PAPERS AND PROCEEDINGS OF THE 13th ANNUAL MEETING

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PART II

THE DISPERSAL OF *AEDES TAENIORHYNCHUS*

II. THE SECOND EXPERIMENT

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The mark-release-recapture experiment of August 1951 (Provost, 1952), was successful enough to encourage us to repeat it with modifications to (1) have the hatching time under control, (2) reduce the larval mortality and effect a better emergence, (3) allow the marked adults to emerge unconfined and fly away freely, and (4) attempt more refined methods of recovery. This second experiment was essentially a replication, nevertheless. It was carried out in June and July of 1952 in the same San Carlos Bay area of southwestern Florida with the work again centered on Sanibel Island. The report on the 1951 experiment should be consulted for background information.

Our present understanding of dispersal in *Aedes taeniorhynchus* has been delineated in two previous papers (Provost 1952, 1953). Essentially it assumes an initial migration which, as in other migratory insects, is an end in itself. After the migration, dispersal progresses as it does in non-migratory species, viz., as a result of flights for food, shelter, oviposition and so on, all of which purposive flights are designated appetential in accordance with the understanding or belief that all behavior is compounded of appetential and consummatory elements (Tinbergen, 1951).

For the basic life history and behavior of this mosquito the reader is referred to papers by Nielsen (in press), Nielsen and Nielsen (1953), Nielsen and Haeger (1955), and Haeger (1955).

A. PRODUCTION OF LARVAE

The experimental design called for concentrating two million early fourth-instar larvae in three wooden troughs, where 68 mc. of P^{32} supplied on allocation from the Isotopes Division of the U. S. Atomic Energy Commission, were to be introduced for marking, as in the 1951 experiment (q.v.). The larvae were to be produced by flooding a small swale containing a good egg deposit. This was attempted and failed for a variety of reasons, so we had to devise another scheme quickly. The swale which had produced larvae for the 1951 experiment was dry and sod flooding in pans showed that a considerable area of *Philoxerus* contained one to two thousand eggs per square foot. There was, however, no standing water within a mile. It was then, in a moment almost of desperation, that the plan was changed to bringing the sod (with eggs) to the water. The technique worked so well that it became the basic method for our experiments thereafter.

A 20-foot wide, clean, and deep roadside borrow-pit was selected as the hatching pool; it was some 200 feet east of the 1951 release point. An earth dam was built to isolate a 100-foot section which was then pumped dry and all fish removed. The *Philoxerus* sod in the egg-laden swale was then cut, in the manner of lawn turf being transplanted, and transported to the "nursery" a mile and a half away. Some 1500 square feet of sod were laid neatly on the bottom of the nursery pool between $09^h30'$ and $17^h00'$ on June 10. Water was immediately pumped in and by 19^h the sod was all flooded. The egg hatch was not all within the two hours of pumping; some hatching occurred from seepage water on the bottom all through the sod-laying interval. The best estimate of the cumulative hatch was that between 10^h and 17^h some 5 percent or 6 percent of the eventual hatch occurred, with nearly all of the remaining hatch coming between 17^h and 20^h.

It was clear that this technique offered excellent possibilities for the production of a controlled hatch. Many refinements were envisioned, but even the first use of the method had successfully yielded the desired number of larvae, about 2¼ million; about 94 percent of them hatched within a 3-hour interval, and all within a pool selected for later ease of transfer of larvae from "nursery" to wooden vats for P^{32} introduction.

B. MARKING WITH RADIOPHOSPHORUS

The larvae were transferred to the vats on June 14 between 06^h and 11^h when they were mostly 16 to 24 hours old as fourth instars. The three vats were close together, some ten feet from the edge of the nursery pool and elevated about three feet above the ground. Each of the 3′ x 6′ x 8″ tanks was half-filled with water from the pool. The larvae were then skimmed from the pool with nets made of gauze stretched tautly across 18″ x 36″ wooden frames. Whenever one of the nets had a good layer of larvae over most of it, it was brought to one of the tanks and gently inverted into the water. Four men in five hours were able thus to transfer 1,900,000 larvae to the tanks with little noticeable mortality.

By the time the P^{32} was introduced to the larvae at 11^h on June 14 it had decayed to a mere 37 millicuries. Two of the tanks, each with 600,000 larvae (3.5/ml), received 13 mc for a P^{32} dosage of .077 μc/ml or .022 μc/larva. The third tank, with 700,000 larvae, received 11 μc, giving a P^{32} dosage of .065 μc/ml or .016 μc/larva.

Although the larvae were fed ground dog biscuit on what we thought was a demand basis there was no appreciable increase in larval radioactivity after 24^h on June 14, indicating that most larvae fed for only 13 hours in the tanks. This, combined with rather low P^{32} dosage, resulted in mosquitoes consideraly less radioactive than those marked the previous year. The newly-emerged males averaged 500 CPM and females, 2,000 CPM.

C. DEVELOPMENT AND EMERGENCE

The temperature in the tanks, which were shaded by a canvas, remained between 73° and 83° F. with a mean of 78° during the pupal period. The first pupa of *Aedes taeniorhynchus* was noticed June 15 at 11^h. We were not able properly to time the pupation in the tanks; we can say only that it occurred during the night of June 15–16, with a peak somewhere near midnight.

