Mem. Inst. Oswaldo Cruz, Rio de Janeiro, Vol. *86* (4): 399-404 oct./dec. 1991

EFFECT OF DELTAMETHRIN SPRAYING ON THE SANDFLY POPULATIONS IN A FOCUS OF AMERICAN CUTANEOUS LEISHMANIASIS

ALDA LIMA FALCÃO; ALBERTO ROCHA FALCÃO; CLAUDIO TEIXEIRA PINTO*
CÉLIA MARIA FERREIRA GONTIJO & ALOÍSIO FALQUETO**

Centro de Pesquisas René Rachou, FIOCRUZ, Caixa Postal 1743, 30190 Belo Horizonte, MG, Brasil
*Quimio Produtos Químicos Comércio e Indústria SA, Rua do Rocha, 155, 20960 Rio de Janeiro, RJ, Brasil
**Departamento de Medicina Social, Centro Biomédico, Universidade Federal do Espírito Santo, Av. Marechal Campos s/nº, 29040 Vitória, ES, Brasil

The effect of deltamethrin of the sandfly population in a focus of American Cutaneous Leishmaniasis in Viana, Espírito Santo State is described. The phlebotomine population density was determined inside and outside houses during a one year period in a treated and untreated area. The results showed a significant reduction in the number of sandflies inside houses in the treated area compared with both the untreated area and the same area before spraying. Despite having a residual action for 12 months after spraying the insecticide was ineffective outside houses. It is concluded therefore that deltamethrin is an efficient insecticide for reducing the number of phlebotomine sandflies inside houses.

Key words: sandflies – deltamethrin – American Cutaneous Leishmaniasis

Direct action against the vector of cutaneous leishmaniasis is crucial for reducing the incidence of this disease. Seyedi-Rashti & Nadina (1975) observed that the disease re-emerged in Iran, after the cessation of DDT antimalarial spraying.

In Brazil, insecticide was first used against the vectors of American Cutaneous Leishmaniasis (ACL) in 1954 by Nery-Guimarães & Bustamante in a focus in Rio de Janeiro State. They used periodic domiciliary spraying. A decrease in sandfly density and disease incidence was noted five years later. Ready et al. (1989) used DDT emulsion in a Brazilian tropical forest region and noted that the lower parts of trees were no longer occupied by *Lutzomyia umbratilis* for at least 11 months.

The use of deltamethrin against sandfly populations in China (Xiong & Jing, 1987) demonstrated its efficiency for the control of *Phlebotomus chinensis*. In Bolivia, deltamethrin was sprayed by Le Pont et al. (1989) in a region where Chagas' disease and cutaneous and visceral leishmaniasis occurred. However, the insecticide proved most successful in controlling the vector of visceral leishmaniasis.

Received 2 January 1991.
Accepted 22 July 1991.

Taking into account the success of the above experiments using deltamethrin, the low toxicity of pyrethroids (Elliot et al., 1978; Mestres & Mestres, 1989) and especially the fact that in Brazil this insecticide has not yet been tested in an ACL focus, the present work was carried out. To evaluate the insecticide and its residual action on the intra-domiciliary population of phlebotomine sandflies captures were made before and after spraying in Viana, Espírito Santo State. Barros et al. (1985) confirmed the existence of an autochthonous focus of active transmission in Viana and in less than five years the disease has affected 11.2% of the population. The sandflies of Viana have previously been studied by Mattos (1981). *Lutzomyia intermedia* was found to be the most abundant species in the domestic environment and is the putative vector in the region.

MATERIALS AND METHODS

Area of study – The localities of Perobas and Coacas were chosen because they were active foci of ACL, had similar epidemiological characteristics, had not previously experienced any control measures and were neighbours. They are located in Viana District (20°21'S – 40°28'W). Espírito Santo State, approximately 19 km from Vitória, the State capital. The

region is mountainous, with heights ranging from 30 to 340 m. The natural vegetation consists of secondary forests in different stages of evolution. The lower areas are covered with prairies and the mountain sides with banana plantations. The climate is tropical. July is usually the coldest month of the year, and February is the warmest. There is rain from December to February, August being the driest month. About 420 inhabitants live in the area and most of the dwellings are very simple and made of brick. Around the houses are shelters for domestic animals and commonly fruit trees.

