Biological Control of Pre-Adult Mosquito using Larvivorous Fish *Gambusia affinis* in Doon Valley, Uttarakhand

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Abstract: **Biological control of mosquito larvae with predators and other biocontrol agents would be a more-effective and eco-friendly approach, avoiding the use of synthetic chemicals and concomitant damage to the environment. In the present study, experiments on feeding efficiency of larvivorous fish *Gambusia affinis* in quantified water were carried out during study period. The maximum prey consumption 37.23 was recorded at 100 ml and minimum predation 14.57 was at 500 ml. The feeding efficiency of *Gambusia affinis* was found negatively correlated both with the increase in quantity of water (r=-0.992) and duration of experiment (r=-0.958) respectively.**

Index Terms: **Biological control, larvivorous fishes, mosquito immature, predators.**

INTRODUCTION

Biological control of mosquito play a very important role in the integrated control methodologies in which all the physical and biological factors such as pesticides, fishes, efficiency of dragonfly nymph and other biotic agents have their own role Yanoviak (2004). Repeated use of synthetic insecticides for mosquito control has disrupted natural biological control systems and led to development of insecticide resistant mosquitoes and undesirable effects on non-target organisms and fostered environmental and human health concern, initiating a search for alternative control measures Kumar et al., (2006). In view of this, renewed interest in biological control agents, particularly aquatic predaceous insects that inhibit mosquitoes in their breeding sites could provide suitable solution and could be included in integrated vector management (IVM) program. The control of mosquito in their larval stage is more efficient in the integrated mosquito management. During the 20th Centaury the Biological control of Mosquito using larvivorous fishes was a very important method to control the Spread of Malaria in and around the sub areas of Urban and Peri-Urban areas by Stav et al., (2000). The objective of this work is to study the effect of quantity of water on the feeding efficiency of larvivorous fishes (*Gambusia affinis*).

REVIEW OF LITERATURE

Different biological agents play different role to control and regulate the population of mosquito through different mechanism namely, completion, parasitism and by predation. From Doon Valley work on larvivorous fishes has also been carried out by Hora and Mukerjee (1936). Later on after 3 decades Das (1960), Lal and Chatterjee (1963), Singh (1964), Grover (1969, 1970), Husain (1987), Kumar et al (1990), Grover et al (1994), Rauthan et al (2001, 2005), Husain. (2003), Uniyal and Kumar (2006), Uniyal and Mehta (2007) and Gupta and Rana (2009) added a lot on fishes of Doon Valley. In the year 1996, Jauhari et al., undertook studies on Larvivorous fish occurring in water bodies of Doon Valley. Hence on the basis of available literature it can be very well said that till date no systematic study on larvivorous fish from Doon Valley has been carried out.

MATERIALS AND METHODS

Collection of mosquito larvae

Mosquito larvae were collected from stagnant freshwater bodies using hand net or scoop net. The larvae were carefully sorted using standard Keys & Catalogues [4, 5 and 6] and allowed into 200 ml plastic beakers. The larvae grown in the laboratory were fed with powdered dog biscuits [7]. The water in the beakers was renewed daily to keep the larvae healthy.

Collection of *Gambusia affinis*

Monthly survey was conducted from January 2019 to December, 2019 and fishes were collected at different sites of the lake with the help of local fishermen. Fishes were also collected from local fish markets. Immediately photographs were taken prior to preservation for the identification. Specimens were preserved in 10% formalin. The fishes were identified using keys for fishes of the Indian subcontinent (Jayaram, 1999; Talwar and Jhingran, 1991).

RESULTS

The feeding efficiency of *Gambusia affinis* was studied in quantified water for one hour interval for a total duration of eight hours. When the quantity of water was 100 ml, the feeding efficiency was high and the maximum prey intake was an average value of 11.2 in the first hour, followed by 200 ml water (8.0), whereas least consumption was recorded in 500 ml of water (4.2). As the span of time of the experiment increases the prey consumption of the larvivorous fish decreases abruptly. In the 2nd hour of the experiment highest consumption was recorded in 100 ml beaker (9.2), whereas lowest was found in 500 ml quantity of water (3.0). Similarly the same pattern of having the highest values were recorded consequently in the 3rd and 4th hour also from 100 ml of water of 7.8 and 5.4 respectively, whereas lowest consumption in the 3rd hour found in 500 ml (2.2) though in 4th hour 300 ml water registers lowest consumption of immature mosquito (0.8). In the 2nd half of the experiment both 100 ml (6th hour 1.0), 200 ml (5th hour 2.8 and 6th hour 1.0), 300 ml (6th hour 1.0; 7th hour 1.0) and 400 ml (8th hour 1.0) record the highest consumption values, whereas in case of lowest consumption parameters 100 ml (8th hour 0.4), 300 ml (8th hour 0.4), 400 ml (5th hour, 1.2), 500 ml (6th hour, 7th hour and 8th hour 0.4) were mainly accounted (Fig. 3).

