THE FECUNDITY OF *AEDES NIGROMACULIS* IN THE LABORATORY—EFFECTS OF BODY WEIGHT AND SIZE OF BLOOD MEAL

T. MIURA [1] AND R. M. TAKAHASHI [1]

ABSTRACT. The mean number of eggs laid by *Aedes nigromaculis* (Ludlow) females after first blood meal from a rabbit was 116.04 with a range of 55 to 218. Females consumed averages of 4.26 to 6.20 mg of blood each within the average duration of 4 minutes when a bull, rabbit, rooster, and man were provided as hosts. There is a significant correlation between the size of 3-day unfed females and the quantity of blood ingested, and the size of the blood meal and the number of eggs laid; however, this correlation does not hold for females that ingested more than 5.18 mg of blood.

Aedes nigromaculis (Ludlow) is the most abundant and noxious mosquito in irrigated pastures throughout the Central Valley of California. Adults occur from April to October and are very aggressive biters of cattle (Husbands and Rosay, 1953). However, the damage resulting from mosquito bites on man and domestic animals has not been carefully studied. Monroe and Hoffman (1957) estimated the volume of blood ingested by one *A. nigromaculis* as 7.2 mg; they also speculated that it would require a feeding rate of 95 females per minute to withdraw 1 quart of blood per day.

The objective of this study was to investigate the relationship between the weight of unfed females, weight of blood meal, and the number of eggs laid. The average number of eggs laid, duration of feeding, and seasonal variation of female size also are reported.

MATERIALS AND METHODS. Mosquitoes used in this study were either laboratory-reared or collected in the field as pupae, and then reared to adults. The methods of rearing and handling were those of Miura (1967). Studies of the relationship between the weight of blood ingested and the number of eggs laid were conducted with approximately 1- to 2-day-old, unfed, field-caught females. Both reared and field-caught females were held without food in the insectary at approximately 25° C and between 75 percent and 85 percent relative humidity.

Animals used as hosts were a young human male, a 6-month-old Holstein bull, a mature domestic rabbit, and a mature leghorn rooster.

The mean volume of blood ingested by females was calculated by separately weighing unfed females and engorged females on a semi-micro analytical balance; for each determination, 11 or more 3-day-old, unfed females were collected at random from a cage, killed with chloroform, and weighed individually; the rest of the females of the same cage were allowed to feed upon a host. Immediately after feeding, engorged females were killed with chloroform and weighed singly. The difference in weights was taken as the mean blood meal size per female. Three-day starved females passed very little anal fluid during and after feeding; therefore, the loss from defecation was not included in the calculation (Service, 1968).

To study the relationship between the body weight of unfed females and weight of the blood meal, about 30 females were taken from a cage, lightly anaesthetized with CO_2, placed singly in preweighed, plastic containers (35 mm in diameter and 25 mm deep) having a nylon screen top, and weighed. Soon after recovery, they

[1] University of California, Mosquito Control Research Laboratory, 5545 East Shields Avenue, Fresno, California 93727.

were allowed to feed upon a rabbit. Immediately after feeding, they were reweighed and the weight of blood ingested was calculated.

Special care was taken to choose field-caught females for studying the relationship between the volume of blood ingested and number of eggs laid. Only unfed young females were used. The weight of females and blood ingested were obtained by the procedure described above. Engorged females were transferred into individual 4-oz Dixie cups with screen tops. Each cup contained 15 ml of tap water and a filter paper (7 cm, circle) which was inserted obliquely so that one end was immersed in the water and the other was near the top. After completion of oviposition, the number of eggs laid and the percent viability were recorded.

To study the relationship between (1) the weight of the unfed females and weight of blood ingested and (2) weight of blood ingested and number of eggs laid, the correlation coefficients were calculated for those females which had fed or laid viable eggs.

RESULTS AND DISCUSSION. *A. nigromaculis* females probably have a wide range of host preference among homeothermal animals, as 3-day starved females usually fed readily on given hosts. The average feeding duration, based on 22 observations was 4 minutes with a range of 0.73 to 9.13 minutes.

The weight of the unfed mosquito varied greatly with season (Table 1). In nature, *A. nigromaculis* populations greatly increase in number toward the latter part of the season (October); and, subsequently, the size of individual mosquitoes becomes smaller. In the laboratory, cultural techniques, such as amount of food, temperature, and density of mosquitoes, also affect the body weight (Table 1).

TABLE 1.—Mean body weight (mg) of 3-day-old, unfed females of *A. nigromaculis*.

Date	No.	Mean ± SE	Range
	Field-caught [a]		
May 25	50	4.19±0.10	2.05–5.40
June 8	57	3.66±0.08	2.70–5.35
June 20	25	2.71±0.11	1.25–4.15
July 20	35	2.39±0.09	1.65–3.90
August 22	50	3.96±0.08	2.95–5.60
October 14	17	2.76±0.12	2.10–3.80
October 24	22	3.13±0.26	2.60–4.00
	Laboratory-reared		
December 3	32	3.77±0.14	2.35–5.05
December 15	11	3.44±0.11	2.95–4.05
December 23	18	2.10±0.11	1.25–3.05
January 6	29	2.73±0.10	1.45–3.65
Grand Mean	346	3.43	1.25–5.60

[a] Collections were made at pupal stage.

