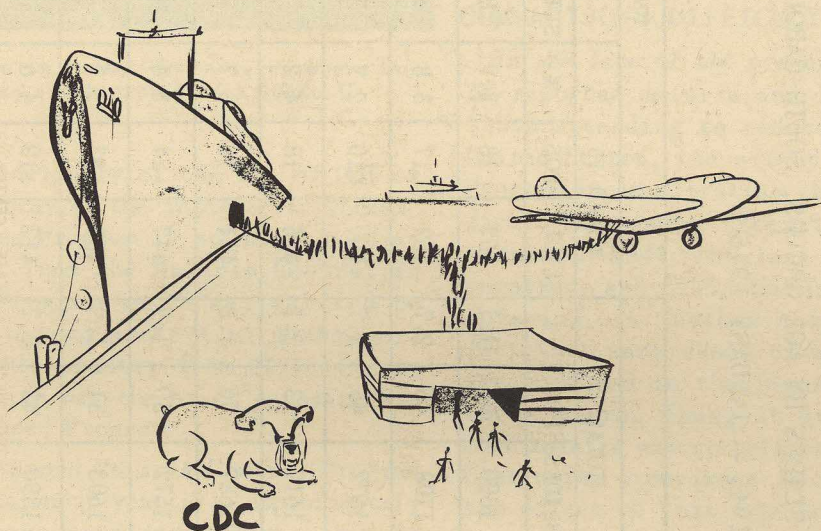


MALARIA CONTROL by DDT RESIDUAL SPRAYING*

A Preliminary Report

by Vernon B. Link



INTRODUCTION

It is estimated that over a half million of our troops acquired malaria during the years of World War II, of which number a certain unknown fraction returned to the United States as carriers, thus increasing our malaria potential to that extent. This potential threatened to reverse the consistent downward trend of malaria cases reported in this country over a period of years. It is too early to be certain whether or not the introduction of large numbers of carriers has actually increased malaria transmission in this country. However, no significant transmission has yet occurred

which could be traced to importation of malaria from abroad. The downward trend of reported cases acquired within the United States is still being maintained.

EXTENDED CONTROL PROGRAM

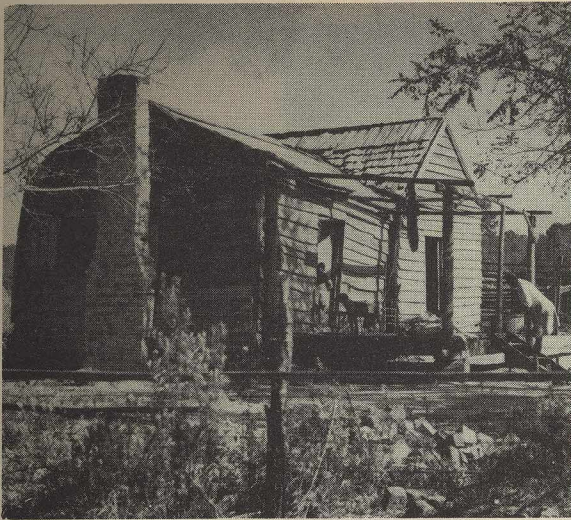
To combat the possibility of transmission of malaria from returning servicemen to the civilian population, especially in the traditionally endemic malaria areas in the South, an emergency program directed against adult mosquitoes was initiated by the U. S. Public Health Service during the 1945 malaria season. The activity is called the Extended Malaria Control Program and

* This article is based on Dr. Link's presentation before the National Malaria Society Meeting in Miami, Florida, November 1, 1946. The complete article will be published in the Journal of the NMS.