Methodology – Nine houses were chosen at random in each area and before insecticide spraying, the density of phlebotomine sandflies was evaluated. Sandfly captures were made in the houses during three consecutive days (September 10th, 11th and 12th, 1986), using Falcão's light trap (Falcão, 1981). In each house was put one light trap during the period of 17:00 h in the evening till 7:00 h in the morning. The density of phlebotomine sandflies captured in Coacas and Perobas did not show a statistically significant difference ($t = 1,57$; $p = 0,23$). Perobas was chosen for spraying because of operational facilities and Coacas was taken as the control area.

In September 15th, 1986, domiciliary and peridomiciliary areas of all the houses in Perobas were sprayed with deltamethrin. Internal and external walls and the roof of the houses were sprayed as well as buildings and trees within 10 m. The insecticide used was deltamethrin (Quimio-Flow SC50) at a dilution of 125 ml/10 l corresponding to a concentration of 25 mg/m^2.

To evaluate the effect of the insecticide, sandfly captures were made in November/86, March/87, May/87, July/87 and September/87, respectively 2.5, 6, 8, 10 and 12 months after spraying. Twenty five houses were chosen at random in Coacas whereas in Perobas all the 54 houses were searched in the domiciliar and peridomiciliar area. All captures were made during the period of 17:00 h in the evening till 7:00 h in the morning. In each house one light trap was placed inside and another outside. Only in the last capture, manual collections were made in all houses of Perobas using a Castro aspirator. These collections were made during the morning when the light traps were taken back.

To evaluate the residual action of the insecticide the wall test was carried out in ten houses, randomly chosen, during the 3rd and 4th captures. A polyvinyl cetila (PVC) device was specially manufactured for the test. The device is 10 cm in diameter and 4 cm high and contains a lateral hole through which the phlebotomine sandflies were introduced. The inferior border is inlaid with foam to maintain the device in complete contact with the wall. The upper part of the device is made of transparent plastic. Two little handles were laterally disposed to fix the device on the wall (Fig. 1). For each test 20 females captured outside houses were chosen. The females had a blood-meal and were kept inside the device attached to the sprayed wall. After 1 h the phlebotomine sandflies were transfered to a cage. Mortality was evaluated 24 hours later. All females used were *Lu. intermedia*.

