

## INSECTARY STUDIES ON LONGEVITY, BLOOD-FEEDING, AND OVIPOSITION BEHAVIOR OF FOUR FLOODWATER MOSQUITO SPECIES IN THE TENNESSEE VALLEY

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**INTRODUCTION.** In connection with field investigations of floodwater mosquito populations in the Tennessee Valley, supporting insectary studies have been made on female behavior of several species of *Aedes* and *Psorophora*. The purpose of this paper is to report results of detailed observations made during 1962-63 on longevity, blood-feeding, and oviposition behavior of individually isolated females of *Aedes vexans*, *Psorophora confinnis*, *P. cyanescens*, and *P. ciliata*.

**METHODS.** The female mosquitoes used in this study were wild-caught within 24 hours after emergence, presumably while taking their first blood meal. This was ascertained by close observation of broods produced by controlled floodings of natural egg beds (Breeland and Pickard, 1963). The specimens, after being allowed to take a full blood meal, were aspirated and taken to the TVA insectary in a common cage provided with sugar water. Healthy, well-fed females were subsequently isolated, one each, in quart-size, paper ice cream cartons with a lid at each end. The bottom lid contained a thin layer of water-saturated, clean, white sand. The top lid was screened with 16-mesh aluminum or copper wire. These containers were numbered consecutively, provided with a sugar-water pad on the screen top, and checked daily. Each day, each female was offered a blood meal (finger on screen top) and provided fresh sugar water. Each carton was checked for eggs which, if present, were counted, recorded, and stored in appropriate moisture-retaining containers. Pertinent data were recorded daily. An isolation was considered successful when the female had lived for at least one week or had taken a full blood meal in confinement.

**RESULTS.** Figures 1 through 4 summarize results obtained on longevity, blood-feeding, and oviposition behavior of 186 isolated females handled as previously described (*Ae. vexans*—30; *P. confinnis*—50; *P. cyanescens*—68; *P. ciliata*—38). The table in the upper portion of each figure gives observations based on collective data for the entire group of specimens observed for each species. The lower portion of each figure gives three bar graphs which depict the behavior of specific females representing (1) a *typical female*, i.e., one which falls very near the center of a normal distribution curve, (2) a *prolific female*, i.e., one which falls on the extreme end of the curve, showing no "central tendency"; and (3) an *erratic female*, i.e., one which is fairly prolific but without "rhythm" in its oviposition and blood meal relationship. This manner of presentation precludes the necessity of presenting repetitious data on numerous females which would not materially change the significance of the observations.

In the bar graphs, blood meals are represented by a black square and the number of eggs by small black diamond-shaped dots. In each case, the first blood meal represented is the field meal at the time of capture. Each dot, according to the legend, represents 10 eggs. This may be misleading in calculating totals from the graphs since dots represent multiples of 10 eggs. Consequently, a single or final dot may vary in representing from 1 to 10 eggs.

A discussion of the results based on the data in figures 1 through 4 is given below. In this discussion, each egg deposition is referred to as a "batch" of eggs in keeping with usual terminology. However, it is apparent that the deposition of

LONGEVITY, BLOOD FEEDING, AND OVIPOSITION RECORDS OF 30 ISOLATED  
Aedes vexans FEMALES, TVA INSECTARY, WILSON DAM, ALABAMA, 1962-63

COLLECTIVE DATA FROM 30 SPECIMENS						
	Range	Av. $\pm$ Std. Error	Mode	Range	Av. $\pm$ Std. Error	Mode
Longevity in days	6-48	23.5 $\pm$ 1.8	27	1-12	3.0 $\pm$ 0.3	2
Number of blood meals	1-8	2.4 $\pm$ 0.5	2	1-226	54.9 $\pm$ 14.1	70
Number preoviposition blood meals	1-3	1.6 $\pm$ 0.1	1	22-546	162.0 $\pm$ 5.7	150
Preoviposition period in days	5-25	9.8 $\pm$ 1.0	5			

