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Bio control efficiency of Odonata nymphs on *Aedes aegypti* larvae

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Abstract: *The predatory potential of Bradinopyga geminata, Crocothemis servilia and Ceriagrion cerinorubellum larvae on Aedes aegypti larvae were recorded for 8 hours with three replicates under laboratory condition to suggest biocontrol methods to get away from the spread of dengue fever. The maximum consumption rate of Bradinopyga geminata was on 1st instar larvae of Aedes aegypti. Crocothemis servilia and Ceriagrion cerinorubellum shows maximum consumption rate on 2nd instar larvae of Aedes aegypti. With respect to the One-way ANOVA test conducted, Bradinopyga geminata shows highest predatory impact on all the instars of Aedes aegypti. The present study reveals that the release of odonata nymphs especially Bradinopyga geminata in areas of dengue epidemics will effectively control the Aedes aegypti larval production and thereby dengue epidemics.*

Keywords: *Bradinopyga geminata, Ceriagrion cerinorubellum, Crocothemis servilia, dengue epidemics, predatory impact, bio control*

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I. Introduction

Dengue has been a major public health problem today and currently there is no effective vaccine. According to the report of World Health Organization every year there may be 50 million to 100 million cases of dengue virus infections worldwide (WHO, 1997). India has been identified as one of the seven countries now regularly reporting incidences of dengue virus infections. Using biological control agents is a better solution to avoid this vector borne disease.

Biological control is a method used to reduce the pest populations in their natural habitats itself by the use of natural enemies including pathogens, parasites or predators. The biological control agents, especially aquatic predaceous insects, inhibit mosquitoes in their breeding sites will provide appropriate solution to the spread of dengue epidemics. The control of mosquito in their larval stage is more efficient than as adults because during the immature stage they are comparatively less mobile and remaining more concentrated than they are in the adult stage.

The literature survey reveals that the predatory insects like odonate nymphs (damselflies and dragonflies) are important predators of many macro invertebrates including the larvae of mosquito (Rayah, 1975; Corbet, 1980; Quiroz-Martinez *et al*., 2005). Bay (1974) reported that dragonfly larvae are known to prey heavily on bottom feeding *Aedes* larvae and also suggested that most mosquito larvae are easy to rear, maintain and make excellent prey for a wide variety of aquatic organisms. Corbet (1980) suggested that introducing the dragonfly larvae into each domestic water-storage containers at monthly intervals can result in virtual elimination of *Aedes aegypti* larvae within three weeks. Dragonfly larvae have good predatory potential and can be used as a biological control agent for the control of mosquito breeding (Singh *et al.*, 2003). The longevity, predatory ability, trophic position and sharing of habitats with mosquito immature stages are all factors in favour of using odonate larvae for biological control (Chatterjee *et al*., 2007). In West Bengal, Mandal *et al*., (2008) suggested that the larvae of five Odonate species used in semi field conditions, significantly lowered the mosquito larval density after 15 days of introduction. Use of odonate larvae in temporary pools or larger habitats, where they can be a potential biological resource in regulating the larval population of the vector and pest mosquitoes, has been demonstrated amply by Mandal *et al.* (2008).

Considering the predatory nature of odonate larvae, experimental analyses were conducted for the three species of odonate nymphs *Bradinopyga geminata*, *Crocothemis servilia* and *Ceriagrion cerinorubellum* to assess their bio control efficiency on *Aedes aegypti* larvae. This study will be useful to suggest bio control methods to get away from the spread of dengue fever.

II. Materials And Methods

The odonate nymphs were collected from different cement ponds at Pala Municipality in Kerala, by hand picking method. Study period was from September 2015 to December 2015. The nymphs of dragonflies such as *Bradinopyga geminata*, *Crocothemis servilia* and nymph of damselfly *Ceriagrion cerinorubellum* were identified with the help of standard keys prepared by Anne (2006), Theischinger (2009) and Srivastava and Sinha (2004). The nymphs were washed with clean water and transferred to 1000 ml beakers to get acclimatized. The immature stages of mosquito larva *Aedes aegypti* were collected from the discarded dishes filled with water. The instar stages (1-4) of the mosquito larvae were identified by observing their setae and siphon sclerotization through the hand held lens.

To determine the predatory potential of these selected odonate nymphs a series of experiments were conducted using 500ml beakers. Both prey and predators (in the ratio 25:1) were added to beakers containing 400 ml of water. The predation experiments for three days were conducted on separate dates for each species and each with three replicates. A control group with only *Aedes aegypti* larvae was also set. Observation was made for a total duration of 8 hours. At the end of each hour the number of preys consumed and those that have killed in the control were recorded. New mosquito larvae were added after each hour to replace those that had been eaten or killed. The method adopted by Aditya et al. (2006) and Nabaneeta et al. (2010) were used to determine the predatory impact.

$$PI = \frac{\sum_{n=1}^{7} PE}{T}$$

Where, PI is the Predatory impact (No. of prey larvae / hr); PE is the prey eaten or killed; T=Time in hours.