Table I

PERCENT POSITIVE BLOOD SLIDES BY AGE GROUPS, SOUTH CAROLINA,
JUNE 1945 — JANUARY 1946

MONTH OF SURVEY	SPRAYED AREA									UNSPRAYED AREA								
	UNDER 10			OVER 10			TOTAL			UNDER 10			OVER 10			TOTAL		
	SLIDES	POS.	%	SLIDES	POS.	%	SLIDES	POS.	%	SLIDES	POS.	%	SLIDES	POS.	%	SLIDES	POS.	%
June	580	33	5.7	1110	36	3.2	1690	69	4.1	462	18	3.9	883	41	4.6	1345	59	4.4
July	592	27	4.6	1116	19	1.7	1708	46	2.7	452	17	3.8	835	10	1.2	1287	27	2.1
August	593	28	4.7	1079	17	1.6	1672	45	2.7	460	10	2.2	808	10	1.2	1268	20	1.6
September	564	28	5.0	1055	15	1.4	1619	43	2.7	426	18	4.2	752	21	2.8	1178	39	3.3
October	573	18	3.1	1064	12	1.1	1637	30	1.8	434	16	3.7	798	22	2.8	1232	38	3.1
November	570	15	2.6	1002	15	1.5	1572	30	1.9	447	24	5.4	815	28	3.4	1262	52	4.1
December	576	15	2.6	1027	16	1.6	1603	31	1.9	435	23	5.3	795	23	2.9	1230	46	3.7
January	589	32	5.4	1001	11	1.1	1590	43	2.7	417	19	4.6	767	18	2.3	1184	37	3.1



Typical house in Santee-Cooper area where one of the malaria study projects is located.

consists principally of the use of DDT as a residual spray on the interior of houses. This Extended Program is so named to distinguish it from the Malaria Control in War Areas Program which was carried on during the war to protect MILITARY personnel in this country from CIVILIAN malaria and which was the exact opposite aim of the Extended Program.

In the Extended Malaria Control Program during the calendar year 1945 approximately 400,000 houses were sprayed one or more times in 119 counties of 13 states, and expanded so that approximately 750,000 houses were sprayed one or more times in 266 counties of 13 states during 1946. Figure 1 shows a map of all areas of operations in 1946.

EXTENDED PROGRAM NOT NEW IDEA

The Extended Program is based on results of laboratory work which demonstrated the residual effect of DDT and its lethal action against adult mosquitoes. Reduction of malaria by controlling adult anophelines is not a new idea. Orenstein (1), in Panama, reduced human malaria by employing laborers to catch adult mosquitoes daily. Russel, Knipe, and Sitapathy (2), in India, reduced human malaria by using pyrethrum sprays to keep interiors of houses free of mosquitoes. Aitken (3), in Italy, used DDT

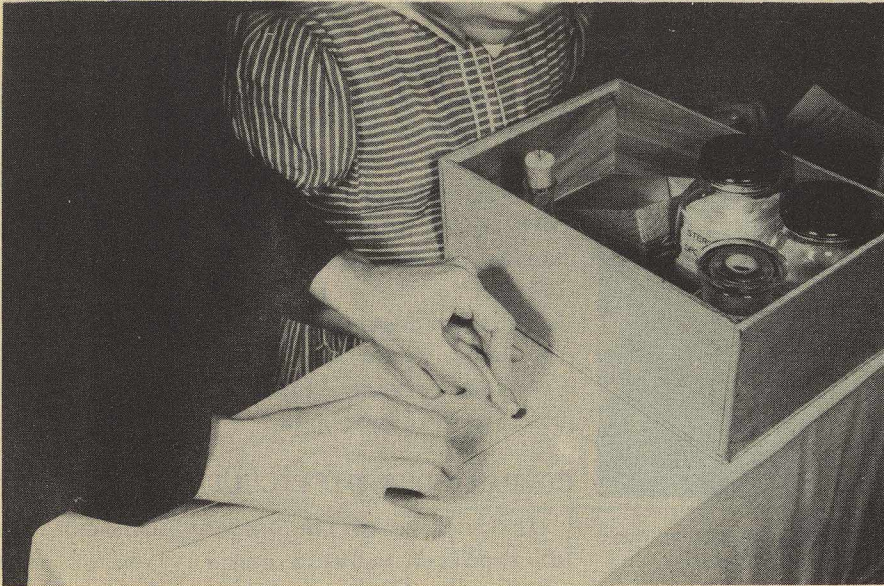
as a residual spray to show a remarkable effect in reducing larval densities, mosquito populations, enlarged spleen frequencies, size of spleens, and positive parasite rates. Trapido (4), in Panama, used DDT as a residual spray to demonstrate a large reduction in numbers of mosquitoes both in the village area outside of treated houses as well as in the forest area adjacent to the village. He also showed a definite reduction of positive blood smears in the sprayed village, a reduction not previously accomplished by ten years of therapeutic methods.

