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Do Permethrin-Treated Screens Repel Sand Flies from Entering Houses?

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Summary

The effects of permethrin-treated screens on sand flies entering treated houses were evaluated in Marigat area of Baringo District, Kenya. Screens treated with 0.50 g/m² a.i. of permethrin 20% E.C. were fitted inside houses and re-treated every 6 months from January 1992 to December 1993. In the treated village, 40.62% sand flies were caught inside while 67.34% sand flies were collected outside houses. In the control village, 32.66% sand flies were collected inside while 59.38% sand flies were caught outside houses. The number of sand flies collected outside houses in the treated village was higher than those collected inside houses in the same village (X^2 = 30.97, df = 11, P = 0.001). Twelve species of sand flies were collected in the area, of which nine species of the Sergentomyia *and three species of the* Phlebotomus *genera.* Phlebotomus martini *and* P. duboscqi, *vectors of visceral and cutaneous leishmaniasis respectively were collected inside houses in both treated and control villages. Permethrin-treated screens fitted inside houses were effective against sand flies as they reduced the number of flies entering houses. However, the treated screens did not seem to have any effect on sand fly species composition. Permethrin-treated screens are an important tool for controlling sand flies in the communities.*

Résumé

Les écrans imprégnés d'insecticide peuvent-ils empêcher les phlébotomes d'entrer dans les maisons ?

Les effets d'écrans traités à la permethrine sur les phlébotomes endophiles ont été évalués dans la région de Marigat, district de Baringo, Kenya. Les écrans imprégnés de 0,50 g par m² d'ingrédient actif de permethrine en concentré émulsionnable à 20% ont été placés dans les maisons et ré-imprégnés tous les six mois de janvier 1992 à décembre 1993. Dans le village traité, 40,62% de phlébotomes ont été capturés à l'intérieur des maisons, alors que 67,34% de phlébotomes ont été attrapés à l'extérieur. Dans le village témoin, 32,66% de phlébotomes ont été capturés à l'intérieur des maisons, alors que 59,38% de phlébotomes ont été attrapés à l'extérieur. Le nombre de phlébotomes capturés à l'extérieur des maisons dans le village traité à été significativement plus élevé que celui collecté à l'intérieur des maisons (X^2 = 30,97; df = 11; P = 0,001). Douze espèces de phlébotomes ont été capturées dans la région, et parmi elles, neuf appartiennent au genre Sergentomyia *et trois au genre* Phlebotomus. Phlebotomus martini, *vecteur de la leishmaniose viscérale et* P. duboscqi, *vecteur de la leishmaniose cutanée ont été capturés à l'intérieur des maisons dans le village traité ainsi que dans le village témoin. Les écrans traités à la permethrine, placés à l'intérieur des maisons se sont révélés efficaces contre les phlébotomes. Ceux-ci réduisaient le nombre de phlébotomes qui entraient dans les maisons. Cependant, ces écrans ne semblent pas avoir un effet sur la composition des espèces de phlébotomes. Les écrans traités à la permethrine constituent un outil important pour contrôler les phlébotomes au sein des communautés.*

Introduction

Fabrics treated screens with synthetic pyrethroids have been recommended by the World Health Organization to control vectors of diseases to man (30). Bednets and eave curtains treated with permethrin have shown to successfully control *Anopheles* malaria mosquitoes in the Gambia (14), Tanzania (15,16), Kenya (24) and Burkina Faso (17). In Central Italy a successful control of *Phlebotomus papatasi* (Scopoli) sand flies was achieved by using permethrin treated screens (20). In The Gambia, the use of mosquito nets treated with synthetic pyrethroids reduced malaria in children by 63% (2), while in Kenya and Ghana the treated nets reduced the death due to malaria among children under five years of age by one third and one sixth respectively (29). In Burkina Faso, an approximately 99% reduction of the overall density of endophilic sand flies was recorded in houses fitted with permethrin-impregnated nets (18). While controlling malaria mosquitoes in Marigat location of Baringo District, Kenya, a reduction of between 52-73% of sandflies inside houses fitted with permethrin-treated wall cloth was reported (25). In Kenya Rift Valley, 81.43% reduction of sand flies in treated houses was reported after the eighth treatment of the screens (6). However, synthetic pyrethroid-treated

