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PREDATION ON MOSQUITO LARVAE BY BEETLE LARVAE, *HYDROPHILUS TRIANGULARIS* AND *DYTISCUS MARGINALIS*

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ABSTRACT. The predators, *Hydrophilus triangularis* (Say) and *Dytiscus marginalis* were offered *Culex quinquefasciatus* larvae at densities of 4, 12, 36, 80, 120 and 200. With one exception, a greater number of mosquito larvae were eaten when the beetle larvae were hungry and more mosquito larvae were consumed when more were available. Although there was some variability in the data which may have been simply due to chance, *D. marginalis* was consistently more effective than *H. triangularis*.

INTRODUCTION

Larvae of predaceous diving beetles, Dytiscidae and water scavengers, Hydrophilidae were found together occupying lentic habitats on the Mississippi Gulf Coast during the summers of 1975 and 1976. Larvae of water scavengers differed from those of water tigers (Dytiscidae) by having a single tarsal claw and toothed mandibles. Larvae of both groups of beetles prey on a wide variety of aquatic organisms and may be cannibalistic. The value of certain aquatic Coleoptera as predators has been investigated both under laboratory and field conditions. Arnett (1963) stated that both the adults and larvae of dytiscids are highly predaceous to some aquatic invertebrates and vertebrates. Chidester (1917) reported that the larvae of dytiscids are important enemies of mosquitoes, especially when they are present in large numbers in small pools. A similar result was noted for hydrophilid larvae, Nielsen and Nielsen (1953). Twinn (1931) found that among the Coleoptera, Dytiscidae have the most potential as biological control agents. In laboratory and field studies James (1964) reported that *Laccophilus*, and *Maculosus* fed on larvae of the rockpool mosquito, thus reducing their numbers considerably. Also, he found that when equal number of chironomid and mosquito larvae were exposed together, similar numbers of each were eaten, but the mosquito larvae were consumed faster than chironomid larvae. Field assessment of predation by species of *Dytiscus, Laccophilus, Agabus* and *Rhantus,* has been reported by a number of workers (James 1965, Kuhlhorn 1961, Lee 1967, Roberts et al. 1967, Sailer et al. 1954, Young 1967). Also, larvae of species of *Dytiscus, Hydrophilus,* and *Dineutus,* were found preying on small fish, Hurst (1945) and tadpoles, Williams (1936). The objective of this study was to determine the reliability of *H. triangularis* and *D. marginalis* as biological control agents of mosquito larvae, *Culex quinquefasciatus* say.

MATERIALS AND METHODS

All tests were conducted at 27°C with a 14-h light and 10-h dark cycle. The *H. triangularis* and *D. marginalis* larvae were collected from marshlands along the Mississippi Gulf Coast, with pint enamel dippers used for larval mosquito surveys and transferred to separate holding vials to prevent cannibalism during transportation to the laboratory. Mosquito larvae were from a laboratory colony originally obtained from the Center for Disease Control in Atlanta, Georgia. All prey used in the investigation were 2nd, 3rd, or 4th stage larvae.

Prior to each test the predators were starved 24 hr to stimulate feeding responses. To determine the rates of predation by the 2 beetle species, prey densities of 4, 12, 36, 80, 120 and 200 larvae were offered to a single beetle larva with 5 replicates of each. The number of prey consumed was recorded at 24, 48, 72, and 96 hours. The 96 hr test period was based on preliminary tests in which high predation levels were realized at prey densities of 4 and 12. Each predator—prey ratio was contained in a ½-pint paper cup with ca. 100 ml of water. A small amount of ground dog food was added as food and the top of each cup was then secured with fine cloth mesh. Mosquito larvae with no predator at each prey density were also used as checks.

RESULTS AND DISCUSSION

Table 1 shows the consumption rate of *H. triangularis* at different prey densities. Except at the highest density level a larger number of prey was consumed during the first 24 hr of the experiment. However, the number of mosquito larvae fed upon by hydrophilid larvae increased from 17 of 20 to 60 of 60 as predation percentages rose from 85 to 100%. With prey densities of 36, 80 and 120 predation levels fluctuated between 81.7, 66.5 and 92.5%. These variables were probably due partially to the fact that different stages of mosquito larvae were used in the experiments. Also, predation level was lowest (55.2%) at the 200 prey density, but this trend was offset by an increase of prey consumption at lower dentisy levels. Thus, an overall average of 80.2% prey consumption was realized during the experimental period.

Comparatively, *D. marginalis* was more effective at all prey densities during the first 24 hr (Table 2) than *H. triangularis*. Furthermore, in all instances, the degree of predation exceeded 96.0%, thus resulting in 99.0% overall average consumption of *Cx. quinquefasciatus* larvae tested. At the 200 density level, it was further revealed that a single *D. marginalis* or *H. triangularis* larva was capable of devouring 196 (97.5%) and 194 (97.0%) mosquito larvae respectively in 24 hr. Also, when equal numbers of pupae and larvae (mosquito) were exposed together in 5 separate ½ pt cups, each with a single *H. triangularis*, fewer pupae were preyed upon than larvae, probably because the pupae were more active and thus were better able to avoid predation and not because of an inherent preference of predators for feeding on larval stages. The data presented in this paper suggest that both predators

Table 1. The number of prey consumed by *H. triangularis* at indicated prey densities

Hours	Prey Density 4	12	36	80	120	200
24	13	48	120	131	456	187
48	4	7	19	54	64	134
72	–	3	5	48	28	43
96	–	2	3	33	7	188
Total	17	60	147	266	555	552
Percent	85.0	100.0	81.7	66.5	92.5	55.2

Table 2. The number of prey consumed by *D. marginalis* at indicated prey densities.

Hours	Prey Density 4	12	36	80	120	200
24	20	59	167	390	597	959
48	–	1	6	10	1	12
72	–	–	1	–	–	6
96	–	–	–	–	–	1
Total	20	60	174	400	598	978
Percent	100.0	100.0	96.7	100.0	99.7	97.8

could have some significant influence in regulating the numbers of mosquito larvae.

Several workers including Notestine (1971) stated that among the invertebrates, Dytiscidae and Hydrophilidae have promise as a biological control measure. However, no suitable method has yet been devised to rear these organisms economically and in large numbers. In laboratory studies Sailer et al. (1954) were able to keep alive only 1 dytiscid larva (genus *Agabus*) for 20 days. In our work we were able to rear several *D. marginalis* larvae for a maximum of 10 days on a diet of mosquito larvae and *H. triangularis* larvae for ca. 30 days on a similar diet.

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