

INDOOR RESTING HEIGHTS OF SOME ANOPHELINES IN COLOMBIA¹

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ABSTRACT. The nocturnal, indoor resting behavior of female anophelines in Colombia was studied. *Anopheles darlingi* and *An. marajoara* had a tendency to rest close to the ground, but *An. oswaldoi* and *An. rangeli* rested higher up. This behavior was independent of bloodfed status (except for *An. oswaldoi*) and whether the surface had been sprayed with DDT. With this information it should be possible to modify insecticide applications to coincide with the resting preferences of these species.

INTRODUCTION

In the national antimalarial program in Colombia, DDT is applied to the inner walls of huts. Potential vectors of malarial parasites resting on walls absorb a lethal dose and die. The insecticide is normally applied from the floor to the ceiling and on other indoor surfaces such as the underside of chairs, tables and beds.

Incomplete treatment of malarious areas (less than 30% since 1980) by the Colombian program is due, in part, to insufficient financial resources, personnel, equipment and increased operational costs. This situation has necessitated the search for alternatives that will reduce the quantity of insecticide used per hut, and allow greater geographic coverage without increasing costs. One possible approach would be for selective insecticide applications to those indoor surfaces where the anopheline mosquito rests, rather than indiscriminate treatment of all interior surfaces in the hut. However, any decision to modify existing treatment procedures must be based on entomological evidence obtained from studies of the indoor resting habits of malaria vectors.

The present study was undertaken to quantify the resting behavior of anopheline mosquitoes in 4 malarious regions of Colombia, and to evaluate the effect of spraying to a height of 1.5 m, compared with the normal spraying height of 3.0 m.

MATERIALS AND METHODS

This study was conducted in the departments of Bolívar, Santander, Meta and Caquetá. Two areas with a high incidence of malaria were selected in each region. Huts in one area were

sprayed with DDT to a height of 1.5 m, whereas huts in the other were sprayed to 3.0 m. Two localities in each area were chosen for entomological evaluation.

Three persons were employed in the study by region. The first person, seated in a room of the hut, allowed mosquitoes to freely bite, fly and rest. The other 2 persons collected the resting female mosquitoes and recorded the height at which each mosquito was found, whether the resting surface had been sprayed with DDT, and if the anopheline was empty or engorged with blood. The mosquitoes were collected biweekly, in different houses between 1930 and 2330 h from 1985 to 1987 between February and November. Mosquitoes were stored individually and later identified to species.

RESULTS

When histograms were prepared for the numbers found on resting heights at 0.5 m intervals (Fig. 1), differences were found between the preferred resting heights of the 4 *Anopheles* species. *Anopheles darlingi* Root and *An. marajoara* Galvão and Damasceno both showed a tendency to rest at lower heights. In contrast, *An. oswaldoi* (Peryassú) and *An. rangeli* Gabaldon, Cova Garcia and Lopez tended to rest on the upper portions of walls.

When the numbers resting above and below the 1.5 m level were considered (Table 1), the differences from the null-point hypothesis of 50:50 above and below 1.5 m height were found to be highly significant for both the 2 low-resting species and the 2 high species, with chi-square values of 639.3, 53.6, 21.6 and 93.4, respectively, the *P* values all being less than 0.005. No statistically significant difference was found in the resting heights of engorged versus empty female *An. darlingi*, *An. marajoara* and *An. rangeli*. Although the resting heights of fed versus unfed *An. oswaldoi* were significantly different (χ^2 , *P* < 0.05, more unfed resting higher), both tended to rest higher than 1.5 m. The most frequent resting height of each species was independent of bloodfed status.

¹ Opinions and assertions contained herein are the private views of the authors and do not necessarily reflect the view of the Colombian Ministry of Health.

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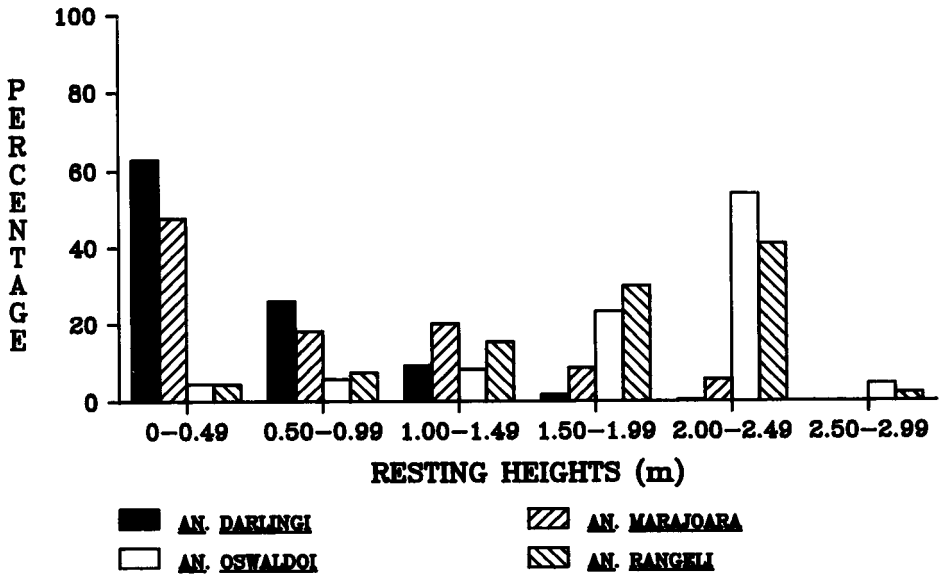


Fig. 1. Resting-height preferences for females of 4 anopheline species of Colombia.