COMPARISONS DIFFICULT

In the face of the present downward trend of reported malaria and in view of other factors tending to reduce malaria in the United States, the effect of the Extended Program in accelerating this trend is difficult to measure. Comparison of cases reported in 1944, the last year before DDT spraying, and 1945, the first year of DDT spraying, is further complicated by the fact that many cases of military malaria are included in the figures reported for those years. Thus, it is not known how much malaria was actually acquired locally. Continuing experience is necessary before the effect of this type of program in decreasing malaria can be measured in terms of reported cases. However, the effect on the incidence of cases of human malaria in areas which have been sprayed with DDT has been measured in the two study projects which were established in the fall of 1944 by the Office of Malaria Control in War Areas and have been continued by the Communicable Disease Center.

SANTEE-COOPER PROJECT

The first of these study projects was located at the Santee-Cooper Reservoir in South Carolina and is a cooperative study with the South Carolina State Board of Health. This region was chosen because it represented the only known high endemic malaria area in the United States. Nearly 20% of the population showed positive blood films in October 1944. A portion of the area adjacent to the reservoir was divided



Thick blood smears were made from all persons in the malaria control survey area.

into approximately equal parts, one of which was sprayed, the other left unsprayed. Each part has a population of approximately 1,500 people, of whom 90% are Negroes. Most of the people work on farms and live in homes which are not mosquito-proofed. A preponderance of the malaria in the area is caused by *Plasmodium falciparum*. *Anopheles quadrimaculatus* is the important mosquito vector in this area.

Houses were sprayed with DDT during the last two weeks of April 1945, and again during the last two weeks of July 1945.

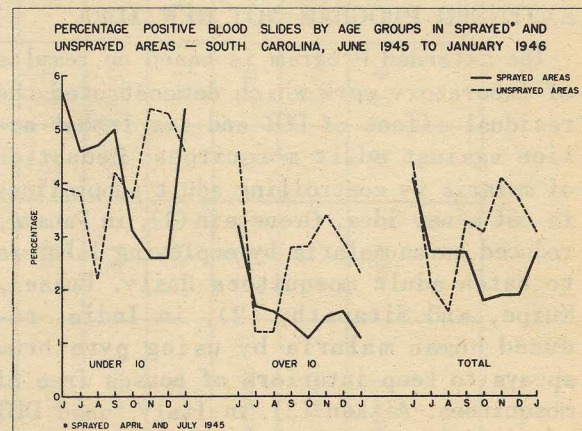
BLOOD SMEAR SURVEYS MADE

The criterion used to measure the amount of malaria present is the thick blood film. Pre-spraying blood surveys were conducted in October 1944 and in April 1945. Post-spraying surveys were carried out at monthly intervals beginning in June 1945, and are still continuing. Figure 2 and table 1 summarize the results of the blood surveys. Unfortunately, even though there were high percentages of positive smears in both areas when the study was begun, there was a rapid fall in these percentages in both the sprayed and the unsprayed areas. However, the rate in the sprayed area decreased after spraying to a rate which was significantly lower than in the unsprayed area during the 1945 malaria transmission season. (5)

PROJECT ESTABLISHED IN PUERTO RICO

The second project established for the purpose of determining what effect DDT has on human malaria was located in Puerto Rico. This is a joint project of the School of Tropical Medicine, Insular Health Department, and the U. S. Public Health Service District No. 6. Epidemiological, entomological, and engineering assistance in starting the study was supplied by the Office of Malaria Control in War Areas. This study is of especial interest because of the fact that the important malaria vector in Puerto Rico is *Anopheles albimanus*, a "wild" mosquito whose habits differ from those of the vector found in the

FIGURE 2



United States as it seldom remains within houses except for a few hours during the night.

Two villages, Humacao Playa and Loisa Aldea, situated in the northeast corner of Puerto Rico, were selected for the study. Humacao Playa was chosen as the sprayed village and Loisa Aldea was left unsprayed. These villages are similar enough in all of the factors involved in malaria transmission to be acceptable as comparable areas. Spraying was accomplished in November 1944, June 1945, and November 1945, and consisted of premise spraying of houses and outbuildings.

TRAP COLLECTIONS

Animal bait trap and light trap collections which were made throughout the year showed that *albimanus* was present in sufficient numbers during the study period to transmit malaria. From one to several hundred *albimanus* were collected from all traps during each night of operation.