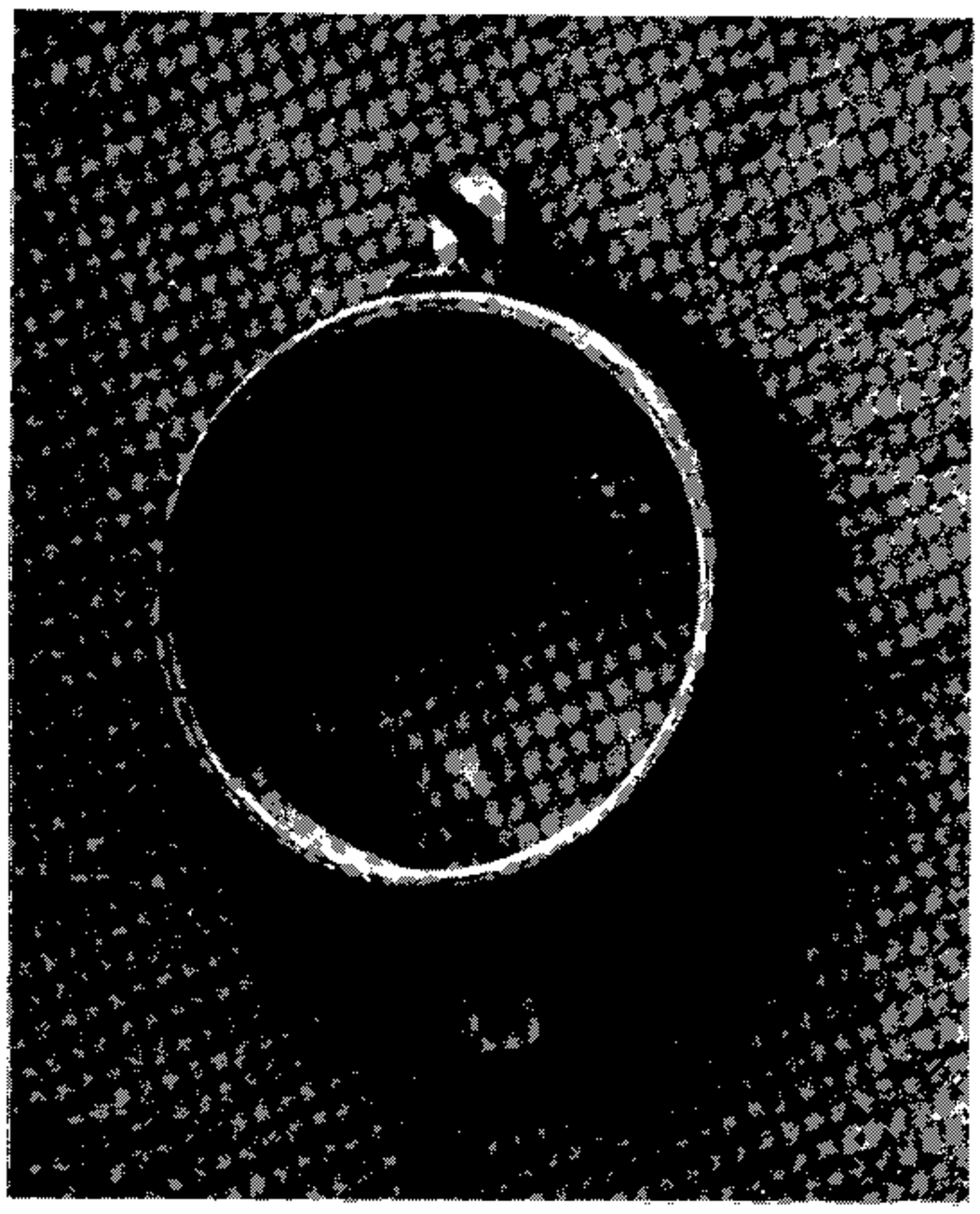

Fig. 1 : device used in the wall tests.

Statistical analysis – The phlebotomine sandfly density was expressed by Williams average (Wiliams, 1937). Student's "t" test was used to compare the phlebotomine density between treated and untreated areas, as well as before and after spraying (Armitage & Berry, 1987). All results of the captures in both areas were compared through the Ranging Analysis

(Armitage & Berry, 1987). Whenever F was significant ($\alpha = 0.05$) the Tuckey Test was used to detect the relevant differences among the averages.

The phlebotomine sandfly number that one could expect to collect in Perobas without deltamethrin spraying, was found using the formula of Molineux et al. (1976):

$$\text{E No.} = \frac{\text{No. Ca}}{\text{No. Cb}} \times \text{No. Tb}$$

E No.: expected number of phlebotomine.
No. Ca: number of phlebotomine in control area after spraying.
No. Cb: number of phlebotomine in control area before spraying.
No. Tb: number of phlebotomine in treated area before spraying.

RESULTS

During one year of captures, 11 species of *Lutzomyia* and two undentified *Brumptomyia* were found in Coacas and Perobas. Five specimens of *Lutzomyia* were not identified as important morphological structures were damaged.

The results of the indoor light trap captures performed in Coacas and Perobas are shown in Table I. Eight different species were collected in Coacas: *Lu. intermedia, Lu. migonei, Lu. fischeri, Lu. quinquefer, Lu. schreiberi, Lu. lenti, Lu. alencari,* and *Lutzomyia* sp. The species *Lu. schreiberi* and *Lu. alencari* were only observed after insecticide spraying. *Lutzomyia intermedia* was the most common species. The overall number of females captures was greater than that of males before (530 ♀♀ and 96 ♂♂) and after spraying (558 ♀♀ and 259 ♂♂). Only males of *Lu. lenti* and *Lu. alencari* species were found.

Two specimens of *Brumptomyia* and 5 species of *Lutzomyia* were captured in Perobas before spraying: *Lu. intermedia, Lu. migonei, Lu. fischeri, Lu longipalpis* and *Lutzomyia* sp. A *Barrettomyia* subgenus and *Lu. quinquefer, Lu. ferreirana, Lu. lenti, Lu. borgmeieri* species were captured only after spraying. *Lu. intermedia* and *Lu. migonei* were the most frequently encountered species both before and after spraying. Again the overall number of the females was greater than of males before (384 ♀♀ and 265 ♂♂) and after spraying (258 ♀♀ and 173 ♂♂).

