A Laboratory Experiment of The Predation by Possible Predators on *Culex tritaeniorhynchus* Larvae

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Abstract: Predation by natural enemies on *Culex tritaeniorhynchus* larvae was studied in the laboratory. *Ceriagrion* sp. nymphs, *Sympetrum frequens* nymphs, *Notonecta triguttata, Rhantus pulverosus, Hydaticus grammicus, Oryzias latipes, Carassius gibelio langsdorfi* and *Migurnus fossillis anguillicaudatus* preyed on mosquito larvae. The developmental stage and behavior of the mosquito larvae affected the efficiency of predation.

Key words: Culex tritaeniorhynchus larvae, predator

INTRODUCTION

It is pointed out that the control of *Culex tritaeniorhynchus* Giles is one of the important measures for prevention of Japanese encephalitis (Simada, 1970; Wada, 1975). This species breeds mainly in paddy fields (Sasa, 1971) where wide varieties of natural enemies exist (Watanabe, 1968). There were reported some experiments and studies about the predation by natural enemies on *Cx. tritaeniorhynchus*. Watanabe *et al.* (1968) showed a list of predators in paddy fields, and Nakamura *et al.* (1969) and Urabe *et al.* (1968) evaluated the efficacy of predation.

We also evaluated the efficacy of predators for *Cx. tritaeniorhynchus* larvae in the laboratory, and results obtained by the experiments are reported here.

MATERIALS AND METHODS

Predators used were collected by a dipper of 13cm in diameter and 7.5cm in depth in weekly census of mosquito immature populations in the rice fields reported by Takagi *et al.* (1995). Period of collection was from June to August in 1983, 1984 and 1985. A variety of predators used were as follows.

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Odonata, 2 species (nymph): *Ceriagrion* sp. and *Sympetrum frequens*

Hemiptera, 3 species (adult): *Sigara substriata, Laccotrephes japonensis* and *Notonecta triguttata*

Coleoptera, 4 species: *Guignotus japonicus* (adult); *Rhantus pulverosus, Hydaticus grammicus* and *Sternolophus* sp. (larva and adult)

Pisces, 3 species: *Oryzias latipes* (2−3cm), *Carassius gibelio langsdorfi* (2−3cm) and *Misgurnus fassilis anguillicaudatus* (3−4cm)

Amphibia, 1 species (nymph): *Rana nigromaculata.*

One individual of a certain predator and 50 old (3rd and 4th instar) larvae of *Cx. tritaeniorhynchus* were placed together in a jar of 24cm in diameter and 12cm in depth with 1 liter distilled tapped water except for *G. japonicus* and *S. substriata.* In the examination of adult *G. japonicus,* 50 mosquito larvae were put in a jar with 10 predators, because we had observed that the predator preyed on larvae in a group, and in that of *S. substriata,* 25 mosquito larvae were put in a jar for 1 predator, because this predator preyed on only a few larvae. In the examination with young mosquito larvae (1st and 2nd instar), 10 nymphs of *Sympetrum frequens* and 10 adults of *Sigara substriata, G. japonicus* and *H. grammicus* were respectively put with 50 larvae.

After 24 hours of coexistence, the number of mosquito larvae remained was counted. As the control, 50 *Cx. tritaeniorhynchus* larvae without predators were used. Temperature was 25−28℃, and light was long day length (14−15 hours light) during the experiment.

The average number of larvae lost from the jar should be the sum of larvae that were preyed or dead. Therefore, the substraction of the number of dead larvae in the control jar from that of larvae that disappeared in the experimental jar gives the estimated number of mosquito larvae consumed by a certain predator. Averages and ranges of 95% confidence limit of lost mosquito larvae were calculated.

RESULTS

The average number of old mosquito larvae that were preyed on or dead was shown in Table 1. A nymph of *Sympetrum frequens,* an adult of *R. pulverosus* and *H. grammicus,* and an individual of *O. latipes, C. g. langsdorfi* and *M. f. anguillicaudatus* consumed more than 30 mosquito larvae per day, and an adult of *N. triguttata* and a larva of *R. pulverosus* consumed more than 20 mosquito larvae. In these predators, significant difference was found between the numbers of mosquito larvae that disappeared from experimental jars and from control jars. No predation was statistically confirmed in *Sigara substriata, Sternolophus* sp., *G. japonicus* and *R. nigromaculata.*

The average number of young mosquito larvae that were preyed or dead was shown in Table 2. No predation was statistically confirmed in nymphs of *Sympetrum frequens* and adults of *Sigara substriata.* Ten adults of *G. japonicus* consumed more than 30 mosquito larvae, and an adult of *H. grammicus* did more than 20 mosquito. Predation was statistically confirmed in these predators.

