ARTICLES

DISPERSAL OF *AEDES TAENIORHYNCHUS* WIEDEMANN NEAR SAVANNAH, GEORGIA [1]

C. M. ELMORE, JR.[2] AND H. F. SCHOOF

The dispersal of the salt-marsh mosquito, *Aedes taeniorhynchus,* has been studied in Florida by Provost (1952, 1957) and near Savannah, Georgia, by Bidlingmayer and Schoof (1957). The present article discusses the dispersal pattern of radioactive *A. taeniorhynchus* released in a second experiment in the Savannah, Georgia, area.

METHODS. The general technique involved collecting and marking *Aedes taeniorhynchus* and *A. sollicitans* larvae, followed by the recapture of the marked adults in light traps distributed over an area 40 miles in diameter.

The chief source of larvae was 2,875 square feet of sod collected from marshes on Tybee, Cockspur, and Pinkney Islands. From the 195 samples, measuring 0.2 sq. ft. each, an average of 2,312 first instar larvae per sq. ft. was obtained upon flooding. Of 5,500 first instar larvae reared for adult identification, 73 percent pupated and most of the pupae reached the adult stage. Based on figures derived from these samples, the total production from the total sod samples was estimated at 5,886,000 larvae. *A. sollicitans* represented about 2 percent and *A. taeniorhynchus* 96 percent.

To increase the number of *A. sollicitans* for the release, 26,900 field-collected females (approximately 85 percent *A. sollicitans*) were caged with grass sod (6″ diameter samples) as oviposition media. These latter were periodically replaced, the exposed sod being kept at 75° F. and 75 percent relative humidity and moistened occasionally to prevent drying. Based on previous observation of the oviposition rate of wild caught females, an estimated 137,000 *A. sollicitans* eggs were obtained.

Sod was collected for 3 weeks and stored on the ground adjacent to the rearing pond (0.5 acre). This sod and that used for *A. sollicitans* oviposition purposes were placed in shallow areas and in the two ditches of the dewatered pond. To insure recovery of the maximum number of *A. sollicitans* larvae, the "oviposition" sod was confined inside small wooden enclosures. The pond area was flooded by opening the tide gate on the evening of August 17. The level of water obtained ranged from 0.5 to 2.0 feet. All water entering the pond passed through a screen strainer to exclude fish or other predators.

Warm weather (temperatures at certain points in the pond were up to 95° F.) from August 18–21 permitted rapid larval development. To supplement the food provided by the sod samples and the pond vegetation, 100 pounds of dog food were broadcast over the pond on August 19–20. Third instar larvae were present on August 20, and the next day the transfer of larvae to the marking trays began. Large cloth scoops were used to recover the larvae and to place them in floating metal transfer trays (2′ x 2′ x 4″). The transfer trays were floated to shore and the contents emptied into paraffined wooden marking trays (4′ x 5′ x 6″). Two sets of six marking trays each were housed in a pyramidal tent. Excess floatage in the water was removed by screening the water poured into the transfer trays and by dipping it from the marking trays.

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[1] From the Technical Development Laboratories, Technology Branch, Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

[2] Present address: Chatham County Mosquito Control Commission, Savannah, Georgia.

In the late afternoon of August 21, the radioactive phosphorus ($H_3P^{32}O_4$) was added to each tray at the rate of 50 microliters per liter of water. Based on volumetric samples, an estimated 3.5 million larvae,[3] or 0.29 million per tray, were exposed to P^{32} treatment, theoretically 0.05 microcurie/larva.

Pupae appeared on the morning of August 22 and in 24 hours were predominant. Emergence began August 23, principally males. The 433 females monitored were marked sufficiently, but 2.2 percent and 5.6 percent of the males of *A. sollicitans* and *A. taeniorhynchus,* respectively, that were checked showed inadequate tagging.

By 18^h August 23, large numbers of males were resting on bushes and other objects within 20 feet of the tents and almost completely covered the interior surfaces of the tents. At $19^h15'$ activity greatly increased and large numbers of specimens were in flight at the entranceway and apex opening of the two tents. The exodus from the tents and from the bushes augmented rapidly so that by $19^h25'$ only a few mosquitoes remained at the tent apex.

