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Reorganization and Cleanness of Peridomiciliar Area to Control Sand flies (Diptera, Psychodidae, Phlebotominae) in South Brazil

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ABSTRACT

The objective of the present work was to evaluate the impact of the reorganization and cleaning of the peridomicily seeking the control of Phlebotominae vectors of **Leishmania**. *Collections of insects were made in domestic animal shelters and in peridomiciliar area located in Jussara farm, Municipality of Jussara, State of Parana, Brazil where cutaneous leishmaniasis has been endemic. The collections were accomplished five nights for month of the 21:00pm for fie hours, in 1996 and 1997. The results were compared the those obtained in the same places in 1992 and 1994. After the collections of 1992 peridomiciliar area was cleaned and organic matter was removed and domestic animals were reallocated. In 1992, 1994 and 1996/97, 10, 7 and 12 Phlebotominae species were observed.* **Lutzomyia (Nyssomyia) whitmani** *was predominant species in whole the collection. The total population of phlebotomine in 1992 was 64,725. After the reorganization measures and cleaning the phlebotomine population decrease in 90%. In 1996/97 the environmental conditions retaked the patterns of the beginning of the work and the population increased for 61.51%. The present work demonstrates that the reorganization and cleaning of the peridomicily can take to a decrease in the Phlebotominae population and like this to decrease the risk of transmission of* **Leishmania** *in endemic areas.*

Key words: Phlebotominae control, Leishmaniasis control, Lutzomyia whitmani, Cutaneous leishmaniasis

INTRODUCTION

The importance of cutaneous leishmaniasis as endemic disease in Brazil has been observed since the beginning of 20th century. About 40,000 human cases of this disease were observed by the end of the 1940's. Between 1980 and 1999 the number of cutaneous leishmaniasis cases reported were more than 400,000 (Ministry of Health, 1997; 2000).

In Parana state, southern of Brazil, at the beginning of colonization in North region cutaneous leishmaniasis was shown an outbreak (Miranda et al., 1955). However, in the 70´s and the 80´s we went through a period of low-level human cases in this state**.** Even so, from 1993 to 1999, 4,873 cases were reported in 276 counties from a total of 399 (Lima, 2000; Ministry of Health, 2000).

At the beginning of 1950's, a large part of Parana´s territory was covered by native forests.

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With the colonization, forests were cut down and were substituted by an extensive coffee plantation area. In 1975, soy, corn, sugar cane, pasture and other cultures substituted the coffee plantations affected by a severe frost. Nowadays, native forests represent just 7.5% of the territory. In the mean time, the anthropic environment became favourable to the *Leishmania* spread. Frequently, in rural areas there are some remaining forests and bushes around the houses, homesteads and enclosures (hen sheds, pigsties, kennels and others) where enzootic concentrations of *Leishmania* remain. The sand flies (Phlebotominae) adaptation to the peridomiciliar area is very evident (Foratini, 1973, Mattos, 1981, Teodoro, 1995, Teodoro, et al., 1993, Vieira et al., 1999).

In Brazil, phlebotomine control is made by insecticide application in houses and enclosures built in the peridomestic area (Nery-Guimarães and Bustamante, 1954, Sherlock and Almeida, 1970, Teodoro et al., 1998). However, the search for more information about the phlebotomine ecology in the anthropic environment can contribute to establishing of plans and strategies to cutaneous leishmaniasis control, instead of using common ways of insecticides for population control of these sand flies.

Teodoro (1995) showed that in 13 months of phlebotomine collections in an area of Jussara farms (from August of 1991 to August of 1992), the density of these dipteras was particularly higher in February, March and April. That is why we have chosen these months for new sand flies collections in 1994 (Teodoro, 1995, Teodoro et al., 1999). Before collections were done the surroundings were cleaned as follows: a) domestic use water piping to septic tank; b) reconstruction of shelters for domestic animals further from human habitation, to a minimum limit of 100 meters; c) some trees were cut down to expose the soil to sunlight, and to avoid humidity; d) removal of organic matter accumulated in the area around the house (removal of leaves and fruits in decomposition; faeces of domestic animals and rest of food supplied to them; agricultural waste).

This study's aim was to verify the impact of reorganization and cleaning of the peridomiciliar area, for six consecutive years, in the reduction of the phlebotomine density in Jussara Farm, seeking cutaneous leishmaniasis control.