The progress of the emergence was followed more precisely. It occurred in the afternoon of June 17, the first adult having appeared at 11^h. Hourly emergences were estimated very roughly as follows:

before 13^h	50,000	18^h–19^h	350,000
13^h–14^h	50,000	19^h–20^h	100,000
14^h–15^h	150,000	20^h–21^h	50,000
15^h–16^h	150,000	Total	1,400,000
16^h–17^h	200,000		
17^h–18^h	300,000	16^h–19^h = 850,000 or 61%	

Using 18^h as the peak of emergence and midnight of June 15 as the peak of pupation, we have a probable pupal duration of 42 hours, which is reasonably close to the expected 44 hours at 78° (Nielsen and Haeger, 1955), considering the crudity of the determination. From hatching to emergence was an even week, but the larvae while in the nursery pool were in the open sun and developed at temperatures much above the 78° to which the pupae were limited.

On the day following the emergence, the animals remaining in the tanks were examined. They were virtually all fourth-instar larvae, indicating an exhaustion of food, for they would otherwise have been pupae. Aliquot counts of these remaining larvae indicated 334,000. Since there had occurred no noticeable mortality in the tanks, the total emergence was 1,560,000 or 82.4 percent of larvae marked. On June 19 the remaining larvae were still not pupating. Samples transferred to jars and fed did pupate, however, supporting our belief that food in the tanks ran out shortly after the larvae were placed in them, and those larvae which had not completed their feeding period by then did not thereafter even become prepupae.

It was remarkable that so much of the emergence should have occurred on one day; the normal situation for "wild" broods is for the emergence to be spread over three to five days with a pronounced peak at the same hour each of those days (Nielsen and Haeger, 1955). It may be that the usual salt-marsh or mangrove breeding area exhibits a great variation in mean water temperatures, as affected by depth and sun exposure, and in quantity and availability of food. In the present experiment all these conditions were outstandingly uniform in the nursery pool. The excellent synchrony in emergence was further preserved by killing all remaining aquatic stages on June 19. Since no appreciable emergence had occurred on either June 18 or 19, all the marked population is known rather precisely to have emerged on June 17 between 13^h and 21^h with a peak around 18^h.

D. RECOVERY TECHNIQUES

The dispersal of marked mosquitoes was studied, as in 1951, by identifying radioactive mosquitoes with a Geiger counter in collections made systematically for a month after the emergence.

LIGHT TRAPS

Sixty-four light traps were operated nightly starting the night of departure, June 17/18, and continuing until mid-July. Their distribution (Fig. 1) was dictated by the lay of the land. One trap was at the departure point and four others were within a mile. Beyond a mile, the traps were set up along four main radii: (1) NW up the length of Sanibel Island and along the outer islands to Placida back on the mainland, (2) N to Woodring Point on Sanibel Island, across 1¾ miles of water to St. James City, then up Pine Island and across Charlotte Harbor to Punta Gorda on the mainland, (3) NE to Bailey's Store on Sanibel Island, across 2¾ miles of water to Punta Rassa on the mainland, then up the Caloosahatchee River, through Ft. Myers, and on to Alva, and (4) E on Sanibel Island to Point Ybel, across 3 miles of water to Fort Myers Beach, then southeast down the mainland coast to Everglades City. Beyond 15 miles the traps were put up where feasible to wire and maintain them. Up to 15 miles an attempt was made to space the traps at mile intervals along each radius, but the discontinuity of land and of wired power made this difficult. Gaps on Sanibel Island and Pine Island were filled with battery-operated traps (S-14, S-15, P-2, P-3).

The 1697 collections yielded 117,185 male and 5,511,958 female *Aedes taeniorhynchus*. The "hot" collections numbered 309 or 18.2 percent of the total. Thirty-six of these hot collections contained 10 or more marked mosquitoes, the largest containing 57. These marked individuals had to be isolated by Geiger counter from unmarked *Aedes taeniorhynchus* averag-

