THE ECOLOGY OF *ANOPHELES ALBIMANUS* (WIED.) IN HAITI

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INTRODUCTION. A review of the literature on *Anopheles albimanus* reveals that this important malaria vector has been studied frequently and intensively throughout the Carribbean region. Foote and Cook (1959) observed that *A. albimanus* is the most common species found in houses in many areas, it returns to outdoor resting places soon after feeding, its outdoor resting places are usually widely dispersed, it feeds on livestock as readily as on man, depending on which is available, is active during twilight and is a strong flyer. He further noted that the larvae live in a great variety of sunlit water habitats. However, since the water must contain many microorganisms, be without putrefaction and in biological equilibrium, the most common breeding sites are large ponds, lakes, seepages, irrigation ditches and rice fields.

Other interesting work on *A. albimanus* was included in the observations of Pratt in 1944 and 1948 on the comparative attractiveness of this species to different wattages in light traps, and the influence of the moon on this type of collection. Pritchard (1944) compared light trap and animal bait trap collections with the conclusion that light traps were superior to animal bait traps in the collection of female *A. albimanus*. Stephens (1947) related the low density of this species in the "dry season" to the decline in the number of malaria cases, and the high density in the "wet season" to the increase in the malaria rate. Rachou *et al.* (1964) studied the various aspects of density, ecology and behavior of this species in relation to a DDT residual spray program. Variations were observed in the density of this species from dry season to wet season and DDT susceptibility and irritability levels were established.

PROCEDURES

A. DENSITY STUDIES. In an effort to quantitate seasonal fluctuations in the density of *A. albimanus* in Haiti, two biting collections were made in six study areas each week during the course of a year.[2] The breeding sites in three of these study areas were of a temporary nature, directly dependent upon rainfall; one site was of a semipermanent type, while the other two study areas were under irrigation and had permanent breeding sites. Water samples were taken in these areas

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[2] Larval surveys were attempted; however, it was not possible to quantitate the results due to the variability in this type of collection.

to establish the pH range and the amount of chlorides in the breeding site waters.

Four human baits of approximately the same age and weight were used 2 nights weekly in each of the areas. Two collectors made the necessary captures. The baits were placed in outside situations between a breeding site and a group of houses. The collections were taken from 10 minutes before sundown until 1 hour and 50 minutes after sundown.

B. BITING AND RESTING BEHAVIOR. To estimate the relative numbers of *A. albimanus* biting outdoors and indoors, four human baits of approximately the same age and weight were placed outdoors between a breeding site and a group of houses and four were placed indoors in a house in the same locality. Two collectors were used outdoors and three collectors indoors. Those outdoors captured the biting mosquitoes while those indoors observed the mosquitoes biting. The engorged mosquitoes were allowed to fly to a resting place where each was captured by one of the indoor collectors. These captured mosquitoes were held for 24-hour mortality counts. Collections were made during the peak period of biting activity 10 minutes before sundown until 1 hour and 50 minutes after sundown. The same situations were used in 498 replications.

C. PERIODICITY. To determine the hourly biting activity of *A. albimanus,* 26 all-night biting collections were made in several localities, characterized by relatively high mosquito densities. Four human baits of approximately the same age and weight were placed in positions between a breeding site and a group of houses. The same number of baits were placed indoors in a house in the same area. Replications were accomplished using the same basic situation. Two collectors were used outdoors and two indoors. The collections were divided into the following periods: 1730–1900, 1900–2100, 2100–2300, 2300–0100, 0100–0700.

RESULTS AND DISCUSSION

A. DENSITY STUDIES. *A. albimanus* was found in the following types of waters: (1) semipermanent flood and rain pools; (2) springs and seepages; (3) irrigated rice fields; (4) shorelines of clear lakes having emergent vegetation; and (5) salt marshes which had been flooded during the rainy season. In all of these waters, emergent vegetation and many algae and microorganisms were found. The water was clear, and intermittent sun appeared to be favorable for larval development. The pH varied from 7.2 to 8.6 in samples taken from these waters. Chlorides as NaCl varied from 33 to 109 ppm.

Table 1 illustrates the relationship between rainfall and anopheline density by adult captures accomplished near temporary, semipermanent and permanent breeding sites. The effect of rainfall on temporary breeding sites and subsequent biting densities was so variable that no direct relationship could be established. Collections near the semipermanent breeding site at Port-de-Paix, however, demonstrated a close correlation between the rainfall and density. Here only a relatively small amount of rain was sufficient to bring water into shoreline breeding sites.

Near permanent breeding sites such as those in the Communes of Gros Morne and Arcahaie rainfall is not solely responsible for fluctuation in anopheline density, but such things as cutting rice or freshly inundating a rice field are of importance. The extent of permanent breeding sites has not been established; however, it has been observed that rice fields, springs and seepages and some lakes are the most common permanent breeding sites.

B. BITING AND RESTING BEHAVIOR. Indoor-outdoor biting collections in high density and low density DDT residual sprayed localities and in a high density unsprayed locality are summarized in Table 2. These data indicate that from 75 to 92 percent of the biting activity takes place outdoors. In addition, it was noted that in low density-sprayed areas proportionately fewer mosquitoes entered the houses for feeding than in the high density-sprayed and unsprayed localities;

TABLE 1.—Biting collections on human baits near temporary and permanent breeding sites during 1963–64 and monthly rainfall.