In the study, maximum prey consumption by the *Gambusia affinis* was accounted in 100 ml water (37.2 average value), merely trailed by 200 ml quantified water (31.0) whereas lowest was found in 500 ml of water (14.8). A negative value of Pearson correlation (r=-0.992) between the increasing quantity of water and decreasing feeding efficiency of *Gambusia affinis* was found in the study featuring the fact when the quantity of water increased, the prey density decreased and so the feeding efficiency *Gambusia affinis* was decreased under laboratory condition (Fig. 4).

Similarly, the consumption rate varies frequently in overall span of the experiment. In the very 1st hour of the experiment the highest average consumption rate was found 38.4, whereas in the last hour of the experiment *i.e*., 8th hour minimum average consumption was found (3.0). Pearson correlation registers here also negative value (r=-0.958) featuring the fact that the predator starved for two days voraciously feed at the beginning and at the later hours, it reached the saturation point and the prey intake was gradually decreased in the following hours (Fig .5).

DISCUSSION

Biological control of mosquito larvae with predators and other biocontrol agents would be an effective approach, avoiding the use of synthetic chemicals and concomitant damage to the environment. This study revealed that *Gambusia affinis* is an efficient predator of mosquito larvae. The predatory impact of *Gambusia affinis* was more for the first instar *Ae. aegypti*, owing to its size and energy requirements. Biological control of mosquito means the destruction of larvae and adult stages of mosquito by their natural enemies. Many insecticides (e.g. DDT, HCH, malathion) and pesticides are used in the control of mosquitoes. But excessive use of chemicals is hazardous for environment as they affect co-existing biotic community and finally the human health. Hence use of Larvivorous fishes is the best medium in controlling immature mosquitoes and thereby in reducing spread of mosquito borne diseases. According to Blaustein et al., (2007) it is very essential to study out the effectiveness of different indigenous larvivorous fishes from different water habitat and their importance in trophic cascade at community level. There are several disadvantages of using larvivorous fish. *Gambusia* when stocked in waters outside their native range, often causes serious negative ecological impacts. *Gambusia* is an opportunistic predator with a highly variable diet that includes algae, zooplankton, aquatic insects, as well as eggs and young of fish and amphibians. Gracia-Berthou, (1999) worked on the diet shift from diatoms to cladocerans to adult insect with the maturation of *Gambusia*. According to Hurlbert et al., (1981) and Bence et al., (1988) they are voracious and highly aggressive fish that compete with the native fish very successfully for viable food and space. The present study also found similar with Chandra et al., (2008) who worked on the mosquito control using larvivorous fishes.

CONCLUSION

Larvivorous fishes are an excellent source to control the breeding population of mosquito borne diseases and their concerned vectors. The biological of mosquito larvae using larvivorous fishes is a most effective method as compared to chemical and physical methods which found very safer for human and non-target populations. This method also has low cost production and lower risk of resistance development. Thus it is concluded that *Gambusia affinis* fish is better biological control agent for mosquito larvae

thus; this fish would be used for vector control program strategy in endemic rural area.

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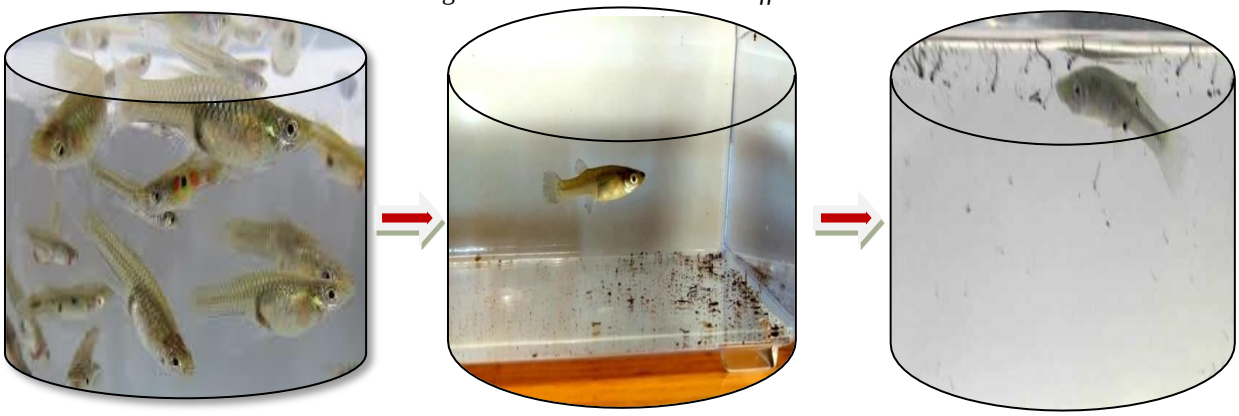
Fig 1: a. Culture of *Gambusia affinis* in lab.