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mosquito nets and curtains have been reported having an excito-repellent effect on malaria mosquito vectors entering houses (9). Malaria mosquitoes have been reduced by use of bednets impregnated with permethrin in The Gambia (2), by permethrin-impregnated curtains and screens in Tanzania (15) and Kenya (24), whereas leishmaniasis sand flies have been drastically reduced by hanging permethrin-treated screens on the walls inside houses (6) and by using permethrin-treated bednets (18,20). The introduction of permethrin-impregnated nets in some villages in Tanzania caused a high mortality of malaria *Anopheles* mosquitoes (16). In The Gambia, Kenya, Burkina Faso and Tanzania, the use of permethrin-treated materials has been associated with the reductions of disease vectors, hence reduction of man-vector contact. In China for example, the use of pyrethroid impregnated bednets reduced the incidence of malaria and its vector densities (28). In Guinea Bissau, a 78% reduction of malaria parasite inoculation rates was due to usage of permethrin-treated bednets (11). The control of sand flies, vectors of leishmaniasis inside houses by spraying chemical insecticides has so far produced no encouraging results in countries such as India (22), Brazil (19) and Panama (7). The only successful sand fly control programme with sprayed insecticide was reported in Peru (10). In South America, spraying of chemicals to control sand flies has been considered impracticable, uneconomical and ecologically unsound (7). For these reasons, endophilic sand fly control has focused on the use of materials treated with pyrethroid insecticides, because of their long lasting effect and low mammalian toxicity (9). Screens treated with synthetic pyrethroids fitted inside houses seem to be an important tool for controlling vector-borne diseases such as leishmaniasis (6, 25) and malaria (9).
In Africa today, the control of both visceral and cutaneous leishmaniasis relies mainly on passive detection of human cases followed by chemotherapy using pentavalent antimonial drugs. These drugs are heavy metals and have shown to cause serious side effects including cardiac and renal failure. Mazzari et al. (21) noted that because leishmaniasis were traditionally considered rural and sylvatic diseases, no attempt was made to establish an organized control campaign. However nowadays, leishmaniasis has been recorded in periurban and urban areas making more populations at risk of acquiring the disease. This has therefore caused its control awareness in a number of countries.

Sand flies of the *Phlebotomus* genus have been confirmed to be the main vectors of leishmaniasis in Africa (23,26) as opposed to *Lutzomyia* species found transmitting this disease in Southern America (12,13). In Kenya, however species of *Phlebotomus* genus have shown to have an anthropophilic behaviour in peridomestic and domestic habitats (MB, personal communication), and transmission of leishmaniasis is thus thought to occur in both habitats. Such observations have led to plan for the use of synthetic pyrethroid impregnated materials, e.g. bednets, wall clothes and room dividers to control endophilic sand flies in the area, with objective to reduce the prevalence of leishmaniasis.
The aim of this study is to determine the effect of permethrin-treated screens fitted inside traditional thatched houses on endophilic sand fly species in Marigat area of Kenya.

Material and methods

Study area. This study was carried out in Marigat Division of Baringo District in the Kenya Rift Valley. The study area was located in the Perkerra irrigation scheme, with a population of approximately 2000 people. Perkerra is situated at latitude 0°28' N and longitude 35°58' E and at an elevation of 1067 m. The mean monthly temperature was 32.2+1.5°C, with mean maximum temperature of 35°C (January/February) and the mean minimum temperature of 30°C (June/July). A 6 month dry season (September-February) is followed by a six month rainy season (March-August) with a total annual rainfall of 653 mm (4). Sand fly peak population occurred in August, a month with moderate rainfall. Sand flies were collected in two villages. Marigat township and Ngambo. In the first village, two hundred houses, randomly selected were fitted with treated screens, whereas houses in Ngambo, the control village, were left without screens. In both treated and control villages, traditional houses were mostly used for sampling sand flies.

Treatment of the screens. Screens were treated as described by Schreck & Self (27) and AHRTAG (3). A permethrin synthetic pyrethroid was used as 20% E.C. (emulsifiable concentrate). The 60-mesh screen (1.5 X 9 m) made of polyester netting was treated with 0.50 g/m^2 active ingredient of permethrin. The treated screens remained fitted inside houses along the walls and were removed for re-treatment every six months from January 1992 to December 1993. Baseline data on sand fly densities in the area was collected before deployment of the screens giving an overall mean density of 6.5 sand flies per house per trap night. The highest sand fly density was 14.5 sand flies while the lowest was 2.5 sand flies per house per trap night (25). During the first, second and third deployment of treated screens, an average sand fly density of 2.9, 3.0 and 2.4 respectively were collected in the area. Thus, during the third deployment of treated screens, the sand fly density was reduced by 63 percent.

Sand fly collections. Sand flies were collected once a week from January 1992 to December 1993 in six houses randomly selected in each village on each collection day. A total of 12 houses per week were sampled. A single clear polythene sheet (1 m^2) coated with castor oil on both sides (so-called sticky trap) was placed overnight horizontally along the wall inside houses next to the permethrin-treated screen or next to the bed in untreated houses. Using sticky traps, collections of sand flies outside and inside houses in both treated and control villages were done at the same period. In total, sand flies were collected for 96 weeks (once a week) from 1152 houses (576 houses in treated villages and the same number of houses in control villages) using 2304 sticky traps of which 1152 traps were placed inside houses and the same number of traps were set outside houses. Caught sand flies were removed from the sticky traps the following morning and identified to species using Abonnenc dichotomic keys (1).

Data analysis. To analyse the effects of permethrin-treated screens on sand flies inside and outside houses, the goodness of fit with a chi-square (X^2) test was performed using an analytical software (STATISTIX Version 3.1). In Table 1, data were presented as back transformed geometric means.