	Temporary breeding sites 1963–1964				Semi-permanent breed. sites 1963–1964				Permanent breeding sites 1963–1964			
	Commune of Mirebalais		Commune of Las Cahobas		Commune of Duvalierville		Commune of Port-de-Paix		Commune of Gros Morne		Commune of Arcahaie	
	Bites/ manhour	Rainfall in cm.	Bites/ manhour	Rainfall in cm.	Bites/ manhour	Rainfall in cm.	Bites/ manhour	Rainfall in cm.	Bites/ manhour	Rainfall in cm.	Bites/ manhour	Rainfall in cm.
October	..	19	..	24	..	..	..	11	..	12	..	..
November	7	23	15	9	0	7	0	26	35	9	..	7
December	4	5	7	4	9	4	25	40	33	4	15	4
January	1	0	0	3	2	1	24	14	27	2	19	1
February	1	4	1	4	16	3	7	3	34	5	58	3
March	2	1	3	9	1	1	12	10	23	3	12	1
April	2	33	1	20	1	15	8	6	15	9	19	15
May	7	17	2	40	6	8	2	3	26	21	31	8
June	17	20	1	23	8	12	14	16	12	15	23	12
July	6	25	3	19	7	9	3	5	39	6	16	9
August	5	28	2	24	2	13	10	11	24	18	10	13
September	37	37	5	24	3	12	12	6	23	15	20	12
October	27	24	4	24	5	..	3	..	46	12	16	..

TABLE 2.—Indoor and outdoor biting records of *Anopheles albimanus* in low and high density areas and indoor resting collections in sprayed and unsprayed areas.

	Indoors		Outdoors
	Biting	Resting	Biting
Low density sprayed localities (186) [1]	273	138	3164
High density sprayed localities (291)	1332	773	5876
High density unsprayed localities (21)	1381	1381	5311

[1] Numbers in parentheses refer to replications.

the highest inside biting was in high density unsprayed areas.

A variety of outdoor resting collection techniques was attempted with little success. Indoor resting collections indicate that approximately one-half of the biting mosquitoes rest in DDT-sprayed houses while all of those biting in unsprayed houses rest for an undetermined time after biting. Twenty-four hour mortality counts were judged invalid since all specimens died within 24 hours and there were none taken from unsprayed houses.

C. PERIODICITY. Studies on the periods of activity of *A. albimanus* as presented in Table 3 indicate that over three-quarters of the biting activity takes place between 1730 and 2100 hours.

SUMMARY AND CONCLUSIONS

A. Observations made during the course of a year indicated that *A. albimanus* breeding is fairly restricted to low coastal areas in which temporary, semipermanent and permanent waters of a specific type exist.

B. Density studies indicated that near semipermanent breeding sites it was possible to correlate fluctuations in *A. albimanus* populations with rainfall. Near temporary breeding sites, however, results of biting collections were too variable to make any correlation.

C. Biting behavior studies indicate that more than three-quarters of the biting activity of *A. albimanus* in Haiti is outdoors. Of the less than one-fourth of the population biting indoors, about half rest on DDT sprayed walls.

D. Studies on the periods of activity of *A. albimanus* (Wied.) indicate that over three-quarters of the biting activity takes place between 1730 and 2100 hours, the hours during which the majority of Haitians living in the provinces are outdoors.

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References

FOOTE, RICHARD H. and COOK, DAVID R. 1959. Mosquitoes of medical importance. U.S.D.A. Agriculture Handbook No. 152.

GARRETT—JONES, C. 1964. A method for estimating the man biting rate. WHO/Mal/450.

TABLE 3.—Indoor and outdoor biting records of *Anopheles albimanus* on human baits between 1730 and 0700 hours.

	Hours				
	1730–1900	1900–2100	2100–2300	2300–0100	0100–0700
Outdoors (26) [1]	946	309	214	158	48
Indoors (26)	261	130	69	21	15
Total	1107	439	283	179	63

[1] Numbers in parentheses refer to replications.

PRATT, HARRY D. 1944. Studies on the comparative attractiveness of 25, 50 and 100-watt bulbs for Puerto Rican *Anopheles*. Mosq. News 4(1):17–18.

———. 1948. Influence of the moon on light trap collections of *Anopheles albimanus* in Puerto Rico. J. Nat. Mal. Soc. 7(3):212–220.

PRITCHARD, A. EARL, and PRATT, HARRY D. 1944. I. A comparison of light trap and animal bait trap anopheline mosquito collections in Puerto Rico. Pub. Hlth. Rpts. 59(7):221–233.

RACHOU, RENI G. *et al.* 1965. Synoptic epidemiological studies of malaria in El Salvador. Am. J. Trop. Med. Hyg. 14(1):1–62.

STEPHENS, PORTER A., and PRATT, HARRY D. 1947. Work with residual DDT spray in Puerto Rico. Science 105(2715):32–33.