A Study on the *Culex quinquefasciatus* Say, 1823 Control Potentiality of *Colisa fasciata* (Bloch & Schneider, 1801) in Laboratory Condition

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Abstract

Colisa fasciata consumed significantly more Chironomus ramosus larvae as compared to Culex quinquefasciatus larvae and pupae when those were offered separately. In paired experiment it consumed significantly more C. ramosus larvae than C. quinquefasciatus larvae. When habitat was modified by incorporating sand and gravels on the floor of the aquarium, C. fasciata consumed significantly more C. quinquefasciatus larvae as compared to C. ramosus larvae. Chesson's food preference index also confirmed these findings. The larvicidal efficiency therefore not only depends on the availability of alternative prey but also on the micro-habitat condition.

Key Words: *Biocontrol, Colisa fasciata, Culex quinquefasciatus larvae and pupae, Chironomus ramosus larvae, dietary preference, larvivorous fish.*

Introduction

The use of fish in mosquito control has been well known for more than 100 years. Petr[1] reported that the use of larvivorous fish for vector control is simple, inexpensive and should be given preference. However, use of exotic fish has raised environmental concern because this leads to the elimination of native fish very significantly[2] and have some adverse effects on biodiversity causing degradation in fresh water ecosystem[3]. The indigenous larvivorous fishes coexisting in the mosquito larval habitat, naturally offer an alternative in this regard. Rama Rao[4] & Krishna et al.[5] have listed *C. fasciata* as a larvivorous fish and Das et al.[6] opined that *C. fasciata* falls in the most efficient category of larvivorous fishes. Phukon & Biswas[7], Bano & Serajuddin[8] in India and Oo et al.[9] in Mayanmar have investigated the larvivorous efficiency of *C. fasciata.* In the present study biocontrol potentiality of *C. fasciata,* a common fish in Purba Medinipur district has been studied by conducting predation experiments on *C. quinquefasciatus* larvae and pupae in the presence of an alternative prey *C. ramosus* larvae, under different habitat condition in laboratory.

Materials and Methods

Fish were trapped using gill net / hand net from pond / fresh water lotic system/ paddy field from the locality. They were gently placed in glass aquarium (60 × 30 × 30 ft) containing water from where those were collected and were acclimatized for a fortnight before the experiment. Mosquito larvae were collected from the drainage system of Tamluk municipality region. The larvae were captured by using hand net (mesh size 200 μm). Collected larvae were transported to the laboratory and kept in an aquarium (size 60 × 30 × 30cm) filled with drain water. *Chironomus ramosus* Choudhuri et al., 1992 were collected from drainage system of Tamluk municipality region along with the sediments were then transported and stocked in the laboratory.

Three glass aquaria (30 × 20 × 24 cm) were filled with 6 lit of pond water from where fish were collected after passing through a plankton net (mesh size 62 μm) the day before every experiment. Acclimatized fish of approximately similar weight (7.74 – 7.80 gm) and length (7.25 – 7.5 cm) were placed, one in each experimental tank and starved for 24 hours. The experiment commenced at 6 am in the next morning and continued for 24 hours.

Predation efficiency and prey preference were studied by offering prey separately and in paired combination. In the first series, in first set only *C. quinquefasciatus* larvae were given as prey and in the second set only *C. quinquefasciatus* pupae were given as prey, in the third set only *C. ramosus* larvae were given as prey. In each experimental aquarium one fish was placed as predator. Each experiment was repeated for three times.

In the second series, in the first set *C. quinquefasciatus* larvae and pupae were given together as prey in 1:1 ratio, in second set *C. quinquefasciatus* larvae and *C. ramosus* larvae were given together as prey in 1:1 ratio in simple glass bottom habitat and in third set *C. quinquefasciatus* and *C. ramosus* larvae were given together as prey in 1:1 ratio in an altered habitat by adding sand and gravel at the substratum of aquaria. Here also experiments were repeated for three times.

Collected data were analysed by using MS-Excel 2013 and IBM SPSS version 25 software. Dietary preference index was computed using the formula of Chesson[10].

$$\hat{\alpha}_i = \frac{\hat{r}_i}{\hat{n}_i}\left[\frac{1}{\Sigma\left(\hat{r}_j/\hat{n}_j\right)}\right]$$

[Where, α_i = Manly's alpha (preference index) for prey type i; r_i, r_j = Proportion of prey type i or j in the diet (i and j = 1, 2, 3….. m); n_i, n_j = proportion of prey type i or j in the environment; m = number of prey types possible]

Result

When prey were offered separately *C. fasciata* consumed significantly more (t = 132.37, p < 0.001) *C. ramosus* larvae as compared to *C. quinquefasciatus* larvae or pupae in course of 24 hours (Figure 1). However, the fish hardly exhibited any preference for either larvae or pupae in the absence of alternative prey. The difference in number consumed being insignificant (t = 4.37).