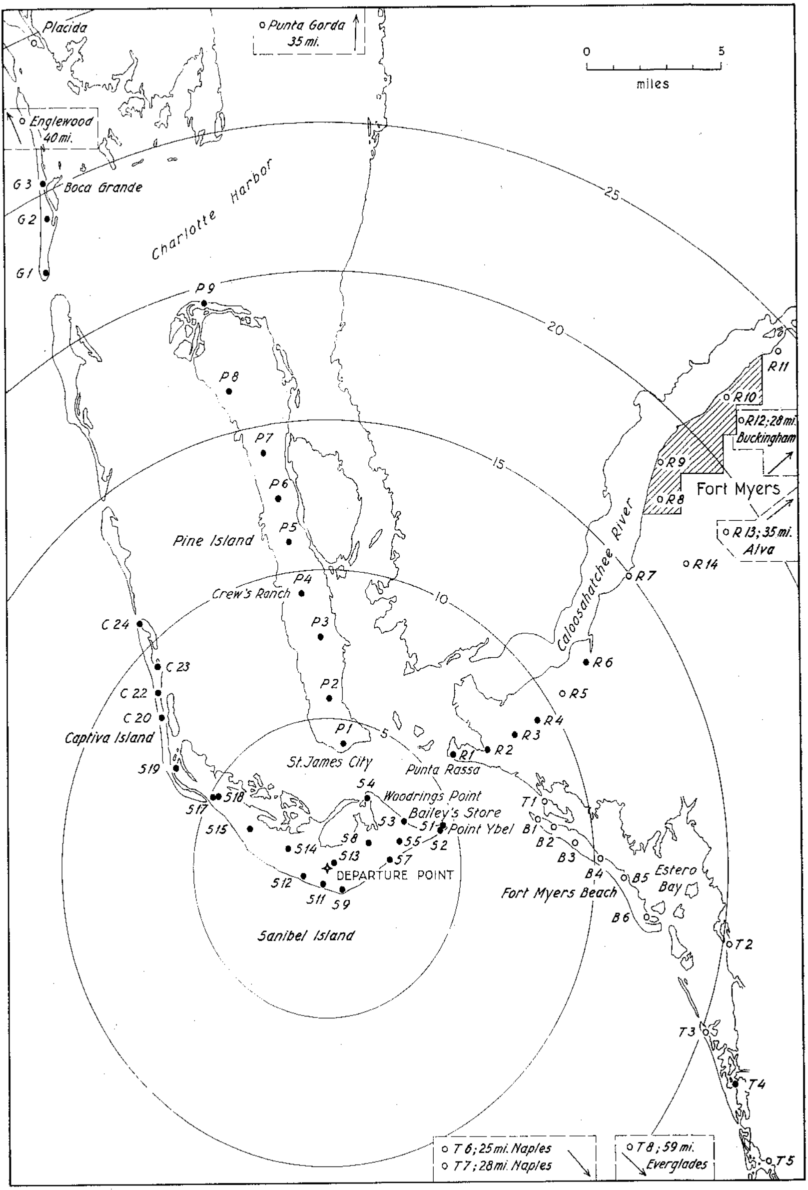

FIG. 1.—Distribution of light traps in second *Aedes taeniorhynchus* dispersal test, Sanibel Island, June 1952. Solid dots are traps which recovered marked females, open circles, traps which did not.

ing 97 males and 9,681 females per hot collection, not to mention the other species. The resulting task of monitoring was far greater than expected. This, in addition to Geiger counter troubles, made it impossible to complete the work before the isotope decayed to background levels; we were left with 110 "hot" light-trap collections with individual marked mosquitoes never isolated. The trend in the 1,132 females recovered indicates that approximately 1,800 marked females were captured by the light traps.

BAIT TRAPS

The bait traps were of a modified Magoon type, 3′ x 6′ with louvers on the two long sides. The goats[1] were of both sexes and moderate to large. Later studies have shown mosquito catches to vary markedly with both size and sex of goats, therefore the collections of marked *Aedes taeniorhynchus* in this experiment must be interpreted cautiously.

Bait traps were used on Sanibel and Captiva Islands only. One was at the departure point. Two were east, 2 and 4½ miles away. Five were to the northwest, 2, 4, and 6 miles away on Sanibel Island, and 8 and 10½ miles away on Captiva Island. The operation of these traps was extremely time-consuming and laborious, and clean collections were hard to obtain.

The eight traps were operated from the day of emergence until July 16, with only 13 collections missed. The entire operation yielded 503,482 female *Aedes taeniorhynchus*. Of the 219 collections, 20 or 9.1 percent were hot. The marked individuals totalled 52.

TRUCK TRAPS

The truck traps were large screen funnels mounted over the cab of pickup trucks and extending to the tail-gate. The opening was 18″ high and 8 feet across, and fashioned like an inverted scoop to gather in not only mosquitoes flying at the level of the funnel opening but also those deflected upward by the front and hood of the truck. At the small end (4″ x 4″) of the funnel, a sleeve of cloth netting was held by an elastic band. The nets were exchanged at flagged points along their routes, making each collection represent a certain stretch of road.

The two truck traps were operated on the main east-west road on Sanibel Island. Starting at a point ¼ mile east of the marking site, one truck went the 4½ miles to Point Ybel and returned, while the other went westward 4½ miles and returned. The routes were divided into portions about 1½ miles long. The total runs were therefore of 18 miles with 14 collections in all. From June 17 to July 12 runs were made starting at 20^h, 23^h, and 04^h; from July 13 to 15 the morning run was eliminated.

The truck trap operation resulted in 1176 collections, of which 77 or 6.6 percent were hot. In all, 82,287 male and 344,148 female *Aedes taeniorhynchus* were collected, of which number 7 males and 89 females were marked.

ROTATING-NET TRAP

A "rotor" trap was operated at the departure point. The nets were a yard square and rotated 17¼ times per minute at the end of 10-foot arms (to center of net). The nets therefore advanced at approximately 12½ miles per hour and each of the two nets sampled approximately 9,600 cubic feet of air per minute.

The trap was operated from June 18 to July 16, with one night of failure. Of its 28 collections, 10 were hot. The nightly collections totalled 5,418 male and 48,665 female *Aedes taeniorhynchus*. On the night of departure 151 male and 119 female marked ones were caught. The remainder of the operation yielded 2 male and 30 female marked mosquitoes (Table 3).

