represent a barrier to the adaptation and survival of *L. intermedia* to the anthropic place, this sandfly was more frequent in summer what increases the probability of the transmission had been occurred during this season.

Carreira-Alves et al. (1998) reported the finding of *L. intermedia* and *L. migonei*, in an area with occurrence of visceral leishmaniasis, in Barra da Tijuca, west of the city of Rio de Janeiro. *L. intermedia* was the predominant species. In addition, these authors called attention to the fact that *L. longipalpis* was not found. Species is the main vector of *Le. (Leishmania) infantum chagasi,* the etiologic agent of visceral leishmaniasis.

L. migonei was found naturally infected with *Leishmania (V.) braziliensis* in Jacarepagua, municipality of Rio de Janeiro by Pita-Pereira et al. (2005). Considering this and other literatures this species can be considered as secondary vector of cutaneous leishmaniasis in the State of Rio de Janeiro.

Alves (2007) registered the presenc of *L. migonei* in Carmo, except for the intradomicile, but with a low frequency. However, this sandfly was not found, abandonment by may have contributed to the migration of the population of *L. migonei* that existed there to a nearby secondary forest.

In this study, we have recorded the presence of armadillo burrows, an animal which is used as a source of feeding for some species of sandflies, among them, *B. brumpti* which was most of the time in the woods and next to armadillo burrows (Aguiar & Medeiros 2003).

B. brumpti occurred with an expressive quantity in summer, mainly in February. In this

month, it was recorded an average temperature of 27º C, which indicates a preference for a warm and humid period. It could be seen that a significant number of the sandflies captured in the woods belonged to *Brumptomyia*, confirming its sylvestral behavior (Aguiar & Soucasaux 1984).

The literature shows the occurrence of *B. brumpti* in domestic, in an endemic area of cutaneous leishmaniasis in the State of Paraná, where it was captured with light trap peridomicile as found Teodoro et al. (1993).

Aguiar & Vieira (2018) otherwise showed that *B. avellari* can be found in these ecotypes. In the study, this species was collected in the sty, which would explain the absence of this species in this study, because this shelter was not investigated. Additionally, in 1994 and 1995, there were *B. guimaraesi* and *B. nitzulescui* in the forest while *B. cardosoi* was found in this same location. Aguiar & Vieira (2018) did not report as one of the main habitats of this species.

In this study, among the species of *Lutzomyia* which have any relation with burrows of animals, namely armadillo, we can cite: *L. aragaoi*, *L. ayrozai, L. davisi, L. lutziana,* from these the second and third the are considered to be vectors *Leishmania* (Rangel & Lainson 2003, Aguiar & Vieira 2018).

L. aragaoi was the third species captured, and a preference for sylvestral environment is one of its characteristics. It is specifically found in burrows of wild animals (Dasypodidae), having an ample distribution in Brazil (Aguiar & Vieira 2018). On São José farm, this species was only collected in the woods and than 3 metres of burrows, leading us to believe that the dispersion of this species is superior to this distance. Presently, there is no record that *L. aragaoi* is taking part in a transmission cycle of *Leishmania*.

L. ayrozai is recognized as a highly anthrophilic species in the mountainous region of the southeast of Brazil (Mayrinks et al. 1979), where it is more frequent in warm and humid months, reducing its density in cold and dry months. Rangel & Lainson (2003) report that *L. ayrozai* can be a probable transmitter of *Leishmania* (*Viannia*) *naiffi* among armadillos, known as reservoirs of this species of *Leishmania* in Amazonian region.

In 2006, this sand fly, together with *L. davisi*, were present only in the woods.

In relation to the *L. davisi*, the literature reports that this sand fly is known as the potential vector of *Le.* (*V.*) *braziliensis* and *Le. naiffi* in Brazil, being found infected in the nature with both protozoans (Grimaldi et al. 1991).

Alves (2007) did not mark the occurrence of *L. aragaoi* and *L. davisi*, or the burrows of wild animals when he studied this same area (J.R. Carreira-Alves, personal communication). It became clear that the armadillo burrow had an important role in the dispersion and distribution of the local sandfly fauna (Aguiar & Vieira 2018).

Although in Carmo *L. whitmani* had been collected in small quantity it is important to observe that this sandfly is seen as the vector of *Le. (V.) braziliensis* in different regions of the Brazil (Grimaldi et al. 1989, Queiroz et al. 1991). It should be also mentioned its association to the transmission of *Le. (V.) shawi*.

L. carrerai carrerai one of the vectors of *Le. (V.) braziliensis* in Brazil and Bolivia (Le Pont et al. 1988), has also the capacity to transmit *Le.* (*Leishmania*) a*mazonensis* (Lainson and Shaw 1972), to hamster (Ryan et al. 1987). Alves (2007) did not found *L. carrerai carrerai* in the previous

study. So, the finding in the present study may be seen as the consequence of a process of sandfly fauna recomposition.

Saraiva et al. (2010) reported the first record of *Leishmania braziliensis* infecting a female of *L. cortelezzii* in the State of Minas Gerais.

In our study, this species was the second most collected in light traps placed near the houses and was also found in the forest.

Considering that, currently, the first animal pens were removed from this site of collection and this species of sandfly have not been registered by Alves, *L. cortelezzii* may have migrated from the existing forest about 40 meters from the house, which would have showed the spread of this species.