MATERIAL AND METHODS

Area of research (Jussara Municipality Parana State, Brazil) and weather conditions

Jussara County is located in the Northwest of Parana State, between 23rd 32' and 23rd 36' South latitude and 52nd 29' and 52nd 23' longitude West. The yearly average rain precipitation, between 1988 and 1997 in the farm was 1,706.6 mm with a monthly average of 142.2 mm. The highest average of rain precipitation in this period was observed in January (292.2 mm) and the lowest average of rain precipitation was in July (55.6mm). In January of 1997 it rained 429 mm in 18 days (Fig. 1). The average yearly temperature during this period was 23.6°C. In the hottest days of the year, the temperature reached 41ºC and on the coldest days it reached negative temperatures. The area of this research was inside of the area described above with more detail (Teodoro et al., 1999).

Procedures

The sand flies were caught in 1992, 1994 and from March, 1996 to April, 1997 for 5 consecutive nights each mouths, from 9 p.m. for five hours.

Phlebotomines were caught in Falcão light-traps (Teodoro, 1995). After collections the sand flies were carried to the laboratory in polystyrene boxes with a wet cloth inside to maintain humidity. At the laboratory sand flies were mounted in eugenol medium, sexed and identified to species (Foratini, 1973, Teodoro, 1995).

After the Phlebotomines collections, all houses in the area were fumigated with DDT and in May, 1996 with deltamethrine (K-Othrine). Since the treatment was only accomplished in the houses, no other notes will be made about it during the rest of the study, because the Phlebotominae collections in 1996/97 were made exclusively in the peridomiciliar areas.

From March, 1996 to April, 1997, phlebotominae collections were made with Falcão light-traps, in the peridomiciliar area in a place called *Horto Florestal*, located near a sugar cane culture planted in 1996, where previously, there were *Pinus elliottii* plantations, *Araucaria angustifolia* and *Piptadenia gonocantha*. To the east there a small forest strip, which is, prolonged along Água do Encontro stream. The traps were installed as described below:

1- Traps A (1996) and A1 (1997) in a hen house in the backyard of house 1;
2- Traps E2 (1996) and E3 (1997) in a pigsty;
3- Traps B1 (1996) and B2 (1997) in the banana plantation in behind house 4 and; traps G2 (1996) and G3 (1997) in a hen house among the behind the houses 5 and 6.