The peridomiciliary captures were carried out only after spraying. Six hundred and seven specimens of 5 species of the *Lutzomyia* genus – *Lu. intermedia, Lu. migonei, Lu. fischeri, Lu. quinquefer* and *Lu. lenti* – were collected in Coacas. *Lu. intermedia* was the most frequently found (90.9%). Only in the first capture, the number of females was greater than that of males. In Perobas, 2653 phlebotomines were captured and 6 species of the *Lutzomyia* genus were identified: *Lu. intermedia, Lu. migonei, Lu. fischeri, Lu. quinquefer, Lu. lenti* and *Lu. alencari.* The prevailing species was *Lu. intermedia* (75.7%) followed by *Lu. migonei* (20.8%). Females were captured in larger number but in the 2nd and 4th captures the number of females was lower than that of males.

The total number of phlebotomine sandflies captured in Perobas after insecticide spraying was nearly half that expected if no spraying had taken place (Table II).

Comparing the captures made before and after spraying in the dwellings of the control area, a significant difference is observed ($F = 3.02$; $p = 0.01$). It was found that the averages observed in the 1st, 2nd and 4th captures were lower than those of the 3rd and 5th, and also lower than the density observed before spraying (Table II, Fig. 2).

In the treated area, the 5 averages that were obtained during the indoor captures showed a significant difference in relation to the density before spraying ($F = 13{,}94$; $p = 1.10 \times 10^{-11}$). However, no significant difference was observed between the averages of the number of phlebotomine sandflies captured after spraying.

The number of insects collected in the houses during the post spraying period were compared between the two areas. The data showed that only in the 3rd ($F = 3.99$; $p = 0.05$) and in the 5th ($F = 5.44$; $p = 0.02$) captures was the density in the untreated area statistically higher than in the treated area. Figure 2 shows that the density in the control area presented two well marked peaks in the 8th and 12th months. In the treated area, however, the density was uniformly low,

TABLE I

Species of phlebotomine sandflies captured indoors in Coacas and Perobas

Species	Before spraying		After spraying	
	Coacas No. (%)	Perobas No. (%)	Coacas No. (%)	Perobas No. (%)
Lu. intermedia	544 (86.9)	335 (51.6)	549 (67.2)	228 (52.9)
Lu. migonei	71 (11.3)	289 (44.5)	239 (29.3)	167 (38.8)
Others	11 (1.8)	25 (3.9)	29 (3.6)	36 (8.6)
Total	626	649	817	431

TABLE II

Number and density (Mw) of phlebotomine sandflies captured indoors in Coacas and Perobas

Captures	Coacas No. (Mw)	Perobas	
		Obs. No. (Mw)	Exp. No.
Pre-spraying	626 (4.84)	649 (7.87)	–
Post-spraying			
2.5 months	23 (0.50)	26 (0.40)	24
6 months	137 (1.13)	90 (0.62)	142
8 months	379 (3.04)	111 (1.04)	393
10 months	61 (1.07)	120 (0.65)	63
12 months	217 (3.15)	84 (0.98)	225
Total	817	431	847

The number of phlebotomine expected was calculated according to Molineux et al. (1976).