Likewise, the resting pattern for these species was also independent of DDT treatment (Table 2). *Anopheles darlingi* and *An. marajoara* showed a tendency to rest at lower heights (Fig. 1), whether the surface was sprayed up to 1.5 or 3.0 m. In the localities sprayed up to 1.5 m, a high proportion of *An. rangeli* and *An. oswaldoi* was found resting on surfaces without insecticide, consistent with the tendency of these species to rest above 1.5 m. In localities sprayed up to 3.0 m, a high proportion of these species rested on sprayed surfaces. Between 2.3 and 33.0% of the mosquitoes were found resting on surfaces that could not be sprayed such as paper, plastics, fabrics (bednets, clothes) metal and floors.

DISCUSSION

Each *Anopheles* species studied had a consistent resting pattern unaffected by feeding condition or insecticide spray on the walls. The tendency of *An. darlingi* to rest at low heights was previously reported in Belem, Brazil (Deane and Damasceno 1948), and in Colombia (Elliott 1972). However, in the Ituxi River region in Amazonas, Brazil, this species showed a tendency to rest on the ceiling, a behavior suggested as a regional difference by Roberts et al. (1987).

With the preferred resting heights observed for these species, effective selective insecticide application appears feasible. In regions where both *An. darlingi* and *An. marajoara* occur, it is possible to apply the insecticide from ground level up to 1.5 m high. In regions where *An. rangeli* and *An. oswaldoi* occur in significant numbers, it will be necessary to continue the

Table 1. Number of female mosquitoes collected at different nocturnal resting heights.

Species	Height (m)	
	0-1.5	>1.5-3.0
<i>An. darlingi</i>		
Fed	535 (98.2)*	10 (1.8)
Unfed	148 (96.7)	5 (3.3)
<i>An. marajoara</i>		
Fed	58 (85.6)	10 (14.4)
Unfed	32 (86.5)	5 (13.5)
<i>An. oswaldoi</i>		
Fed	19 (30.2)	44 (69.8)**
Unfed	44 (10.7)	83 (89.2)
<i>An. rangeli</i>		
Fed	33 (30.0)	77 (70.0)
Unfed	29 (24.6)	89 (75.4)

* The number in parentheses is the percentage in the category.

** $P < 0.05$, fed vs. unfed *An. oswaldoi*.

routine procedure of applying insecticide to a height of 3.0 m on the walls.

However, it will be necessary to evaluate selective applications with epidemiological information. Selective insecticide applications have been successful in Italy and Yugoslavia, where the malaria vector *An. maculipennis* Meigen showed a tendency to rest above 1.5 m (Pampuna 1966). Selective application has been proposed for the island of Java in Indonesia, where the vector *An. aconitus* Dönitz prefers to rest below 1.5 m (Damar et al. 1981).

Selective insecticide applications permit more efficient coverage by reducing the amount and time required for application. In regions where

Table 2. Nocturnal resting-heights with regard to spray status on the walls.

Species	No. collected	Percentage on 3 surface types		
		With DDT	Without DDT	Unsprayed objects*
Locality A**				
<i>An. darlingi</i>	592	91.5	4.4	4.1
<i>An. marajoara</i>	44	70.5	25.0	4.5
<i>An. oswaldoi</i>	83	14.5	78.3	7.2
<i>An. rangeli</i>	96	26.0	71.0	3.0
Locality B**				
<i>An. darlingi</i>	106	58.5	8.4	33.0
<i>An. marajoara</i>	61	67.2	8.2	24.6
<i>An. oswaldoi</i>	73	83.5	13.7	2.7
<i>An. rangeli</i>	132	89.4	8.3	2.3

* Plastic, paper, fabrics, metal, floor.

** Locality A sprayed to 1.5 m, locality B sprayed to 3.0 m.

DDT is not desirable (e.g., because of DDT resistance), selective application would be even more advantageous because of the high cost of alternative insecticides. However, because regional differences in the resting behavior of each species are possible, it is always necessary to evaluate resting height preferences for each locality.

Although the majority of anophelines were found resting on sprayed surfaces in localities sprayed up to 3.0 m, some were found on non-sprayed surfaces, hence reducing the effectiveness of indoor spraying. This behavior justifies the necessity to carry out complementary control measures, like the use of bednets or curtains impregnated with permethrin or deltamethrin or repellents, in order to minimize man-mosquito contact.

ACKNOWLEDGMENTS

The cooperation of the Campanas Directas, Ministry of Public Health, Colombia, especially A. Rodriguez, is gratefully acknowledged. We thank all the field personnel of the Servicio de Erradicacion de la Malaria (SEM) who assisted in the collections, with special thanks to Arge-

miro Hernandez, Henry Jimenez, Alcides Carrillo, Libardo Cabrera and Nelson Angarita. We also thank G. A. Fleming, PAHO entomologist in Bogota, G. G. Clark and P. Reiter, Centers for Disease Control (CDC) entomologists in Puerto Rico and G. Marten, CDC New Orleans, for reviewing the manuscript.

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