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Research Article

BIO-CONTROL OF MOSQUITO LARVAE THROUGH THE BLACK MOLLY, *POECILIA SPHENOPS*

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ABSTRACT

Ever increasing mosquito populations is a major cause for many human health hazards due to the transmission of the protozoan and microbial parasites. Additionally, usages of larvicides to control the mosquito population result in many health problems for human beings. Hence, it is suggested that bio-control of mosquito by controlling their larval populations through predator animals will be the best option. In the present study the common ornamental fish, black molly (*Poecilia sphenops*) is used in experiments designed to assess the predation of different instars of *Anopheles* mosquito larvae by this fish. Results indicate juveniles to adults of black molly predate on mosquito larvae. It is recorded that the molly actively chase the mosquito larvae and try to immobilize it by an active encounter with its jaws and then swallows early instars while the advanced instars are further attacked before consuming them. The early instars of mosquito larvae were active predators than the later stages. Present study shows variations with regards to the predation of different instars of mosquito larvae by black molly. The present experiment indicates that the black molly shows good efficacy towards mosquito larvae and hence this fish can be used effectively to control mosquito larvae of all the species.

Keywords: Black molly, Mosquito larvae, Bio-control, Predation.

INTRODUCTION

Mosquito-borne diseases continue to be a major problem in almost all tropical and subtropical countries. They are responsible for the transmission of the pathogens causing some of the most life-threatening and debilitating diseases of man, like malaria, yellow fever, dengue fever, chikungunya, filariasis, encephalitis, etc. Environmental protection agencies have banned or placed severe restrictions on the use of many pesticides, which were formerly used in mosquito control programmes, and there are now fewer adulticides available than there have been for the last 20 years (Collins and Blackwell, 2005). The harmful effects of chemicals on mosquitoes, as well as on non-target populations, and the development of resistance to these chemicals in mosquitoes along with recent resurgence of different mosquito-borne diseases (Milam *et al.*, 2000) have prompted us to explore simple sustainable methods of mosquito control. The eradication of mosquito using adulticides is not a prudent strategy, as the adult stage occurs alongside human habitation, and they can easily escape remedial measures (Service, 1983, 1992). Biological control refers to the introduction or manipulation of organisms to suppress vector populations. As biological mosquito control agents, larvivorous fish (i.e., those that feed on immature stages of mosquitoes) are being used extensively all over the world since the early 1900s (Raghavendra and Subbarao, 2002). A number of hatcheries for mass production were established for bioenvironmental control of malaria at many places in India and fish were transported to the villages where they were stocked and introduced in the mosquito breeding places from time-to-time.

Use of larvivorous fish like *Gambusia affinis* and *Poecilia reticulata* in different mosquito breeding habitats (Ghosh *et al.*, 2011; Haq *et al.*, 1993; Fletcher *et al.*, 1992) in mosquito control has been well established. However, reports on operational level scaling up or large scale use of fishes are scanty (Ghosh *et al.*, 2002, 2005; Haq *et al.*, 2003). *Poecilia sphenops* are small, usually brightly-colored, viviparous fishes of fresh or brackish warm waters. They may prove

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to be a good option to insecticides in vector control where breeding habitats of malaria vectors are confined. Black mollies are voracious, feeding on mosquito larvae in breeding sites like drains and tanks. Bloodworms, micro worms, fruit flies, Daphnia and chopped up earthworms are other examples of suitable food for molly.

The desirable qualities of fishes to serve as bio-control of mosquito larvae are small size to survive in shallow water; surface feeding and carnivorous nature; surviving in the absence of mosquito larvae; easy to rear; withstanding a wide range of temperature and light intensity; hardy and able to withstand transport and handling; insignificant/useless as food for other predators; and having preference for mosquito larvae over other types of food available at the water surface. Biological control is expected to play an increasing role in vector management strategies of the future. In developing countries like India, success of such strategies depends on developing simple technology backed by a campaign of public education. The review of Chandra *et al*. (2008) presents information on different larvivorous fish species and the present status of their use in mosquito control.

The black molly, *Poecilia sphenops* is a common ornamental fish widely occurring in the Indian sub-continent. In the present study, its application in the control of mosquito larvae is evaluated through feeding trials in the laboratory.

