NOTES ON THE LIFE HISTORY OF ANOPHELES ALBIMANUS AND GRABHAMII *

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In the preparation of a film depicting the activities of the Malaria Prevention Bureau of the Department of Health of San Juan, Porto Rico, it was felt desirable to include as complete a picture as possible of the life history of *Anopheles albimanus*, the important transmitter of the region. In order that various phases of the mosquito life cycle be available for photography when desired, many preliminary observations were made, some of which had been carried on over a long period. Published data on egg laying and hatching of larvae are not numerous and these notes are therefore written with the feeling that repetition may be justified.

These observations were recorded during the months of August and September when the maximum, minimum and mean temperatures were 85.5°, 77.2°, 81.4° F., and 85.3°, 74.8°, and 80.6° F., respectively. The mosquitoes were caught already engorged in animal traps.

DEPOSITION OF EGGS

Time after blood meal: Oviposition did not take place the first night following the meal. The majority deposited eggs on the second or third night, usually the former. A few did not lay any eggs until the fourth or fifth night.

Time of day: Deposition of eggs was not observed during the day, at least up to sunset. Egg laying was actually noted at 9:00 P. M., at 10:00 P. M. and at 1:00 A.M. Repeated observations at other hours indicated that deposition took place at any hour during the night, but that it was a little more common before 10:00 P. M.

Egg laying: The mosquito usually became quite active just before laying and was easily disturbed, especially *A. albimanus*. When the process began the mosquito was often much less sensitive to noise and light, particularly so *A. grabhamii*, which in one instance at least, continued to lay while exposed to two 1,000-candle-power lamps from one to two feet away, even after removal of the glass dish

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enclosing it. One specimen of *A. albimanus,* however, flew away three times while being photographed and was returned each time to the container where it continued laying. There was no constant position assumed during oviposition. Some eggs were expelled while the mosquito rested on the upper portion of the container far from the water (a weakened mosquito practically lay on the water while depositing eggs); but the mosquito usually stood in its normal position if not entirely on the moistened area, at least, with its middle or hind feet in the water or on moistened paper.

The eggs were extruded one by one, usually, in an almost continuous stream at first and often standing on end as they came out. They dropped into the water or upon whatever the mosquito rested. If in the water they soon assumed their usual position; if on other surfaces, sometimes a heap was formed, as on one occasion where a pile about one-fourth of an inch high and three to four eggs across accumulated. The eggs were practically white when laid but within two to three hours they changed gradually to a dark brown color, usually appearing as black, but by more oblique illumination were shown to be brown. The last few eggs were often expelled with some force. If the mosquito was undisturbed it would often lay all of its eggs in one spot. More often a large group was found with a few additional eggs scattered about. The entire operation required only a few minutes.

Number of eggs: Counts of the ova deposited by eight *A. albimanus* were: Average 160; minimum 61; maximum 221. Under favorable conditions, however, approximately 200 might be the average egg output of this mosquito. Thirty *A. graphamii* deposited an average of 132 eggs, a minimum of 35 and a maximum of 278.

Development of the larvae: At the temperature prevailing during the course of these studies, from 40 to 44 hours were required for the development of the larvae within the eggs. The larvae could best be observed under the microscope with the source of light below and to one side. The structures about the head and thorax were most clearly distinguished and usually only four to six hours were necessary from the time any structure could be observed until hatching took place. The head appeared to be decidedly more transparent than the remainder of the larvae. Shortly before hatching, the divisions into abdominal segments became evident. At about this time some striking markings appeared on the dorsal surface. Among the first to appear were the arrangements of the lateral, abdominal, and thoracic hairs, those on each side being grouped together in a bundle forming a "V" or an "X" over the head with the bundle from the

opposite side. Below, the most prominent objects seen were the eyes. The head was always located at the larger end of the egg. Practically without exception the larva lay in an inverted position, i. e., the dorsal surface down. Previous to breaking of the shell it was never possible to detect any movement of the larva within the egg, the impression being that the larva was compressed tightly within the shell. The break in the shell first appeared near the water-line, on the undersurface of the large end of the egg, and usually proceeded rapidly up one side. The cap thus produced was pushed out on the head of the larva until the opening was wide enough for the protrusion of the larva. The head could be seen slipping out first. Then the larva with vermicular movements crawled partially out of the shell into the water. Usually a pause followed; then the larva suddenly became active and the caudal part of the body still held within the shell was jerked away.

In most cases the above process required only a few seconds; in some instances the process of hatching was very slow and on one occasion two hours elapsed between the time the shell first broke and the larva swam away. It was specially rapid in eggs which were returned to water after being allowed to dry, or those kept at a low temperature shortly before hatching time. An entire batch of more than 100 eggs was observed to hatch within a few minutes after the return to water. In many of these cases the end of the egg broke open while the egg was still out of water, and in some instances the entire batch was seen in this condition. These hatched almost simultaneously after having been placed in water.

Hatching occurred any hour of the day or night but more frequently during the warmer hours. The process was usually a very short one and practically all the larvae from a single batch of eggs was seen to leave the eggs at the same time. Sunlight did not seen to be essential, for the entire process was observed in a room entirely devoid of sunlight.

The impression was obtained that the process of hatching was dependent upon the activity of the larvae, but hatching could be completed with dead larvae as well. This was especially noticed in mature eggs which had been allowed to dry too long. Upon returning them to water the same hatching process took place except more slowly and there was no active movement of the larvae.

Change from larva to pupa: Comparatively, the duration of the larval stage varied much more than the other immature stages. The minimum period from egg to pupa was found to be from four to five days. Shortly before pupation, the larva appeared to be somewhat

shortened and very much broader, specially across the thorax. The larva, which had previously been active, became quiet and the mouth brushes now remained still. Worm-like movements were seen throughout the body of the larvae—a linear split appeared on the middle of the dorsum, through which the pupa passed. A few quick jerks served to free the pupa of its larval skin; the entire process required but a short time. Emergence occurred only during the day, usually in the afternoon.

Emergence of the mosquito: Mosquitoes were never seen to emerge on the same night of the day the pupa became free. On the second night, however, or approximately thirty to thirty-six hours after formation of pupae, large numbers might be expected to emerge, or perhaps twenty-four hours later. Possibly this phenomenon occurs at any hour of the day or night, though it was never observed in the daytime. One can always expect a large proportion of any batch to emerge just after sundown, as this seemed to be the time most favorable for this change to take place.