On August 24, a predominantly female population covered the interior surfaces of the tents and rested on the ground and bushes up to 40 feet from the tents. Activity at the apex of each tent gradually increased from $17^h45'$ to $18^h47'$ when small groups of specimens began to leave the tents. At 19^h the adults were concentrated on the leeward side of tents. At $19^h20'$, they began to depart in large numbers; 3 minutes later, 50 percent were estimated to have left; 6 minutes, 75 percent; and 12 minutes later, only 10 percent of the original population remained. This population showed no further activity through $20^h30'$, the last time of observation.

Recovery of radioactive specimens was chiefly with 94 light traps located at distances of 0.1 to 20 miles from the release point (Figure 1). In the 90° sector southwest of the release point, sufficient stations were placed along the circumferences of the 2-, 4-, 6-, 8-, and 10-mile circles to insure proportionate sampling of the peripheries of each zone in the sector. The nine traps located at isolated sites were powered by AC or DC generators and trap No. 8 was operated on a Coast Guard lightship about 20 miles offshore. The generator-powered traps functioned satisfactorily on only 60 percent of the trap nights.

All traps operated nightly from August 22 through September 9. From September 10 through September 14, the ten land-based traps nearest the release point were checked daily. Other traps were operated nightly but the catch was removed on alternate days. All collections were processed with a count rate meter[4] and the tagged specimens removed and identified.

Each night for the period August 25 to September 1, three guinea-pig bait traps, three dry-ice bait traps, and one (2 nights) or two light traps were operated 0.25 mile south of the release point to compare the efficiencies of the three types of traps in collecting the radioactive specimens.

RESULTS. Fifty-one tagged *A. sollicitans* (11 males and 40 females) were recovered. Nine males were captured in the trap nearest the release site during the first 6 nights. The remaining two were taken 2 miles from the release site, one SW of the third, and the other NNW on the fifth night after release. Of the 40 female *A. sollicitans,* 17 were collected at the release site on the first to the ninth nights after release and one on the fifteenth night. At 2 miles from the release site, 16 females were taken during the first to eleventh nights after release and one on the seventeenth night after release. The other five female *A. sollicitans* were taken 4 miles from the release point on the third, sixth, seventh, and ninth nights after release. Recoveries occurred in all directions, but

[3] Approximately 10 percent were *A. sollicitans.*

[4] Model 1615B, Nuclear Instruments Chemical Corp., Chicago, Illinois. Use of trade names is for identification purposes only and does not constitute product-endorsement by the Public Health Service.

