NOTES ON THE USE OF FRESH WATER FISH AS CONSUMERS OF MOSQUITO LARVAE IN CONTAINERS USED IN THE HOME

Based Upon Experience in Guayaquil, Ecuador, and Mérida, Yucatán, Mexico

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THE present day campaign to control yellow fever or to eradicate an endemic center of this disease is based solely upon the reduction of the *Aëdes calopus* by anti-larvae measures to a theoretical minimum called the "safety index."

As early as 1908, Carter suggested that anti-larvae measures alone should be sufficient to check the spread of yellow fever and that, faithfully applied for a reasonable time, they should completely clear an endemic yellow fever center. He held that isolation or even screening the sick, the reporting of cases, and the fumigation of infected homes were unnecessary.

The initial campaign to be conducted exclusively along anti-larvae lines was carried on by Converse at Iqüitos in 1913. Beverley applied the same measures with success at Buenaventura, Colombia, in 1916. The first large endemic center to be cleared by strictly anti-larvae measures was Guayaquil, Ecuador, in 1919. Here, for the first time, the systematic use of fish was depended upon to destroy mosquito larvae in fresh water containers.

Unquestionably, a modern water system carrying an abundant supply of potable water, available to the majority of homes at all hours of the day and night, is the measure to be recommended for the permanent elimination of yellow fever from endemic centers, and for rendering other areas non-infectible. Financial considerations, unfortunately, make such a system impracticable for many communities where yellow fever is present. It is in such communities that the sanitarian must resort to the next best plan.

The systematic use of fish in fresh water containers has so simplified the problem, and so shortened the time necessary to reduce the *Aëdes calopus* to the safety index, that it is now accepted as the first temporary measure to be employed in yellow fever areas where fish are available and water is stored in reasonably large containers, such as tanks, barrels, or cisterns. In desert areas such as Carter encountered in Peru, where fish are not to be had, or in communities where the water is stored in receptacles too small to support fish life for the time necessary to conclude a campaign, the mosquito larvae may be removed from the water containers by straining the water through a cloth.

With the exception of metal tanks, for which no satisfactory fish has yet been discovered, fish can be employed as larvae destroyers in all classes of reasonably large water-storing receptacles. The four factors needed to insure their effectiveness are:

That the fish be in a sound condition when placed in the container.

That the water in the container receive sufficient air to support fish life.

That the container be protected from the sun.

That there be placed at the bottom of the container, against the side, a cave-like arrangement beneath or behind which the fish can rest or can hide when frightened. A condensed milk can, a curved piece of earthenware, or an elevated stone device made by resting a flat stone on two other stones, will suffice.

As a general rule, all fresh-water fish that can adapt themselves to the confines of containers will consume mosquito larvae. I have used with excellent re-

sults species of top minnow, carp, pike, mullet, and perch, and also shrimp and small turtles. Unfortunately, some species of fish which consume great quantities of mosquito larvae are unable to adjust themselves to the narrow limits of the average container. These usually free themselves by "jumping," or else become sluggish, and sicken and die. At Guayaquil the "huijas," a most satisfactory destroyer of mosquito larvae, would throw itself three feet into the air in its efforts to escape from a barrel.

Larvae-eating fish may be roughly divided into "top feeders" and "bottom feeders." All top-feeding fish are most effective where there is plenty of sunlight. They seem unable to locate larvae in dark containers, such as partially covered tanks or cisterns. They are very satisfactory when placed in swimming pools, pilas, fountains, and other open receptacles. Here they not only thrive, but increase in numbers, and keep the containers continually free of mosquito larvae. It is the bottom-feeding fish, however, that have up to the present given the best results in reducing the *Aëdes calopus* index in both Mérida and Guayaquil.

In Mérida the following was the procedure for stocking the various types of containers:

Aljibe or cistern, one fish only, preferably male .....Bottom feeder
Well, if filled from below, two or more .....Top feeders
Well, receiving rain from roof or patio, one or more.....Bottom feeders
Barrel, one fish only.....Bottom feeder
Pila, fountain, etc., two or more.Top feeders

The usual method of securing a supply of fish for containers is to arrange with local fishermen to furnish a fixed number at stated periods. The contractor delivers the fish into a prepared pila, well, or cistern, being paid only for live fish. These are allowed to rest a few days before distribution begins. The cost varies with the supply and demand, averaging from one-half to one cent each. A pin-hook with raw meat is used to catch the fish. The injury resulting from the pin-hook is a very slight one, from which the fish readily recovers; less than two per cent so caught have died. When fish are plentiful a "throw net" is used.

While the fish are in the health department's pilas they receive a small ration of white bread daily. Once distributed, they must feed upon such material as is to be found in the water containers. The health service does not advise or encourage home feeding of the fish, for fear they will be overfed and become too sluggish to hunt larvae.

Fish are distributed in the following manner to the staff in charge of control measures: Each district inspector anticipates the day's needs and notifies the central office, which in turn submits each list to the man in charge of the pilas. This employee takes from the pila the number of fish requisitioned, all being selected for their size and apparent soundness, and delivers them to the central office. Here the district inspector receives a day's supply, which he places in a five-gallon pail half filled with clean, fresh water. It is necessary to change this water frequently during the day to insure the fish sufficient oxygen to keep them in fit condition to be transferred to their new home. Unless this small detail is observed, many fish will die soon after being placed in a container, thus prejudicing people against the experiment.

The question frequently arises as to the possibility of fish excrement contaminating the water. This might occur if a large number of fish were placed in a container holding a small quantity of water. To avoid such a contingency, inspectors are instructed to place one fish, preferably a male, in receptacles holding drinking water.

In the case of pilas, fountains, and similar containers, the foregoing possibilities do not have to be considered. The health department may, therefore, use this class of receptacle as hatcheries, and thus assure a future supply of fish adapted to life in small containers.