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The prey consumption and prey preference of the larvae of the mosquito *Culex (Lutzia) raptor* on the larvae of *Culex quinquefasciatus*

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Abstract. The maximum consumption of the larvae of the pest and vector mosquito *Culex quinquefasciatus* by the predatory mosquito *Culex (Lutzia) raptor* was studied at various instars of both the predator and the prey. The prey preferences of the predator when given lavae of different instars were also investigated. The IVth instar of the predator consumed the maximum number of Ist instar and the maximum biomass of IVth instar larvae of the prey. Instars I and II of the predator preferred the Ist of the prey; instars III and IV of the predator preferred instars II and III of the prey respectively. The predator consumed an average of 157.1 larvae during its whole larval period, when each instar of the predator was given its preferred instar of the prey.
Key words. Biological control; mosquito larvae: *Culex (Lutzia) raptor*.

During its larval stages the mosquito *Culex (Lutzia) raptor* is a predator on other species of mosquito larvae[1]. Larvae of this predatory species have been observed in the same sites as larvae of other species of mosquitos, especially those of *Culex quinquefasciatus*, a vector of Bancroftian filariasis and a major urban nuisance mosquito in India. The feeding habits of *C. (L.) raptor* have been reported earlier[2], but there has been no detailed study on its predatory potential. The maximum prey consumption and the prey preference are basic elements in the evaluation of a predator as a possible biological control agent. To obtain some understanding of the predatory potential of *C. (L.) raptor*, a quantitative study was undertaken.

Materials and methods

Egg rafts of *Culex (Lutzia) raptor* Edwards and *Culex quinquefasciatus* Say were collected from cement tanks containing rain-water during August 1994 in Parangipettai, a town on the south-east coast of India (Lat. 11° 29′ N; Long. 79° 47′ E). Larvae hatched from the egg rafts were reared in plastic trays containing tap water. Larvae of *C. quinquefasciatus* were fed with powdered yeast and dog-biscuit. Larvae of *C. (L.) raptor* were fed with larvae of *C. quinquefasciatus*. To determine the number of larvae eaten by the predator, each larval instar of the predator was released separately along with each instar of the prey larvae[3]. The number of the prey larvae was approximately double that expected to be consumed in a period of 24 h. To determine the prey preference of the predator between different larval instars of the prey, each instar of the predator was realeased along with an equal number of prey larvae of each of two different instars, i.e. instars I and II, I and III, I and IV, II and III, II and IV and III and IV. The procedure is detailed elsewhere[4]. The number of larvae of each instar of the prey consumed by the predator was calculated from the number of larvae each instar of the prey left at the end of 24 h. The biomass of the prey larvae eaten by the predator was determined by multiplying the individual wet weight of larvae of that instar by the number of larvae eaten. The individual larval weight was calculated by weighing 50 larvae, after removing the water from their bodies using blotting paper. All the experiments were conducted in 500 ml beakers containing 450 ml of tap water, and five replicates were maintained simultaneously for each of the experiments, under controlled conditions (28 ± 2 °C). Student's t-test was used to test the statistical significance of the observed differences.

Results and discussion

The number and biomass of larvae eaten varied with the instar of both the predator and the prey (table 1). The Ist instar predator fed only on the same instar of the prey larvae, whereas all other instars of the predator fed to some extent on all the larval instars of the prey. As the predator grew, the number of larvae eaten also increased. For instance, the number of instar I prey larvae eaten by the predator per 24 h period increased from 26.4 (1.3 mg biomass) to 157.0 (7.9 mg biomass) as the predator developed from instar I to instar IV. The predator consumed a larger number of the prey larvae of early instars, but the biomass of larvae eaten was lower than when the later instars were provided. For instance, a IVth instar predator ate 157.0 larvae of instar I, as against only 19.8 larvae of instar IV, with a biomass of 7.9 and 76.0 mg respectively. The lower biomass consumed when instar I larvae were provided can be attributed to the excessive effort that would be

Table 1. Number and biomass of *C. quinquefasciatus* eaten per 24 h period when only a single instar was supplied.

Instar of predator	Number of larvae or pupae eaten/predator/24 h				
	instar of prey I	II	III	IV	Pupae
I	26.4 ± 1.0	-	-	-	-
II	71.4 ± 2.4	23.6 ± 2.0	8.4 ± 1.2	5.8 ± 1.2	-
III	115.2 ± 6.3	36.6 ± 3.1	20.8 ± 1.2	11.8 ± 1.2	3.6 ± 0.8
IV	157.0 ± 6.3	117.0 ± 8.4	23.2 ± 2.6	19.8 ± 1.9	12.8 ± 1.6
	biomass of larvae or pupae eaten/predator/24 h				
I	1.3 ± 0.1	-	-	-	-
II	3.6 ± 0.1	15.1 ± 1.3	15.9 ± 2.3	22.3 ± 4.6	-
III	5.8 ± 0.3	23.4 ± 2.0	39.3 ± 2.3	45.3 ± 4.6	16.2 ± 3.6
IV	7.9 ± 0.3	74.9 ± 5.3	43.9 ± 4.9	76.0 ± 7.3	57.6 ± 7.2

- Not fed. Values are average of five replicates ± standard error.