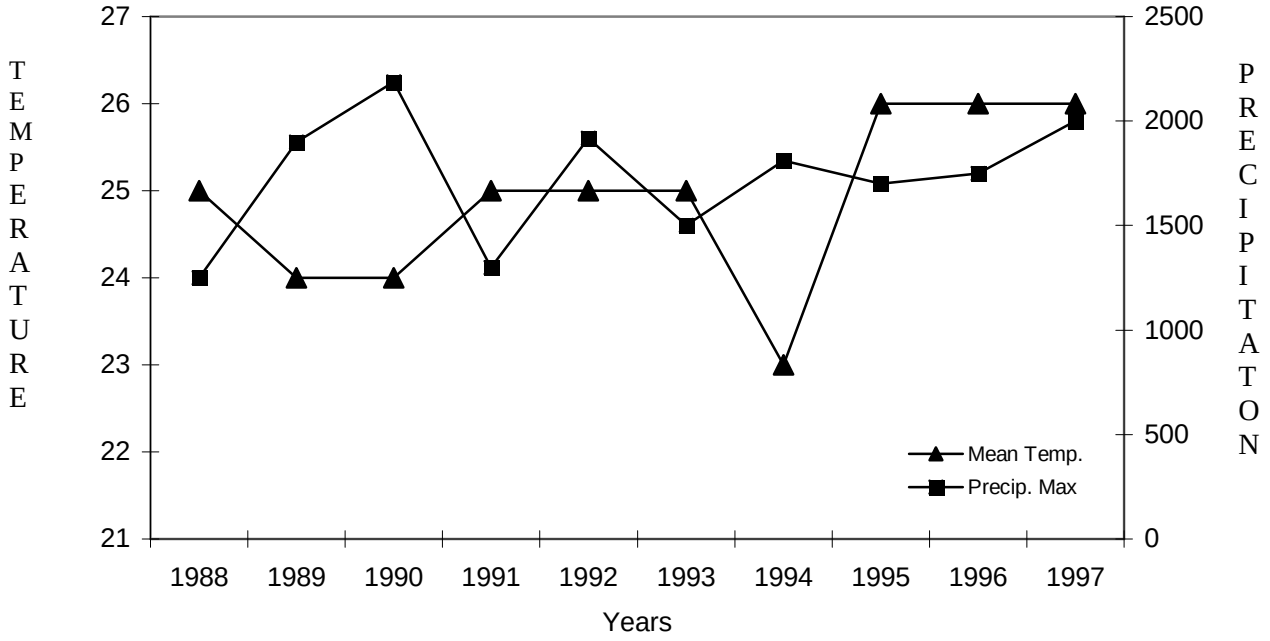

Figure 1 - Temperature and precipitation registered in Jussara County, Parana State, South Brazil between 1988 - 1997.

The changes done to reorganize the environment and another practiced by inhabitants didn't allow installation of Falcão light traps in the same places as previously (Teodoro et al., 1999). We decided for monthly collections of phlebotomine, from March, 96 to April, 97, to evaluate for a longer period of time the dimension of the impact that those measures adopted in 1994 had on the phlebotomine population, taking advantage of the time inhabitants' stayed in the area.

Collection period

Phlebotomines collections were made during 1 year, from March 1996 to April 1997. The results of collections were compared with the collections made in 1991/1992 and 1994 (Teodoro et al., 1999 and Tables 2, 3, 4 and 5).

RESULTS

The phlebotomine species collected in Jussara farms in 1996/97 were: *Lutzomyia (Nyssomyia) whitmani* (Antunes and Coutinho, 1939), *Lutzomyia (Nyssomyia) neivai* (Pinto, 1926); *Lutzomyia migonei* (França, 1920); *Lutzomyia (Pintomyia) pessoai* (Coutinho and Barretto, 1940); *Lutzomyia (Pintomyia) fischeri* (Pinto, 1926); *Lutzomyia shannoni* (Dyar, 1929); *Lutzomyia monticola* (Costa Lima, 1932); *Lutzomyia cortelezzii* (Brèthes, 1924); *Brumptomyia brumpti* (Larousse, 1920); *Brumptomyia cunhai* (Mangabeira, 1942).

The number of phlebotomine species collected in 1991/92, 1994, 1996/97 were 10, 7, 12 respectively (Table 1). *Lu. whitmani* was the dominant species in all periods of collections while that *Lu. neivai* was the second dominant species.

In 1992 the proportion of *Lu. whitmani* (81.9%) was superior to the one of *Lu. neivai* (10.3%). In 1994 the proportion of *Lu. whitmani* was of 69.5% and *Lu. neivai* was 28.4%. In 1996/97 the proportions of *Lu.*

whitmani and *Lu. neivai* was 75.3% and 21.0%, respectively. Among all others species variations also occurred in the same proportion.

In the environment 1 the hourly average (HA) of phlebotomines collected was just higher in April 1996 when compared to HA of February, March and April of other years (Table 2).

In environment 2, the frequency of phlebotomines in February, March and April of 1994 and 96/97 were much less to HA of these months in 1992 (Table 3). In environment 3 the HA of March and April of 1996 and February to April of 1997 were always lower to those observed from February to April of 1992 and 1994 (Table 4). In the table 5 we can see that in the environment 1 phlebotomine HA collected in April (489.6), October (347.8) and November (485.0) of 1996/97 were higher than the HA of October (302.0) and November (56.0) of 1991 and April (369.7) of 1992.

In environment 2 the HA May (855.6), October (249.8) and November (564.5) 1996 were higher than HA October (205.7) and November (79.3) of 1991 and May (667.0) 1992.

Table 1 - Sand fly collections in domiciliar and peridomiciliar area in Jussara Farm, Jussara, Parana State, Brazil, from August 1991 to August 1992, in February and March 1994, and from March 1996 to April 1997.

