



Biological control of mosquito using aquatic predatory insects: Nymphal damselfly (odonata: zygoptera)

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Abstract

Damselfly nymphs of three size groups by length viz., 6 ± 1 mm, 12 ± 1 mm and 18 ± 1 mm were tested for their predation over different developmental stages of mosquito, *Aedes aegypti*. The predator's consumption over I, II, III and IV instar stages and pupae of the mosquito was remarkable. However, the predators, irrespective of the size, preferred young prey larvae rather than the mature ones. The consumption rate was in relation to the size of predators i.e., 6 ± 1 mm and 18 ± 1 mm, respectively. Also, density of prey proportionately influenced the rate of predation. Percent success rate of the predator over prey was 25.1, 42.8 and 72.6 relative to the size groups, respectively. Nymph consumed less number of prey compared to that of 12mm and 18 mm, respectively.

Keywords: Biological control, Mosquitoes, Predatory insects and Damselfly.

Introduction

Arthropods of orders Hemiptera, Heteroptera, Coleoptera and Odonata have been reported as predators of mosquitoes (Lundkvist *et al.*, 2003; Aditya *et al.*, 2004; Blaustein *et al.*, 2005; Shaalan *et al.*, 2007; Chandra *et al.*, 2008; Sankaralingam and Venkatesan, 1989; Culler and Lamp, 2009). It has been stated that in ponds, and temporary pools these predators play a role in regulation of dipteran populations, particularly mosquitoes and chironomids. The aim of the present study is to find out predatory efficiency of Nymphal Damselfly, *Pyrhosoma nymphula* (Insecta : Odonata : Zygoptera) found in Kerala region on the aquatic stages of mosquitoes, *Aedes aegypti*.

Materials and methods

Nymphal Damselfly were collected from the lake near Cherpulachery in Palakkad district

using hand nylon 1 mm mesh net with a metal handle of one meter length according to the methods for insect sampling described by Murdoch *et al.* (1984) and Fischer *et al.* (2000). They were brought to the laboratory in plastic containers/buckets along with some amount of debris and water of the lake concerned. The aquatic predators of three size groups by length viz. 6 ± 1 mm, 12 ± 1 mm and 18 ± 1 mm were selected and maintained in containers under laboratory conditions providing mosquito larvae *ad libitum* as food. Mosquito larvae at different stages of development viz., I, II, III, IV instars and pupae were supplied as prey were reared separately under laboratory conditions as described by Kumar and Rai (1991) and Lyimo *et al.* (1992).

Experiment was conducted to determine predatory efficiency i.e. consumption rate of predators, over different aquatic stages of

mosquitoes (I, II, III, IV instar larvae and pupae), adopting the methods described by Scott and Murdoch (1984). Three individuals of the predator of any one of the size groups (6±1 mm, 12±1 mm and 18±1 mm) were kept starved for 24 hours in separate plastic containers of 1 lit volume filled with 750 ml of unchlorinated tap water, as one per container and supplied 50 mosquito larvae, at a particular stage of development, each. Twenty four hour later, number of live prey available in each of the experimental containers and the larvae found full bodied but dead were also recorded. From this record, the mean number of larvae consumed per predator in 24 hours and percentage of consumption by each size group of predator over different instar stages of mosquito larvae (I/ II/ III/ IV instar/ pupae) was calculated.

Attack rate and success rate were determined according to Scott and Murdoch (1983). One individual of the predator type 12±1mm, was placed in a glass container 500 ml of water and 50 larvae (IV instar) of *Aedes* mosquitoes. The number of attempts made by the capture the prey was counted directly for 2 hours as well as number of prey remained unconsumed at the end of 2 hours was recorded. The experiment was replicated 5 times. From the data obtained, success rate was calculated by dividing the value of killed by the number attacked and expressed in percent.

Results

The mean consumption rate per predator at 6±1 mm size towards the larvae at I ,II,III, IV instar stages and pupae was 49.4, 41.6, 31.8, 20.8 and 6.4 for 24 hours, and the consumption rate of 12±1 mm and 18±1 mm predators was 72.4, 60.8, 50.2, 40 and 14.2, as well as 80, 71.8, 62, 51.8 and 20.2, respectively. A gradual decrease was observed in the consumption rate of the predator with the age of prey. In general, young larvae were preferred in large numbers compared

to the older ones. The efficiency of the predator on the mosquito larvae was also analyzed in terms of Clearance rate (CR) i.e., the overall capacity of the predator to predate on the prey larvae. The values of CR also confirmed that the predator capture and consume more number of immature larvae than mature ones Table – 1.