When *C. fasciata* was offered larvae and pupae of *C. quinquefasciatus* together, it showed a significance preference for pupae over larvae as it consumed significantly more pupae as compared to larvae and this finding also confirmed by the preference index (Table 1).

Table 1. Consumption by *C. fasciata* when prey were offered together along with preference index.

Prey	*C. quinquefasciatus* **pupae consumed**	*C. quinquefasciatus* **larvae consumed**	**t**
Mean ± SE (Range)	308.33±3.61 (296-327)	236.56±2.92(228-250)	22.37*
Preference Index	0.57	0.43	22.30*

*(p< 0.001)

When *C. quinquefasciatus* larvae and *C. ramosus* larvae were offered together, C. *fasciata* consumed significantly more *C. ramosus* larvae as compared to *C. quinquefasciatus* larvae and showed a significant preference for *C. ramosus* larvae as revealed by preference index (Table 2, Figure 2).

Table 2. Consumption by *C. fasciata* when prey were given together along with the preference index.

Prey	*C. ramosus* larvae consumed	*C. quinquefasciatus* larvae consumed	t
Mean ± SE (Range)	670.78±3.21 (656-684)	231.22±2.46 (223-140)	132.85*
Preference Index	0.74	0.26	139.77*

*(p< 0.001)

When *Culex* and *Chironomus* larvae were offered together in an altered habitat with sand and gravel added to the substratum of the aquarium the fish consumed significantly more *C. quinquefasciatus* larvae as compared to *C. ramosus* larvae and the food preference shifted in favour of *C. quinquefasciatus* larvae as revealed by the preference index (Table 3, Figure 2).

Table 3. Consumption by *C. fasciata* when prey were given together in altered habitat along with the preference index.

Prey	*C. quinquefasciatus* larvae consumed	*C. ramosus* larvae consumed	t
Mean ± SE (Range)	432.44±4.57(417-460)	284.44±3.94(264-298)	29.06*
Preference Index	0.60	0.40	28.06*

*(p< 0.001)

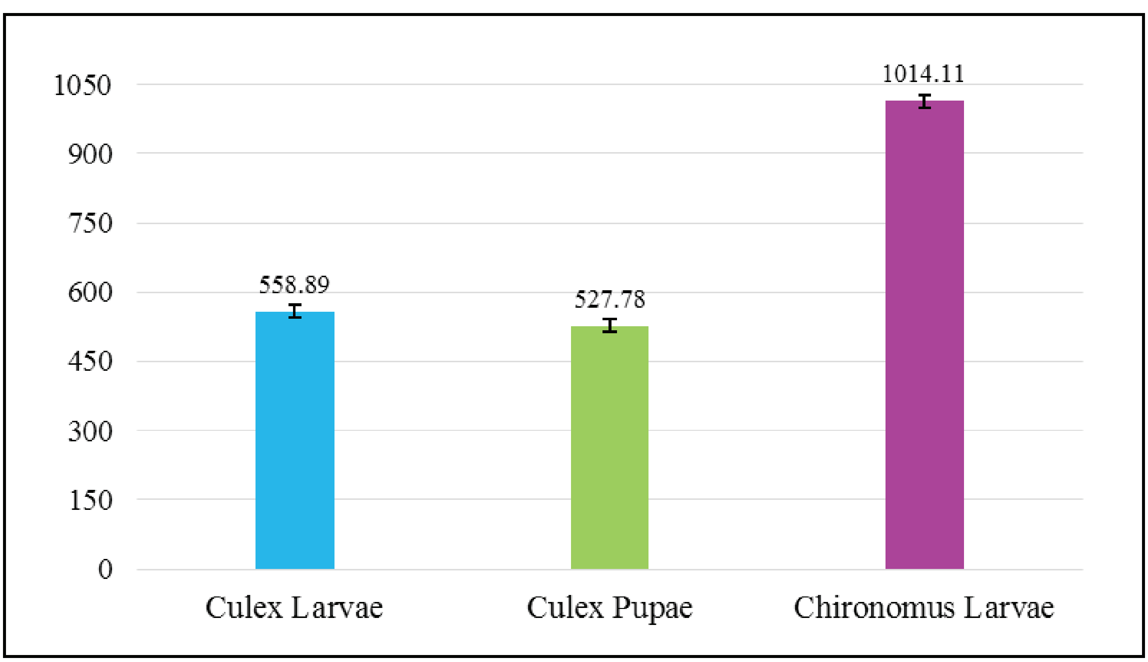

Figure 1. Consumption by *Colisa fasciata* when prey were given separately.