Year **Species of sand flies/**	**1991/92**	**%**	**1994**	**%**	**1996/97**	**%**
Lutzomyia whitmani	53,006	81.9	4,383	69.5	29,994	75.3
Lutzomyia neivai	6,679	10.3	1,792	28.4	8,352	21.0
Lutzomyia migonei	3,533	5.5	80	1.3	997	2.5
Lutzomyia pessoai	512	0.8	24	0.4	257	0.6
Lutzomyia fischeri	605	0.9	29	0.5	164	0.4
Lutzomyia shanoni	11	-	-	-	30	-
Lutzomyia monticola	17	-	-	-	4	-
Lutzomyia cortelezzii	-	-	-	-	2	-
Lutzomyia firmatoi	9	-	3	-	-	-
Brumptomyia brumpti	8	-	2	-	9	-
Brumptomyia cunhai	-	-	-	-	6	-
Lutzomyia sp.	345	0.5	-	-	2	-
TOTAL	64,725	-	6,311	100.0	39,817	-
HA	1,659.6		150.3		355.5	

Hourly Average (HA)

Table 2 - Sand fly collections in the peridomiciliar area of environment 1, which took place at Jussara Farm, Jussara, State of Parana, Brazil.

Year	**1992**		**1994**		**1996**		**1997**	
Month/Falcão traps	R/P	HA	R1/P1	HA	A	HA	A1	HA
February	840	280	109	7.3	-	-	18	2.3
March	656	218.7	328	21.9	348	43.5	22	2.8
April	1,109	369.7	336	28.0	3,917	489.6	49	6.1

HA = hourly average; R e R1 = traps installed in domicile (house 1); P/P1 (pigsty), A/A1 (hens shed) environment around house 1 (in the peri-domicile).

Table 3 - Sand fly collections in peridomiciliar area from environment 2 which took place at Jussara Farm, Jussara, State of Parana, Brazil.

Year	**1992**		**1994**		**1996**		**1997**	
Month/ Falcão traps	E	HA	E1	HA	E2	HA	E3	HA
February	6,099	2,033.0	19	1.3	-		141	17.6
March	3,199	1,066.0	364	24.3	3,060	382.5	2,406	300.8
April	3,919	1,306.3	570	47.5	3,300	412.5	1,742	217.8

HA = Hourly Average; E, E1, E2 e E3 = traps installed inside stable

Table 4 - Sand fly collections in peridomiciliar area of environment 3 which took place at Jussara Farm, Jussara, State of Parana, Brazil.

Year	**1992**		**1994**		**1996**		**1997**	
Month/Falcão traps	T/C/G	HA	B/L/G1	HA	B1/G2	HA	B2/G3	HA
February	5,169	1,723.0	1,459	97.3	-	-	4.0	0.5
March	5,940	1,980.0	1,442	96.1	43	5.4	1.0	0.1
April	8,852	2,950.6	1,684	140.3	608	76.0	98	12.3

HA = Hourly Average; T = traps installed in a porch from house 4; C (kennel), G (hens shed), B/B1/B2 (banana trees), L (laundry), G1/G2/G3 (hens shed) = in environment of houses 4 and 5.

DISCUSSION

The Phlebotominae main importance demands more frequent investigations about the ecology of these sand flies and should be considered routine at the public health services, in all areas where the leishmaniasis is endemic (Teodoro et al., 1998). In the north of Parana researches on phlebotominae sand flies have been accomplished in peridomiciliar and homestead areas in agricultural properties where human cases of cutaneous leishmaniasis occurred (Teodoro, 1995, Teodoro et al., 1993, 1998, 1999). From these studies, it was observed that *Lutzomyia withmani* was the prevailing species in different area of north Parana. The period of higher prevalence corresponded to October and May.

Table 5 - Sand fly collections in a peridomiciliar area at Jussara farm, Jussara, Parana State, Brazil.

Year **Environment** **Falcão traps** **Month**	**91/92** **1** **R/P** **(N)**	**HA**	**91/92** **2** **E** **(N)**	**HA**	**91/92** **3** **TCG** **(N)**	**HA**
August	177	59.0	563	187.7	3,739	1,246.3
September	1,110	370.0	840	280.0	1,282	427.3
October	906	302.0	617	205.7	409	136.3
November	168	56.0	238	79.3	2,835	945.0
December	591	197.0	463	154.3	4,055	1,351.7
January	1,255	418.3	1,507	502.3	1,692	564.0
February	840	280.0	6,099	2,033.0	5,169	1,723.0
March	656	218.7	3,199	1,066.3	5,942	1,980.7
April	1,109	369.7	3,919	1,306.3	8,852	2,950.7
May	1,005	335.0	2,001	667.0	2,335	778.3
June	264	88.0	69	23.0	6	2.0
July	107	35.7	199	66.3	47	15.7
August	146	48.7	245	81.7	61	20.3
-	-	-	-	-	-	-
Total	**8,334**		**19,959**	**-**	**36,424**	**-**

(Cont.)