[1] These animals were kindly lent us by the (then) U.S.D.A. Bureau of Entomloogy and Plant Quarantine screw-worm eradication research program, at that time on Sanibel Island.

E. THE DEPARTURE

From previously acquired knowledge we knew that the departure on a migratory flight would occur at night only, and only when the new adults were over 6 to 8 hours old (Nielsen, in press). When the big emergence came on June 17 in late afternoon, it was surmised that the departure would be mostly after midnight.

A canvas had been spread over the larval vats for shade. As the emergence progressed in the afternoon, the new mosquitoes expanded their occupation of available resting surfaces. In time the inside and outside of the vats, together with the sawhorses that kept them off the ground, were solid resting mosquitoes. Then the advancing numbers spread to the grass in the shade, then up the canvas ropes, and finally all over the underside of the canvas. By sunset, the outside of the canvas was well-covered, with many crowded along the "ridgepole" of the tent-like canvas while the mosquito mass had spilled out to occupy the grass within several feet of the tent. Some of the mosquitoes reached out to within a few feet of the rotating net trap which had been set up about 40 feet from the tent. After sunset some of the mosquitoes left permanently when disturbed but most resettled and remained. At several of the poles holding the tent and at the gable ends, wisps of mosquitoes took off spontaneously in "puffs" much as Nielsen had noticed in earlier studies (Nielsen, in press). The overwhelming majority stayed behind, however, and two hours after sunset there appeared to be virtually as many mosquitoes as at sunset. Between midnight and 03^h there was a gradual departure. Well before dawn, the great mass of new mosquitoes had gone.

All the recovery methods were in operation on the night of departure (Table 1). Recaptures away from the departure point were too few to mean anything but that whatever flight was under way was not being adequately sampled. The light trap at the point of departure caught 35 marked mosquitoes. This is an excellent demonstration of the fact that newly-emerged mosquitoes and those taking off on their first dispersal flight are simply not attracted to light. Thirty-five caught when a million and a half were within 100 feet of the trap during a good deal of the night certainly indicates no light attraction. The 35 caught were accidentally

TABLE 1.—Recoveries of marked *Aedes taeniorhynchus* during night of departure, June 17–18, 1952, on Sanibel Island

	Light Trap			Rotating Net Trap		
	Time	♂	♀	Time	♂	♀
At departure point (DpP)	Sunset–21^h	5	6	18^h–20^h	128	42
	21^h–22^h			20 –22	30	40
	22 –23		1	22 –23	4	3
	23 –24	5	5	23 –24	5	12
	00 –01		2	00 –01	3	7
	01 –02		2	01 –02	6	19
	02 –03	2	2	02 –03	2	16
	03 –04	3		03 –04		1
	04 –05		1	04 –05	2	6
	05 –06		1	05 –06	1	13
	Total	15	20	Total	181	159
Light trap S–9 ¾ mile southeast of DpP.	1 ♀ sometime during night.					
Truck trap, along E-W road ½ mile north of DpP.	c. $23^h30'$			1 male		
	c. $04^h15'$			1 female		
	c. $04^h45'$			1 male		

sucked in as they flew through the trap. The rotating net trap also caught extremely small numbers, very likely because the angle of take-off for most of the mosquitoes carried them clear over the nets, which were only three feet above the ground some 40 feet from the tanks. Those caught before sunset (18^h–20^h) were undoubtedly disturbed mosquitoes which had flown within the orbit of the trap.

F. THE MIGRATORY FLIGHT

If the migration occurs on the night of departure, the data in Table 1 indicate a very poor sampling of actual migrants. If migration occurs also on the second night, again it appears that actual migrants were inadequately sampled. Disregarding collections at the point of departure, we find the following array of total marked females recovered per night in the different samplings:

Night from departure:	Dp	2	3	4	5	6
Truck traps	1	9	*23*	13	6	8
Goat-bait traps	0	1	7	*17*	9	7
Light traps	1	20	201	235	*317*	151

A study of this series is enlightening, remembering always the possible influence of weather conditions.

Light traps sample only that portion of the population which is at the time positively phototactic. It is still not known under what physiological conditions female *A. taeniorhynchus* are attracted to light. The 1951 experiment (q.v.) demonstrated a peak of light-trap attraction every five days, starting on the fourth. In this experiment the first peak was on the fifth night and subsequent peaks were not established. It is clear, however, that light traps recovered very few marked females on the night of departure and the next night, in both experiments. If these are the migration nights, we must conclude that light traps do not adequately sample the migrants, however efficient they may later be in sampling the brood after it has "settled down."

Traps baited with goats also attract a certain segment of a brood only, viz., the ones searching for blood at that time. In this experiment the first peak of attraction was on the fourth night, substantiating the finding of Nielsen and Nielsen (1953) that biting is most severe the fourth night after emergence. From the figures given above, it is obvious that bait traps do not sample migrant females any better than light traps.