The predators of smaller size group consumed relatively less number of prey larvae irrespective of the instar stages compared to those of larger size groups. For instance, the consumption rate of 6 mm damselfly nymph against mosquito larvae at II instar stage was 41.6 per 24 hours, whereas that of 12 mm and 18 mm predators was 60.8 and 71.8 per 24 hours, respectively.

The predator consumed an average of 45.6 mosquito larvae out of 150 offered. The consumption rate was 51.6 when the predator was supplied with 200 larvae and it was 60.2 out of 250 prey. The difference in consumption of the predator when provided with 200 and 250 mosquito larvae compared to that of 150 was 6.0 and 14.6, respectively. Thus, it indicated the fact that higher density of prey enhanced predation rate i.e., availability of more prey supported rapid consumption (Table - 2).

The mean number of mosquito larvae attacked by the predators of 6, 12 and 18 mm size groups in 2 hours was 44.4, 55.8 and 48.2, out of which the number consumed was 11.2, 23.8 and 34.8, respectively. Accordingly, success rate was computed as 0.251, 0.428 and 0.726 and in per cent 25.1, 42.8 and 72.6 of the prey attacked was successfully devoured by the predator (Table 3).

Discussion

The present observation on the predatory efficiency of nymphal Damselfly, *Pyrrosoma* sp. over the different developmental stages of the mosquito, *Ae. aegypti* conspicuously indicated that individuals of nymphal Damselfly are efficient predators of the mosquito larvae. The clearance rate, a statistical parameter of the predator's

Table - 1. Cumulative data of consumption rate /24 hours of nymphal damselfly of 6±1 mm, 12±1 mm and 18±1 mm size over different instar larvae of mosquito, *Aedes aegypti*.

Instar stages of Mosquito	Size and performance of the predator					
	6±1 mm		12±1 mm		18±1 mm	
	% consumption	Clearance Rate	% consumption	Clearance Rate	% consumption	Clearance Rate
I	49.4*	0.070	72.4*	0.077	80*	0.079
II	41.6	0.067	60.8	0.074	71.8	0.077
III	31.8	0.062	50.2	0.070	62	0.074
IV	20.8	0.054	40	0.067	51.8	0.7121
Pupae	6.4	0.033	14.2	0.048	20.2	0.5438

Significant difference (P<0.00001) in consumption rate between and among the predators of various size. *,Consumption rate is statistically different (P<0.001) from that of higher instar stages.

Table - 2. Cumulative data of consumption rate of the nymphal damselfly (12±1mm) in relation to density (number) of larvae at IV instar stage of mosquito, *Aedes aegypti*.

No. of mosquito larvae introduced	No. of mosquito larvae consumed	Different from that of medium with more than 150 larvae
150	45.6*	-
200	51.+6	6.0
250	60.2	14.6

*, Significant difference (P<0.001) in the number of larvae consumed from the media contained more than 150 mosquito larvae.

Table - 3. Cumulative data of success rate of predators in different size groups on IV instar stage of mosquito, *Aedes aegypti*.

Size Groups (mm) of predator	Success rate	% success*
6±1	0.251	25.1
12±1	0.428	42.8
18±1	0.726	72.6

consumption in a litre of medium, also confirmed the fact. Reports on the observations on predation of various odonate nymphs over mosquito larvae are available (Sankaralingam and Venkatesan, 1989; Sebastian *et al.*, 1990).

Young prey larvae were more preferred by the predators than those at late stages in particular at pupal stage. The preference of this

predator towards larvae of smaller size may be attributed to its foraging behavior. Nymphal Damselfly are exceedingly voracious creatures, as they will kill and suck out mosquito larvae (Subramanian, 2005). It has been suggested that the odonate nymphs could be used as potential predators in biological control of *Aedes* mosquitoes (Mandal *et al.*, 2008).

In the present study the rate of consumption was found increased with the number of larvae available in the medium. Ambrose *et al.* (1993) and Miura and Takahashi (2007) showed that more prey was consumed as the prey density increased. Mandal *et al.* (2008) estimated that the prey consumption was linearly related to the number of predators and prey available but inversely with space.

The predator, nymphal Damsselfy showed a difference between attack rate and success rate. Only 25, 42 and 72 per cent of the larvae attacked were consumed by the predator of size 6, 12 and 18 mm, respectively. The difference in attack rate and success rate of the predator may be due to factors such as prey may reduce foraging activity (Peacor and Werner, 2000), migrate to less favorable places (Turner, 2004).

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