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Study on the larvivorous efficacy of five ornamental fishes under laboratory conditions in Kolkata, West Bengal

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Abstract
Mosquito larvae can be a potential vector, responsible for severe outbreaks of malaria, dengue, bancroftian filariasis and arboviral infections. Various methods have been tried and many more still being developed to eliminate or reduce mosquito population. Environmental concerns surrounding the use of chemical methods to control mosquitoes have led experts to explore more eco-friendly alternatives. One promising approach involves biological control methods, which aim to manage mosquito populations through the introduction or enhancement of natural predators, parasites, or disease-causing organisms. These natural enemies help to keep mosquito numbers in check while minimizing environmental impact. The present study focused on using Ornamental fishes as predators of mosquito larvae and the rate at which mosquito larvae were consumed as well as the other feeding preferences of five ornamental fishes (Betta, Angel, tiger barb, guppy, rasbora) were noted and compared. The rate of consumption was noted between 47-60 larvae per fish per day. While all of the five fish groups consumed almost all the mosquito larvae given to them in presence of fish pellets, *Betta* sp. and *Puntigrus* sp. consumed a moderate amount of fish pellets whereas others' consumption of fish pellets were nearly negligible.

Keywords: Mosquito larvae, ornamental fishes, biological control, dengue fever

Introduction

Mosquitoes are significant vectors of numerous serious diseases globally, including malaria, dengue fever, filariasis, encephalitis, equine infectious anemia, yellow fever, and chikungunya [2] noted that mosquito-borne diseases are expected to remain a major issue in tropical and subtropical regions, contributing to over 3 million deaths annually. Mosquito larvae, the immature stage of insects belonging to the family Culicidae, play a crucial role in the aquatic ecosystem by providing food for various organisms. They undergo complete metamorphosis, consisting of four distinct stages: egg, larva, pupa, and adult. The life cycle begins with an adult female laying eggs in stagnant or slow-moving water sources, such as ponds, puddles, ditches, or containers. These eggs hatch into larvae within days to a week, depending on environmental conditions like temperature and humidity, and the larvae feed on organic matter, algae, and microorganisms present in the water. The larval stage typically lasts several days to a few weeks.

To mitigate the risk of mosquito-borne diseases, it is essential to eliminate mosquito larvae or treat breeding sites and employ preventive measures such as mosquito nets, repellents, and protective clothing. Traditional methods of mosquito control, including the use of insecticides, repellents, and fogging, have environmental drawbacks and can lead to increased resistance among mosquito populations. Chemical treatments not only contribute to environmental pollution but also deplete beneficial insect species, create secondary pest problems, and result in pesticide residue accumulation in non-target organisms, including humans [7]. In contrast, biological control methods using larvicidal fish species are being explored as eco-friendly, sustainable, and cost-effective alternatives [8]. Effective larvicidal fish should be hardy, small in size, adaptable to shallow and deep waters, prolific breeders, and capable of thriving in confined water bodies without contaminating the water [3, 5, 1].

Gerberich and Laird (1985) identified over 253 fish species considered for mosquito biocontrol globally, with notable examples including *Poecilia reticulata* (Guppy), *Poecilia sphenops* (Black Molly), *Betta splendens (*Betta fish), *Carassius auratus* (Goldfish), and *Pterophyllum scalare* (Angel Fish), which are effective predators of *Aedes albopictus* larvae. Although fish cultivation can significantly reduce mosquito populations, it is crucial to continue community education on dengue prevention, emphasizing the elimination of other breeding sites such as discarded containers and clean gutters. While fish cultivation alone may not completely eradicate mosquito larvae or dengue, it can be an effective component of an integrated vector management strategy that combines biological control, insecticide use, and community engagement.

In West Bengal, limited research has been conducted on the use of ornamental fishes for mosquito control. This study represents a preliminary effort to assess the larvicidal efficacy of five ornamental fish species—Betta fish (*Betta* sp.), Angel fish (*Pterophyllum* sp.), Tiger Barb (*Puntigrus* sp.), Guppy (*Poecilia* sp.), and Rasbora (*Rasbora* sp.)—in controlling mosquito larvae under laboratory conditions, with the presence of alternative food sources.