MATERIALS AND METHODS

Different sized black mollies were brought from Kolathur Fish Farm (Chennai, India) to the laboratory with least disturbances. These fishes were acclimatized in the laboratory conditions and maintained with Aini pellet feed (Made in China) prior to the experiments. They were offered food to satiation and then starved for 24 h before utilizing them for the experiments. These fishes were divided into four groups with regard to their total length. In each group 10 active fishes of similar length weight were included. Mean and standard deviation of total length of the first, second, third and fourth group of mollies were 9.35±0.30, 10.66±0.29, 12.33±0.20 and 13.46±0.15, respectively. *Anopheles* mosquito larvae were collected from the local drainage canals and the instars were separated into four groups. The length of I, II, III and IV instars were 2.1±0.2, 3.8±0.3, 5.4±0.7 and 7.3±0.5 mm, respectively.

In the feeding trial, one fish was introduced in four 1-L beakers with 20 preys of I, II, III and IV instars of *Anopheles* in each beaker. Predation was observed constantly in order to record the consumption of different instar of mosquito larvae by the fish for one hour. Ten trials were conducted for all the four groups of fishes and mean and standard deviation was calculated. The experimental data was subjected to one-way ANOVA to test the statistical significance.

RESULTS AND DISCUSSION

The total length (Mean±SD) of four groups of mollies used in the present study is given in the Table 1. Mollies of all the four groups predated on all the four instars of mosquito larvae and consumed them. Results indicated that the juveniles of black molly attacked and predated on mosquito larvae. It is recorded that the molly actively chased the mosquito larvae and tried to immobilize it by an active encounter with its jaws and then swallowed early instars, while the advanced instars were further attacked and inactivated before consuming them. The early instars of mosquito larvae were actively predated than the later stages. One-day-old molly fish consumed an average of 2.50±0.70 I instar mosquito larvae. The average number of II, III and IV instars consumed were 1.90±0.73, 0.50±0.04 and 0.20±0.08, respectively, in one hour. Ten-day-old fishes consumed an average of 4.30±0.94, 2.80±0.94, 1.30±0.27 and 0.40±0.12 number of instars I, II, III and IV of mosquito larvae, respectively. Twenty-day-old fishes fed on 7.10±0.87 I instars at an average, and 5.60±0.84, 2.80±0.63 and 1.40±0.51 on II, III and IV instars in one hour, respectively. Thirty-day-old fish consumed an average of 10.20±1.03 I instars, followed by 7.10±0.99, 2.20±0.63 and 2.00±0.47 II, III and IV instar mosquito larvae, respectively (Table 2). This result clearly shows that one-day-old molly feeds more readily on I and II instars of *Anopheles* mosquito larvae than the III and IV instars, which indicates that small-sized fish preferred to have smaller prey as food than the large-sized prey. This could be due to the smaller mouth size of day 1 fishes. Day 30 fish consumed all the instars stages, albeit, IV instar stage was easily consumed by these fishes than the other groups of fishes. The larger mouth size of thirty-day fishes makes it easier for consuming large-sized preys. Large-sized fish reaches the satiation level with less number of large-sized prey (IV instar), whereas more number of small-sized prey (I instar) is required to reach the satiation level. One-way ANOVA showed significant differences at $p<0.05$ level for different stages of *Anopheles* mosquitoes consumed by molly (Table 3).

Table 1. Different days and total length (Mean±SD) of *Poecilia sphenops.*

Total Length of Fishes (Mean±SD)			
	N (no. of fishes)	Mean (mm)	SD
Day 1 (Group-1)	10	9.3500	0.30175
Day 10 (Group-2)	10	10.6600	0.29982
Day 20 (Group-3)	10	12.3300	0.20800
Day 30 (Group-4)	10	13.4650	0.15652

Table 2. Number of different instars of *Anopheles* larvae consumed by mollies (Mean±SD) in 1 Hour.

	Day 1 molly fish	Day 10 molly fish	Day 20 molly fish	Day 30 molly fish
I instar	2.50±0.70	4.30±0.94	7.10±0.87	10.20±1.03
II instar	1.90±0.73	2.80±0.94	5.60±0.84	7.10±0.99
III instar	0.50±0.04	1.30±0.27	2.80±0.63	2.20±0.63
IV instar	0.20±0.08	0.40±0.12	1.40±0.51	2.00±0.47

Table 3. One-way ANOVA of the different instars of *Anopheles* larvae consumed by mollies.