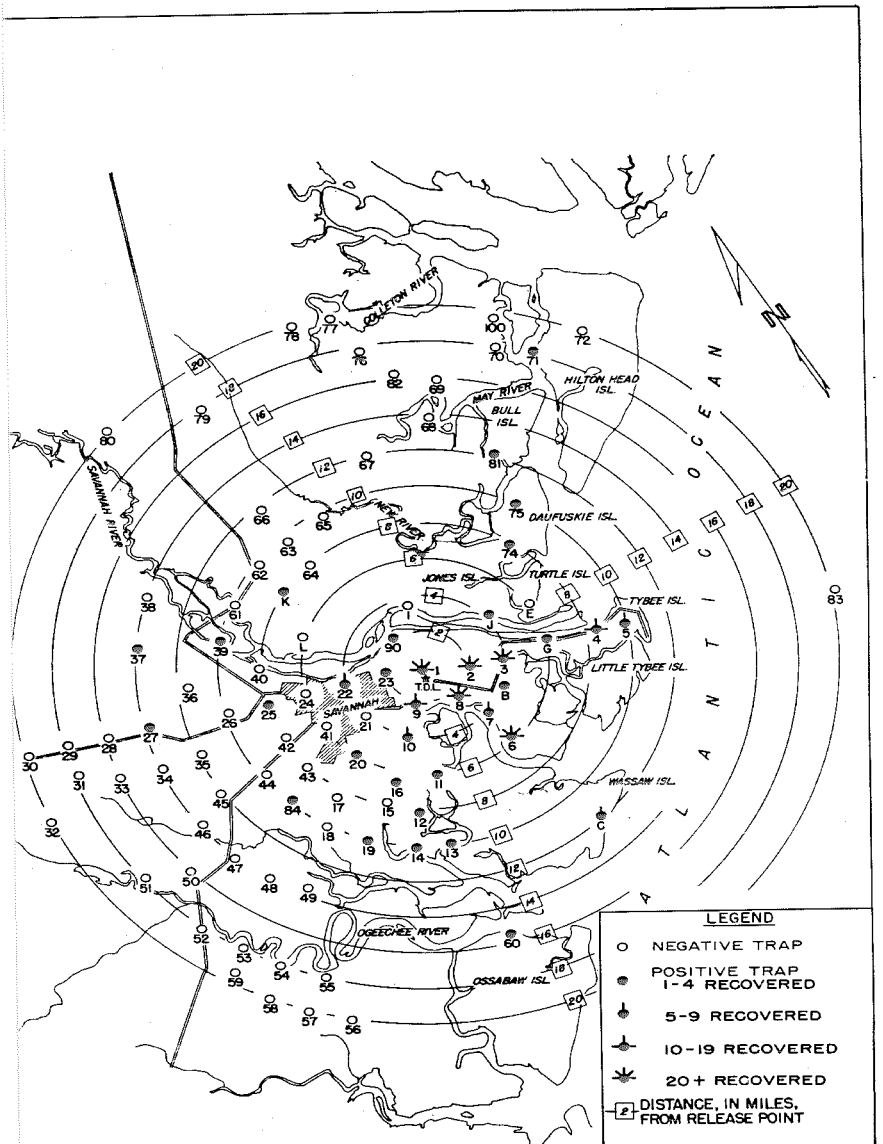

FIG. 1.—Map of study area showing distribution and recovery rates for 94 light traps.

more than two-thirds of the captures at 2 miles and four-fifths of those at 4 miles were SE of the release point.

The distribution of trap stations where tagged *A. taeniorhynchus* females were taken is shown in Figure 1, and the numbers of specimens captured per night in each trap are summarized in Table 1. With the exception of one mosquito in trap K, 8 miles NNW of the release point, all recoveries north of the Savannah River were made in the traps located on islands along the coast.

Traps to the south on Wilmington, Wassaw, and Ossabaw Islands, the latter at a distance of 16 miles, all were positive. The dispersal of mosquitoes along the coast seemed to be more uniform than in an equivalent area inland from the release site. With the exception of two generator traps, inoperative on about half the trap nights, all traps located within 10 miles of the coast from Ossabaw Island to Bull Island were positive.

Twenty-three of the 29 *A. taeniorhynchus* males were taken in the trap nearest the release site, seven on the night of release, and the remainder on the first to tenth nights after release. The other six males were captured in a S to SW direction 2 miles from the release site between the first and twelfth nights after release.

The night the female mosquitoes dispersed from the release site, a single specimen was taken at 2 miles. The same trap recovered five adults on night 1. On night 2, the five stations at 2 miles and one trap at 4 miles were positive. On night 4, the first recoveries beyond 2 miles occurred when single specimens were trapped at 6, 8, and 10 miles. At distances of 12, 14, 16, and 18 miles, the first collections of tagged mosquitoes were on days 5, 8, 9, and 8, respectively.

Maximum specimen recovery occurred on day 8 when 57 mosquitoes were captured. Daily captures of 19 or more specimens were obtained on days 2 through 10 except for days 3 and 9 when only 12 specimens were taken. The maximum daily collection for a single trap was 23 specimens (trap 8, 2 miles). At distances of 6 miles and beyond, most positive c lections represented a single specimen cept for the seven mosquitoes taken trap C on night 10. The maximum nu ber of traps positive was 12 on days and 7.

A comparison of the total numbers radioactive female *A. taeniorhynchus* tak each day by traps 0–2 miles, 4–6 mi and 8–12 miles from the release po shows that peak collections occurred night 8 for the 0–2 mile and the 4–6 m trap groups and on night 10 for the m distant traps. Secondary peaks in the c mile zone occurred on nights 2 and 11

In the 90° sector SW of the rele point, the trap stations were at 2-mile tervals along the circumferences of the 4-, 6-, 8-, and 10-mile circles. To inst proportionate sampling, the percent of t total catch of tagged female *A. taeniorh chus* captured at each distance within t sector gives a relative indication of t distance the mosquitoes moved from t release point. Results were as follows: mile, 66.4 percent; 2 miles, 15.7 perce 4 miles, 7.1 percent; 6 miles, 4.3 perce 8 miles, 2.9 percent; and 10 miles, percent.