REPRESENTATIVE SPECIMENS

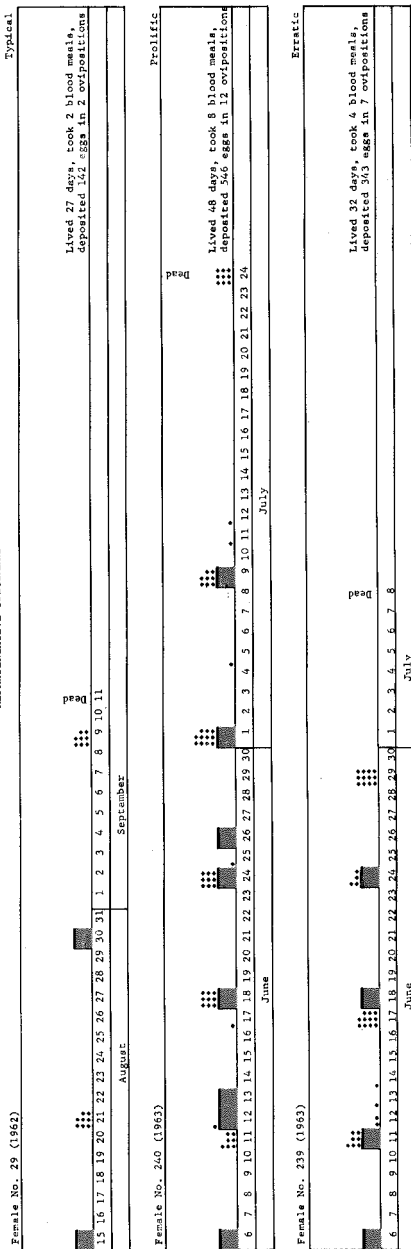


FIG. 1

LONGEVITY, BLOOD FEEDING, AND OVIPOSITION RECORDS OF 50 ISOLATED  
*ESOROTHRA CONFIRMIS* FEMALES, TVA INSECTARY, WILSON DAM, ALABAMA, 1962-63

COLLECTIVE DATA FROM 50 SPECIMENS

	Range	Av. $\pm$ Std. Error	Mode		Range	Av. $\pm$ Std. Error	Mode
Longevity in days	10-63	35.1 $\pm$ 2.8	41	Number of ovipositions	1-18	5.6 $\pm$ 0.8	9
Number of blood meals	1-18	6.2 $\pm$ 0.6	3	Number of eggs per oviposition	1-181	55.2 $\pm$ 3.6	110
Number preoviposition blood meals	1-5	2.7 $\pm$ 0.2	3	Lifetime egg deposition	11-1046	314.8 $\pm$ 16.1	650
Preoviposition period in days	5-49	14.5 $\pm$ 0.8	13				