Carvalho et al. (2014) reported that *L. fischeri* was found naturally infected with *Le. (V.) braziliensis* in the southeast and south of Brazil. In 2006/07, *L. fischeri* was only collected in the forest in a very low frequency, results that agreed with those reported by Forattini (1973). This species was most frequent in the summer and was not collected by Alves (2007).

Lainson (1983) suggested that *L. fischeri* can have adapted to the anthropic environments; however, it also transmits *Le. (V.) braziliensis* to the wild animals in the secondary forests.

According to the literature the species *L. intemerdia*, *L. whitmani*, *L. migonei*, *L. ayrozai*, *L. davisi* and *L. carreirai carreirai*, collected in both studies, are *Leishmania* vectors.

It is Worth noting that five species are considered vectors of cutaneous leishmaniasis in Brazil: *L. intemerdia*, *L. whitmani*, *L. davisi*, *L. ayrozai* and *L. carreirai carreirai*, which correspond to 94.4 % of the specimens captured in the 2006, with 93.3 % being from *L. intermedia.*

L. lenti was captured inside the residence by Alves (2007). Although it has been captured on a large scale in this place, there is no evidence that this species is a vector of leishmaniasis in Brazil (Andrade Filho et al. 2001).

However, this was the first record of *L. lenti* in the mountainous region of the State of Rio de Janeiro (Alves 2007).

Alves (2007) reported that *L. quinquefer* was collected in the external wall. In our study, this species was also collected in the peridomicile, but in a banana tree using a light trap. In both the studies, this species was collected in low frequency in the summer, suggesting its preference for hot and humid climates.

Rangel et al. (1990) reported that *L. quinquefer* was collected only in dogs and horses in Mesquita, State of Rio de Janeiro, an area with cases of ATL in humans and dogs caused by *Le. (Viannia) braziliensis*. Menezes et al. (2002) observed that, in this area, some specimens of *L. quinquefer* were attracted to human beings in forest habitats.

De Souza et al. (1995) studied the sandfly fauna of São José do Vale do Rio Preto, State of Rio de Janeiro, observed various *L. quinquefer* specimens which fed from a gecko on the external wall.

L. quinquefer can belong to a group of sandflies that feeds off cold blooded animals (E.A.B. Galati, unpublished data). However, when Galati et al. (1996) studied the sandfly fauna from Gorguinho, Mato Grosso do Sul, they collected a sample of *L. quinquefer* using human bait, probably by accident.

Also, Brazil & Brazil (2003) and Brazil et al. (2006) collected various species of sandfly, including *L. quinquefer*, which was believed to have a preference to feeding off cold blooded animals.

Alves (2007) did not report the occurrence of *L. monticola*, but collected male specimens in the peridomicile and in the forest using light traps. In the forest, specimen was collected in February, while the others were collected in March.

We also collected a male specimens of *L. monticola* of peridomicile in August 2006, since this environment is not the preferred habitat for

these species, unless there are domestic animal shelters (Aguiar & Medeiros 2003).

Considering the revision made by Carvalho et al. (2014), we registered for the first time the collection of the above mentioned species in the municipality of Carmo.

Additionally, we call attention to the record of the species *B. avellari* and *B. nitzulescui* as new in the mountain region of State of Rio de Janeiro.

Likewise, we point out as new records for Carmo nine species of the genre *Lutzomyia*: *L. fischeri*, *L. lanei*, *L. lutziana*, *L. monticola*, *L. aragoai*, *L. cortelezzii*, *L. sordellii*, *L. carrerai carrerai* and *L. davisi*. In addition, the latter two species are cited for the first time in the mountain region of the State of Rio de Janeiro. As pointed out by Alves 2008, Carreira-Alves 2008.

In their research, Aguiar & Vieira (2018) pointed out the main habitats of sand flies in Brazil. We highlight the following, the location and the species that were collected in our study in environments different from those recorded by the authors.

In tree trunk were collected *L. intermedia* and *L. lenti*; while in the stye *L. ayrozai* and *B. guimaraesi* and finally in forest we recorded the presence of *B. avellari*, *B. brumpti*, *B. cardosoi*, *B. guimaraesi*, *B. nitzulescui*, *L. aragaoi*, *L. ayrozai*, *L. cortelezzii*, *L. davisi*, *L. fischeri*, *L. lanei*, *L. lenti*, *L. migonei*, *L. monticola*, *L. quinquefer*, *L. sordellii* and *L. whitmani* (Alves 2007, 2008, Carreira-Alves 2008).

CONCLUSION

The abundance was relatively greater in 1994/95 and showed that the presence of styes influenced the collection of specimens, besides revealing *L. intermedia* high preference for pigs and their shelters. In 2006/07 and showed that the removal of domestic animal shelters modified the sandfly fauna and confirmed the high adaptability of *L. intermedia*, to the changes made by man in the studied location.

It has been proved yet that these modifications influenced the dispersion and distribution of sandflies fauna existing in the woods. At the same time, it was formed a marginal area with the necessary ecological conditions for the species of peridomicile. In relation to that, it can be supposed that in 2006/07 there was a major diversity of the suspicious species as vector of *Leishmania*.

In general, our data can help to improve the public health services and develop effective measures for the control of leishmaniasis vectors in Carmo county and in the mountainous region of Rio de Janeiro State.

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