A preferential movement to the SE s tor is obvious when the average numb of radioactive *A. taeniorhynchus* fema captured per positive trap station at ea distance are compared in the four sect except at 14, 18, and 20 miles where traps were located in the SE sector. At t other distances, the maximum recovery tagged female *A. taeniorhynchus* was c tained in a trap located in the SE sect The 86 specimens taken in No. 8 w only slightly below the 93 females covered from trap No. 1 at the release si

To detect a possible relationship of wi direction and velocity to mosquito mo ment, measurements of these factors w made hourly, 6 p.m. to 6 a.m. for a 3-we period. Summation of wind movemei was made for each 3-hour period beg ning at 6 p.m.; these data showed th during the first 7 days the resultant mo ment from 6 p.m. to 9 p.m. was from t ESE; from 9 p.m. to 3 a.m. from the N

TABLE 1.—Distance, direction, and numbers of radioactively tagged *Aedes taeniorhynchus* caught by light traps after release on August 24, 1955.

Distance in Miles From Release	Direction From Release	August								September											TOTAL
		0*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17-18	19-20	21 +	
		24**	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10-11	12-13	14 +	
0.1	–	1	5	11	X	4	7	13	22	16	2	1	10					1				93
2	ESE			6	3	4	4	7	5	10	1	1	5		1	1		1	1			50
2	S	1	5	9	4	3	5	7	10	23		9	5	2	2			1				86
2	SW			1	2	3	2	3		3				1			1	2	1			19
2	WNW			2	1																	3
2	NNW			1				1					2									4
4	E					X		1	2			X	X	X		X	X	–	–	–	–	3
4	ESE				1	4	6	4	5	7	4	7	14	1	1							54
4	SE		X		X	X	1	X	2		X	X	X	X		X	X	X	X			3
4	SSE			1						2								2				5
4	SW				1	1		1	1				1									5
4	WNW					1		2							2							5
6	ESE		X				1	1	1	X	X	X					X	X	X	X		3
6	SSE						3	3	4	8	3	2	1					1		2		27
6	SSW					1					1				1							3
6	SW								1			1										2
6	WSW											1										1
8	ENE		•		•		•		•		•	1	•	1	•		•					2
8	ESE					1		1				3		1	2	2		1				11
8	SSW								1													1
8	WNW														1	1					1	3
8	NNW									1		X	X			X	X	X	X			1
10	ENE		•		•		•	1	•		•		•		•		•					1
10	ESE									1		1	1	2	1	1					X	7
10	SSW					1																1
10	SW								1													1
10	WSW											2						1				4
10	NW												1									2
12	NE										1											1
12	SSE						1		1	X		7					X				–	9
14	WNW													1								1
14	NW									1	1											2
16	SSW					•				•	1			•				1				2
18	NE									1											1	2
Total, Exclusive of Trap No. 1		1	5	20	12	19	23	32	34	57	12	35	30	9	11	5	1	10	2	2	2	322
Total		2	10	31	12	23	30	45	56	73	14	36	40	9	11	5	1	11	2	2	2	415

Day of release taken as day 0.
Note covers period 6:00 PM to midnight of date specified and 12:01 AM to 6:00 AM of next day.
Indicates trap did not operate. – Indicates collections discontinued. • Indicates first day of a two-day combined collection.

and from 3 a.m. to 6 a.m. from NNW. During the second week the resultant movement for the three time periods was from the NNW.

Of the 3,133 radioactive *A. taeniorhynchus* and *A. sollicitans* taken in the 41 guinea pig, 32 dry-ice, and 27 light trap collections located at 0.25 mile, the former species predominated. Nightly recovery rates for *A. taeniorhynchus* were markedly higher in the light trap versus the guinea pig-baited trap. Maximum difference was on night two when more than 300 specimens were recovered in the light trap, approximately four times the number in the guinea pig trap. With *A. sollicitans* the maximum number per night was 24, the guinea pig and light traps recovering approximately equal numbers. Fewer specimens of either species were recovered from the dry-ice trap.

DISCUSSION. In the previous release of approximately 2 million mosquitoes in the Savannah, Georgia, area (Bidlingmayer and Schoof, 1957), the same trapping pattern resulted in a recovery of 165 tagged *A. taeniorhynchus* females. This number is slightly lower than the recovery rate of the present experiment, 322 specimens of *A. taeniorhynchus* from a release of approximately 3.0 million mosquitoes. In both studies, 34 of the traps were positive and 19 of the positive traps represented the same sites. The percentage distribution of the tagged mosquitoes at the different distances were similar in the two tests; at 2 miles, 61 percent and 50 percent were recovered in the previous and present release, respectively; at 4 miles, 16 percent and 23 percent; at 6 miles, 10 percent and 11 percent; at 8 miles, 4 percent and 6 percent; at 10 miles, 1 percent and 4 percent; and at 12 miles, 2 percent and 3 percent.