(Cont. Table 5)

Year Environment Falcão traps Month	96/97 1 A/A1 (N)	HA	96/97 2 E1/E2 (N)	HA	96/97 3 B1/B2G2/G3 (N)	HA
March	348	43.5	3,060	382.5	43	5.4
April	3,917	489.6*	3,300	412.5	608	76.0
May	837	104.6	6,845	855.6*	501	29.5
June	5	0.6	7	0.9	15	1.8
July	-	0	-	-	0	-
August	56	7.0	848	106.0	50	6.3
September	98	12.3	1,075	134.4	10	1.3
October	2,782	347.8*	1,999	249.8*	138	17.3
November	3,880	485.0*	4,516	564.5*	40	5.0
December	28	35	212	26.5	11	1.4
January	73	9.1	18	2.3	15	1.9
February	18	2.3	141	17.6	4	0.5
March	22	2.8	2,406	300.8	2	0.3
April	49	6.1	1,742	217.8	98	12.3
Total	**12,113**	**-**	**26,169**	**-**	**1,535**	**-**

N) insect number, HA = hourly average; R and P = traps installed inside of a residence and in a pigsty, respectively; T/C/G = installed traps in the porch of an uninhabited house, of a kennel and inside of a hen shed, respectively; A and A1 = traps installed at the hen shed at the backyard of house (1); A, E1 and E2 = snares installed inside of a same stable; B1, B2 (in the middle of banana trees), G2, G3 (hen house) = in the peridomiciliar area of houses 4 and 5. *In these months phlebotomines HA was higher in the second stage of collections (1996/97) in relation to the first (1991/1992) in the environment 1 and 2.

Luz et al., (2000) demonstrated the important role of this specie in *Leishmania* transmission. The authors found three females naturally infected by *Leishmania (Viannia) braziliensis*. Because it was an area where there were several cases of human leishmaniasis, environmental changes were proposed in the peridomiciliar area in order to reduce attraction of phlebotomines and reservoirs.

The environmental changes introduced here represented by the reorganization and cleaning of the peridomiciliar, contributed to an expressive reduction of these insects' population. Inhabitants of the studied area accomplished the whole proposed measures in the first year because there were occurrences of human leishmaniasis cases. However, in the subsequent years, they neglected the measures proposed and by the end of 1997, most inhabitants moved to urban zone.

The hourly average of phlebotomines frequency observed in the environment 1, 2 and 3, from February to April, 1994 and from March, 1996 to April, 1997 were always smaller than those in 1992, except in April, October and November 1996 in the environment 1, and May, October and November in the environment 2 of the same year. Theses results could be influenced by meteorological conditions, reducing the phlebotomine population, due to the rain volume in January of that year (429 mm in 18 days). In other periods of collections, from 1994 to 1996, however, the temperatures and rain precipitation observed (Fig. 1) were more constant.

There were changes in the proportion of *Lu whitmani* and other phlebotomines species, but it was evident that this species was prevalent in the three periods of collections (82% in 1991/92, 69.5% in 1994 and 75.3% in 1996/1997). The proportion of *Lu neivai* was higher in 1994 and in 1996, when compared to 1992. Possibly it was easier for *Lu neivai* to adapt to an environment with a larger anthropy degree, due to control measures. As Gomes and Neves, (1998) had observed, *Lu intermedia s.l.* (synonym of *Lu neivai* after Marcondes,1996*)* adapted well to the environment with high anthropy degree. On the other hand, it was observed that the proportion of *Lu neivai* that grew in 1994, decreased again in the period of collections in 1996/97. It was believed that the impact provoked by the prophylactic measures accomplished in the area of collections in 1994 also contemplated in the proportions of other species of the phlebotominae fauna. Except for the fumigation in May 1996, the other measured prophylactic was neglected, and the area where the sand flies were collected in the period 1996/97, was acquiring environmental characteristics similar to 1994, which justified the growth of the population.