b. Mosquito larvae Feeding Mechanism by *Gambusia affinis*

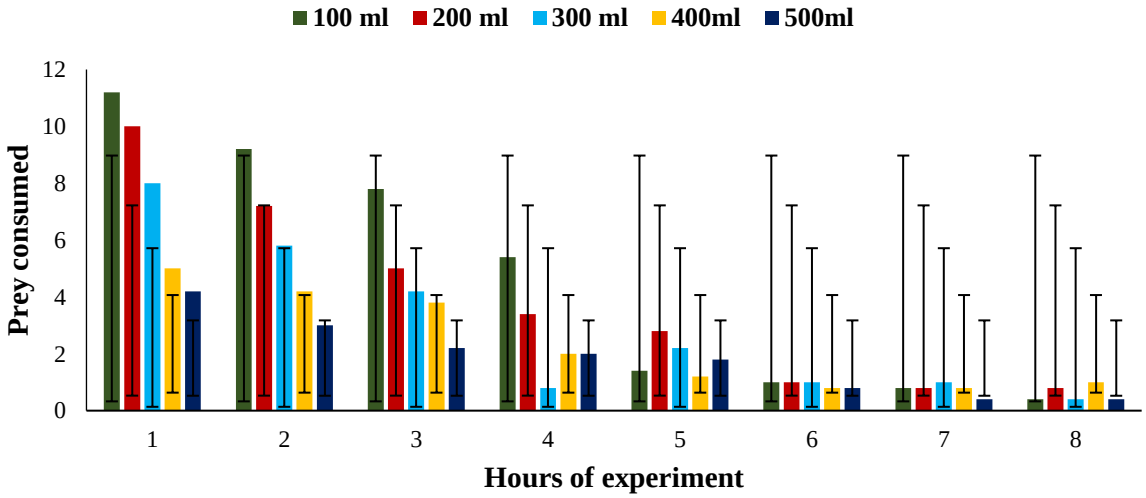


Fig. 3: Prey consumption of *Gambusia affinis* per hour of experiment.

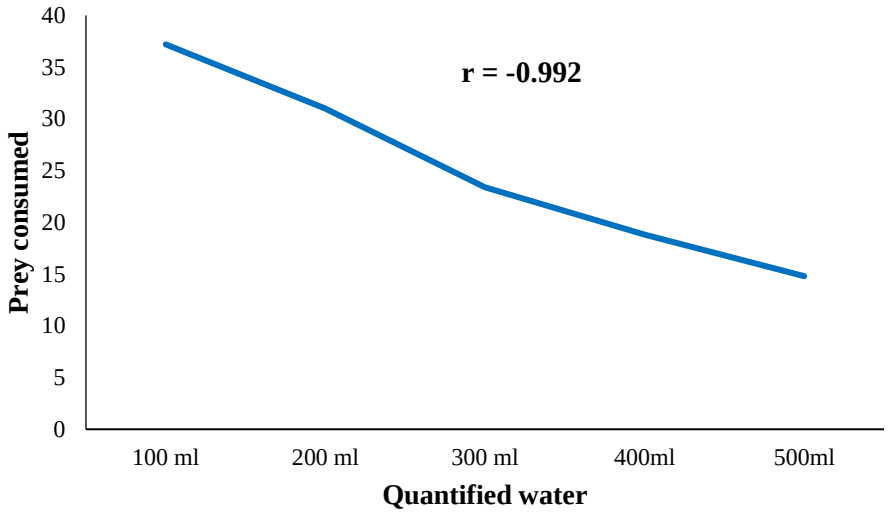


Fig. 4: Pearson correlation of prey consumption vs. quantified water.

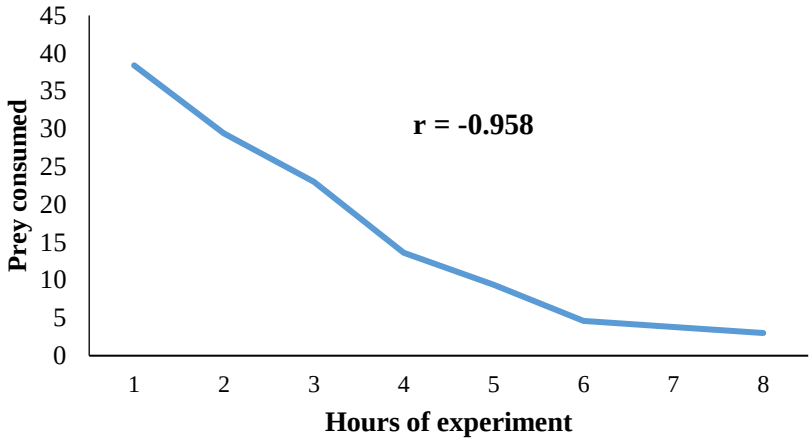


Fig.5: Pearson correlation of prey consumption vs. time.