The clearance rate (CR) reflects the combined effect of search ability, killing and consumption by the predator and prey evasion, in unit time and space. CR was determined by using the method suggested by Gilbert and Burns (1999).

$$CR = \frac{V (\ln P)}{TN}$$

Where, CR is the Clearance rate of predators (% of prey killed liters/ day/ predator); V is the volume of water; P is the % of prey killed; T is the Time (in day); N is the Number of predators.

III. Result And Discussion

Experimental studies were carried out to assess the predatory efficiency of the nymphs. In order to measure the bio control efficiency, predatory potential of three odonata nymph species *Bradinopyga geminata*,

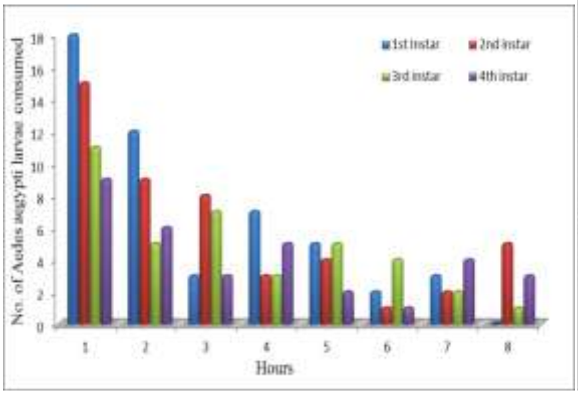

Fig. 1 Predation of *Bradinopyga geminata* on *Aedes aegypti* larvae

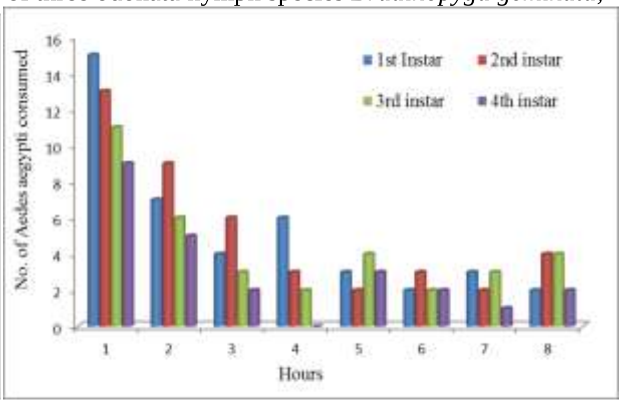

Fig.2 Predation of *Crocothemis servilia* on *Aedes aegypti* larvae

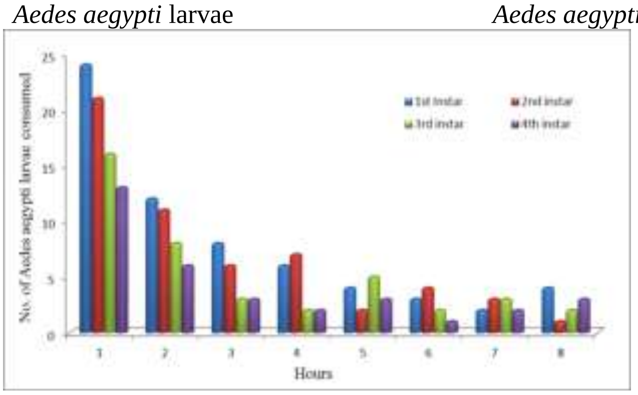

Fig.3 Predation of *Ceriagrion cerinorubellum* on *Aedes aegypti* larvae

Table 1. Percentage of consumption/hour of *Aedes aegyp*ti by odonate nymphs

Hours	*Bradinopyga geminata*				*Crocothemis servilia*				*Ceriagrion cerinorubellum*			
	1st Instar	2nd instar	3rd instar	4th instar	1st Instar	2nd instar	3rd instar	4th instar	1st Instar	2nd instar	3rd instar	4th instar
1	96	84	64	44	72	60	44	36	60	52	44	36
2	48	44	32	20	48	36	20	24	28	36	24	20
3	32	24	12	28	12	32	28	12	16	24	12	8
4	24	28	8	12	28	12	12	20	24	12	8	0
5	16	8	20	20	20	16	20	8	12	8	16	12
6	12	16	8	16	8	4	16	4	8	12	8	8
7	8	12	12	8	12	8	8	16	12	8	12	4
8	16	4	8	4	0	20	4	12	8	16	16	8

Crocothemis servilia and *Ceriagrion cerinorubellum* were recorded for 8 hours with three replicates. The average values of the three replicates were taken for further analysis and percentage of consumption in each hour are given in table 1. The number of 1st, 2nd, 3rd and 4th instar of *Aedes aegypti* were consumed in each hour by *Bradinopyga geminata*, *Crocothemis servilia* and *Ceriagrion cerinorubellum* are given in Figs.1, 2 and 3.

