

THE UTILITY OF THE ODONATE NAIADS *BRADINOPYGA GEMINATA* (RAMBUR) AS BIO- CONTROL AGENT AGAINST MOSQUITO LARVAL POPULATION IN THE DOMESTIC HABITATS

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Abstract: The Mosquito larvae and *Bradinopyga geminata* naiads prey predator behavior were recorded for 12 hours including a starvation period of 4 hours in 3 replicates in laboratory condition for effective control of mosquito larvae population in domestic habitats. The *Bradinopyga geminata* naiads were used as predator against the mosquito larvae and they showed a searching time of average of 14.3 +/- 1-5 seconds and handling time of an average of 13.01 +/- 1.28 seconds per larvae for a naiad of average size of 2cm. The present study revealed *Bradinopyga geminata* naiads as effective predator against the mosquito larvae to control its population in domestic habitats.

Keywords: Predatory naiads, *B. geminata*, mosquito bio-control agent.

I. INTRODUCTION

The dragonflies belong to the suborder Anisoptera of the order Odonata, and to the class Insecta. Odonates consist of about 500 genera and about 4500 species. Their origin goes back to the midst of time where the giant dragonfly forms recorded from the carboniferous forest. Recently they attained the greatest abundance in the Neotropical region and except for Japan; No part of the world Palearctic zones contain the abundance of striking dragonfly fauna. Anisopteran fauna of the world includes more than 3000 species and in India there are around 600 species falling under 4 different families, viz., Cordulegasteridae, Gomphidae, Aeshinidae and Libellulidae.

The naiads of the dragonflies are well recognized aquatic predator preying on various life stages of different organisms inhabit the freshwater aquatic ecosystem (Manu *et al.*, 1988).

The Odonate *Bradinopyga geminata* is diurnal in habit and the winged adults are conspicuous near the freshwater habitats like ponds, lakes and rivers, which form the 'rendezvous' (Corbert 1962) or "encounter site" (Parker 1978). Some species which can complete their development in six weeks or less, occur in temporary water (Bay and Aderson 1965). Based on their "spatial distribution" the naiads fall under two major categories, sprawlers that lie in ambush or stalk their prey at the bottom and climber naiads seek their prey randomly in the habitats (Bay 1974). The mosquito larvae are readily consumed by the climber naiads of *B. geminata*. After metamorphosis the emerging aerial adults seek their adult mosquito prey on wings from the terrestrial habitat. The predatory naiads because of their high predatory efficiency and long aquatic larval duration act as a beast of prey and play an important role as a significant biotic predatory mortality factor in the aquatic prey – predator realm. The predation of larvivorous naiads is well recognized against mosquito larvae in the aquatic ecosystem. Predation on natural population brings effective fluctuations in the population size in an ecosystem (Odum 1963). Tomo, (1992) reported the predation of *Toxorhynchites splendens* on *Aedes albopictus* mosquito larvae. Takaya Kemoto (1986) reported the odonate *Sympetrum frequens* naiads as natural enemies of mosquito larvae *Anopheles sinensis*. Kuhlhorn's (1961) investigation on the various hydro fauna also explains about naiads as limiting factors for *Anopheles* larvae.

From these observations it is evident that both the adult as well as the naiads play an important role as predators against mosquito larvae and adult population both in the aquatic and terrestrial ecosystem.

Manu (*et al.*, 1988) explained the preference of dragonfly naiads towards mosquito larval prey. The prey-predator interaction is a spontaneous natural biotic phenomenon exists among the carnivorous plants as well as animals which are predatory in their diet. The phenomenon of prey-predator interaction is predominantly well pronounced among the animal kingdom rather than the plant kingdom, because the later is sedentary, hence locomotion is primary factor enhances the exercise of predation among animals. This interaction is expressed at all tropic levels in every ecosystem, above the herbivorous level in order to maintain the "Ecological Balance" in the ecosystem. To evaluate these naiads as bio-control agents, it is essential to understand their

distribution, predatory efficiency and consumption rate, predation including the prey-predator numerical response under natural behavior in and around the domestic habitats where the mosquito menace cause and spread various kinds of pestilence diseases like Cholera, Malaria, Encephalitis and Dengue fever by acting as a biological vector for those agents because of their genetic plasticity immediately develop resistance to chemical control agents. As the result it will be appropriate to use bio-control methods against mosquitoes with the harmless biocontrol agents.