Table 2. Number and biomass of *C. quinquefasciatus* eaten when two instars were supplied.

Instar of predator	Ratio of number of larvae of each instar eaten/predator/24 h					
	instar of prey I:II	I:III	I:IV	II:III	II:IV	III:IV
I	26.4:0**	26.4:0**	26.4:0**	-	-	-
II	27.8:15.2*	30.6:6.4**	71.4:0**	12.6:4.3*	23.6:0**	6.4:2.0*
III	9.2:32.6*	7.2:19.8*	2.2:11.8*	20.4:10.8**	22.2:4.6**	8.8:6.4*
IV	34.8:104.2*	0:23.2**	0:19.8**	8.0:22.6**	9.4:18.2**	12.4:8.6*
	ratio of larvae in biomass eaten /predator/24 h					
I	1.3:0**	1.3:0**	1.3:0**	-	-	-
II	1.4:9.7**	1.5:12.1**	3.6:0**	8.1:8.1^{NS}	15.1:0**	12.1:7.7^{NS}
III	0.5:20.9**	0.4:37.4**	0.1:45.3**	13.1:20.4*	14.2:17.7^{NS}	16.6:24.6*
IV	1.7:66.7**	0:43.9**	0:76.0**	5.1:42.7**	6.0:69.9**	23.4:33.0*

- Not fed, * significant at 5% level, ** significant at 1% level, NS = not significant.

required to catch the very large number of instar I larvae whose biomass would equal that of the small number of instar IV larvae consumed. It was also noted that instars III and IV of the predator fed even on pupae of the prey, when larval stages were not available.

When a choice of two instars of the prey was given, the prey preference of the predator between the two instars varied with the instars of both the predator and the prey (table 2). Instar I of the predator ate only the instar I of the prey larvae. Instars II, III and IV of the predator preferred instars I, II and III of the prey respectively. The prey preference of instar II of the predator was in the order I > II > III > IV in terms of number and II = III > I > IV in terms of biomass. The prey preference of instar III of the predator was in the order II > III > IV > I in terms of number and IV > III > II > I in terms of biomass. The prey preference of instar IV of the predator was in the order III > IV > II > I in terms of number and IV > III > II > I in terms of biomass.

The predator consumed 157.1 larvae with a biomass of 72.2 mg during its whole larval period, when each of its instars was given the most preferred larval instars of the prey. *Culex (Lutzia) fuscanus* has also been reported to eat a maximum of 157 larvae of *C. quinquefasciatus* during its whole larval period[4]. The nymphs of the dragonfly *Mesogomphus lineatus*, with a body weight of 160 mg, ate 21 larvae of *Culex quinquefasciatus* per day, which is equivalent to 24.9% of the predator's body weight[5]. The nymphs of the dragonfly *Brachithemis contaminata*, with a body weight of 200 mg, consumed 21 larvae of *Aedes aegypti*[6] or 25 larvae of *Culex quinquefasciatus*[7] per day. The nymphs of the damselfly *Enallagma civile*, at the 11th instar, ate 6 larvae of *Culex tarsalis* per day[3]. The fish *Therapon jarbua*, with a body weight of 1.5 g, consumed 144 larvae of *Culex sitiens* per day, equivalent to 21.2% of its body weight[8]. Compared to these biological control agents, a IVth instar larvae of *C. (L.) raptor* has a high predatory potential, since it could consume 19.8 IVth instar larvae of *C. quinquefasciatus* per day, which is equivalent to 1,146%

of its body weight (76.0 mg of prey larvae/6.63 mg of IV instar predator).

These results indicate that *C. (L.) raptor* has considerable potential for controlling the larvae of *C. quinquefasciatus*. The predator and the prey have similar breeding habitats. The predator was observed not to bite humans in the laboratory conditions of the present study, which confirms earlier reports that *C. (L.) raptor* is not a man-biter[9]. The predator has been observed to breed along with other species of mosquitoes in some breeding sites. However, the adaptation of the predator to all the types of habitat used by the prey, especially the most polluted ones, has yet to studied. The population of *C. (L.) raptor* would have to be artificially increased for the successful control of other mosquito species to occur. The feasibility of mass rearing of *C. (L.) raptor* therefore needs to be studied.

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