Materials and methods

1. Sites of collection

Various species of mosquito larvae, predominantly *Aedes* spp. and *Culex* spp., were collected from stagnant and slow-moving water sources, including puddles, drains, and water-filled containers in the Salt Lake area of Kolkata.

Fig 1: Map showing the collecting site

2. Collection of ornamental fish and fish pellets

Three individuals of each of five ornamental fish species—Betta fish (*Betta* sp.), Angel fish (*Pterophyllum* sp.), Tiger Barb (*Puntigrus* sp.), Guppy (*Poecilia* sp.), and Rasbora (*Rasbora* sp.)—were procured from local ornamental fish suppliers. These fish, of comparable age groups, were acclimatized to laboratory conditions over a one-week period and were provided with artificial fish pellets during this time.

3. Experimental design

For each fish species, two distinct experimental sets were conducted at room temperature with various food combinations to assess larvivorous efficiency. Each experimental set was repeated over a period of seven days to ensure that the fish had sufficient time to acclimate to the different food combinations. In each trial, individual fish were placed in glass beakers and allowed to predate on mosquito larvae for a continuous three-hour period, with three replicates for each condition. The number of mosquito larvae consumed by each fish was recorded at one-hour intervals.

In the first experimental set, each fish was provided with 50 larvae and observed for three hours. In the second set, each fish was given 20 larvae and 20 fish pellets, and observed for one hour. The quantities of ingested larvae and pellets were meticulously recorded for each trial.

4. Statistical analysis

A two-way ANOVA was performed using Windows Excel version 10 to analyse the effects of five fish species and their food combinations. Statistical significance was determined with a threshold set at $p<0.05$. The results of the two-way ANOVA revealed that the interaction between mosquito larvae and fish pellets was highly significant at the 0.05 confidence level.

Results

In a preliminary experiment conducted over a period of seven consecutive days to assess the food preferences of five fish species towards mosquito larvae, it was observed that *Betta* sp., *Poecilia* sp., and *Rasbora* sp. exhibited superior larvicidal efficacy compared to *Pterophyllum* sp. and *Puntigrus* sp. This evaluation was carried out in the absence of alternative food sources.

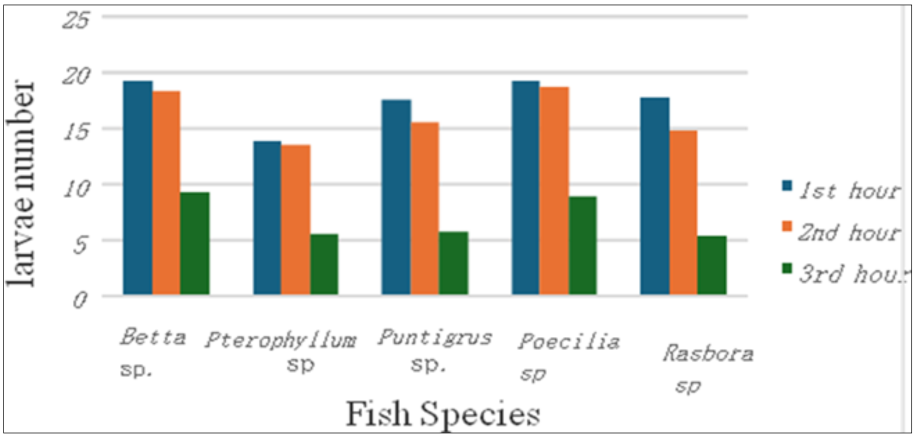

Fig 2: Hourly mean consumption of mosquito larvae by different fishes in number

The second experiment aimed to investigate about the food selection behaviour of five fishes between mosquito larvae & fish pellet. The results demonstrated a clear preference across all of the five fish groups for mosquito larvae over the food pellets as detailed in table 2 and figure 6. Specifically *Puntigrus* sp., *Betta* sp., and *Rasbora* sp., were observed to consume a moderate quantity of fish pellets alongside the larvae. In contrast, *Pterophyllum* sp. and *Rasbora* sp. exhibited minimal consumption of fish pellets. These findings indicate a strong preference for mosquito larvae among the fish, with varying degrees of acceptance for fish pellets depending on the species.