REPRESENTATIVE SPECIMENS

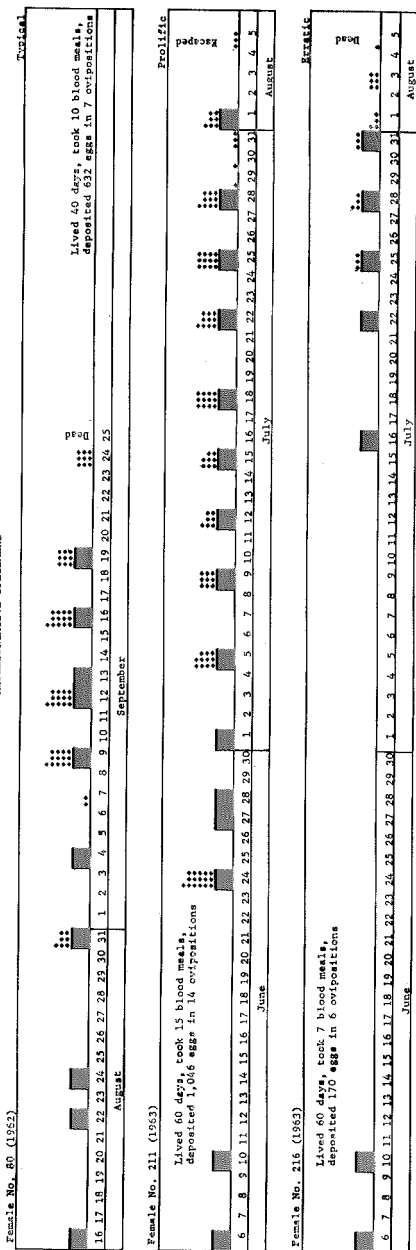


FIG. 2

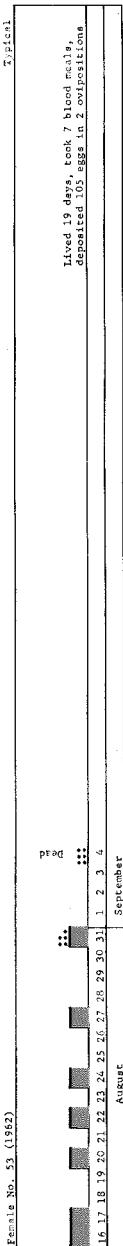
LONGEVITY, BLOOD FEEDING, AND OVIPOSITION RECORDS OF 66 ISOLATED  
*PSOROPHORA CARMELIENSIS* FEMALES, TVA INSECTARY, WILSON DAM, ALABAMA, 1962-63

COLLECTIVE DATA FROM 68 SPECIMENS

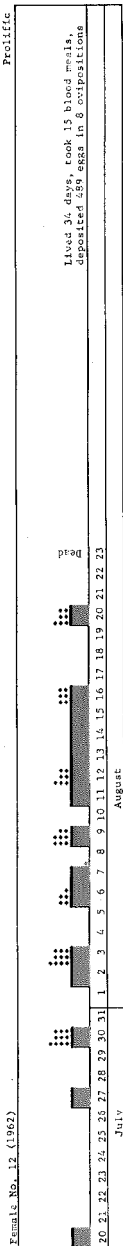
	Range	Av. $\pm$ Std. Error	Mode	Range	Av. $\pm$ Std. Error	Mode
Longevity in days	6-44	18.8 $\pm$ 0.8	17	1-10	2.4 $\pm$ 0.3	2
Number of blood meals	1-15	5.0 $\pm$ 0.4	6	1-99	40.9 $\pm$ 2.9	50
Number preoviposition blood meals	1-8	3.6 $\pm$ 0.3	5	2-489	99.3 $\pm$ 15.0	100
Preoviposition period in days	5-22	12.4 $\pm$ 0.7	15			

REPRESENTATIVE SPECIMENS

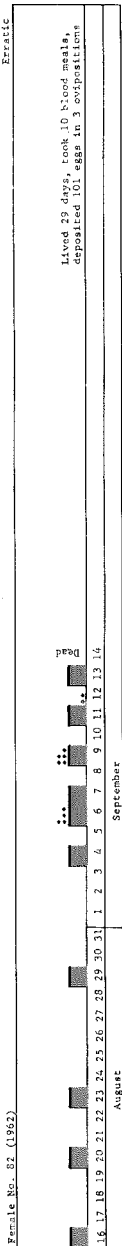
Female No. 53 (1962)



Female No. 12 (1962)



Female No. 82 (1962)



Each dot represents 10 eggs  
 Blood meals

FIG. 3

a "batch," i.e., all the eggs ready for deposition at one time may require more than one act of oviposition (see Fig. 1, female No. 240—June 11/12, 17/18, 24/25); hence the term "oviposition" rather than "batch" is used in figures 1 through 4.

*Aedes vexans* (Fig. 1). In these studies, the 30 *Ae. vexans* females survived from 6 to 48 days, took from 1 to 8 blood meals, and had a preoviposition period ranging from 5 to 25 days during which time the number of blood meals ranged from 1 to 3. The lifetime egg production of this species ranged from 22 to 546 eggs deposited in from 1 to 12 batches ranging in size from 1 to 226 eggs per batch.

The typical *Ae. vexans* female represented by specimen No. 29 deposited 71 eggs on the 6th day following its initial blood meal and, after an interval of 8 days, took its second and last blood meal followed by the deposition of 71 eggs in a single batch after an interval of 9 days. Death followed 2 days later on the 27th day. This specimen lived 27 days, took 2 blood meals, and deposited 142 eggs.

