

## An Attempt to Control Phlebotomine Sand Flies (Diptera: Psychodidae) by Residual Spraying with Deltamethrin in a Colombian Village

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*An attempt was made to control phlebotomine sand flies biting indoors in a rural community near Cali, Colombia, using the residual insecticide "K-Othrine" (deltamethrin) sprayed on the inside walls of houses. Twelve houses were divided into matched pairs based on physical characteristics, one house in each pair being left untreated while the inside walls of the other were sprayed with 1% deltamethrin at a concentration of 500 mg a.i./m<sup>2</sup>. Sand flies were sampled each week using protected human bait and sticky trap collections for four months after spraying. The number of sand flies (*Lutzomyia youngi*) collected on sticky traps was significantly lower ( $P = 0.004$ ) in the untreated houses than in the treated ones with which they were matched. This difference was not significant for *L. columbiana*; the other anthropophilic species were not present in large numbers. The numbers collected on human bait in treated and untreated houses were not significantly different for either species. Activity of the insecticide as determined by contact bioassays remained high throughout the study and failure to control the insects was attributed to two factors: the tendency of sand flies to bite before making contact with the insecticide and the fact that the number of sand flies that entered houses represented a relatively small proportion of the population in the wooded areas surrounding the settlement in the study.*

Key words: *Lutzomyia youngi* - *Lutzomyia columbiana* - deltamethrin - sand fly control - Colombia

Phlebotomine sand flies (Diptera: Psychodidae) are highly susceptible to insecticides and in certain areas effective control of these insects has been achieved as a side-effect of malaria eradication programmes, in which the walls of houses are sprayed to kill resting *Anopheles* mosquitoes (Vioukov 1987). Residual formulations of dichloro-diphenyltrichloroethane (DDT) have also been used in many areas to specifically control sand flies, particularly in the Old World (Jacusiell 1947, Hertig 1949, Pandya 1983), but also in Peru (Hertig & Fairchild 1948). The synthetic pyrethroid deltamethrin has also been used against sand flies in Bolivia (Le Pont et al. 1989) and Brazil (Falcão et al. 1991, Marcondes & Nascimento 1993). Nevertheless, rather less information is available on the control of New World sand flies, which tend to live in ecologically more complex habitats than their Old World relatives of the genus *Phlebotomus* and have less predisposition to enter houses and bite. As such Ameri-

can cutaneous leishmaniasis is often considered to be acquired principally in extradomiciliary and occupational situations (Lainson 1983), where vector control by conventional methods would be difficult or impossible.

Although the above is true for many situations, in others there is evidence of intradomiciliary transmission of *Leishmania* (Escobar et al. 1992), generally based on the presence of cutaneous leishmaniasis cases among babies or infants who would not normally be outdoors when sand flies are active. Another factor that should however be taken into account is the ambient temperature after dark. In mountainous areas of the Neotropics such as the Andes of Colombia this may fall considerably, forcing local inhabitants to wear heavy clothing or remain indoors, both of which reduce their exposure to the bites of sand flies. Indoor biting in such situations therefore assumes great importance and sand fly control by conventional means becomes more feasible. These control measures include the use of impregnated bednets and curtains to cover doors and windows as well as the application of residual insecticides to walls.

This article reports the results of a four-month pilot study on the efficacy of "K-Othrine" (deltamethrin) applied as a residual spray to the walls

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of houses to reduce the biting nuisance caused by sand flies in a settlement near Cali, Colombia.

### MATERIALS AND METHODS

*Preliminary observations* - The study was conducted at Alto Aguacatal, a small settlement within the city limits of Cali, Colombia, between November 1992 and March 1993. The village lies at an altitude of approximately 1770 m above sea level and consists of 13 houses, the majority constructed of adobe. The inhabitants of Alto Aguacatal are agricultural workers, coffee being the main crop. Mean annual temperature of the village is 20°C.

Although no cases of cutaneous leishmaniasis have been reported from Alto Aguacatal, the inhabitants complain of the nuisance caused by "palomillas" (phlebotomine sand flies) which enter houses after dark and bite throughout the night, particularly at certain periods of the year. Most people remain indoors after dark since temperatures drop sharply in Alto Aguacatal after sunset, this fall often exacerbated by cloud descending from the surrounding mountains.

Two sampling methods were employed to determine which species of sand flies bit indoors and estimate the biting rate. The first consisted of human bait collections in which volunteers collected sand flies that landed on them during the two hours of peak sand fly activity (19:30-21:30, or the first 2 hr after sunset) using a mouth aspirator. These insects were killed and immersed in a 5% detergent solution for 48 hr to clear them sufficiently for taxonomic characters (female spermathecae and external genitalia of males) to be distinguished. Although this method is slower and less effective than using agents such as lactophenol, it was found to be adequate for the relatively small numbers of insects collected during the study.