It would appear at first thought that truck traps sample the migrants since they are air samplers and not attractant samplers. It is seen, however, that the greatest catch was on the third night, the second night recovering only 1/3 as much and the first night 1/20. If truck traps were non-selective their catches would reflect generally the population curve as it decreased with age and the first and second nights would normally exceed the third and fourth nights. The record, on the contrary, indicated very poor sampling of the population on the first two nights. This is indirect evidence that the migratory flight was either or both (1) at levels well above the height of the truck traps, and (2) in channels or streams which could only by rare chance be intercepted by trucks.

The conclusion, then, is that the actual migration was not sampled in this experiment and that all the collecting methods employed sampled the marked population only after the migratory interval, when it had settled down and was dispersing by appetential flight only.

G. THE ULTIMATE DISPERSAL OF FEMALES

The weather on the night of departure was that of a typical summer day in the area. According to the U. S. Weather Bureau the conditions at Ft. Myers were as follows. Temperatures dropped from 78.6° F. at 18^h to 73.0° at 05^h in the morning. The relative humidity remained above 90 percent all night. Cloud cover was complete at 18^h but disappeared totally by 21^h; there was no precipitation. The winds were from east

TABLE 2.—Recoveries of marked *Aedes taeniorhynchus* females in light traps after departure (Dp) on Sanibel Island, June 17–18, 1952. DpP is departure point. x are radioactive collections not monitored down to individual mosquitoes.

	Nights from Exodus Light Trap	Miles	Dp	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<1 mile	DpP	0	20	2	2	1	2	3	3	1	—	x	—	—	x	x	—	x	x	—	—	—	—	—	—	—
	S – 13	¼		3	19	25	36	15	5	2	3	x	x	x	x	x	x	x	x	x	x	—	—	—	—	—
	S – 9	¾	1	2	6	12	11	2	4	7	8	x	—	—	x	—	—	—	x	—	—	—	—	—	—	—
	S – 11	¾		1	17	1	—	1	4	4	1	x	x	x	x	—	x	x	—	x	—	—	—	—	—	—
	S – 12	1			3	1	1	—	2	2	—	—	—	—	—	x	—	—	x	—	—	—	—	—	—	—
NW—Outer Islands	S – 14	1¾			10	7	7	4	3	7	4	x	—	x	—	—	—	—	—	x	—	—	—	—	—	—
	S – 15	3¼			1	4	4	4	—	—	—	x	—	—	—	x	—	—	—	—	—	—	—	—	—	—
	S – 17	5			—	2	4	3	1	1	—	x	—	x	—	—	—	—	x	—	—	—	—	—	—	—
	S – 18	5			—	1	2	2	2	x	4	x	—	—	—	—	x	—	—	—	—	—	—	—	—	—
	S – 19	7			11	24	33	10	1	3	1	x	x	x	x	—	—	x	—	x	—	—	—	—	—	1
	C – 20	8			1	6	2	6	1	2	2	x	x	x	—	—	—	—	—	—	—	—	—	—	—	—
	C – 22	9			2	1	15	7	2	4	1	x	x	—	—	—	—	—	—	—	—	—	x	—	—	—
	C – 23	9½			1	2	—	6	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	C – 24	11			3	4	3	6	4	4	2	x	x	—	—	x	—	x	—	—	x	—	—	1	—	—
	G – 1	22½			—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	G – 2	24			—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	G – 3	25			—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Placida	30			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Englewood	40			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N—Pine Island	S – 4	2¾			28	26	57	4	5	10	6	x	x	x	x	x	x	—	—	—	—	—	—	—	—	—
	P – 1	4½			1	1	—	—	1	2	2	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	P – 2	5¾			—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	P – 3	7½			—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	P – 4	9½			4	4	9	11	x	—	x	x	—	x	—	—	—	—	—	—	—	—	—	—	—	—
	P – 5	11			2	6	2	5	1	—	x	x	x	—	—	x	—	—	—	—	—	—	—	—	—	—
	P – 6	12½			—	2	4	2	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	P – 7	14½			1	2	5	4	3	1	x	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	P – 8	16½			—	6	—	3	2	—	x	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	P – 9	19½			—	1	1	4	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Punta Gorda	35			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