*Psorophora confinnis* (Fig. 2). The 50 *P. confinnis* females observed in this study survived from 10 to 63 days, took from 1 to 18 blood meals, and had a preoviposition period ranging from 5 to 49 days during which time the number of blood meals ranged from 1 to 5. The lifetime egg production of this species ranged from 11 to 1,046 eggs deposited in from 1 to 18 batches ranging in size from 1 to 181 eggs per batch.

The typical *P. confinnis* female of this group is represented by specimen No. 80 which took 3 blood meals (1st, 7th, and 9th days) after emergence before depositing her first eggs on the 15th day of her adult life. Following this, blood feeding and egg laying followed a rather rhythmic pattern until her death on the 40th day after taking 10 blood meals and depositing a total of 632 eggs in 7 batches. Of note in this group is the extremely long preoviposition period (49 days) of specimen No. 216.

*Psorophora cyanoescens* (Fig. 3). The 68 *P. cyanoescens* females making up this group survived from 6 to 44 days, took from 1 to 15 blood meals, and had a preoviposition period ranging from 5 to 22 days during which time the number of blood meals ranged from 1 to 8. The lifetime egg production of this group ranged from 2 to 489 eggs deposited in from 1 to 10 batches ranging in size from 1 to 99 eggs per batch.

The typical specimen in this group is represented by female No. 53 which took 6 blood meals (1st, 2d, 4th, 6th, 8th, and 11th days) prior to depositing her first eggs on the 16th day after emergence. After depositing these eggs she took her seventh and last blood meal and, after an interval of 3 more days, deposited her last egg batch and died. It appears that several blood meals are characteristically required by *P. cyanoescens* before eggs are deposited.

*Psorophora ciliata* (Fig. 4). The 38 *P. ciliata* females observed survived from 11 to 53 days, took from 1 to 12 blood meals, and had a preoviposition period ranging from 5 to 39 days during which time the number of blood meals ranged from 1 to 6. The cumulative egg total for life ranged from 3 to 392 eggs deposited in from 1 to 12 batches ranging from 1 to 91 eggs per batch. The typical *P. ciliata* female of this group is represented by specimen No. 102 which took 4 blood meals (1st, 5th, 7th, and 15th days) after emergence before depositing her first eggs on the 18th day of her adult life. Thereafter eggs were deposited and blood meals taken at intervals of 2, 6, and 4 days, respectively. This was followed by death on the 32d day. This female took a total of 7 blood meals and deposited 195 eggs in 5 batches.

*P. ciliata*, like *P. cyanoescens*, characteristically took several blood meals prior to depositing eggs. Specimen No. 73 deserves special mention in that an unusually long preoviposition period (39 days) occurred with a correspondingly large number of blood meals (6) being taken

LONGEVITY, BLOOD FEEDING, AND OVIPOSITION RECORDS OF 38 ISOLATED  
*PSOROPHORA CILIATA* FEMALES, TVA INSECTARY, WILSON DAM, ALABAMA, 1962-63

COLLECTIVE DATA FROM 38 SPECIMENS						
	Range	AV. $\pm$ Std. Error	Mode	Range	AV. $\pm$ Std. Error	Mode
Longevity in days	11-53	30.8 $\pm$ 2.2	32	1-12	4.3 $\pm$ 0.5	5
Number of blood meals	1-12	5.4 $\pm$ 0.5	5	1-91	26.4 $\pm$ 0.2	45
Number preoviposition blood meals	1-6	2.8 $\pm$ 0.3	3	3-392	112.4 $\pm$ 13.2	120
Preoviposition period in days	5-39	16.0 $\pm$ 1.5	14			