The second sampling method involved hanging six sticky traps (sheets of unwaxed paper coated in castor oil) on each of two lines hung parallel to one of the walls at 2 m and 30 cm above the floor of each dwelling. Sticky trap collections were made in six of the houses for seven weeks prior to the study. These traps were inspected each week, when sand flies were carefully removed by mounted needle, stored in 5% detergent solution for 48 hr to remove the oil and then identified to species.

Extradomiciliary sand fly activity was determined by making Shannon trap collections in wooded areas surrounding the houses, again between 19:30-21:30 hr.

*Insecticide trial* - The twelve houses used in the control study were divided into six matched pairs, based on features that might affect absorption of insecticide (wall area, construction material), sand fly density (proximity of wooded areas) and the degree of intradomiciliary activity

(number of doors and windows, number of inhabitants, presence of domestic animals). One house in each pair had its walls treated with a 1% wettable powder formulation of "K-Othrine" (deltamethrin) at a concentration of 500 mg a.i./m<sup>2</sup>, using a knapsack sprayer fitted with a fan nozzle.

The other house in each pair was left untreated. This insecticide was selected because of its high safety coefficient (the acute oral LD50 of K-Othrine for rats is 5560 times that for house flies, whereas comparative values for DDT and malathion are 11.3 and 50 respectively) and low vapour pressure ( $2 \times 10^{-8}$  mbar at 25°C).

Numbers of sand flies in treated and untreated houses were determined as before. Since it was not possible to make human bait collections in all of the houses every week, biting catches were restricted to three dwellings of each category selected at random each week.

### RESULTS

*Preliminary observations* - The sand fly fauna of Alto Aguacatal was found to consist of three anthropophilic species, of which *Lutzomyia youngi* Feliciangeli & Murillo was the most numerous, comprising 56.5% of sticky trap collections and 67.6% of sand flies collected in the Shannon trap. Next in importance was *L. colombiana* (Ristorcelli & Van Ty), which constituted 46.6% of sticky trap and 27.3% of Shannon trap collections. The third species, *L. lichi* (Floch & Abonnenc) made up only 1.8% of sticky trap collections and 4.9% of those made by Shannon trap. Although all three species have been infected with *Le. braziliensis* in the laboratory (Warburg et al. 1991) and may be involved in the transmission of this or other *Leishmania* species, in southwestern Colombia, to date there have been no reports of cutaneous leishmaniasis from Alto Aguacatal. Note that Warburg et al. (1991) misidentified *L. youngi* as the closely related *L. townsendi* (Ortiz), females of the two species being morphologically identical. The possible role of *L. youngi* in *Leishmania* transmission in Venezuela is discussed in Feliciangeli et al. (1992).

Mean number of sand flies/house/week collected on sticky traps prior to the intervention varied between 0.3-5.0 for *L. youngi* and 0.2-7.5 for *L. colombiana*. Extradomiciliary activity of these species as determined by Shannon trap varied between 4.5-36.5/man-hr for *L. youngi* and 5.0-11.5/man-hr for *L. colombiana*.

The number of sand flies of both species collected on sticky traps during the four months after spraying is shown in Table I. Analysis by Wilcoxon 2-sample test revealed that the number of *L. youngi* collected in treated houses was significantly larger than that in untreated houses. A significant difference was not seen in *L. colombiana*, although again the overall numbers of flies

caught by sticky trap in treated houses was higher than that in untreated houses. The difference between the numbers collected in treated and control houses was most marked in pair 1, in which sticky traps in the treated house collected 67.8% of all *L. youngi* and 62.8% of all *L. columbiana* taken during the study.

TABLE I

Number of sand flies collected by sticky traps in houses treated with 1% deltamethrin or left untreated, Alto Aguacatal, Colombia

Species	Total No.		T/C ratio	P
	Treated	Control		
<i>Lutzomyia youngi</i>	546	63	8.7:1	0.004
<i>Lutzomyia columbiana</i>	436	80	5.4:1	ns

The results of human bait collections are shown in Table II and suggest the opposite of the relationship seen based on sticky trap collections for treated and untreated houses. Overall numbers of sand flies of both species caught on human bait was higher in untreated than treated houses although these differences were not found to be significant when analyzed by Wilcoxon 2-sample test.

Insects from a laboratory colony (F1) of *L. youngi* were used in contact bioassays 76 and 109 days after application of the insecticide, in which 10 sand flies were introduced into each of three plastic cones of base diameter 10 cm fixed to the walls of treated and control houses. Mortality of sand flies in the treated group after 30 min was 100% in both trials, while control mortality was less than 10%.