NE—Up. Caloosahatchee River	S – 8	1½		3	17	14	2	12	5	2	6	x	x	x	x	x	x	–	–	x	–	x	–	–	–	–
	S – 3	3		3	29	28	37	6	6	8	14	x	x	x	–	x	x	x	–	x	–	–	–	x	–	–
	R – 1	5½			–	1	–	1	–	–	–	x	–	x	–	–	–	–	–	–	–	–	–	–	–	–
	R – 2	6½			1	1	–	1	1	3	x	x	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 3	8			–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 4	9		1	2	3	1	1	–	–	1	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–
	R – 5	10½			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 6	11½			–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 7	14½			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
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	R – 8	17			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 9	18			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 10	21			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 11	23			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 12	28			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	R – 13	35			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E & SE—Ft. Myers Bch.—Mainland	S – 7	2			5	4	2	7	1	1	–	x	–	–	–	–	–	x	–	–	–	–	–	–	–	–
	S – 5	2½		1	–	13	37	7	9	5	5	x	x	x	–	x	x	–	x	–	–	–	–	–	–	–
	S – 2	4		3	16	15	19	7	11	3	8	x	x	–	–	x	x	–	–	–	–	–	–	–	–	–
	S – 1	4¼		1	19	14	18	6	7	7	10	x	–	–	–	x	–	–	–	–	–	–	–	–	–	–
	B – 1	7½		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	B – 2	8			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	T – 1	8½			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	B – 3	9			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	B – 4	10			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	B – 5	10½			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	B – 6	11½			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	T – 2	15			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	T – 3	15			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	T – 4	16½			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
	T – 5	19			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	T – 6	25			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	T – 7	28			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	T – 8	59			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Within 1 mile of DpP.		<1	21	8	47	40	50	21	18	16	12	x	x	x	x	x	x	x	x	x	x	–	–	–	–	–
NW to Islands		1–40	–	–	29	53	70	48	19	x	14	x	x	x	x	x	x	x	x	x	x	–	x	1	–	1
N to Pine Island +		1–35	–	–	36	49	79	34	x	13	x	x	x	x	x	x	x	–	–	–	–	–	–	–	–	–
NE to mainland (river)		1–35	–	7	49	47	42	21	13	13	x	x	x	x	x	x	x	x	–	x	–	x	x	–	–	–
SE to mainland (coast)		1–59	–	5	40	46	76	27	28	16	23	x	x	x	–	x	x	x	x	–	–	–	–	–	–	–
Total			21	20	201	235	317	151	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1	–	1

and south, particularly east, throughout the night; velocities were generally 3 to 7 miles per hour. Sunset was at $19^h24'$ and sunrise at $05^h36'$.

On Sanibel Island, at the point of departure, an accurate record of wind conditions was kept. The resulting picture (Fig. 2) differs in minor details only from what was indicated at Ft. Myers, 20 miles away. During most of the departure, the wind was from the southeast, averaging 4 miles per hour. On the three nights following the departure, wind directions and velocities were determined on a synchronized basis during the early part of the night and before dawn, at the marking point, at Point Ybel, and at Woodring's Point. There were so many cases of opposite winds at these points within a two-mile radius, and so little overall agreement in either direction or speed of wind, that we cannot assume that wind measurements taken at one point prevailed over any sizeable geographical area.

During the release of the 1951 experiment the wind was from the east and averaged 4½ miles per hour. The general similarity of wind conditions between the two experiments at the point and time of departure makes it feasible to discuss differences in dispersal on the basis of variables other than weather.

Light-Trap Recoveries (Table 2)

Because light traps attract the females of *Aedes taeniorhynchus* mostly when they are four or five days old, it is not possible to learn any details of the actual migratory flight from their recaptures. A mosquito caught at a light trap ten miles away on the fifth night could have reached that locality on the first night within a few hours of departure. Or the migratory flight could have brought it only half the distance, the remainder having been spanned by any number of appetential flights (Provost, 1953). Marked *Psorophora ferox, Haemagogus spegazzinii,* and *Aedes serratus* released at advanced ages when the likelihood of further migration was extremely slight have nevertheless flown over 10 kilometers (Causey *et al.,* 1950) in what were almost surely

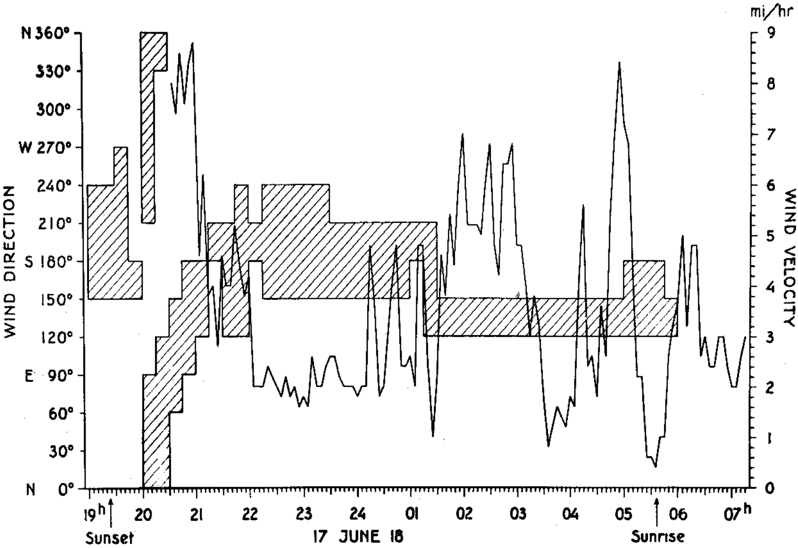

Fig. 2.—Wind conditions at departure point on night of departure. The mosquitoes left mostly between midnight and 03^h.