Table 1: The mean consumption rate of three distinct fishes against mosquito larvae with respect to fish pellet

Fish name	Mean consumption (in 7 days)	
	Mosquito Larvae	Fish Pellet
Betta sp.	60	28.57
Pterophyllum sp.	51.29	3.86
Puntigrus sp.	58.71	35.14
Poecilia sp.	60	16.86
Rasbora sp.	52.57	24.86

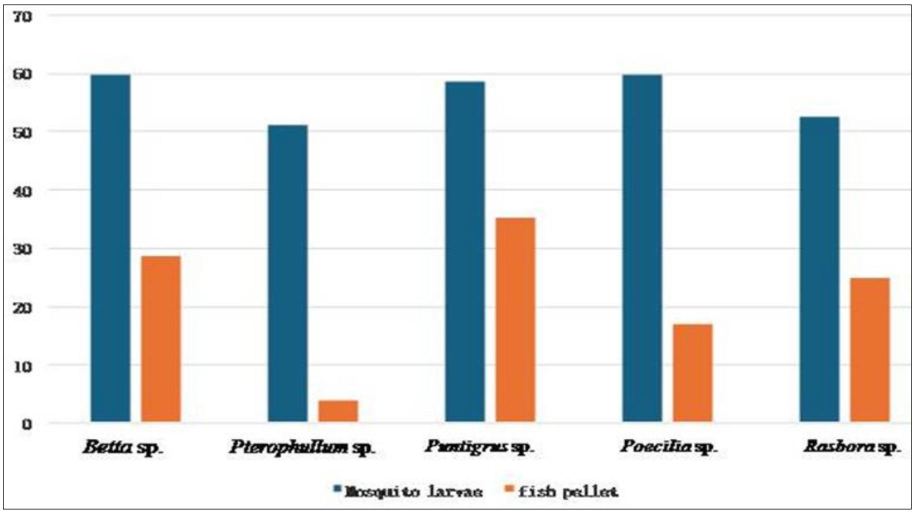

Fig 3: Mean consumption rate of 5 distinct fishes against mosquito larvae with respect to fish pellet

The two-way ANOVA result showed that the interaction between mosquito larvae & fish pellet are extremely significant at 0.05 level confidence (Table 3).

Table 2: Two-way ANOVA of the three different fishes on consumption of mosquito larvae & fish pellets

	Sum of Squares	df	Mean Square	F value	P Value	Significant
Fishes	228.05	4	103.17	2.74	$p<0.05$	YES
Larvae and pellets	2508.01	1	1560.38	120.71	$p<0.05$	YES
Interaction	270.62	4	103.30	3.25	$p<0.05$	YES

* Significant at 0.05 level of confidence

Discussion

Observations from the current study reveal that *Pterophyllum* sp., *Poecilia* sp., and *Rasbora* sp. exhibit a significantly higher preference for mosquito larvae compared to artificial food pellets. In contrast, *Puntigrus* sp. and *Betta* sp. consumed both food types substantially within the allotted time frame, with consumption rates ranging from 47 to 60 larvae per fish per day.

Previous research has demonstrated the larvicidal potential of ornamental fish, particularly Guppy fish, in managing mosquito populations [4, 6], and similar results were observed in our laboratory experiments.

Further, Rao *et al*. (2015) found that *Puntius chola* consumed a greater quantity of larvae compared to other available food items. Additionally, *Poecilia sphenops* has been recognized as an effective species for mosquito control programs [9]. These findings underscore the efficacy of ornamental fish in mosquito larvae control strategies, highlighting their simplicity and cost-effectiveness.

Conclusion

The presence of ornamental fish in mosquito breeding habitats not only aids in controlling vector populations but also supports ecological balance. Among the five species examined—*Pterophyllum* sp. (Angel fish), *Poecilia* sp. (Guppy fish), *Rasbora* sp. (Rasbora fish), *Puntigrus* sp. (Tiger Barb), and *Betta sp*. (Betta fish)—*Pterophyllum* sp., *Poecilia* sp., and *Rasbora* sp. have demonstrated superior mosquito larvicidal efficacy when supplemented with artificial food. Conversely, *Puntigrus* sp. and *Betta* sp. exhibit a preference for both mosquito larvae and artificial food.

Given that mosquitoes are increasingly developing resistance to chemical insecticides, the use of larvivorous fish represents a promising alternative for controlling mosquito larvae and thereby preventing the transmission of vector-borne diseases. Thus, ornamental fish offer a viable option for vector control programs, especially when other methods are ineffective.

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