II. MATERIALS AND METHODS

Survey:

A thorough survey was made in the different place of Kancheepuram and Thiruvallur District to identify the encounter site for *Bradinopyga geminata*, which also forms a site for their oviposition. Survey was made to collect live naiads from the different habitats to confirm their breeding sites and also the presence of the naiads. Lakes, ponds, wells, cement water tanks and marshy places were inspected for the presence of *Bradinopyga geminata* naiads in and around the domestic areas of the above mentioned districts.

Collection:

For the present study live naiads of the dragonfly *Bradinopyga geminata* were collected from their respective aquatic habitats, including freshwater cement tanks, ponds and lakes in and around Tambaram, 40 kms away from Chennai. The naiads were collected using water net, which is a modified fish-landing net, with 50cm hoop, 2cm handle and a net bag with mesh size of 5 mm across to reduce air resistance. Dark material used for the net and it should be tuff enough to resist thorns submerged in the aquatic habitats. The collected naiads were subsequently transferred to plastic containers provided with water and perforated lid for sufficient aeration. Then they were brought to the laboratory and released into the troughs with freshwater and the prey material *Tubifex tubifex* (annelida), commercially available worms and mosquito larvae (Diptera). In the present study the naiads of *Bradinopyga geminate* were reared *en mass* by providing above mentioned prey materials and allowed to grow up to the final instar stage, then utilized for observation and dissection. To avoid cannibalism among naiads they were separated in groups based on their body size.

Prey predator Dynamics:

To assess the searching time of these predators within a known area, the naiads were released into a container of known area provided with a single mosquito larvae was used. The time of capture of the prey (Mosquito larvae) were recorded and from this duration, time of release of the naiads to time of the prey captured was calculated. For studying the handling time the time taken by the predator to consume the captured prey, starved naiads were released into a container provided with mosquito larvae and with the help of a stopwatch the time taken by the naiads to consume the larval prey was calculated and this experiment repeated 10 times to get the range in the handling time.

III. RESULT AND DISCUSSION:

Feeding Behavior:

Study on the feeding behavior of the *Bradinopyga geminata* naiads revealed that it involves a series of stimulus-response events starting from the location of the prey to its consumption. The sequential event successively involves (i) active prey search (ii) prey capture (iii) prey escape tactics and (iv) Feeding. The primary stimulus for predation appears to the active movement of the prey in the aquatic habitat. Non-living objects were moved inside the experimental containers and the naiads oriented and moved towards the objects. It reveals that only the movement of the object act as stimuli to initiate them to orient towards the moving objects, particularly with reference to the escape tactics of the prey. The defensive mechanism of the prey is not significant against the predation of the *Bradinopyga geminata* naiad. When no satiation occurred after the feeding, the predator hunted again for more prey, till it attains the satiation.

Searching time

When the hungry naiads were released into the experimental set up, for their location and orientation towards the mosquito larval prey, the naiads of *Bradinopyga geminata* took an average of 14.3 +/- 1-5 seconds. The increase in the prey density within a given area reduced the searching time of the *Bradinopyga geminata* naiads. On the other hand an increase in the area for search increases the duration. The frequency of the larval prey movement in the water body appears to be the primary factor influencing the searching time.

It is evident from the present study, the predatory naiads of *Bradinopyga geminata*, not only the distribution of the prey alone decides the searching time but also the active movement of the predator within the system appears to have more impact on the searching time of the predator. It is evident that the larval prey densities within a given experimental area have greater impact on the predatory efficiency on the predatory naiads of *Bradinopyga geminata*.