Table 1. Average number of old mosquito larvae (3rd and 4th instar) being preyed or dead per day in experimental jars and control jars

Predator	Experimental jars		Control		No. larvae preyed [A−B]
	Replication	No. larvae lost (SD) [A]	Replication	No. larvae lost (SD) [B]	
Insecta					
Odonata					
Ceriagrion sp.	3	22.3(6.6)a	3	5.0(2.2)b	17.3
S. frequens (nymph)	70	35.0(8.9)a	7	3.1(2.8)b	31.9
Hemiptera					
S. substriata (adult)	18	3.5(2.4)a	6	0.0(0.0)a	3.5
L. japonensis (adult)	12	29.8(12.0)a	4	5.3(1.9)a	24.5
N. triguttata (adult)	5	34.0(9.7)a	3	4.3(1.2)b	29.7
Coleoptera					
G. japonicus (10 adults)	44	7.9(7.4)a	5	4.2(2.7)a	3.7
R. pulverosus (larva)	7	29.9(2.5)a	3	4.3(1.2)b	25.6
R. pulverosus (adult)	59	39.1(11.6)a	4	5.3(1.9)b	33.8
H. grammicus (larva)	2	27.0(−)	2	5.5(−)	21.5
H. grammicus (adult)	14	38.2(7.2)a	3	4.3(1.2)b	33.9
Sternolophus sp. (larva)	10	16.7(7.6)a	3	5.0(2.9)a	11.7
Sternolophus sp. (adult)	9	9.2(8.2)a	3	6.0(1.6)a	3.2
Pisces					
O. latipes (2−3cm)	14	37.5(12.8)a	4	5.3(1.9)b	32.2
C. g. langsdorfi (2−3cm)	26	42.5(12.0)a	3	6.0(1.6)b	36.5
M. f. anguillicaudatus (3−4cm)	25	39.4(12.1)a	4	6.5(2.5)b	32.9
Amphibia					
R. nigromaculata (nymph)	23	11.9(7.7)a	4	5.3(1.9)a	6.6

Averages in the same row followed by different letters are significantly different ($p<0.05$).

Table 2. Average number of young mosquito larvae (1st or 2nd instar) preyed or dead per day in experimental jars and control jars

Candidate	Experimental jars		Control		No. larvae preyed [A−B]
	Replication	No. larvae lost (SD) [A]	Replication	No. larvae lost (SD) [B]	
Insecta					
Odonata					
S. frequens (nymph)	11	3.7(6.9)a	5	0.2(0.4)a	3.5
Hemiptera					
S. substriata (adult)	12	3.0 (1.0)a	5	0.2(0.4)a	2.8
Coleoptera					
G. japonicus (10 adults)	16	35.2(14.1)a	5	0.2(0.4)b	35.0
H. grammicus (adult)	5	28.4(4.6)a	5	0.2(0.4)b	24.2

Averages in the same row followed by different letters are significantly different ($p<0.05$).

G. japonicus preyed on more young larvae than old larvae. On the contrary, *Sympetrum frequens, H. grammicus* and *Sigara substriata* equally consumed both ages of mosquito larvae. *H. grammicus* preyed on more mosquito larvae than the other 2 species.

DISCUSSION

Watanabe *et al.* (1968) in Okayama, and Nakamura *et al.* (1969) in Osaka suggested that nymphs of Odonata, Dytiscidae and Pisces are effective predators on *Cx. tritaeniorhynchus.* Our results agree with them, because these predators also preyed on a good number of *Cx. tritaeniorhynchus* larvae in our experiments.

Effectiveness on mosquito larval control by *Gambusia affinis* or *Poecilia reticurata,* both of which are fishes occupying the water surface, was reported (Sasa *et al.* 1965, Sato 1974). In our experiments, both *C. g. langsdorfi,* which is a mid−layer fish, and *M. f. anguillicaudatus,* a benthic fish, were confirmed to be potential predators for mosquito larvae, just as *O. latipes,* a surface occupier. But it must be taken into account that the fishes used were young, of which body length was ca. 3cm, and the food of fishes changes as they grow.

In the preference of predators for mosquito larvae, 4 types were distinguished as follows. 1, old mosquito larvae feeder (ex., nymphs of Odonata); 2, young mosquito larvae feeder (ex., *G. japonicus*); 3, all age mosquito larvae feeder (ex., Dytiscidae); 4, all age but only a few mosquito larvae feeder. These types are according to size, activity and the manner of predation. The body length of *G. japonicus* adult is 2mm long, and it can prey on only young mosquito larvae. On the other hand, young mosquito larvae may be too small to be preyed by Odonata nymphs of which body length exceeds 15mm.

The present results did not fully explain the extent of predation on *Cx. tritaeniorhynchus* larvae in paddy fields by predators examined. In the present experiment, the predation was evaluated as one−pair match experiment with a species of predator and *Cx. tritaeniorhynchus* larvae, but in the fields many species of predators and preys coexist in the same rice field.

Sympterum frequens (nymphs), *R. pulverosus* (larvae and adults), *H. grammicus* (larvae and adults), *O. latipes, C. g. langsdorfi,* and *M. f. anguillicaudatus* are likely to be effective natural enemies for *Cx. tritaeniorhynchus* in rice fields, as Watanabe *et al.* (1968) and Nakamura *et al.* (1969) observed.

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