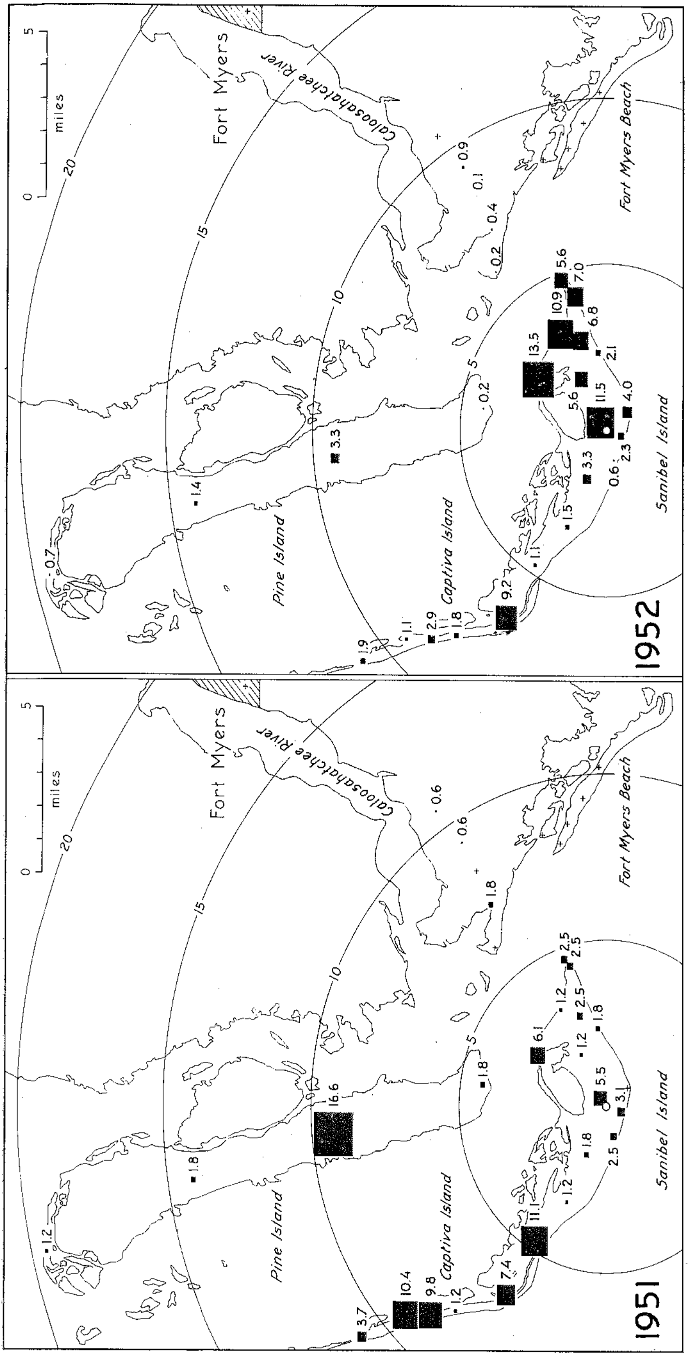

FIG. 3.—Comparison of 1951 and 1952 dispersals of female *Aedes taeniorhynchus* based on traps operated in both experiments and recoveries for first six nights. Figures are per cent of total recovery for experiment and size of square is proportional thereto. Crosses are negative traps.

appetential flights. We must remember, then, that a light-trap recovery in itself gives us no information on when or how the mosquito reached that particular point.

The ultimate area of occupancy by the marked brood on the basis of females recovered in light traps is given in Fig. 1 and is seen to be very much like that obtained in the 1951 experiment (q.v.). In order to compare the two experiments better, only those traps which were used both years and the results of the first six nights only, are plotted in Fig. 3. In both experiments the distant dispersal was primarily downwind, i.e. north and west on the outer islands and on Pine Island. The Pine Island route involved a 1¾ mile flight over water, at minimum. The seeming "pile-up" at Woodring's Point (S-4), in both experiments, suggests that many may have been deterred from an over-water flight of some two miles, even when downwind. Nevertheless substantial numbers crossed over to Pine Island; in the 1951 experiment no less than 16.6 percent of all females recovered by light trap in the first six nights were caught at Crew's Ranch near the middle of Pine Island. The apparent accumulation at Woodring's Point was therefore more likely the result of appetential flight concentration about a good resting and breeding area.

In both experiments there also seemed to be a piling up at Point Ybel, 4½ miles east of the point of departure, with exceedingly few mosquitoes crossing the 2¾ miles of water northeasterly to the mainland. The few which did cross, to appear at points up the road toward Ft. Myers, could easily have gone across on the ferry. This is very likely since passenger cars line up at the Sanibel ferry-landing several times a day at a spot notoriously mosquito-ridden.

None of the marked mosquitoes flew eastward or southeastward to Ft. Myers Beach, 3 miles over water, and on down the mainland coast. The lone female from the second experiment captured at the southern end of Estero Bay (T-4) 21 days after emergence probably reached that point by passive transport, because any flight to that distant (16½ miles) point would certainly have yielded many recaptures the first few nights after departure, not only there but at the many traps in that direction at lesser distances. The outstanding conclusion from these two experiments is, therefore, that *Aedes taeniorhynchus* do not undertake long flights over water against the wind.

The most pronounced difference between the two experiments is that in 1951 50 percent of the females left Sanibel Island while in 1952 only 16 percent did so. This is explainable most easily on the assumption that migratory flights occur only on the night of departure. In 1951 the departure was at twilight and the mosquitoes presumably had all night to migrate; half of them flew to Captiva and Pine Islands. In 1952 some of the earlier ones to take off were presumably able to do the same thing and thus account for the 8 percent recovered on Captiva and the 6 percent on Pine Island, but the great majority did not take off until after midnight and were apparently still on Sanibel Island at dawn and so 84 percent of marked mosquitoes were eventually recaptured on the island. If this explanation is correct, another conclusion is implied, viz. that appetential flights are not undertaken over any wide expanses of water. The true explanation of these dispersals will, of course, have to await a better understanding of both migratory and appetential flights.