		Sum of Squares	df	Mean Square	F	Sig.
Instar I	Between Groups	17.475	3	5.825		
	Within Groups	15.500	36	0.431		
	Total	32.975	39		13.529	.000*
Instar II	Between Groups	38.475	3	12.825		
	Within Groups	12.500	36	0.347		
	Total	50.975	39		36.936	.000*
Instar III	Between Groups	117.600	3	39.200		
	Within Groups	14.800	36	0.411		
	Total	132.400	39		95.351	.000*
Instar IV	Between Groups	190.275	3	63.425		
	Within Groups	16.500	36	0.458		
	Total	206.775	39		138.382	.000*

*Significant at 0.05 level confident

Similar to the present study, many fishes were reported to play a vital role as bio-control agents of vectors of many diseases. Recently, three indigenous fish species of Assam viz., *Channa gachua*, *Puntius sophore* and *Trichogaster fasciata* were documented as larvivorous fish. Out of these three species, *C. gachua* was found to consume a maximum number of mosquito larvae followed by *P. sophore* and *T. fasciata*. It was also observed that all the fish species consumed maximum numbers of mosquito larvae at first 30 minutes and Thereafter the feeding intensity decreased. Being a voracious feeder and carnivorous in nature *C. gachua* is reported to consume large number of mosquito larvae if available in the surrounding (Phukon and Biswas, 2013).

Anyaele and Obembe (2011) reported that *Aphyosemion gularis* is a strong bio-control agent due to the fact that it can be used for the control of both *Anopheles* and *Culex* mosquitoes. However, their bio-control efficacy will be most exploited against *Anopheles* larvae. The fish will most likely do well even in the presence of alternative preys such as ostracods. Studies of Devi and Jauhari (2011) also revealed that the fish *Aplocheilus panchax* showed higher preference to live food and that too on Anopheline larvae and hence this fish could be one of the efficient bio-control agents in fields and thus in reducing mosquito-borne diseases. However, Mannaa *et al.* (2008) reported that the consumption of IV instar *Culex quinquefasciatus* larvae by individual *Poecilia reticulata* ranged between 65 and 84 in a three-hour feeding period and varied with the size of fish. The selectivity coefficient revealed a significantly low preference for the *Cx. quinquefasciatus* larvae compared to the chironomid larvae and tubificid worms, when all the three prey types were present. The total consumption of all the prey types varied with the predator density, but the selectivity index for the mosquito larvae was significantly low in all the instances. Nevertheless, present study suggests that being an ornamental fish *P. sphenops* could be used as an ideal bio-control agent of mosquito larvae in all mosquito-breeding habitats, including urban and sub-urban areas as well as in the backyard of houses.

Das and Amalraj (1997) opined that there are some reservations about biological control against malaria and they considered it to be more difficult to use than chemicals and sometimes agents can be effective in controlling vectors at laboratory conditions, but they may fail in the field. In addition to that they may also be specific in terms of type of mosquito to be controlled and the type of habitat for their performance. It has been found that introduction of the exotic, voracious and aggressive *G. affinis* actually led to the elimination of native fishes very significantly.

Review of WHO (2003) has shown that biological control using fish is best achieved as part of an integrated vector control strategy. While larval control by fish, like chemical larviciding, will reduce vector densities, a nearly perfect larval control is required to significantly reduce the risk of malaria transmission in a given area. A nearly complete larval control is possible in well-defined situations (semi-arid areas, oases, urban areas, etc.) and would require, among other things, a thorough knowledge of the vector ecology, geographical reconnaissance of larval habitats in targeted areas and a significant degree of skill in breeding, transportation and use of fish.

CONCLUSIONS

In conclusion, the use of larvivorous fish has been found to be an effective and environment-friendly and sustainable selective vector control method. The results of the present study indicate that the use of larvivorous fishes can be of great help to state vector control programme. There is a need to strengthen the vector control programme by providing the necessary trainings on technical aspects, operational issues such as fish identification, collection, transportation, introduction of the fish in all mosquito breeding habitats, precautions during handling and fish density determination etc. Although the use of larvivorous fishes in the vector control programme has been taken up on operational scale with variable performance levels but large-scale operational use of larvivorous fish for vector control still remains under exploited at the national level and there is an urgent need to set up a national level research and training facility.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest associated with this article.

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