RESULTS OF BLOOD FILM SURVEYS

Three blood film surveys were made in the late fall of 1944, in early spring of 1945, and the late fall of 1945. The results of these surveys are shown in summary on figure 3 and table 2. It will



Typical street in Humacao Playa, Puerto Rican village selected for DDT spraying studies. CDC spray crew and equipment truck at right.

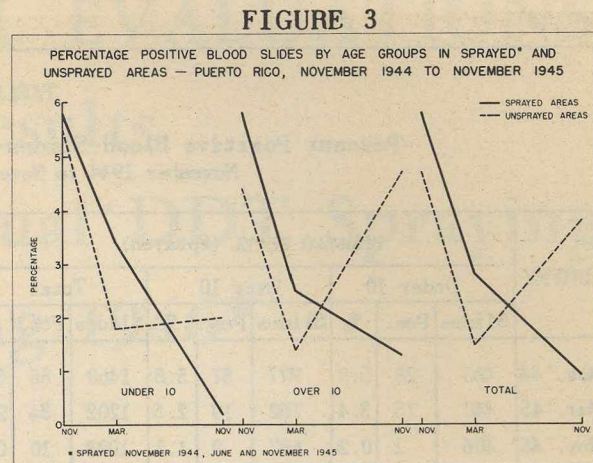


FIGURE 3

be noted that both villages show a decrease in positive smears in the second survey which represents the normal seasonal decline in the incidence of malaria transmission. On the third survey, however, a very significant difference in positive blood smears is seen in which the sprayed village showed only 0.9% positive smears while the unsprayed village showed 3.8% positive smears. The 0-9 year age group in the sprayed village shows the greatest decrease of all in the third survey. Since positivity in younger age groups is often used as an index of transmission, it is considered to be especially significant

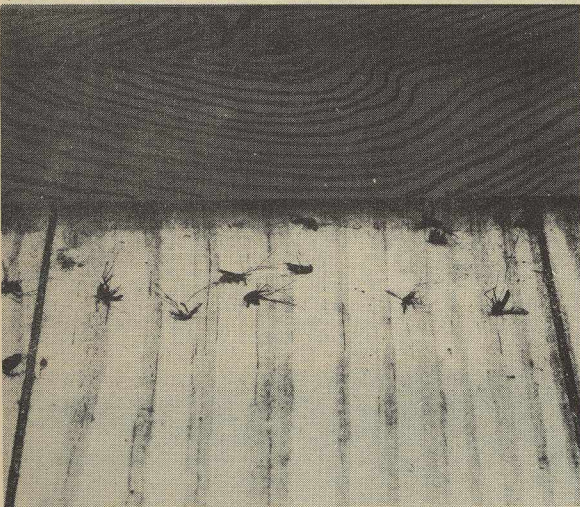


Native crew workers in Puerto Rico are shown the intricacies of spray equipment.

TABLE 2
Percent Positive Blood Slides by Age Groups, Puerto Rico
November 1944 to November 1945 *

SURVEY	HUMACAO PLAYA (Sprayed)									LOIZA ALDEA (Unsprayed)								
	Under 10			Over 10			Total			Under 10			Over 10			Total		
	Slides	Pos.	%	Slides	Pos.	%	Slides	Pos.	%	Slides	Pos.	%	Slides	Pos.	%	Slides	Pos.	%
Nov. '44	483	28	5.8	977	57	5.8	1460	85	5.8	380	21	5.5	891	39	4.4	1271	60	4.7
Mar. '45	440	15	3.4	762	19	2.5	1202	34	2.8	276	5	1.8	576	8	1.4	852	13	1.5
Nov. '45	406	1	0.2	687	9	1.3	1093	10	0.9	292	6	2.0	576	27	4.7	868	33	3.8

that so few positives were recorded in this group in comparison with the number of positives in the same age group of the unsprayed village. (6)



Mosquitoes die soon after contacting walls and other surfaces sprayed with DDT.

ACKNOWLEDGEMENT

Acknowledgement is due to Surgeon (R) R. F. Reider, Medical Officer in Charge, Malaria Investigations Project, Manning South Carolina, for providing data used in figure 2 and table 1.

Similar acknowledgement is due to Sanitary Engineer (R) Porter A. Stephens, U. S. Public Health Service District No. 6, San Juan, Puerto Rico, for providing data used in figure 3 and table 2.

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