REPRESENTATIVE SPECIMENS

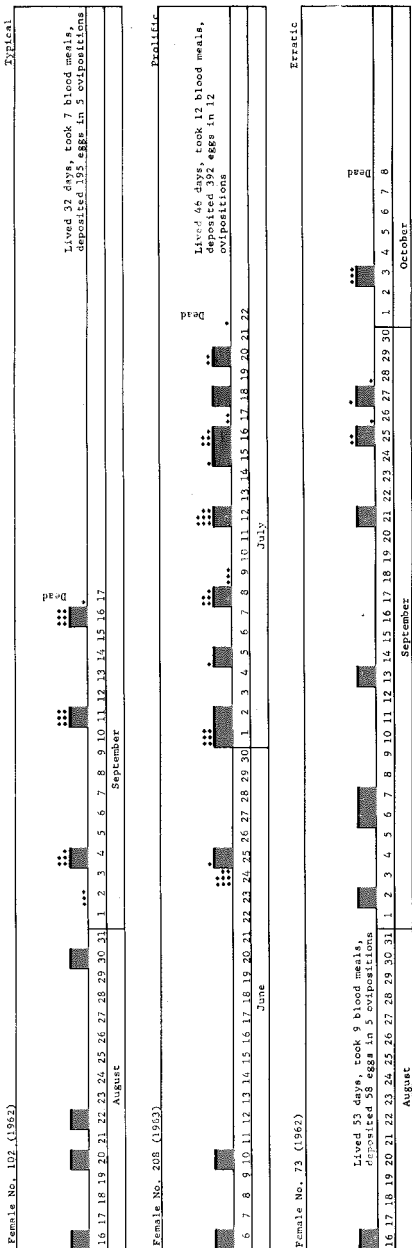


FIG. 4

before eggs were deposited. A specimen with such erratic behavior as this could be very misleading in epidemiological investigations involving the use of "gonotrophic concordance."

**SUMMARY.** Observations on 186 individually isolated females of four species of floodwater mosquitoes (*Ae. vexans*—30; *P. confinnis*—50; *P. cyanescens*—68; and *P. ciliata*—38) at Wilson Dam, Alabama, during 1962–63 emphasize longevity and sequential blood feeding and oviposition behavior. Longevity varied from a mode of 17 days in *P. cyanescens* to 41 days in *P. confinnis*; the longevity mode in *Ae. vexans* was 27 days and in *P. ciliata*, 32 days. *P. confinnis* was exceptionally prolific, depositing a mode of 650 eggs during life as compared to 150, 120, and 100, respectively, for *Ae. vexans*, *P. ciliata*, and *P. cyanescens*. The three *Psorophora* species characteristically required several blood meals (mode, 3–5) before the first

eggs were deposited with a correspondingly long preoviposition period (mode, 13–15 days). *Ae. vexans*, on the other hand, began depositing eggs after the first blood meal and had a short preoviposition period (mode, 5 days). The *Psorophora* species took more (mode, 5–6) and closer spaced blood meals with associated egg depositions (mode, 2–9) than did *Ae. vexans* (mode: blood meals—2; ovipositions—2).

Figures are presented in which specimens showing "typical," "prolific," and "erratic" behavior for each species are represented graphically and collective data for each group are presented in table form.

#### Reference

- BREELAND, S. G., and PICKARD, EUGENE. 1963. Life history studies on artificially produced broods of floodwater mosquitoes in the Tennessee Valley. Mosquito News 23(2):75–85.

## LABORATORY EVALUATION OF CERTAIN LARVICIDES AGAINST *ANOPHELES QUADRIMACULATUS* SAY.

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With the development of resistance to chlorinated hydrocarbons and other chemicals by mosquitoes a wide spectrum of new insecticides has become available. At present there are few data concerning the toxicity of these new substances either to different species of mosquitoes or to various strains within a species. Such information is basic in the choice of insecticides for specific control situations and also for following the development of resistances and cross-resistances in mosquito populations.

This paper presents the dosage-mortality relationships of one recently-collected field strain and one laboratory inbred strain of *Anopheles quadrimaculatus* with respect to

a number of larvicides and candidate larvicides.

**MATERIALS AND METHODS.** The following strains were utilized in this study:

*Dothan*: A strain collected in Dothan, Alabama in January 1964; after three generations of laboratory rearing it was utilized in this study. Following World War II, DDT was used extensively in Dothan area to control mosquitoes, house flies and the pests of cotton and peanuts (F. S. Arant, personal communication, 1964).

*Bethesda*: A strain obtained in 1962 from the Naval Medical Research Institute, Bethesda, where it had been in