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Culex quinquefasciatus Say, 1823 larvae feeding ability of *Puntius sophore* (Hamilton, 1822) in laboratory condition

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ABSTRACT

When *Puntius sophore* was offered larvae and pupae of *Culex quinquefasciatus* separately then it consumed more or less similar number of larvae and pupae but when it was offered both of these food item in equal proportion, then it consumed significantly more pupae than larvae. The fish had a definitive preference for *Chironomus ramosus* larvae irrespective of whether those were offered separately or together with *C. quinquefasciatus* larvae. However, when the habitat structure was modified by the addition of sand and gravels on the bed of the aquarium then the dietary preference altered in favour of *C. quinquefasciatus* larvae indicating that the food preference of *P. sophore* depends not only on alternative prey but also on habitat structure.

Key words : Biocontrol, *Chironomus ramosus* larva, *Culex quinquefasciatus* larva, food preference, *Puntius sophore*.

INTRODUCTION

Integrated vector management efforts are now oriented towards controlling larval stages and/or the adult stages of mosquitoes using biological means, where various concerns at the ecological, environmental, social, and economical levels are highly considered (Beier, 2008). Among all the biocontrol agents, larvivorous fish are widely used in vector control which are being used extensively all over the world since early 1900s (Raghavendra and Subbarao, 2002). It is important to know about the predators and their mosquito larval preference in the presence of alternative prey species in natural condition (Arthington and Marshall, 1999). Indigenous fish are generally preferred over the exotic species because they are well adapted to the local environment, easily available at low costs and also the local people are aware of their native habit & habitats. Another very important thing is the predator's adaptability to the introduced environment and interaction with the other native organisms already present in that environment (Denoth *et al*., 2002 and Carlson *et al*., 2004). Although considerable work has been done on various larvivorous fish yet little attention has been paid on the biocontrol potentiality of *Puntius* species. Only Barik *et al*. (2018) have worked on the larvivorous ability of *Puntius tetrazona,* Brahman and Chandra (2015, 2016) of *P. conchonius* and *P. ticto* and Phukon and Biswas (2013) of *P. sophore*. In the present study, larvivorous efficacy of Puntius *sophore* (Hamilton, 1822) has been investigated in presence of alternative prey in laboratory condition and modified habitat structure. *P. sophore* was used to eliminate the larvae of *Culex quinquefasciatus* Say, 1823, which is a vector of not only *Wuchereria bancrofti* but also responsible for the transmission of St. Louis encephalitis, Western equine encephalitis, West Nile fever, and may be a vector of the Zika virus which causes dengue like fever (Garvey, 2016), in presence of its pupae as well as larvae of *Chironomus ramosus* Choudhuri *et al.* (1992).

MATERIALS AND METHODS

P. sophore were trapped using gill net / hand net from the pond in and around Tamluk municipal area. These were gently placed in a glass aquarium (size = 60 × 30 × 30 cm) containing water of the

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water body from where those were collected and acclimatized for a fortnight before the commencement of experiments. Mosquito larvae were collected from the drainage system of Tamluk Municipality region, where water remains stagnant for most of the time. 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 × 30 cm) filled with drain water. *Culex quinquefasciatus* Say, 1823 larvae were identified following Tyagi *et al*. (2015) and stocked in another aquarium for use in experiments. *Chironomus ramosus* Choudhuri *et al*., 1992 were collected from drainage system of Tamluk Municipality region along with the sediments using trays and baskets. Those were then transported and stocked in laboratory.

Three glass aquaria (size = 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 (4.17 - 4.31 gm) and length (6.75 - 6.98 cm) placed one in each experimental tank and were 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 together in paired combination. In the first series in first set only *C. quinquefasciatus* larvae were given as prey in three aquaria each with one fish. In the second set only *C. quinquefasciatus* pupae were given as prey in three aquaria each with one fish. In the third set only *C. ramosus* larvae were given as prey in three aquaria each with one fish. 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 three aquaria each with one fish. In second set *C. quinquefasciatus* larvae and *C. ramosus* larvae were given together as prey in 1:1 ratio in three aquaria each with one fish. In third set *C. quinquefasciatus* and *C. ramosus* larvae were given together as prey in 1:1 ratio in three aquaria each with one fish in an altered habitat by adding sand and gravel at the substratum of aquaria. Here also experiments were repeated for three times.

Data collected were analysed by using MS-Excel 2013 and IBM SPSS version 25 software. Dietary preference index was computed using the formula of Chesson (1978).

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

[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]

RESULTS AND DISCUSSION

When *P. sophore* was allowed to feed on prey offered separately it consumed (Fig. 1) significantly more *C. ramosus* larvae as compared to *C. quinquefasciatus* larvae or pupae in course of 24 hours (t = 57.84, p < 0.001). However, the fish hardly exhibited any preference for either larvae or pupae in the absence of alternative prey type. The difference in number consumed being insignificant (t = 1.02).

When *P. sophore* was offered larvae and pupae of *C. quinquefasciatus* together, it showed a preference for *C. quinquefasciatus* pupae over *C. quinquefasciatus* larvae as revealed by the preference index (Table 1) and consumed significantly more pupae as compared to larvae.

