J. Ecophysiol. Occup. Hlth. 16(1 & 2), 2016, 7–12

DOI : 10.15512/joeoh/2016/v16i1&2/15697

Comparative Study of Larvicidal Efficacy of Four Indigenous Fish with an Exotic Top Water Minnow, *Gambusia affinis*

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Abstract: *The present work was designed to compare the larvicidal efficacy of four indigenous fish namely Rasbora daniconius, Esomus dandricus, Trichogaster fasciata and Trichogaster lalia with an exotic top water minnow, Gambusia affinis in the laboratory for 30 days. The experiment was performed in glass aquarium with 100 larvae as a feed to each one for duration of 2:00 hours. The study revealed that all the fishes are concerned with larvicidal potential with differences in their feeding efficiency. Mean final body weight was found to be maximum in exotic mosquito fish, Gambusia affinis (2.52±0.414) in the present study and it was significantly different (p=0.0001) from other fishes. The sequence of predation efficacy noted in the present study was Gambusia affinis>Esomus dandricus>Rasbora daniconius>Trichogaster fasciata>Trichogaster lalia.*

Keywords: *Gambusia affinis*, Indigenous Fish, Larvivorous Fishes, Mosquito Larvae.

Introduction

Moquitoes possess great efficiency of transmitting many hazardous diseases throughout the world which includes malaria, dengue, filariasis, encephalitis, equine infectious anaemia, yellow fever and chikungunya Pant *et al*., (1981), Hass and Pal, (1984), Lichtenberg and Getz, (1985), Fletcher *et al*., (1992) Homski *et al*., (1994) Walker, (2002). Chandra *et al*., (2008) reported that mosquito borne diseases not only will be continued to be a major problem in almost all tropical and subtropical countries but also will be responsible for more than 3 million deaths per year Fang (2010). Many chemical and biological methods are being employed to control these mosquito-borne diseases, which have proved to be the biggest threat to the society. Chemical control methods were used to eradicate them, but due to intensive use of these chemicals they became less effective because of development of resistance in mosquitoes Zaman, (1980), Novak and Lampman, (2001). Moreover the uses of chemicals increased environmental pollution depleted beneficial insects' species, out broken secondary pests and as a result bioaccumulation of pesticide residues occurred in non-target organisms including humans Novak and Lampman, (2001). Nowadays attempts are being made to use larvi-cidal fish species as biological controlling agent which is considered to be the best alternative to chemicals to fight against mosquitoes and their larvae Ritchie and Laidlawbell, (1994), Raghavendra and Subbarao, (2002). Mohamed, (2003), Ghosh *et al*., (2005), Yildirim and Karacuha, (2007). Gerberich and Laird (1985) reported that there are more than 253 fish species which have been considered for mosquito biocontrol programme throughout the world, among them notable indigenous fishes are *Rasbora daniconius, Trichogaster*

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fasciata, Trichogaster lalia, Notopterus notopterus, Esomus dandricus, Puntius ticto, Puntius sophore, Puntius conchonius, Channa gachua, Anabas testudines, Wallago attu, Chanda nama and *Mystus bleekeri* Morton *et al*., (1988) Neng *et al*., (1987) Kim *et al*., (1994). Job (1940) pointed out that the larvi-cidal fish must be hardy in nature, small in size and capable to live in shallow water among thick weeds where mosquitoes usually breed. Besides, these larvi-cidal fish should be draught resistance, able to flourish in both deep and shallow waters, must be prolific breeders, ability to breed in confined water successfully, also capable of living in drinking water tanks and pools without contaminating its water Menon and Rajagopalan, (1978) Gupta *et al*., (1992). The exotic fish such as top water minnow, *Gambusia affinis* and guppy, *Poecilia reticulate* are considered to be most successful and widely used for a longer period of time in India to control mosquitoes as reported by Sharma, (1994), Chatterjee and Chandra, (1997), Singaravelu *et al.,* (1997). But *Gambusia* and *Poecilia* being invasive in nature they compete with the indigenous fish and other aquatic organisms for food and space.

Keeping in mind the paucity of information on the use of Indigenous fish species to control mosquitoes the present experiment was designed to investigate the predation potential of few indigenous fish species with an exotic top minnow, *Gambusia affinis* in the laboratory for 30 days.

