THE EFFECT OF FLOWING WATER ON MORTALITY RATES OF *AEDES AEGYPTI* (L.) LARVAE

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In order to determine the effect of increasing velocities of water and the length of time in these waters on the mortality rates of *Aedes aegypti* (L.) larvae, a series of detailed tests were conducted.

Groups of 25 larvae, five days old, were placed in flowing water and the mortality rate observed at the end of a period of time. This was done for rates of flow ranging from one-half foot per second to four feet per second and for periods of time from four hours to 72 hours. Corresponding to each of these groups, a check group was observed in still water. The experiment was repeated once.

APPARATUS

These tests were run in the "stream-tank" (Sudia, 1951). In addition to the stream-tank, other apparatus was required to provide similar temperature conditions for the control groups. The water bath principle was employed by placing the battery jar used as a control in an aquarium to which was added a 16-inch pencil heater. This heater was controlled by a DeKotinsky Thermo-regulator. A stirring device was added to the aquarium to prevent temperature layering. A Foxboro Recording Thermometer was used to record simultaneously the temperature of the water in the stream-tank and the controls.

CONDITIONS DURING THE TESTING PERIOD

Air temperature. The temperature in the room in which these tests were conducted remained fairly constant at $80 \pm 5°$ F.

Water temperatures. Since the tap water when first introduced to the stream-tank was fairly cool, the equipment was operated for several hours until a stabilized temperature was reached. The water temperature rose to 86° F probably due to the heating effect of the pump. During the operation of the stream-tank over a period of time, the temperature of the water did not vary more than several degrees above or below 86° F. The regulator for the controls was adjusted to provide similar temperatures.

Height of the water level. All tests were conducted with the water level at five inches. The nozzles were set 2.5 inches below the surface of the water.

Measuring the water flow. A Pitot tube was employed to measure the velocity of the water. This apparatus gives readings for the specific point in the stream in which it is placed. The point chosen to take these readings was half the distance from one nozzle around to the other, at a depth of two inches, and two inches from the outer wall of the tank. It is inherent in the design of the stream-tank that the greatest velocity of the water is directly in front of the nozzle and decreases gradually as the water flows toward the second nozzle where it is increased again.

Food. The larvae were fed coarsely ground Purina Checker Dog Chow as needed. Feeding was considered to be nearly equal for both the controls and the

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test specimens because the quantity of food introduced to the stream-tank, based proportionally to the amount of water used, was in slight excess of the amount of food placed in the control battery jar.

METHOD OF CONDUCTING INDIVIDUAL TESTS

The velocity of the water was adjusted to a specific speed and the 25 larvae introduced for a predetermined length of time as 8, 18, 24 hours etc. Another 25 larvae were picked at random from the same source as the test specimens and placed in the control battery jar. After the specified time had elapsed, the larvae were recovered from the stream-tank and the control jar and isolated in pint Mason jars where they were fed and the adults permitted to emerge. All figures presented in table 1 indicate the number of specimens failing to reach the adult stage.

TABLE 1

Number of deaths per group of 25 larvae.

Hours	Experiment A		Experiment B	
	Control	Test	Control	Test
		0.5 ft/sec		
8	4	6	0	5
18	0	9	0	3
24	2	7	3	6
48	1	6	4	10
60	3	11	0	9
72	1	25	1	14
		1 ft/sec		
8	2	3	1	7
18	2	5	1	4
24	0	4	1	5
48	3	9	4	11
60	3	12	1	11
72	0	15	2	19
		2 ft/sec		
8	0	11	5	15
24	2	16	1	21
48	1	25	0	25
72	1	25	0	25
		3 ft/sec		
4	2	25	1	25
8	2	25	4	25
24	1	25	0	25
48	4	25	0	25
		4 ft/sec		
4	1	25	0	25
8	1	25	2	25
24	2	25	1	25

STATISTICAL ANALYSIS

Attention is turned to the control groups to see, first, if these groups give any evidence of not being uniform and, second, if the increase of time in water increases the mortality rate.

There was no significant difference between the percentage mortalities for a fixed time interval and there was no significant difference between the percentage

mortalities for different time intervals. The common percent mortality was 5.98 percent; a 95 percent confidence interval for this percent is 4.5 to 7.5 percent. From this it is concluded that the groups of larvae are homogeneous and that the mortality in still water is about 6 percent, for at least the time interval four to 72 hours. In view of these results, the data for experiments A and B were combined. The deaths per group of 50 expressed as a percent are given in table 2.

TABLE 2

Deaths per group of 50 expressed as percent. The numbers in parentheses indicate the limits of a 95 percent confidence interval.

Speed of Current	Time						
	4	8	18	24	48	60	72
0.5		22 (11–36)	24 (13–38)	26 (14–40)	32 (19–46)	40 (26–55)	78 (64–89)
1		20 (12–34)	18 (9–32)	18 (9–32)	40 (26–55)	46 (32–65)	68 (53–81)
2		52 (37–66)		74 (60–85)	100 (92–100)		100 (92–100)
3	100 (92–100)	100 (92–100)		100 (92–100)	100 (92–100)		
4	100 (92–100)	100 (92–100)		100 (92–100)			

TABLE 3

T test for trend.

Speed	T	Probability	Time	T	Probability
½	0	0.001	8	1	0.008
1	2½	0.048	24	1	0.008
2	0	0.042	48	0	0.042

For a given speed of current, the mortality percentages for the extreme times are significantly different. Similarly, for a given time the mortality percentages for the extreme speeds are significantly different. The T test for trend (Mann, 1945) was performed as follows. Using speed 1 as an example, we counted the number of times an element in

20 18 18 40 46 68

was greater than element to the right of it. Calling a tie ½, we get $T=2\frac{1}{2}$. If the probability of obtaining a $T=2\frac{1}{2}$ is small (under a random arrangement), it is inferred that a trend exists.

This test was carried out for several speeds and times and the results are in table 3. The data show that for a given speed mortality increases as the time increases, and that for a given time the mortality increases as the speed increases. It is noted that all of the mortality percentages were significantly greater than six percent—the still water mortality.

The times of 50 percent mortality were determined to lie between:

60 and 70 hours for a speed of 0.5 ft./second
60 and 72 hours for a speed of 1.0 ft./second
less than 8 hours for a speed of 2.0 ft./second
less than 4 hours for a speed of 3.0 ft./second
less than 4 hours for a speed of 4.0 ft./second

SUMMARY

A series of tests were conducted to determine the effect of various velocities of flowing water and different lengths of time in these waters upon the larvae of *Aedes aegypti*. Flowing water conditions were obtained in the laboratory by the use of the stream-tank. Additional equipment provided the control larvae with similar conditions except for the substitution of still water for flowing water.

Groups of 25 larvae, five days old, were placed in the stream-tank, and in the control jar where they remained for a predetermined length of time. During this time, they were fed equivalent amounts of food. Upon the termination of this test period, the larvae were recovered and isolated in separate pint jars to continue their development. The mortality rate was based upon the number of larvae failing to reach the adult stage.

It was found that for the times between four and 72 hours, the mortality rate in still water was about six percent, independent of time. However, for water that is flowing, the data show that for a given speed mortality increases as the time increases, and that for a given time mortality increases as the speed increases. The times of 50 percent mortalities are also given.

LITERATURE CITED

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