DISCUSSION

The length of the study (131 days) was well within the period in which the insecticidal efficacy of K-Othrine sprayed on adobe walls is

thought to remain undiminished, the manufacturers recommending repeat applications at six-month intervals (P Walker, Roussel-Uclaf/SOVA, pers. comm.). Quesada (1993) found that the mortality of *L. youngi* exposed for 30 min to adobe treated with deltamethrin at a concentration of 25 mg/m<sup>2</sup> remained at 100% up to 90 days after application, falling to 86.7% after 120 days.

The number of houses treated during the present study was probably too low to affect the population levels of sand flies to a marked extent in Alto Aguacatal, since the insects entering the six treated houses to bite probably represented a small fraction of the total sand fly population of the village. The highest recorded biting rate for any of the intradomiciliary human bait collections was 28 per man-hr, although most samples were much smaller. Nevertheless based on the results shown in Table II it does appear that residual spraying of walls with deltamethrin may have reduced biting by sand flies, although not the amount of sand flies that entered houses. The sand flies that were collected off human bait in treated houses may have been those that alit on the volunteers without touching the insecticide beforehand, since contact with deltamethrin is known to have a repellent/excitatory effect that would reduce the predisposition of these insects to feed. Herrer (1956) noted that *L. verrucarum* (Townsend) in Peru often entered houses without touching walls, took a blood meal, then flew outside again without ever making contact with walls treated with DDT.

The high number of sand flies caught on sticky traps in treated houses may be explained by reduced mobility of the insects after touching the walls. While sand flies that took a blood meal in untreated houses could fly outside immediately afterwards or after resting briefly on the walls, those alighting on the walls of treated houses after feeding would make contact with deltamethrin, resulting in intoxication and reduced flying capability. These insects would therefore spend more time inside the houses and have a greater possibility of coming into contact with the sticky traps. Sand flies with fresh blood meals (not from the volunteers) were seen resting on the

TABLE II

Number of sand flies collected/man-hr on human bait on in houses treated with 1% deltamethrin or left untreated, Alto Aguacatal, Colombia

Species	Mean No./man-hr ± 1 SD			
	Treated	Control	T/C ratio	P
<i>Lutzomyia youngi</i>	0.70 ± 0.74	2.95 ± 3.50	0.24:1	ns
<i>Lutzomyia columbiana</i>	0.45 ± 0.73	0.83 ± 0.42	0.54:1	ns

walls of untreated houses on several occasions. Le Pont et al. (1989) found that treatment of interior and exterior walls of houses and animal shelters in Yungas, Bolivia was very effective against *L. longipalpis* (Lutz & Neiva), which disappeared for up to ten months after spraying. The effect on *L. nuñeztovari anglesi* Le Pont & Desjeux was less marked, probably due to the more exophilic behaviour of this species. Falcão et al. (1991) found that indoor spraying was effective in reducing the numbers of sand flies [principally *L. intermedia* (Lutz & Neiva) and *L. migonei* (Franca)] biting inside houses in Viana, Brazil. In another Brazilian study, Marcondes & Nascimento (1993) found *L. longipalpis* on some walls treated with deltamethrin only 14 days after spraying. While our results suggest that residual spraying of walls is an effective method of reducing sand fly biting, it should be noted that none of the families participating in the study perceived a significant difference after treatment. This was particularly true in the house where activity of the insects was greater, and biting was recorded by the inhabitants within 48 hr of treatment of the walls of their house. This may have been the result of sand flies entering and biting before making contact with the treated surface.

If sand fly populations in wooded areas surrounding the dwellings were sufficiently large to offset losses then the beneficial effects of insecticidal treatment would not be discerned by the occupants of treated houses. It is possible that prolonged use of residual insecticides might be effective in reducing population levels to such an extent that the numbers of sand flies entering houses is significantly diminished. However the unwillingness of several of the families in Alto Aguacatal to continue participation in the study after four months meant that this could not be measured.

Apart from the fact that sand flies may bite before contacting treated surfaces, use of residual insecticides sprayed on walls to control sand flies has the disadvantages of requiring trained personnel and special equipment. In communities as small as Alto Aguacatal these measures may not have a significant effect on the sand fly populations, especially if not applied by most or all households in the community. An alternative strategy would be the use of impregnated mosquito nets that can be treated with insecticide regularly by the members of rural communities themselves and offer more complete protection, at least after the users have retired for the night. Impregnated curtains hung across doors and windows would offer some protection before the occupants of a house have gone to bed. In some situations, however, residual insecticides sprayed on the walls of houses may offer a viable strategy for control of sand flies and leishmaniasis if local governmental or community organizations provide infrastructure to sustain such a programme.

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