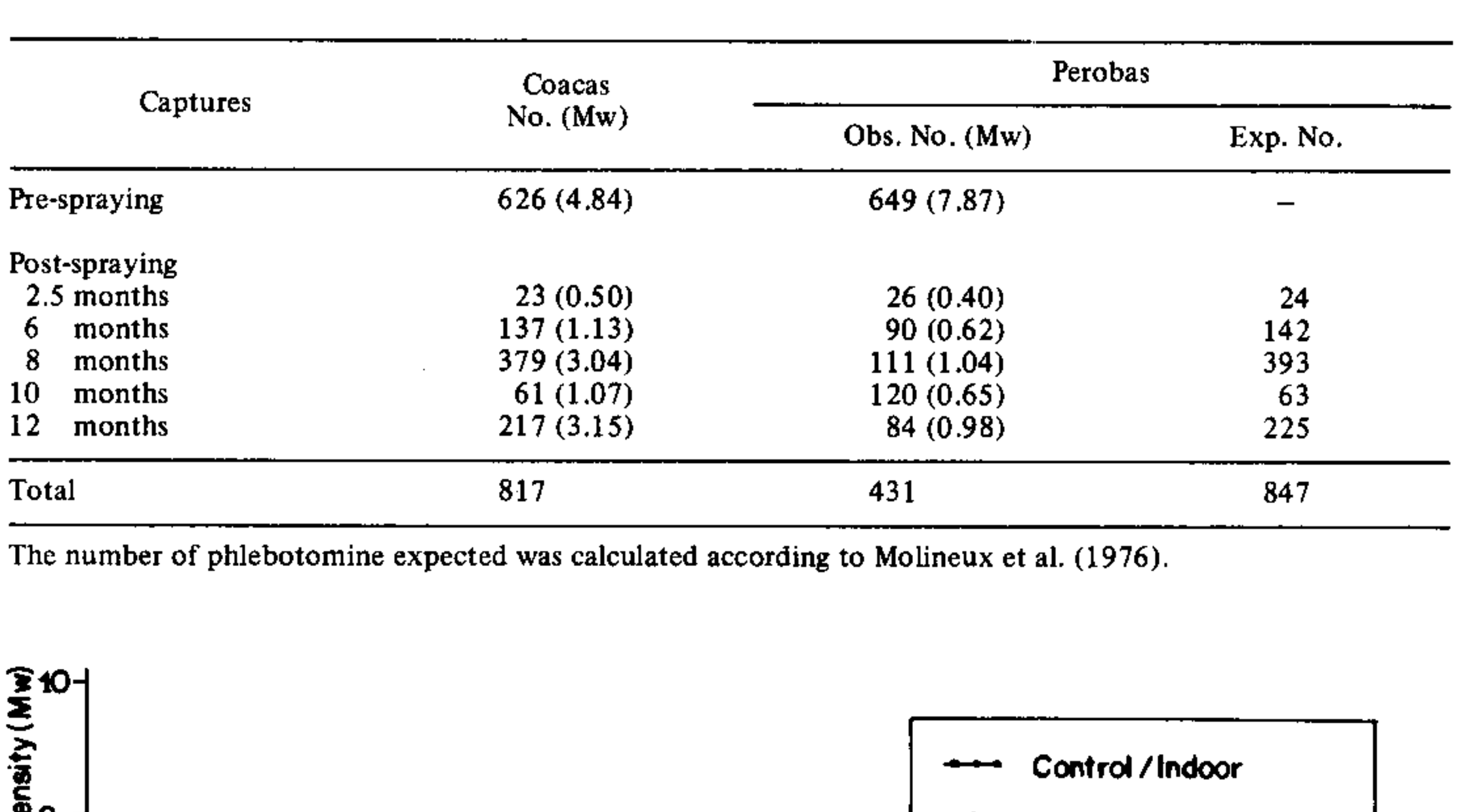

Fig. 2: density of phlebotomine sandflies captured indoors and outdoors in the control and treated area.

resulting in a significant difference between the density in the two areas in the 8th and 12th months.

The analysis of the results obtained from peridomiciliary captures (Fig. 2) showed that the density of the phlebotomine sandflies did not vary significantly ($p > 0.05$), between treated and untreated areas.

The wall test made in the 8th and 10th months after spraying showed that 100% of the specimens were dead after 24 h.

In the last capture manual collections were made in all the houses of the treated area and only in one house, were two males and one female of *Lu. intermedia* found.

DISCUSSION

Martins et al. (1978) found 29 species of *Lutzomyia* in 20 different localities in the State of Espírito Santo. To date, 20 of these have been identified in Viana District: *Lu. alencari, Lu. fischeri, Lu. hirsuta, Lu. schreiberi, Lu. ferreirana, Lu. zikani, Lu. quinquefer, Lu. flaviscutellata, Lu. intermedia, Lu. whitmani, Lu. callipyga, Lu. tupynambai, Lu. edwardsi, Lu. migonei, Lu. gasparviannai, Lu. microps, Lu. nordestina, Lu. paulwilliamsi, Lu. termitophila* and specimens of a species that has not been identified yet of the subgenus *Pintomyia* (Mattos, 1981). Among these species, 8 were captured during the experimental period in Coacas and Perobas. Two other species – *Lu. lenti* and *Lu. borgmeieri* – were caught there for the first time. The occurrence of *Lu. longipalpis* in this area had already been reported by Coelho et al. (1982).