Results

Twelve sand fly species of the genus *Phlebotomus* and *Sergentomyia* were identified in Marigat area (Table 1). 2,667 sandfly specimens were collected between January 1992 and December 1993 in permethrin-treated and control villages. These were: *Phlebotomus martini* Parrot (0.26%), *P. duboscqi* Neveu-Lemaire (0.11%), *P. rodhaini* Parrot (0.07%), *Sergentomyia antennata* Newstead (50.95%), *S. bedfordi* Newstead (26.39%), *S. schwetzi* Adler, Theodor & Parrot (11.39%), *S. africana* Newstead (6.29%), *S. ingrami* Newstead (2.47%), *S. adleri* Theodor (1.12%), *S. clydei* Sinton (0.59%), *S. affinis* Theodor (0.11%), and *S. squamipleuris* Newstead (0.18%).

Analysing the sand fly species composition, it was observed that all the *Sergentomyia* species (9 species) were present in both treated and control areas, whereas the *Phlebotomus* species (3 species) were more present in the treated area (Table 1). Among the *Phlebotomus* species, only *P. martini* was present in the control area, and they were all caught from houses.

Comparing the numbers of sand flies (all species) inside and outside houses in both permethrin-treated and control villages, it was noted that: in the treated village, more sand flies were collected outside (67.34%) than inside treated houses (40.62%), while in the control village, 59.38% sand flies were found inside houses and 32.66% were collected outside houses. The number of sand flies collected inside houses in the control village was significantly higher than ones collected inside houses in treated village (X^2 = 30.97, df = 11, P = 0.001). Inversely, the number of sand flies collected outside treated houses (67.34%) was higher than ones collected outside houses in the control village (40.62%).

Discussion

The reduction in sand fly numbers caught inside treated houses in Marigat area of Baringo District, Kenya may have been caused by the use of permethrin-treated screens. This was not the case for their species composition as there was no differences between species of sand fly collected in control and those caught in treated houses.

The analysis of the numbers of sand flies caught in the treated village has shown that more sand flies were collected outside than inside treated houses. Curtis (9) has reported similar flushing out effect of synthetic pyrethroid insecticides to insect vectors from their hiding places and, hence to pick up a lethal dose of the insecticide leading to high mortalities.

Studies on sand flies in the Marigat area have shown that *P. martini*, a vector of visceral leishmaniasis (26), and *P. duboscqi*, a vector of cutaneous leishmaniasis (23) are both found inside human habitations (5). From our observations, we conclude that screens treated with permethrin hung inside houses can reduce the number of endophylic sand flies entering houses.

The relatively low number of sand flies of the genus *Phlebotomus* collected inside houses has a significant epidemiological importance in leishmaniasis transmission. Coene (8) noted that the transmission of malaria depends largely on the sporozite rates rather than on the (low) densities of mosquito populations. Basimike and Mutinga (6) reported that in Marigat area of Kenya,

Table 1
Mean sand flies collected inside and outside treated and control houses in Marigat area.

Species	Treated area (Marigat township)				Control area (Ngambo)			
	inside houses		outside houses		inside houses		outside houses	
P. martini	0.50	(2)	0.25	(1)	1.00	(4)	0.00	(0)
P. duboscqi	0.50	(2)	0.25	(1)	0.00	(0)	0.00	(0)
P. rodhaini	0.50	(2)	0.00	(0)	0.00	(0)	0.00	(0)
S. antennata	80.25	(321)	91.50	(366)	124.75	(499)	43.25	(173)
S. bedfordi	40.00	(160)	55.75	(233)	57.50	(230)	22.75	(91)
S. schwetzi	25.50	(102)	18.25	(73)	23.25	(93)	9.00	(36)
S. africana	6.00	(24)	8.75	(35)	18.25	(73)	9.00	(36)
S. ingrami	4.75	(19)	5.75	(23)	4.50	(18)	1.50	(6)
S. adleri	1.50	(6)	1.00	(4)	3.50	(14)	1.50	(6)
S. clydei	0.75	(3)	0.50	(2)	1.50	(6)	1.25	(5)
S. affinis	0.25	(1)	0.00	(0)	0.25	(1)	0.25	(1)
S. squamipleuris	0.25	(1)	0.50	(2)	0.50	(2)	0.00	(0)
Total numbers	643		730		940		354	

Values are back transformed geometric means.
In brackets are numbers of collected sand flies.

the transmission of *Leishmania* parasite to humans by *Phlebotomus martini* and *P. duboscqi* is not density dependent. Thus, a few individuals of sand fly vectors in an area are capable to cause the spread of leishmaniasis within the human population.

The use of permethrin synthetic pyrethroid has shown to reduce sand flies entering inside houses in Baringo area of Kenya as was the case in India (22), Brazil (19) and in Panama (7). In Peru (10), the use of chemical insecticides has produced successful result in sand fly control.

It is therefore noted that any use of permethrin synthetic pyrethroid to control phlebotomine sand flies can contribute to significantly reduce its leishmaniasis transmitted disease to man.

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