Materials and Methods

Four indigenous fish species namely *Trichogaster fasciata, Trichogaster lalia, Rasbora daniconius* and *Esomus dandricus* were collected using cast and drag nets from river Gomti at Lucknow region and exotic fish, *Gambusia affinis* was brought from an aquarium shop. The details of the fish species selected for the experiment are given in the Table 1. They were acclimatized separately in the laboratory for 7 days. Total 50 fishes were divided into10 aquaria of equal size, each containing 5 fishes and grouped as ‘A’ (*G.affinis*), ‘B’ (*E.dandricus*), ‘C’ (*R.daniconius*), ‘D’ (*C.fasciata*) and ‘E’ (*C.lalia*). The experiment was performed in duplicates. The weights of all the fishes were taken from an electronic balance sensitive up to 0.001. The experiment was conducted for

Table 1. Details of the Different Fish Species Selected for the Experiment

Group Name	Name of Fish Species	Common Name	Size (cm)	Order, Family	Distribution	Feeding Habit
A	*Gambusia affinis*	Top water minnow	6.0	Cyprinodontiformes, Poeciliidae	United State, introduce in India about 40 years ago.	Carnivore
B	*Esomus dandricus*	Dendua	6.8	Cypriniformes, Cyprinidae	Pakistan, Bangladesh, Nepal, Afghanistan and Sri Lanka	Carnivore
C	*Rasbora daniconius*	Dendua	8.8	Cypriniformes, Cyprinidae	India, Pakistan, Ceylon, Burma and Malaya Archipelago.	Carnivore
D	*Trichogaster fasciata*	Giant gourami	12.5	Perciformes, Osphronemidae	Assam, Myanmar, Punjab, Pakistan and Peninsular India.	Omnivore
E	*Trichogaster lalia*	Dwarf gourami	5	Perciformes, Osphronemidae	North India, Assam, Uttar Pradesh, Bihar, Bengal.	Omnivore

30 days in the month of September in order to get the maximum number of mosquito larvae. The larvae were brought from nearby pond of Lucknow University with the help of a scoop net and they were sieved to remove the phytoplankton, zooplankton, insects and dry leaves. A total of 100 larvae were given as a feed to each aquarium for duration of 2:0 hours in a day time in order to know the predation efficacy. After the feeding duration, the numbers of larvae left in the aquaria were counted and removed. The weight of all the specimens of fish species was taken at duration of 10 days till the end of experiment. Data are presented as mean ± SEM, and a probability level of 5% was used as the minimal criterian of significance. The weight gained by the fish species was statistically analysed through one way ANOVA followed by Tukey's post hoc test. A statistical analysis was carried out through Graph Pad Prism software (version 5.0) and Paleontological software (PAST, version 3.12).

Results and Discussion

The maximum and minimum weights were gained by *Gambusia affinis* and *Trichogaster lalia* respectively in the present study. Also feeding efficiency of larvivorous fish species during 2:00 hour's interval time was determine which pointed out that *G.affinis* possess highest feeding efficacy potential as compare to other fishes used in the experiment, as given in Table 2.

The sequence of predation efficacy in the present study was as follows: *Gambusia affinis>Esomus dandricus>Rasbora daniconius> Trichogaster fasciata>Trichogaster lalia*. The mean weight gained by the different species of fish in the present study was highly significant (Figure 1). *G. affinis*, an exotic top water minnow gained the maximum weight (2.52 ± 0.414) in the present study followed by carnivorous fishes such as *E. dandricus* (2.22 ± 0.109), *R. daniconius* (1.94 ± 0.054) and further by omnivorous fishes like *T. fasciata* (1.72 ± 0.083) and *T. lalia* (1.62 ± 0.044) as given in Table 3.

Statistical analysis for the mean weight gain among all groups which revealed the significance of (One way ANOVA: p=0.0001, F=6.524, Table 4). Multiple group comparison test, post hoc Tukey's HSD which showed the high significance of group 'A' from group 'E' (p=0.000427), 'C' (p=0.008849) and 'D' (p=0.000427) respectively detailed in Table 5.

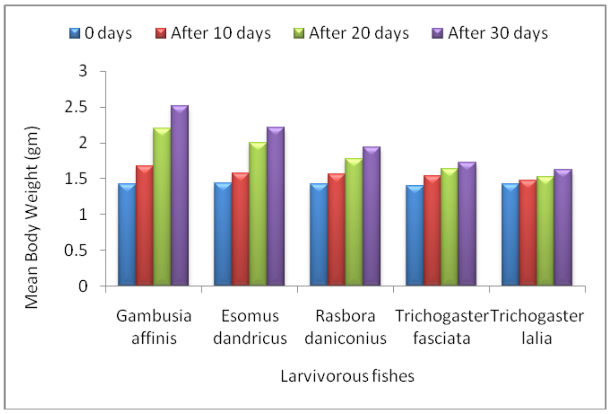

Fig. 1 Mean Body Weight of the Fish Species During 2:00 Hrs Interval

Table 2. Feeding Efficiency of Larvivorous Fish Species During 2:00 Hrs Interval Time

S. No	Name of Fish Species	No. of Specimens	No. of Larvae Supplied	No. of Larvae Eaten	No. of Larvae Left
Group A	*Gambusia affinis*	5	100	90	10
Group B	*Esomus dandricus*	5	100	79	21
Group C	*Rasbora daniconius*	5	100	69	31
Group D	*Trichogaster fasciata*	5	100	57	43
Group E	*Trichogaster lalia*	5	100	42	58