Among the species captured, four feed on man (Young & Fairchild, 1974): *Lu. intermedia, Lu. migonei, Lu. fischeri* and *Lu. longipalpis.* Only *Lu. intermedia* and *Lu. migonei* showed significant density. *Lu. intermedia* was the predominant species in the two areas studied, and it presented a high density both inside and around houses. This confirms the observations of Barros et al. (1985) and Falqueto et al. (1986) who considered *Lu. intermedia* as the main vector of ACL transmission in Viana. *Lu. intermedia* is the most frequent species found in houses and in domestic animal shelters in Brazilian endemic areas due to its ability to adapt to artificial ecotopes (Marzochi, 1989).

The density of phlebotomine sandflies inside the houses in Coacas varied during the course of the year. Similar seasonal fluctuations were also observed by Mattos (1981). However, in Perobas the density of the phlebotomine sandflies found inside the houses did not fluctuate. During the whole year, after the insecticide spraying, the number of specimens inside the dwellings was kept at low levels, although the density in the peridomiciliary area was high (Fig. 2). This shows that a factor acted to control the number of phlebotomine sandflies in the dwellings, impairing the natural fluctuation, as it occurred in the control area. The only factor that was different between the two areas was the use of deltamethrin in the dwellings of Perobas. The controlling action of the insecticide on the phlebotomine sandflies populations is clear since the total number of specimens captured in the treated area was approximately 50% less than would be expected in deltamethrin had not been used.

The effectiveness of deltamethrin against *Lu. intermedia* was also observed by Ripoll et al. (1987) in Argentina. The use of the insecticide indoors and in the peridomiciliary area diminished the density of the phlebotomine sandflies, and also controlled an outbreak of ACL caused by *Leishmania braziliensis.*

The residual action of deltamethrin was proved by the wall test. Ten months after the spraying, 100% of the tested insects died. It was also observed that the density of the insects inside the houses in the last capture was as low as in the previous captures. This demonstrates that the residual action of deltamethrin remained for at least one year.

These observations agree with the results of Le Pont et al. (1989) in Bolivia, where one spray application was enough to eliminate *Lu. longipalpis* from the dwellings and chicken houses during 9 and 10 months, respectively.

The residual action of deltamethrin was observed in China against *Phlebotomus chinensis,* keeping the density of the sandflies reduced during the whole period when numbers are normally high (Xiong & Jing, 1987).

In conclusion the reduction of the density of phlebotomine sandflies in the houses of Perobas was due to the use of deltamethrin, demonstrating its effectiveness in controlling phlebotomine sandfly numbers inside houses.

ACKNOWLEDGEMENTS

To Dr José Tasso Aires de Alencar, ex-Diretor of the SUCAM-ES. To Prof. Gelcílio Coutinho Barros, from Espírito Santo University, for his logistical support. To Edilson Lemos de Castro and Simão Heraldo do Rosário for their collaboration in the field work. To Regina Maria de Oliveira Rezende for the technical support. To Dr Dilermando Fazito Rezende for the collaboration on the statistical analysis. To Dr Álvaro José Romanha, Dr Andrew J. G. Simpson and Dr Richard Ward for his critical reading of the manuscript.

REFERENCES

ARMITAGE, P. & BERRY, G., 1987. *Statistical Methods in Medical Research.* Blackwell Scientific Publications, Oxford, 2nd ed., 559 p.

BARROS, G. C.; SESSA, P. A.; MATTOS, E. A.; CARIAS, V. R. D.; MAYRINK, W.; ALENCAR, J. T. A., FALQUETO, A. & JESUS, A. C., 1985. Foco de Leishmaniose Tegumentar Americana nos municípios de Viana e Cariacica, Estado do Espírito Santo, Brasil. *Rev. Saúde pública, 19:* 146-153.

COELHO, M. V.; FALCÃO, A. R.; COUTINHO, G. B.; FALCÃO, A. L.; SESSA, P. A. & MATTOS, E. A., 1982. Suscetibilidade de flebótomos do município de Viana, Espírito Santo, a amostras de *Leishmania.* VII Congresso Brasileiro de Parasitologia, Porto Alegre, p. 10.