The principal differences in the recovery patterns of the two tests were in the peak periods of recapture and in the elapsed time to the collection of marked specimens at distances beyond 2 miles. In the first test, 59 percent of the specimens were trapped within 4 days after release; in the second release, only 18 percent of the recaptures occurred within 4 days. At days, the percentages of recovered sp mens were essentially the same for b tests (90 and 87).

In the first test, recaptures occurred 6, 8, 10, 14, and 20 miles within 3 d after release, but in the current study specimens collected in that time per were trapped within 4 miles. These ferences in recovery time and pattern sumably arose from weather variations vailing during the two tests. During first three nights of the first test weather was clear each evening but in second release the initial three trapp nights were characterized by heavy th derstorms at dusk during the normal riod of maximum mosquito moveme Presumably these storms curtailed m quito activity to the extent that the chan of their dispersing and entering traps w reduced.

The data from this and the earlier (Bidlingmayer and Schoof, 1957) or nating from the same release site sh that *A. taeniorhynchus* dispersal as me ured by the recapture method can exte 16–20 miles in opposite directions fr the release point. However, in each stu 73 percent to 77 percent of the mosquit taken (exclusive of trap No. 1) w within 4 miles of the release sites. T pattern of recovery was related to the tance from the release site as the data the Savannah sector reflected. On a ti to recovery basis these data show ini recoveries at 6 and 10 miles on day 4, 4 miles on day 4, and at 2 miles on day

Although the data for the two t show similarity as to the overall recov rates, the speed with which the fema on the first study moved to great distan is in direct contrast to the slower disp sion in the second test. This marked ference in two tests conducted from same release sites and with the same p cedures emphasizes the variability t must occur with the different broods en nating from various localities. Unfor nately, the expense and time involved carrying out dispersion studies preclude

g range evaluation of the dispersal pat-
n of these two salt marsh species.

SUMMARY. From the release of approxi-
tely 3 million P^{32}-tagged *Aedes taeni-
ynchus* near Savannah, Georgia, 415
ales and 29 males were recovered in
ht traps located at distances up to 20
les from the departure point. Recov-
s beyond 4 miles did not occur until
fourth night after release. Female
cimens were captured at distances up
18 miles but more than 75 percent of
recoveries, exclusive of one trap 0.1
le from the release point, were within
4 miles. The maximum distance at which
males were trapped was 2 miles from the
departure point.

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FIELD TESTS ON THE PERSISTENCE OF MOSQUITO LARVICIDES IN ALKALINE WATER IN CALIFORNIA

LAWRENCE L. LEWALLEN [1]

California State Department of Public Health, Bureau of Vector Control, Fresno

NTRODUCTION. The frequency of ap-
cation of mosquito larvicides in control
ograms in certain areas of California
pends in part on the persistence of the
ecticide in waters which are highly
aline. When chlorinated hydrocarbon
ecticides were used prior to the develop-
nt of resistance, one larvicidal applica-
n often remained effective for several
ys (Robinson, 1946). Miles (1960) re-
rted on the residual effectiveness of sev-
l chlorinated hydrocarbons for 2 to 3
sons against floodwater mosquitoes.
Residue problems on agricultural crops
d the development of physiological re-
tance have precluded the use of chlor-
ted hydrocarbons for mosquito larvicid-
in most California abatement districts;
a consequence organophosphorus com-
unds have become widely used in mos-
ito control programs.

Organophosphorus compounds vary considerably in the rate with which they are hydrolyzed by alkaline water. Easily hydrolyzed insecticides frequently are not effective in the field even at high dosage rates, and under certain conditions they remain toxic to mosquitoes for only a few hours. To plan the most effective frequency of applications, the stability of organophosphorus compounds and other mosquito larvicides must be evaluated under field conditions.

METHODS AND MATERIALS. Since irrigated pastures were not suitable for field studies, a pilot study area was provided at Traver with the cooperation of the United States Department of Agriculture, the Delta Mosquito Abatement District, and the Kaweah Delta Gun Club of Traver.

In these 10′ x 136′ (1/32 acre) test plots, variables such as depth of water and movement of water from one plot to another were controlled. A natural cover of

The author gratefully acknowledges the as-
ance of Mr. William H. Wilder in conducting
s for this study.