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A METHOD FOR REARING THE MOSQUITO *CULEX PIPIENS MOLESTUS* FORSK[1]

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This laboratory is engaged in the evaluation of chemicals, furnished by the U.S. D.A., as candidate repellents against a number of blood-sucking insects including the local mosquito *Culex pipiens molestus* Forsk. It is the most common mosquito in houses in this country, and a fierce biter which attacks mostly in the dark. Since relatively large numbers of this mosquito are necessary for the screening tests, a simple technique has been devised to rear large numbers of them. The method may also be adopted to rear other species of mosquitoes.

DESCRIPTION OF THE REARING CONTAINER. The rearing container (Fig. 1) is a commercially available plastic container (36 cm in diameter at the base, 43 cm in diameter at the top, with a 2 cm rim, and 43 cm high). Close to the bottom of the container there is a hard plastic tube B, (1.6 cm inside diameter) in the form of an inverted T. At the ends of this tube, which are outside the container, small rubber tubes A & D are connected. They can be closed and opened by clamps. At the other end of this tube, which is inside the container, a screened metal tube is attached C (3 cm in diameter and 28 cm long). Another hard plastic tube H (1.6 cm inside diameter) comes out from the bottom of the container. It has at its end a small rubber tube with a clamp I. To the end of this tube a screened metal tube J (5 cm in diameter and 20 cm long) can be connected, whenever necessary. The top of the container is covered with cheesecloth E, tightened to the container by a rubber band. On top of it is placed, when necessary, a cover F made of a plastic screen, except for the rim (3 cm) which is of hard plastic. There are four holes (5 cm in diameter) in this plastic screen. Into these holes are inserted, when required, four inverted jars G which contain about 90 cc of a 10 percent sugar solution. The plastic covers of the jars are each perforated

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by 30 or more tiny holes (about 1 mm in diameter).

REARING PROCEDURES. The rearing is carried out in a room at 28–30° C. The rearing container is filled almost to capacity with about 36 liters of tap water, and 4 additional liters of water, which was previously in contact with hay for 3 or more days, was added. This provides a good start of microorganisms in the water. About 400 rafts of eggs obtained from autogenous females (such a raft contains on the average 30 eggs), or 100 rafts of eggs obtained from females which have had a blood meal (such a raft contains on the average 100 eggs) are placed in the water. About 6 gr. of bread crumbs (2 full specially made spoons) are added, and the top of the container is then covered with cheesecloth.

On the 3rd day, 5 spoonfuls of bread crumbs are added, on the 4th day 6 spoonfuls, and on the 5th day 7 spoonfuls. On the 6th day the water in the container is

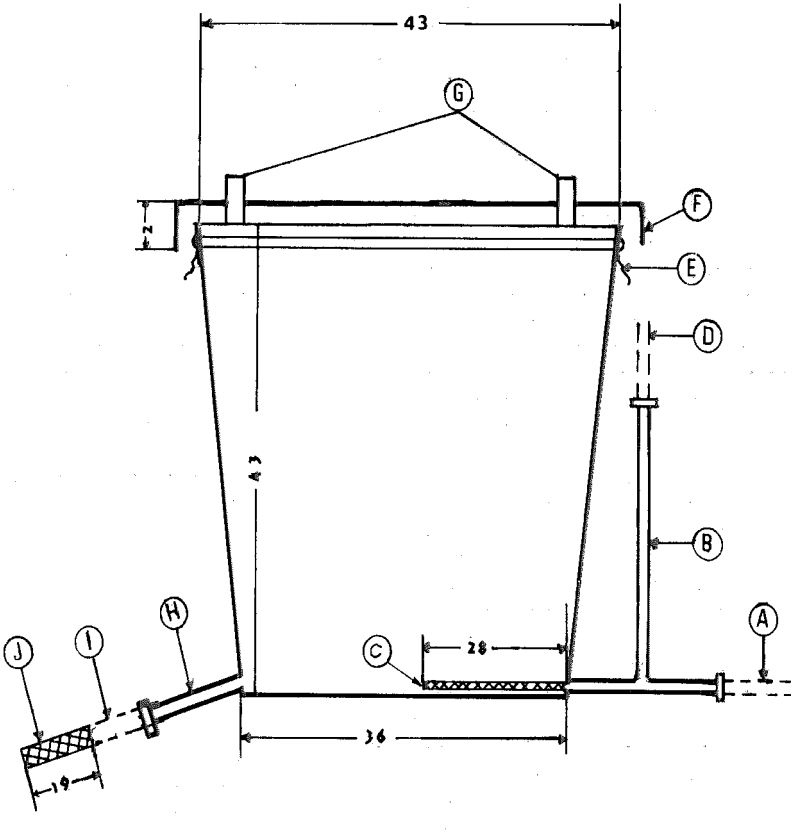

FIG. 1.—Diagram of container for rearing *Culex* mosquitoes.

A. Rubber tube with clamp. B. Plastic T tube.
C. Screened metal tube. D. Rubber tube with clamp.
E. Cheese-cloth. F. Screened plastic cover.
G. Inverted jars containing sugar solution. H. Plastic tube.
I. Rubber tube with clamp. J. Screened tube which can be connected to rubber tube I.

changed for fresh tap water. This is done by opening clamp A. Most of the water is drained, while the larvae are retained inside the container due to the screened metal tube C; tube A is closed, and fresh water is introduced through tube D until the container is about half filled. On the 7th day the adults start to emerge. The top of the container is then covered with the plastic screen cover F. Four small jars G containing a 10 percent sugar solution are then placed inverted into the four holes of the plastic screen cover, so that the perforated cover of the jars come in contact with the cheesecloth. This permits the sugar solution to moisten the cheesecloth, thus enabling the mosquitoes to feed. On the 8th (and sometimes also on the 9th) day the water in the container is changed to fresh tap water, as previously described. On the 10th day most of the adults have emerged.