Table 2. Percentage of consumption of *Aedes aegypti* by odonate nymphs

Species	1st Instar	2nd instar	3rd instar	4th instar
Bradinopyga geminata	75.00	69.62	64.06	60.00
Crocothemis servilia	66.67	70.15	61.29	60.00
Ceriagrion cerinorubellum	64.62	66.67	62.50	51.06

Bradinopyga geminata shows maximum consumption rate on 1st instar larvae of *Aedes aegypti* (75%), followed by 2nd, 3rd and 4thinstars (69.62%, 64.06% and 60%) regarding the whole experimental time (Table 1&2). *Crocothemis servilia* shows maximum consumption rate on 2nd instar larvae of *Aedes aegypti* (70.15%) followed by 1st, 3rd and 4thinstars (66.67%, 61.29% and 60%) respectively. *Ceriagrion cerinorubellum* has maximum consumption rate on the 2nd instar larvae of *Aedes aegypti* (66.67%) followed by 1st (64.61%); 3rd (62.5%).The lowest consumption rate by *Ceriagrion cerinorubellum* was observed in 4th instar larvae of *Aedes aegypti* (51.06%). The consumption rate was found to be maximal for all instars in the 1st hour. Comparing the consumption rate of the three species reveals that *Bradinopyga geminata* shows maximum consumption rate on all the instars of *Aedes aegypti* i.e. the size of the prey in relation to the predator influences the predation rate. No larval mortality was found in the control set.

Predatory Impact

Table 3. Predatory Impacts of odonate nymphs on *Aedes aegypti*

Species	1st Instar	2nd instar	3rd instar	4th instar
Bradinopyga geminata	31.5	27.5	20.5	16.5
Crocothemis servilia	25	23.5	19	16.5
Ceriagrion cerinorubellum	21	21	17.5	12

The predatory impact (PI) shows the prey killing efficiency of the predators. In the present analysis *Bradinopyga geminata* shows highest predatory impact (31.5) on 1st instars of *Aedes aegyp*ti and 27.5, 20.5 and 16.5 were the corresponding predatory impact values of *Bradinopyga geminata* for 2nd, 3rd and 4th instars. The PI of *Crocothemis servilia* on 1st instar was 25 followed by 23.5 for 2nd instars, 19 for 3rd instars and 16.5 for the 4th instars. The comparison of PI of *Ceriagrion cerinorubellum* with PI of above two species shows a decrease in the PI of *Ceriagrion cerinorubellum* i.e. 21 for 1st and 2nd instar, 17.5 for 3rdinstar and 12 for 4th instar of *Aedes aegypti*, which is due to the small size of the predator and lower energy requirements. The results are shown in table 3.

Clearance Rate

The clearance rate shows the combined effect of search ability, killing and consumption by the predator and prey evasion in unit time and space. The clearance rate observed for each species with respect to different instars of *Aedes aegypti* larvae are given in table 4. In the present analyses the highest clearance rate was observed for *Bradinopyga geminata,* the values ranges *between* 1.73 and 1.64; the CR values for *Crocothemis servilia* range between 1.64 and 1.70 and the lower values were observed for *Ceriagrion cerinorubellum*, between 1.57 and 1.68

Table 4. Clearance rate of odonate nymphs o*n Aedes aegypti*

Species	1st Instar	2nd instar	3rd instar	4th instar
Bradinopyga geminata	1.73	1.70	1.66	1.64
Crocothemis servilia	1.68	1.70	1.65	1.64
Ceriagrion cerinorubellum	1.67	1.68	1.65	1.57

The predatory potential of *Bradinopyga* geminata and *Ceriagrion coromandelianum* larvae on *Aedes aegypti* larvae was investigated by Venkatesh and Tyagi in 2013, and said that *Bradinopyga* geminata consuming more mosquito larvae. They also suggest that a single anisopteran larva is sufficient for eliminating the huge mass of larval mosquitoes breeding in a cement tank or a cement cistern. Therefore, this biological control agent could be released to control Aedes larval production in areas of dengue epidemics. According to the study of Venkatesh and Tyagi (2015), *Bradinopyga geminata* larvae are efficient predators of mosquito larvae. The rate of consumption was dependent on the size of the prey and the density of the predator. The predatory impact of *Bradinopyga geminata* was more for the first instar *Aedes aegypti*, owing to its size and energy requirements.

IV. Conclusion

From the present study it is concluded that a single anisopteran nymph is sufficient for eliminating the large mass of larval mosquitoes breeding in different water bodies. Since the odonate nymph *Bradinopyga geminata* shows highest predatory efficiency on *Aedes aegypti* and they are commonly seen in all fresh water bodies and it is easy to culture in cement tanks or artificial ponds, it will be more beneficial to control mosquito larvae. The results obtained from the experiment ensure that the release of these biological control agents in areas of dengue epidemics will effectively control the *Aedes aegypti* larval production and thereby dengue epidemics.

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