Handling Time

The handling time of the predator is the time of capture of the prey to the entire consumption of the prey. In the prey predator system it is necessary to assess the basic qualifications of the predator regarding the handling time towards the prey total consumption, to utilize it as a bio-control agent against any species. The size of the prey plays a major role in deciding the

handling time of the predator. Apart from the size, the defensive mechanism (prey escape tactics) of the prey towards the predator and the capture tactics by the predator also influence the handling time.

To capture the prey the naiads of *Bradinopyga geminata* took only a few seconds, but towards the decline of the predatory activity the larvae were held up in the mouth even upto 3 minutes before the start of consumption. The handling time of *Bradinopyga geminata* naiads towards the mosquito larval prey is an average of 13.01±/ 1.28 seconds per larvae. The handling time of mosquito larvae was also correlated with the size of the predator, were the last instar naiads of *Bradinopyga geminata* were measured about an average of 2 cm.

Table 1. INFLUENCE OF INCREASING AREA ON THE EFFICIENCY OF BRADINOPYGA GEMINATA

Predatory / Prey density	Area Sq.cm.	NUMBER OF LARVAL PREY CONSUMED									
		6 A.M	7 A.M	8 A.M	9 A.M	POST FEEDING PAUSE 10 AM – 2 PM (No feeding)	3 P.M	4 P.M	5 P.M	6 P.M	
		I HR	II HR	III HR	IV HR		IX HR	X HR	XI HR	XII HR	
5 : 100	83.36 Petridish	47.5±2.14	5	-	-		-	-	5±1.12	42.5±.12	
5 : 100	660.78 Trough	30.5±.89	10.5±2.10	7.3±2.35	1.0±1.02		1.0±1.02	4.8±2.33	8.15±2.15	26±2.34	
5 : 100	704 Tray	29.1±1.3	14.5±1.0	7.8±1.0	2.0±1.58		2.0±1.48	7.5±6.15	7.8±1.15	24.1±1.3	
10 : 100	83.36	95±2.24	5	-	-		-	-	5±2.24	85±2.24	
10 : 100	660.78	61.1±3.78	23.3±4.03	14.6±4.76	1.0±1.06		1.0±1.06	9.6±4.76	18.3±4.03	51.1±3.78	
10 : 100	704	58.2±2.6	22.7±2.1	15.1±1.3	4.0±3.38		4.0±3.38	10.5±11.3	15.7±2.1	48.2±2.6	
20 : 100	83.36	100	14.5±1.0	-	-		-	-	-	100	
20 : 100	660.78	85.9±	5	-	-		-	-	8.1±2.5	75.9±2.78	
20 : 100	704	79.0±2.08	23.3±4.03	-	-		-	-	17.0±2.1	70±2.08	

A. Venkatesh and B.K. Tyagi (2015) has reported *Bradinopyga geminata* naiads as potential predator against the mosquito larvae and they can be used as an efficient bio control agent against the mosquito larvae and as an operative tool in vector control program. Sonia Jacob *et al.*, 2017 in their study revealed *Bradinopyga geminata* naiads release in dengue affected areas will effectively control the *Aedes aegypti* larval production to control the epidemic.

IV. CONCLUSION

The present study shows the *Bradinaopyga geminata* naiad as an efficient predator against the mosquito larvae where the nymphs showed effective searching time and handling time of its aquatic prey. Even a single nymph is enough to control an *en masse* of mosquito population. It is found that *B. germinata* also select overhead cement and plastic water storing tanks in the open terres in domestic habitats for oviposition where the mosquitoes also breeds and proliferate. The result obtained from this study confirm the *Bradinaopyga geminata* naiads as effective bio control agent to control mosquito larvae population in domestic water bodies to control the mosquito related diseases.

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