The average volumes of blood ingested by unfed females from a man, bull, rabbit, and rooster are shown in Table 2. Females of the same weight ingested nearly equal amounts of blood from each of these host animals. According to Husbands and Rosay (1953), in nature females of this species prefer to take cattle blood over other domestic animals including man;

TABLE 2.—Mean volume of blood ingested by 3-day-old, unfed females of *A. nigromaculis* on various hosts.[a]

Host	Unfed female (wt in mg)			Blood meal (wt in mg)		
	No.	Mean ± SE	Range	No.	Mean ± SE	Range
Bull	22	3.13±0.26	2.60–4.00	30	5.57±0.41	2.72–10.67
Bull	17	2.76±0.12	2.10–3.80	8	4.26±0.53	2.24– 6.69
Man	50	3.96±0.08	2.95–5.60	40	5.55±0.34	2.04–10.99
Rabbit	50	3.96±0.08	2.95–5.60	50	6.20±0.26	2.54–10.39
Rooster	50	3.96±0.08	2.95–5.60	50	5.35±0.27	2.39– 9.59

[a] The blood volumes are determined by subtracting the average unfed weight from each fed weight.

however, if opportunities are given, they will take blood meal from many domestic animals including fowl. Generally, larger females ingested more blood from any one particular host; for example, females with a mean weight of 3.13 mg took an average of 5.57 mg of blood, whereas another group with a mean weight of 2.76 mg took an average of 4.26 mg of blood from the same host (bull). There is a positive correlation (r=0.707) between the body weight of females and weight of blood ingested (Figure 1). This may simply indicate that larger females have larger midguts and therefore can ingest more blood at a single feeding.

Although larger specimens consumed more blood than smaller ones, small females seem to ingest more blood in proportion to their weight. The ratio of weight of blood ingested to weight of unfed females is shown in Table 3. It is

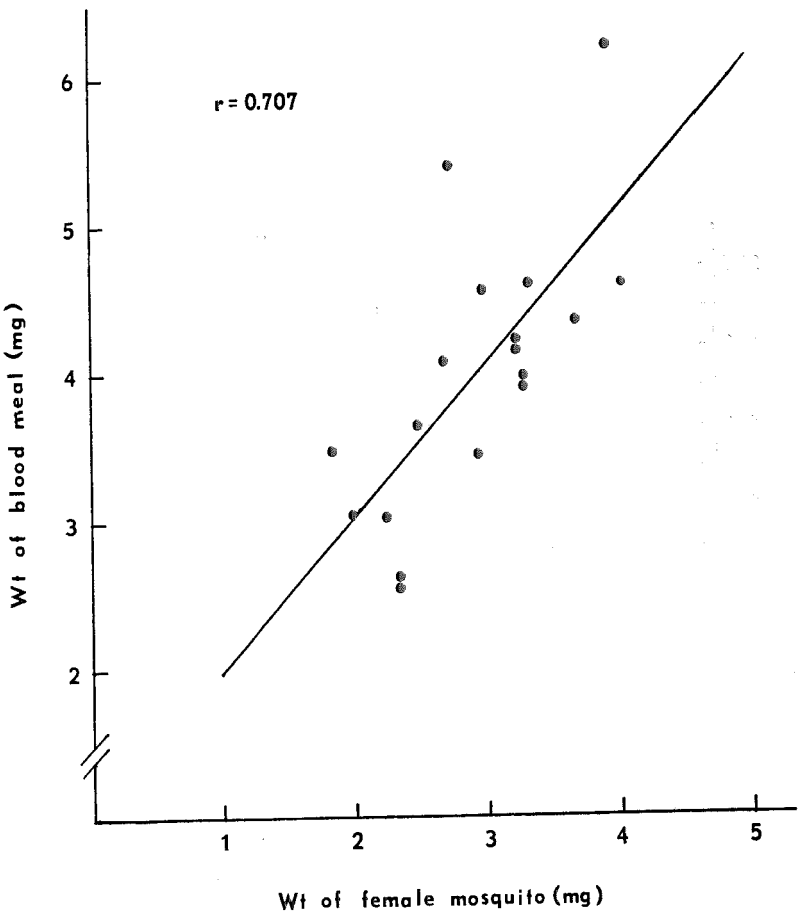

FIG. 1.—Scatter diagram showing relationship between the weight of 3-day-old, unfed female *A. nigromaculis* and the weight of blood ingested.

TABLE 3.—Relationship between the body weight of *A. nigromaculis* females and the blood volume ingested.