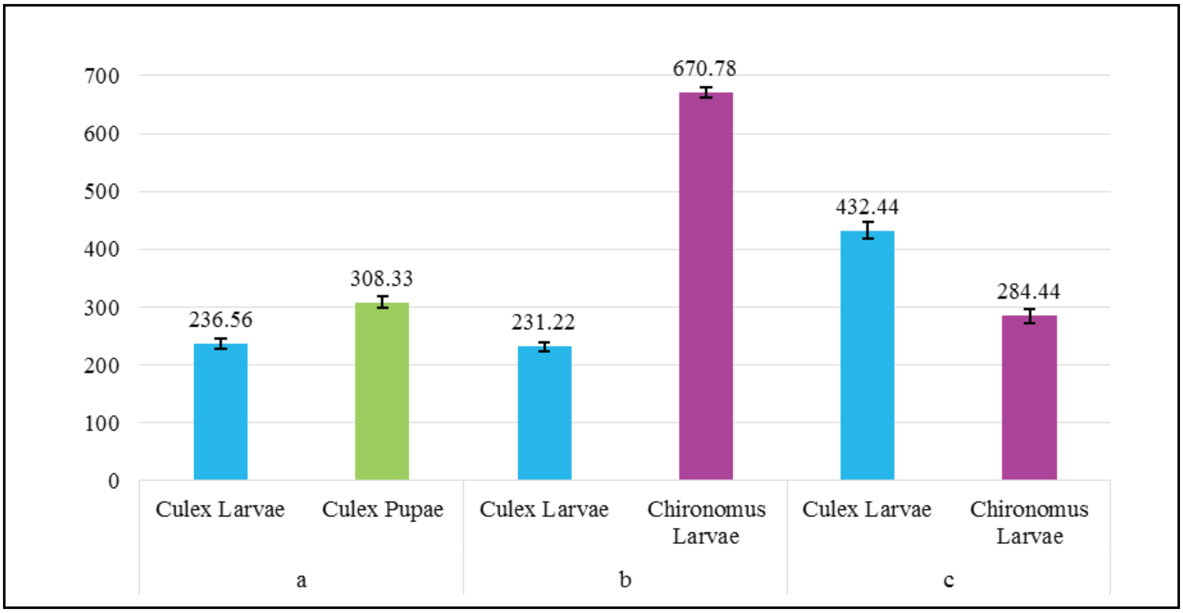

Figure 2. Consumption by *C. fasciata* when prey were offered together; a) *Culex quinquefasciatus* larvae and pupae, b) *Culex quinquefasciatus* and *Chironomus ramosus* larvae, c) *Culex quinquefasciatus* and *Chironomus ramosus* larvae in altered substratum.

Discussion

C. fasciata exhibited a more or less similar consumption preference for both larvae and pupae of *C. quinquefasciatus* but consumed significantly more pupae when both were simultaneously available as food. However, irrespective of the presence or absence of *C. quinquefasciatus* larvae, *C. fasciata* consumed significantly more *C. ramosus* larvae. Phukon & Biswas[7] and Bano & Serajuddin[8] opined that *C. fasciata* is an efficient consumer of mosquito larvae. However, they did not mention genus and species of mosquito. Oo et al.[9] studied the larvicidal efficiency of *C. fasciata* on *Ades* larvae in Mayanmar. The rate of mosquito consumption in 24 hours in the present study is considerably more than the findings of the Phukon & Biswas[7]. In their study Manna et al.[11] observed that another larvivorous fish *Poecilia reticulata* exhibited a definitive preference for *Chironomus* larvae over *C. quinquefasciatus* larvae. Devi and Jauhari[12] and Barik et al.[13] on the contrary observed that *Aplocheilus panchax* and *Puntius tetrazona* consumed more mosquito larvae even in presence of alternative prey, the chironomid larvae. Larvivorous predators have a wide range of prey choice and presence of alternative prey influence the target prey consumption[14]. Relative abundance of alternative prey may also alter the consumption rate of the mosquito larvae[15,16]. In presence of alternative prey biocontrol potentiality of hemipteran bugs[17] and odonate naiads[18] decreased considerably. Therefore, presence of alternative prey poses an adverse effect on elimination of target prey.

Present investigation reveals that when habitat was altered by providing sand & gravel bed in the aquarium, then *C. fasciata* consumed more *C. quinquefasciatus* larvae than *C. ramosus* larvae. Unlike mosquito larvae, which live mostly at the water surface in stagnant water, chironomid larvae live at the bottom or on submerged plants and objects[19]. Thus not only alternative prey but the habitat structure also changes the prey preference of the predator. Similar observation has also been made by Pahari et al.[20]. In natural condition, column-surface feeding fish like *C. fasciata* will always prefer to consume suspended mosquito larvae rather than the chironomid larvae.

As such it may be concluded that *C. fasciata* is an effective biological control agent for mosquito larvae. This species may be cultured in aquaria & tanks in large scale and could be used in eradication of mosquito borne disease successfully.

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Ethical Clearance: No ethical issues were involved. No fish was sacrificed.

Conflict of Interest: Nil

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