THE ROLE OF CERTAIN ARTHROPODS IN REDUCING MOSQUITO POPULATIONS OF PERMANENT PONDS IN OHIO

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An examination of the literature shows that transient rather than permanent bodies of water are most favorable to the production of mosquitoes, and further that there is little data explaining why this is so. Part of the answer may lie in (1) the fact that the mosquito fauna of permanent ponds is different from that of temporary ponds and pools, although Mead (1949) has shown that species such as *Anopheles quadrimaculatus*, *Aedes vexans*, and *Culex pipiens* breed in both types of habitat, and (2) the fact that there is higher mortality among the larvae in permanent ponds.

The predatory activity of the arthropod fauna doubtless causes much of this larval mortality. However, most general works dealing with mosquitoes only briefly discuss arthropod predation and thus leave the impression that it is unimportant. Arthropods other than insects have seldom aroused the interest of investigators, and relationships other than predation have been given little consideration.

The writer has conducted an inquiry into these problems and here reports some observations which he made concerning predation and competition in permanent ponds. The work was carried out during the summers of 1947 and 1948, and the principal facility used was the Ohio State University farm pond. This pond was inspected several times each week. Supplementary aquarium studies were carried on concurrently. In addition, a number of other ponds and pools were observed at irregular intervals for the purpose of making comparisons.

LIMITS TO POPULATIONS OF MOSQUITO LARVAE

Many insects and some other arthropods prey upon mosquito larvae. Furthermore, the arthropods can limit mosquito breeding in other ways. Thus a large reservoir of predators is supported by the herbivores, such as mayflies and midges, which are present throughout the year. Whenever mosquito larvae are introduced into the pond, predators are already present and will begin to take a toll. Since the midges and other herbivores provide a series of alternate hosts for the predators, the mosquito population will not build up ahead of a lagging predator increase.

Secondly, the arthropods compete with the mosquito larvae for the available food. Little is known about this competition. Weed (1924) made a very brief report of a pond in which he thought cladocerans completely prevented mosquito breeding by utilizing all of the food.

Finally, the larger arthropods can create an unfavorable physical environment for mosquito larvae by their movements. This is because the larvae and pupae of many mosquito species move rapidly when they are disturbed and constant escape reactions can slow down their development and expose them to predation. When *Aedes aegypti* larvae were kept in an aquarium with hydrophilid adults, many of them died because the beetles were constantly moving. Such mortality doubtless rarely if ever occurs naturally. In ponds hydrophilid adults spend most of the time feeding and resting on the bottom with occasional trips to the surface where they obtain air. Since there are several beetles per lineal foot of shore in the Ohio University pond in July, they would continuously disturb any immature mosquitos in the vicinity. The constant motions of notonectids and gyrinids would also produce a pronounced disturbance of larvae in their paths.

SOME IMPORTANT PREDATORS: COPEPODS AND INSECTS

Haub (1930) in a review of the literature does not mention copepods. The present author has not discovered any report of their predacious activity since that time. However, some species of these microcrustaceans readily feed upon first and second instar mosquito larvae when they are kept in aquaria.

Several species of *Cyclops* are common inhabitants of shore water and the water among the plants in ponds and lakes. Mosquito larvae probably occur in their normal diet. Members of the genus can capture moving larvae and retain a grasp throughout vigorous movements of the prey even though this prey is often larger than the captor. These copepods attack both culicine and anopheline type larvae, but they capture culicines much more often.

During 1948 a group of *Cyclops* was kept in a small dish and provided daily with *Aedes aegypti* larvae. The copepods seized the larvae seconds after they were added. Individual copepods consumed about five first and second larvae per day. *Aedes aegypti* larvae placed in a large aquarium with a mixed population of small invertebrates, including copepods, disappeared, and they were probably taken by the *Cyclops* which were the only predacious metazoan species present.

The relatively large aquatic insect predators of many species probably consume many more larvae than do the copepods. Odonatan nymphs are among the most numerous predators in many ponds and the habits of a number of species are such that they would encounter mosquito larvae. For instance, damselfly nymphs cling to stems along which mosquito larvae feed. The long-legged nymphs of the dragonfly *Erythemis simplicicolis* wander about in the vegetation and in the little pools within the surface blanket of algae. Bottom dwelling forms such as *Libellula* spp. probably move to shallow water at night, as they are sometimes seen moving back to central parts of the pond from the shore between midmorning and noon.