Interpreting the dispersal as the result of a migration only, with dispersal by appetential flights inconsequential, would force the conclusion that large numbers migrated upwind or quartering the wind, especially in the 1952 experiment. If, contrariwise, we assume that appetential flights may span miles of terrain, it becomes possible that all the marked mosquitoes went downwind and that the occupation of the eastern half of Sanibel Island was the result of post-migration movements. These latter movements would tend to concentrate the mosquitoes where

TABLE 3.—Recoveries of marked *Aedes taeniorhynchus* females in truck traps, in traps baited with goats, and rotating net trap (at departure point), on Sanibel and Captiva Islands

Nights from Departure (Dp)		Dp	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Truck Traps	Within ½ mile	1	4	3	1	1	2	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	East ½ mile +		2	6	4	2	4	2	1	—	—	—	—	—	1	—	1	—	1	—	—	—	—	—	—
	West ½ mile +		3	14	8	3	2	6	3	3	—	2	1	—	1	1	—	1	—	—	—	—	—	—	1
	Within ½ mile	1	4	3	1	1	2	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	½–1½ miles		2	6	5	3	1	3	2	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1
	1½–3 miles		2	9	4	1	2	2	—	1	—	1	1	—	1	1	1	—	1	—	—	—	—	—	—
	3 –4½ miles		1	5	3	1	3	3	2	1	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—
	Total	1	9	23	13	6	8	8	8	3	—	2	1	—	2	1	1	1	1	—	—	—	—	—	1
Goat Traps	Departure Point			5	4	4	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
	East: 2 miles			—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	East: 4½ miles		1	2	10	—	6	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—
	Northwest: 2 miles			—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Northwest: 4 miles			—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Northwest: 6 miles			—	—	2	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
	Northwest: 8 miles			—	—	3	—	—	—	—	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—
	Northwest: 10½ miles			—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Total		1	7	17	9	7	3	—	—	1	—	—	3	—	—	—	—	1	—	3	—	—	—	—
Rotating Net Trap		159	7	3	5	5	5	2	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—

TABLE 4.—Recoveries of marked *Aedes taeniorhynchus* males after departure June 17–18, 1952 on Sanibel Island

Nights from Exodus		Dp	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Light Traps	Departure Point	15		1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	S – 13 (¼ mile NNE)		1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	S – 9 (¾ mile SW)			—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	S – 11 (¾ mile S)			1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Truck Traps	Departure Point (—½ m.)	2	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	½ – 1½ miles W			—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1½ – 3 miles E			—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—

resting and breeding areas are superior and close to one another—exactly the situation at such light traps as S-1, S-3, S-4, and S-19.

GOAT-TRAP RECOVERIES (Table 3)

The ultimate dispersal of the marked brood cannot be very well assessed from the bait-trap recoveries of this experiment. There were encouraging signs, however, for later usefulness of a better-designed baiting program. The recoveries did give some intimation of the first biting cycle, as mentioned earlier, and recoveries as late as the 20th night give some indication of biting at advanced ages. There is no obvious explanation for the strange fact that goat-trap collections were high on precisely the nights when truck-trap collections were low. This was particularly noticeable after the first gonotrophic cycle.

TRUCK-TRAP RECOVERIES (Table 3)

Marked females were caught by truck trap up to the 24th night from departure. The trucks operated up to 4½ miles east and west of the departure point, and within these limits there seemed to be no correlation of numbers with distance. The recoveries to the west, however, were twice as numerous as those to the east, a result difficult to interpret without more detailed information on where the brood settled down. The truck traps have a great potential for establishing the eventual dispersal of a brood, but they need further study as a technique.

H. THE DISPERSAL OF MALES

The dispersal of male *Aedes taeniorhynchus* as revealed in this experiment (Table 4) was a repetition of the 1951 findings (q.v.). The questions raised by the latter still remain unanswered. Sampling of twilight swarms was attempted, with negative results. Such collecting may be the only way to determine the ultimate dispersal of males, but it would have to be done on a far greater scale than was attempted in this experiment.

I. SUMMARY

1. A new technique for the production of *Aedes taeniorhynchus* in the field under controlled conditions is described.

2. A million and a half radioactive mosquitoes were allowed to disperse freely from the middle of Sanibel Island, the main departure occurring in the middle of the night.

3. Recoveries were by means of light traps, goat-baited traps, and air-sampling traps mounted on trucks.

4. Females were recovered up to 25 miles away and until the 24th night after emergence.

5. Only a few males were recovered, all within three miles.

6. The dispersal was generally downwind.

7. Findings support the following hypotheses:

a. Migration occurs the night of departure only, therefore twilight departures will result in longer migrations than middle-of-the-night departures.

b. Appetential flights expand the range of occupation by a brood much beyond what is established by the migration.

c. Appetential flights are not undertaken across any sizable expanse of water.

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