Weight of female (mg)	No. sample	Mean (blood ingested/ body weight)
3.5–4.0	3	1.35
3.0–3.5	6	1.36
2.5–3.0	11	1.46
2.0–2.5	8	1.60
–2.0	4	1.79
Grand Mean	32	1.51

noteworthy that the lightest group (2.00 mg) took 1.79 times its body weight while the heaviest one (4.00 mg) consumed only 1.35 times its body weight.

The number of eggs laid in a batch varied greatly among individual females. Of 92 females examined, the largest number of eggs produced was 218 and the smallest one was 55, the mean being 116.04.

The relationship between the number of eggs laid and weight of blood ingested is shown in Figure 2. The correlation is highly significant (r=0.599, significant at the 1 percent level), or, in other words, more eggs were produced by the females which took more blood. This phenomenon has been reported in *Aedes* species (Barlow, 1955, Colless and Chellapah, 1960).

The number of oocytes in an ovary of a given specimen is probably determined genetically. However, total egg production (oocyte maturation) is influenced by many factors, such as quantity and quality of nutrition, mating, and physical and

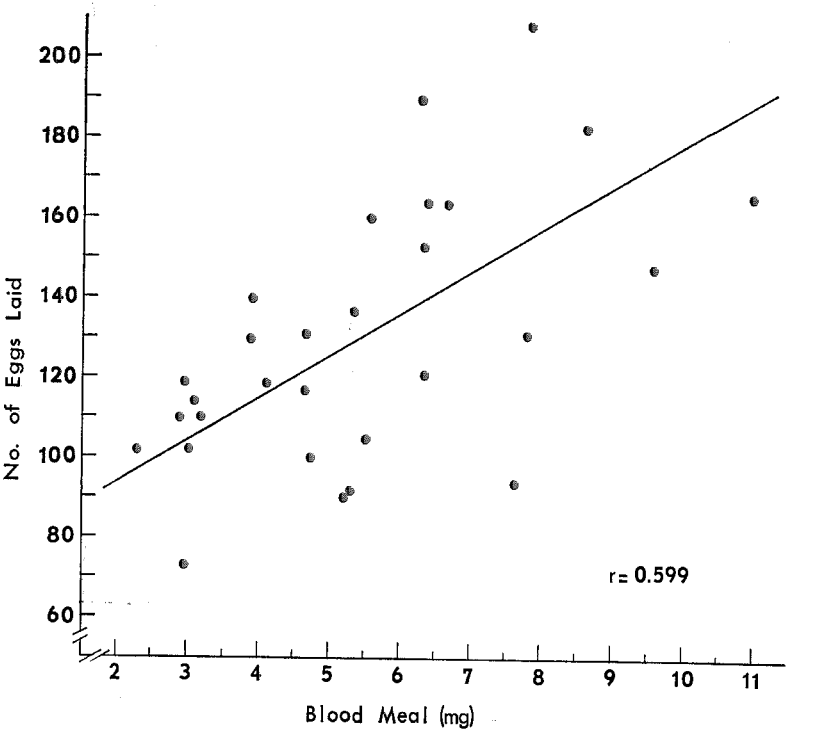

FIG. 2.—Scatter diagram showing relationship between the weight of blood ingested by unfed *A. nigromaculis* female and the number of eggs laid.

chemical environmental conditions. (Engelmann, 1970). Among them, nutrition is probably the most important factor (Colless and Chellapah, 1960; Bellamy and Bracken, 1971). Figure 2 also shows that the number of eggs produced by females which ingested smaller amounts of blood is more closely associated with the regression line, i.e., points in the scatter diagram are closely distributed along the line. However, the numbers of eggs from females which took a large blood meal were irregular. For example, one female which ingested 7.6 mg of blood laid only 94 eggs, while another female which consumed 7.8 mg blood laid 209 eggs (Figure 2).

Engorged females were classified into two categories—"partially" and "fully" engorged based upon their blood meal size. Females which ingested more than 5.18 mg are defined as fully engorged and those that obtained less than 5.18 mg as partially engorged. This critical weight, 5.18 mg, was selected because average unfed *A. nigromaculis* females weighed 3.43 mg (Table 1) and they can ingest blood about 1.51 times their own body weight in a single feeding (Table 3). For fully engorged females, there was no significant correlation between the number of eggs laid and amount of blood ingested ($r=0.474$).

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CHROMOSOMAL TRANSLOCATIONS IN *ANOPHELES ALBIMANUS* WIEDEMANN

M. G. RABBANI AND J. B. KITZMILLER

Department of Zoology, University of Illinois, Urbana, Illinois 61801

INTRODUCTION

Reciprocal chromosomal translocations are of considerable interest and seem to be quite promising as a practical tool in genetic control of insect pests (Curtis, 1968; Laven, 1969; Rai, 1967; Rai and Asman, 1968; Serebrovoskii, 1940; Wagoner *et al.*, 1969) and in linkage group-chromosome correlation studies (McDonald and Rai, 1970; Sakai *et al.*, 1971; Wagoner, 1967).

Although progress in translocation stud-