Other insects including notonectids, dytiscid larvae and adults, naucorids, hydrometrids, some neuropterons, and hydrophilid larvae prey on immature mosquitos. On the average, according to aquarium studies made by the author, a centimeter long insect predator can destroy ten third and fourth instar mosquito larvae per day. A large anisopteran nymph will consume as many as one hundred large larvae in a day.

The larvae of hydrophilid beetles of the genus *Tropisternus* are especially important predators. Hixson (1943) presented data indicating that in Florida larvae of *Tropisternus* spp. were the principal predators of anopheline larvae in an association in which no minnows were present.

The present author found that *Tropisternus* larvae have structures and feeding habits which make them efficient in destroying mosquito pupae. These beetle larvae obtain air through posterior spiracles which are kept in contact with the water surface. Therefore they walk about on vegetation or along the shore where the water is a half inch or so deep in places where mosquito pupae tend to collect. Furthermore, the hydrophilid larvae move continuously and they will leave the water and travel overland and possibly reach small isolated puddles containing mosquito larvae.

When *Tropisternus* larvae ingest food they hold the head out of the water and spend considerable time macerating their prey. This manner of eating further confines them to the top half inch of water.

These beetle larvae when kept in an aquarium captured mosquito pupae easily, but they had difficulty in catching the larvae. Field observations of feeding were difficult to make. In one instance a beetle larva and a mosquito pupa were dipped together from a ditch. The larva immediately captured the pupa. A farm water tank examined in late August contained anopheline larvae and hydrophilid larvae and numerous smaller invertebrates. No mosquito pupae were present so it is probable that the hydrophilids were destroying them as they formed.

THE IMPORTANCE OF ARTHROPOD PREDATION

Arthropod predators are abundant and have a great diversity of structure and habit. Throughout the year various species inhabit open water and vegetated areas, shore and bottom areas, and regions of low and high oxygen concentration. The soft-bodied mosquito larvae which swim conspicuously and which spend a pupal period exposed at the water surface, would seem to be susceptible to these predators.

These predators, therefore, very likely help prevent a large production of mosquitoes in permanent bodies of water. This is indirectly indicated by Herms, Hackett, and others who list ecological provinces in order of importance of mosquito production as: (1) floodwater remnants, (2) artificial containers, (3) woodland pools, (4) swamp-ponds, and (5) streams and ditches.

This is roughly in inverse order to habitats listed according to the abundance of predacious arthropods. Similarly, Mead (1949) states that the worst pests in central Ohio are temporary pool breaders such as *Aedes vexans* (Meigen), *A. stimulans* (Walker), *A. trivittatus* (Coquillet), and species of *Culex* and *Psorophora*.

A survey in the Columbus area will disclose small temporary pools of water with a surface area of a few square feet which contain more mosquito larvae than large permanent ponds. Mead's records of mosquito larvae in the University pond show *Anopheles quadrimaculatus* larvae or pupae present on August 1, 8, and 25, and Sept. 21, 1948. But on the 25th of August, even though a dense algal mat was present, there was only a total of 17 larvae and two pupae in 75 dips. These low pond populations are probably often the result of the rich insect and copepod fauna present.

SUMMARY

Arthropods prey upon mosquito larvae and maintain reservoirs of predators. They compete with mosquito larvae for food and space.

Copepods of the genus *Cyclops*, which are abundant in quiet water, feed upon first and second instar larvae of mosquitoes. Hydrophilid larvae of the genus *Tropisternus* have habits which make them important mosquito pupal predators.

Permanent ponds produce fewer mosquitoes than do transient ponds and pools. Arthropod predation is probably an important cause of mosquito larval mortality in permanent ponds.

LITERATURE CITED

Haub, J. G. 1931. The Gyrinidae and other predators of mosquito larvae. Master's Thesis, Ohio State University.

Hixson, H. 1943. Data and observations on the natural reduction of *Anopheles* mosquito larvae in certain environments. Florida Ent. 26: 17–24.

Mead, F. W. 1949. Ecology of central Ohio mosquitoes. Master's Thesis, Ohio State University.

Weed, A. C. 1924. Another factor in mosquito control. Ecology 5: 110–111.