Table 3. Body Weight (Mean ± SEM) of the Fish Species During the Experiment

Experimental Days	***Gambusia affinis***	***Esomus dandricus***	***Rasbora daniconius***	***Trichogaster fasciata***	***Trichogaster lalia***
0 days	1.42 ± 0.192	1.44 ± 0.167	1.42 ± 0.083	1.40 ± 0.122	1.42 ± 0.148
After 10 days	1.68 ± 0.083	1.58 ± 0.083	1.56 ± 0.089	1.54 ± 0.054	1.48 ± 0.044
After 20 days	2.20 ± 0.100	2.00 ± 0.158	1.78 ± 0.130	1.64 ± 0.054	1.52 ± 0.044
After 30 days	2.52 ± 0.414	2.22 ± 0.109	1.94 ± 0.054	1.72 ± 0.083	1.62 ± 0.044

Table 4. Statistical Analysis by One Way ANOVA

	Sum of Square	Degree of Freedom	Mean Square	'P' value	'F' value
Treatment (Between Coloumns)	2.322	4	0.5804	0.0001***	6.524
Residual (Within Columns)	8.452	95	0.08897		
Total	10.77	99			

Significance level (*less than 0.05, **less than 0.01 and *** less than 0.001)

Table 5. One Way ANOVA Followed by Tukey´s Test for Comparison Between all Groups Used in the Experiment

Tukey´s Multiple Comparison Test	Mean Diff.	P value	95% CI of Difference
Group A vs Group B	0.1450	0.5412	–0.117 to 0.407
Group A vs Group C	0.3200	0.008849**	0.057 to 0.5829
Group A vs Group D	0.3600	0.002312**	0.097 to 0.6229
Group A vs Group E	0.4100	0.000427***	0.147 to 0.6729
Group B vs Group C	0.1700	0.3487	–0.087 to0.4379
Group B vs Group D	0.2150	0.1608	–0.047 to 0.477
Group B vs Group E	0.2650	0.04653*	0.0020 to 0.527
Group C vs Group D	0.04000	0.9932	–0.222 to 0.302
Group C vs Group E	0.09000	0.8748	–0.172 to 0.352
Group D vs Group E	0.05000	0.9841	–0.212 to 0.312

Significance level (*less than 0.05, **less than 0.01 and *** less than 0.001)

The Indigenous fish such as *E. dandricus, R. daniconius, T. fasciata* and *T. lalia* were found to be quite useful for mosquito control in the present experiment without any ecological and environmental hindrance. Rupp *et al,* (1996) suggested that the only native fishes should be used for biological control of mosquitoes in order to avoid the invasive nature of exotic species such as *Gambusia* and *Poecilia*. The Indigenous larvivorous fishes showed excellent results with high predation efficiency and good survival ability in all water bodies such as rivers, wetland, ponds and ditches by tolerating high salinity and high turbidity. Besides this they do not cause any harm to other native fishes and also breed naturally. The experimental

Indigenous fishes such as *E. dandricus, R. daniconius, T. fasciata* and *T. lalia* required no proper care and the cost of introducing them is also quite low than that of the chemicals .

Biological control considered to be not only the best method but highly effective in vector management as compared to the other used chemical methods as it is effective and safe to human and other non-target populations, producing lower risk of resistance development and offers low cost of production Yap HH *et al,* (1985). But it is considered to be quite challenging and difficult to use the fish as biological control than chemicals Das and Amalraj, (1997) and confined to the laboratory scale Spielman *et al*., (1993). The widely used exotic mosquito fish, *G. affinis* in India considered being having some serious negative ecological impacts as it led to the elimination of native fishes (WHO Technical Report Series, 1995). Rupp, (1996), Gratz *et al.,* (1996), Morgan and Buttemer, (1996) have revealed the negative ecological impacts of mosquito fish on non-target organisms and on the natural environment. As the mosquito fish, *Gambusia* matures it prefers variations in their diet from small diatoms to cladocerans to adult insects Garcia-Berthou (1999). Moreover, *G. affinis* is highly voracious and aggressive in nature, and found to be successfully competing with the native fishes for their proper food and space. Ritchie and Laidlawbell, (1994) reported that the mosquito fish prey on mosquito larvae, thus disrupting their life cycle and also found to repel ovipositor. The *Gambusia* essentially depleted all large zooplanktons while rotifers and phytoplankton densities increased Hurlbert and Mulla, (1981), Bence, (1988). Therefore, the strategy of biological control through indigenous larvivorous fishes can be applied on a large scale which is pollution free and economically viable.

Acknowledgements

The authors are thankful to the Head, Department of Zoology, University of Lucknow, Lucknow for providing all necessary facilities during the study. One of the authors also thanks to UGC for BSR fellowship.

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