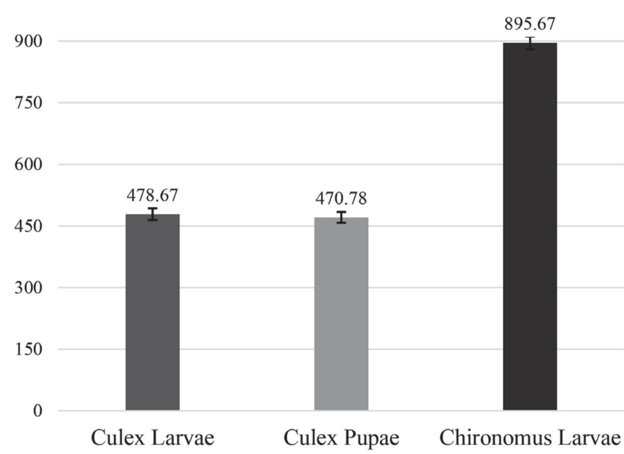

Fig. 1. Consumption by *P. sophore*, when prey were given separately.

Table 1. Consumption by *P. sophore* when prey were offered together along with preference index.

Prey	*C. quinquefasciatus* larvae consumed	*C. quinquefasciatus* pupae consumed	t (p < 0.001)
± SE (Range)	220.33 ± 2.09 (212-228)	254.89 ± 2.03 (245-266)	-9.88
Preference Index	0.46	0.54	-9.43

When *P. sophore* was offered, *C. quinquefasciatus* larvae and *C. ramosus* larvae in 1:1 ratio it showed a significant preference for *C. ramosus* larvae as revealed by the preference index (Table 2) and consumed significantly more *C. ramosus* larvae as compared to *C. quinquefasciatus* larvae (Table 2, Fig. 2).

However, when these were offered together in an altered habitat with sand and gravel added to the substratum of the aquarium the food preference changed in favour of *C. quinquefasciatus* larvae as reveled by the preference index (Table 3). The fish consumed significantly more *C. quinquefasciatus* larvae as compared to *C. ramosus* larvae (Table 3, Fig. 2).

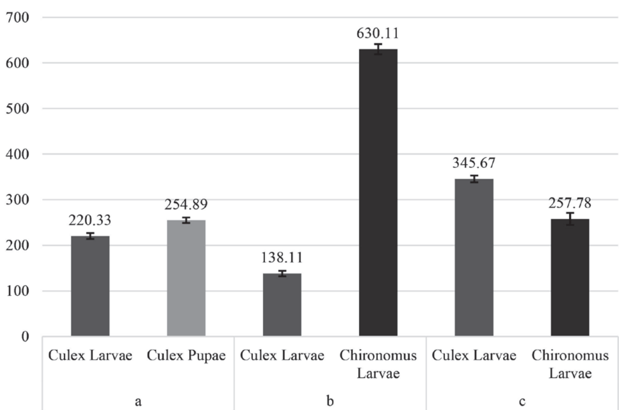

Fig. 2. Consumption by *P. sophore* when prey were offered together; a) *Culex quinquefasciatus* larvae and pupae, b) *Culex quinquefasciatus* and *Chironomus ramosus* larvae, c) *Culex quinquefasciatus* and *Chironomus ramosus* larvae in altered substratum.

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

Prey	*C. quinquefasciatus* larvae consumed	*C. ramosus* larvae consumed	t (p < 0.001)
± SE (Range)	138.11 ± 2.05 (126-147)	630.11 ± 3.78 (615-647)	-157.57
Preference Index	0.18	0.82	-159.2

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

Prey	*C. quinquefasciatus* larvae consumed	*C. ramosus* larvae consumed	t (p < 0.001)
± SE (Range)	345.67 ± 2.50 (334-355)	257.78 ± 4.40 (246-279)	19.34
Preference Index	0.57	0.43	15.56

In the present investigation *P. sophore* showed a more or less similar consumption preference for both larvae and pupae of *C. quinquefasciatus* but consumed significantly more pupae when both were available as food. However, irrespective of the presence or absence of *C. quinquefasciatus* larvae *P. sophore* consumed numerically more *C. ramosus* larvae. Feeding on mosquito larvae by *P. sophore*, *P. conchonius* and *P. ticto* have also been reported by Phukon and Biswas (2013), Brahman and Chandra (2015, 2016). However, consumption rate in the present study were considerably high as compared to that reported by Phukon and Biswas (2013). Manna *et al*. (2008) also observed that *Poecilia reticulata* exhibited a definitive preference for *Chironomus* larvae over *C. quinquefasciatus* larvae. Devi and Jauhari (2011) and Barik *et al*. (2018) on the contrary observed that *Aplocheilus panchax* and *Puntius tetrazona* consumed more mosquito larvae even in presence of alternative prey, chironomid larvae. Larvivorous predators have a wide range of prey choice and presence of alternative prey influence the target prey consumption (Aditya *et al*., 2012). In presence of alternative prey biocontrol potentiality was reduced considerably, of hemipteran bugs (Saha *et al*., 2010) and odonate naiads (Pahari *et al*., 2018). Relative abundance of alternative prey may also alter the consumption rate of the mosquito larvae (Quintans *et al*., 2010). Therefore, presence of alternative prey poses an adverse effect on elimination of target prey, larvae of *Culex quinquefasciatus.*

Present investigation reveals that when habitat was altered by providing sand & gravel bed in the aquarium, then *P. sophore* tended to feed more on *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 (Bay, 2003). Thus not only alternative prey but the habitat structure also changes the prey preference of the predator. In natural condition, surface feeding fish like *P. sophore* will always prefer to consume suspended mosquito larvae rather than the chironomid larvae.

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