The water and all its contents (larval and pupal exuvia, bread crumbs and other debris) is then removed. This is done by opening tube I into which was inserted the metal screened tube J. The bottom of the container is washed off from all possible debris by introducing water through tube A and letting it out through tube J. The purpose of the screened tube J is twofold: to prevent any possible escape of adults when the water is removed, and to collect all the debris, which may still include some pupae, inside a closed screen in order to prevent it from passing into the drainage. After the washing, the upper screen cover F and the small jars containing the sugar solution are removed. The container is then turned upside down to remove any remaining water, and left in this position for a few hours or overnight to dry. If left overnight, a piece of cotton, soaked in a 10 percent sugar solution, is stuck under the cheesecloth D to enable the mosquitoes to feed. When the inside of the container is dry, it is placed in a cold room (4° C) for a few minutes to inactivate the mosquitoes. The latter are then removed, weighed into equal groups and placed in cages to be used for testing candidate repellents. A jar containing water is placed inside the cage for drinking and egg laying. Some honey smeared on a piece of foam rubber is given as food to the adults.

DISCUSSION. The method described has been used in our laboratory for over 2 years, and was found to have many advantages. We produed close to 10,000 mosquitoes per rearing container. The fact that the water in the rearing container can be changed with ease at any time is of great importance. It may happen that cultures are spoiled due to the fact that a scum is formed on the surface of the water, which suffocates the larvae and pupae. This scum is formed when too much food is added to a given number of larvae. When it is seen that scum is forming, the immediate exchange to fresh water will remedy the culture. Too little food will keep the water clean, but on the other hand the development of the larvae will not be uniform, the adults will be small, and the time of development will be prolonged (Bar-Zeev, 1957). The exchange to fresh water in the pupal stage is sometimes absolutely necessary. The pupae do not feed, while the microorganisms in the water continue to develop. At this time, the development of scum on the surface of the water is more likely than at other times. Due to the fact that the water can be easily changed, it is also possible to wait until practically all the pupae have emerged. It is also important to exchange the water when the adults are emerging in order to keep the water clean. If the water is unclean many adults will drown. This does not occur when the water is kept clean.

This method has also the advantage that mosquitoes do not escape. The container is made in such a way that no opening to the mosquitoes is necessary. The amount of handling required is small. One part time worker in our laboratory rears over 20,000 mosquitoes per week.

This mosquito is autogenous, and therefore, can be reared without blood meals. However, if sometimes large numbers of mosquitoes are required in a short period of time, the number of eggs can be greatly

increased by one or more blood meals. This was sometimes done by introducing a rat, enclosed in a screened tube, into a mosquito cage.

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BIONOMICS OF A POPULATION OF *CULEX PIPIENS QUINQUEFASCIATUS* SAY

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ABSTRACT. Calculations were made concerning the biotic increase (rate of successful reproduction) of an indigenous population of *Culex pipiens quinquefasciatus* Say exposed to the stress of total population control (release of chemosterilized males and the collection of egg rafts in ovitraps). Before control was applied, rates of increase from generation to generation varied from 1 to 3.5X, indication of a relatively stable population. Also, the rate of increase in the first generation after the stress was applied was the same as that in the generation just before stress was applied. Then, as control progressed toward suppression and eventual eradiction, the rate rose to 5.0X and finally to 10X (in about two to four generations depending on the environmental conditions). The normal rates of survival of the various stages in this environment probably limited the maximum biotic increase of this population to 10X.

The new integrated approaches to the control or suppression of insect populations in which sterility or genetic manipulation will play a part require quantitative information about the bionomics of populations as they exist in nature. Knipling (1968) stressed the importance of data relating to the total numbers of insects in a field population and their capacity to increase from generation to generation when he outlined the general requirements for suppression of insect populations through the introduction of sterility or by integrated techniques. Weidhaas (1968) proposed that such necessary bionomic information could be obtained by using sterility as a tag.

Recently, we reported two experiments in which sterile male mosquitoes, *Culex pipiens quinquefasciatus* Say (=*fatigans*), were released into an indigenous population on a small island, Seahorse Key, off the Gulf Coast of Florida (Patterson *et al.*, 1970a and b). The results of both tests demonstrated the validity of the concept of control of this mosquito by sterile-male releases; they also demonstrated the usefulness of induced sterility as a tag in obtaining bionomic data. Thus, we were able to calculate the absolute density of each generation of this specific population (expressed as the number of adults emerging into the population per unit time) and the percentage of the population of each generation remaining (after the application of the stress of total population control) to produce the next generation. In the present paper, we use these calculations to determine the actual biotic increase demonstrated in each generation of this population and explore the relationship between the mortalities of the various stages and the observed rates of biotic increase.

In the two experiments on Seahorse Key, the male *C. p. quinquefasciatus* used for the releases were reared at the laboratory in a carport and sterilized chemically (in 1968, by exposure of adults to tepa and in 1969, by exposure of pupae to thiotepa). In 1968, an average 2500 sterile males per day were released in August and Septem-