ELLIOT, M.; JANES, N. F. & POTTER, C., 1978. The future of pyrethroids in insect control. *Ann. Rev. Entomol., 23:* 443-469.

FALCÃO, A. R., 1981. Um novo modelo de armadilha luminosa de sucção para pequenos insetos. *Mem. Inst. Oswaldo Cruz, 76:* 303-305.

FALQUETO, A.; COURA, J. R.; BARROS, G. C.; GRIMALDI Fº , G.; SESSA, P. A.; CARIAS, V. R. D.; JESUS, A. C. & ALENCAR, J. T. A., 1986. Participação do cão no ciclo da transmissão da Leishmaniose Tegumentar no município de Viana, Estado do Espírito Santo, Brasil. *Mem. Inst. Oswaldo Cruz, 81:* 155-163.

LE PONT, F.; MARISCAL PADILLA, J.; DESJEUX, P.; RICHARD, A. & MOUCHET, J., 1989. Impact de pulverisations de Deltamethrin dans un foyer de Leishmaniose de Bolivie. *Ann. Soc. Belge Med. Trop., 69:* 223-232.

MARTINS, A. V.; WILLIAMS, P. & FALCÃO, A. L., 1978. *American sandflies (Diptera: Psychodidae, Phlebotomine).* Academia Brasileira de Ciências, Rio de Janeiro, 195 p.

MARZOCHI, M. C. A., 1989. A leishmaniose tegumentar no Brasil. In Grandes Endemias Brasileiras. Editora Universidade de Brasília, Brasília (in press).

MATTOS, E. A., 1981. *Bionomia dos flebotomíneos de Perobas, Município de Viana (ES), área endêmica de leishmaniose tegumentar americana.* Master Science Thesis. Instituto de Ciências Biológicas, UFMG, 137 p.

MESTRES, R. & MESTRES, G., 1989. Deltamethrin agricultural and health protection uses and its environmental safety. VI Congresso Brasileiro de Toxicologia, São Paulo.

MOLINEUX, L.; SHIDRAWI, G. R.; CLARK, J. L.; BOUZAGUET, R.; ASHKAR, T. & DIETZ, K., 1976. The impact of propoxur on *Anopheles gambiae* s.l. and some other anopheline populations, and its relationship with some pre-spraying variables. *Bull. World Health Organ., 54:* 379-389.

NERY-GUIMARÃES, F. & BUSTAMANTE, F. M., 1954. Aplicação domiciliária de DDT como base da profilaxia de Leishmanioses. Estudo de um foco de Leishmaniose mucocutânea cinco anos depois da aspersão periódica com aquele inseticida. *Rev. Bras. Malariol. e D. Trop., 6:* 127-130.

READY, P. D.; ARIAS, J. R. & FREITAS, R. A., 1985. A pilot study to control *Lutzomyia umbratilis* (Diptera, Psychodidae), the major vector of *Leishmania braziliensis guyanensis,* in a peri-urban rainforest of Manaus, Amazonas State, Brazil. *Mem. Inst. Oswaldo Cruz, 80:* 27-36.

RIPOLL, C.; REMONDEGUI, C.; ROMANO, F.; CAORLIN, O. & RIVETTI, E., 1987. Brote de Leishmaniasis tegumentária en la provincia de Jujuy, Argentina. II Congresso Argentino de Protozoologia, La Falda, Cordoba, Argentina, p. 51.

SEYEDI-RASHTI, M. A. & NADIM, A., 1975. Re-establishment of cutaneous leishmaniasis after cessation of anti-malaria spraying. *Trop. Geogr. Med., 27:* 79-82.

WILLIAMS, C. B., 1939. The use of logarithms in the interpretation of certain entomological problems. *Ann. appl. Biol., 24:* 404-414.

XIONG GUANG-HUA & JIN CHANG-FA, 1987. Studies on Deltamethrin in the control of peri-wild *Phlebotomus chinensis. Chinese J. Parasitol. Parasitic Disease, 5:* 176-179.

YOUNG, D. G. & FAIRCHILD, G. B., 1974. *Studies of Phlebotomine Sandflies.* Gainsville: Department of Entomology and Nematology, University of Florida, 151 p.