The main characteristics of the phlebotominae places for proliferation are the presence of organic matter,

humidity and absence of light (Forattini, 1973). These conditions are frequently found in natural microhabitats and in shelters for domestic animals in the peridomiciliar of rural areas, and in the periurban places. Souza et al., (1999) and Vieira et al., (1999) have observed the presence of phlebotomine reproduction in the peridomiciliar environment and in shelters for domestic animals. Hence, the reorganization and cleaning of the peridomiciliar has been contributing to the decrease in sand flies population in this area and in the alteration of the proportions of the component species of the fauna in these diptera. Thus, these measures could have applications in the prophylaxis of the leishmaniasis. Luz et al. (2000) have observed a rate of 0.18% of *Lu whitmani* female infected (3 females from 1,628 dissected). If this rate was considered the same for the place where this study was accomplished, in 1992, there would be 119 females parasited with promastigotes forms and in 1994 this number dropped to 11.4. This would represent a reduction of 90% of insects parasited, which justified the hypothesis of this work..

The domicile fumigation in phlebotomine control has been applied frequently and we have been checking for effectiveness (Nery-Guimarães and Bustamante, 1954, Ministry of Health, 2000, Teodoro,1995). However, the use of alternative measures that could be incorporated into the inhabitants of endemic areas, for example in those that were used in this work and of the zooprofilaxy, deserved further investigations.

With the results obtained in about six years of investigation we concluded: i) the impact of the reorganization and cleaning of the peridomiciliar area have been contributing to reduce the phlebotominae population in this environment and consequently decreasing the risk of transmission of *Leishmania* to human and to domestic animals; ii) the impact measures should precede the hotter and rainier months, before the increase of phlebotominae population that represent a risk period; iii) the construction of houses and shelter of close domestic animals in the remaining forests allowed the phlebotomines traffic to the peridomiciliar area and houses, increasing chances of human infection; iv) the number of females captured in the peridomiciliar area lifted the hypothesis of transmission in peridomicile; v) the changes in the proportions of *Lu neivai* happened, possibly, as a consequence of the best adaptation of this species to the anthropic environment, in detriment of *Lu whitmani; iv) Lu whitmani* could have potential of transmission of *Leishmania*, in the summer and autumn, because their population is higher; vii) except in 1997, phlebotominae population was not influenced by meteorological conditions and their composition was not altered in periods of collections, because the temperatures and rain precipitation didn't suffer much alterations; viii) the knowledge of the reservoirs of *Leishmania* is indispensable; complementary measures could be implemented to decrease the rate of infection of the sand flies.

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RESUMO

O objetivo do presente trabalho foi avaliar o impacto da reorganização e limpeza do peridomicílio no controle de flebotomíneos vetores de *Leishmania*. Foram feitas coletas de insetos em abrigos de animais domésticos e em área peridomiciliar localizadas na Fazenda de Jussara, Município de Jussara, Estado de Paraná, Brasil onde leishmaniose tegumentar é endêmica. As coletas foram realizadas cinco noites por mês das 21:00 horas a 1:00 hora da manhã em 1996 e 1997. Os resultados foram comparados àqueles obtidos nos mesmos locais (ecótopo) em 1992 e 1994. Após as coletas de 1992 foram feitas limpezas do peridomicílio com a retirada de matéria orgânica e relocação dos animais domésticos. Em 1992 foram observados 10 espécies de flebotomíneos, em 1994 um total de sete e em 1996/97 foram identificadas 12 espécies. *Lutzomyia (Nyssomyia) whitmani* foi a espécie predominante em todas as coletas, tanto em 1992 quanto em 1997. A população total de flebotomíneos em 1992 era de 64.725. Após as medidas de reorganização e limpeza o número de insetos passou para 6.311 em 1994. Em 1996/97 como as condições ambientais retomavam os padrões do início do trabalho a população aumentou para 39.817. O presente trabalho demonstra que a reorganização e limpeza do peridomicílio em zonas endêmicas pode levar a um decréscimo na população de flebotomíneos e assim diminuir o risco de transmissão de *Leishmania* em áreas endêmicas. Estas medidas devem ser implementadas anualmente, principalmente no período a risco de transmissão (Janeiro a Maio).

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