International Journal of Mosquito Research

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2016; 3(4): 53-57

Received: 10-05-2016
Accepted: 11-06-2016

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Effect of environmental attributes and mosquito larvae on growth parameter of larvicidal fish, *Rasbora daniconius*

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Abstract
Present study was aimed to investigate the effect of environmental factors and mosquito larvae as food on fish body growth and to aware village people for mosquito vector management and aquaculture economics in small ponds. The experiment was setup in water storage tank in open environmental conditions in village.
Growth of fingerlings in the tank was found to be exponential, where the degree of variance in size among the fingerlings increased with age. Fingerlings were shown significant differences in their growth rates. *Rasbora daniconius* was very hardy and strong larvivore in the natural environmental conditions. The positive and highly significant correlation 0.9935 was found between length and weight of *R. daniconius*.

Keywords: Local larvicidal fish, local habitat, length and weight, aquaculture, vector free village

1. Introduction
The most common mosquito breeding places such as underground cement tanks, ground level tanks, fountains, wells, mill hydrant tanks, cattle troughs and ponds were exclusively monitored. Since mosquitoes need water to complete their life cycle, the source of a mosquito problem can be just a place, where water collect. Mosquito larvae associated with permanent bodies of water generally live in shallow water (1 ft or less). Most of the mosquito species associated with marshes or swamps actually breed in temporary pools along the margins of these habitats [12, 26, 30, 31]. In recent time, mosquitoes become more dangerous in tropical and subtropical areas and are becoming major problem for human health. In rural areas during rainy season disease transmission risk is increased for village peoples and animals because lack of facilities and adequate knowledge for management of mosquito vectors [10, 13, 31, 32]. They are responsible for more than 3 million deaths per year [14].The chemical control of mosquitoes has a number of drawbacks including being costly, causing environmental pollution and resistance development in mosquitoes [43]. A well-known alternative method to chemicals in the fight against mosquitoes is using larvicidal fish, which not only predate on mosquito larvae, but also have been found to repel oviposition [33]. Native fish should be used for biological control of mosquitoes as opposed to introducing exotic species [25, 34]. During operational period mass production of local larvicidal fish should be establishment for regular availability [19]. *Rasbora daniconius* and *Puntius ticto* are strong candidates as biological control agents, having an affinity for mosquito larvae as well as being very eurythermal and euryhaline [7, 8, 32,3 9]. In comparison to commercially grown fish, however, little is known on the biology of cypriniformes for efficient large-scale production.
For efficient control of mosquito larvae further investigations are to be needed to provide information for maximizing production rates of the fish. Efficient, low-cost fish-culture programs are essential, especially in developing countries where tropical diseases are one of the main obstacles for development [9, 18]. Among the live feeds that fish consumes, mosquito larvae are one of the most favorite food items for the larvicidal fish [1]. Larvicidal fish should be surface feeders and carnivorous in habit and should have a predilection for mosquito larvae even in the presence of other food materials.

Fish culture activities in many other parts of the world create the need to have adequate knowledge of good stocking to obtain better and healthier yields. Stocking density is an important indicator that determines the economic viability of the production system [2]. Considering the importance of the predation efficiency in relation to fish size as mosquito control agents, the present work was initiated to aquaculture economics along with assess the larvivorous potential of *R. daniconious* fish commonly available in rivers, ponds and pokhars in Chitrakoot area.

2. Materials and Methods

Initially *Rasbora daniconius* fish was collected from river Mandakini (25^0 08' 14'' to $25^0$16'17''N 80^0 51' 01'' to 80^0 50' 28''E) and transferred in to the laboratory. All fish were acclimatized under laboratory and field conditions over a week before the experiments. Initial size of fish at the time of introduction was 1.5 to 2.0 cm and body weight 0.8 to 1.5g per fish. For the feed trial experiment 03 cemented tanks (1m x 1m x 1/2m) were selected for a period of six months starting from September to February 2012-2013. The experimental feed (1000 *Culex* mosquito larvae) was applied twice a week at a rate of 5% (5g) of the body weight over a six month trails. Density was 50 fingerlings in the tank. Ten (10) fish were randomly selected from each tank; the weight (g) was taken by a digital balance (Citizen CTG 302) and the standard length (cm) from the tip of the snout to the tip of the caudal peduncle by placing the fish in a Petri dish on a normal scale.

The field culture method was adopted by Adak *et al*. 1994; Ghosh *et al*. 1994 and Ghosh *et al*. 2003. The experiment was terminated on the last February, 2013. The fish were harvested from tanks and their final length and weight were measured. The survival rate was estimated as follows:

$$\text{Survival rate (SR \%)} = \frac{\text{(No. of fish harvested)}}{\text{Initial no. of fish}} \times 100$$

The physico-chemical parameters such as water temperature, dissolved oxygen (DO), pH and total hardness (calcium and magnesium) were monitored weekly throughout the experimental period. Water quality parameters were analyzed using standard methods according to APHA- AWWA-WPCF, 1998 [4]. The pH was taken by pH meter (ESICO MADEIN 1010) and temperature by Mercury thermometer (accuracy 0.5). The variation in length gain (cm) and weight gain (g) of the fish under treatments over a six month were tested using bivariate analysis. Significant results (P<0.05) were further tested. Statistical analysis of raw data was calculated using SAS-JMP (USA) Software 9.03 version.

Knowing the best densities for a species is a critical factor for good husbandry practices and creating efficient culture systems. Local peoples have to aware and to prepare for practice of biological control program (Photograph 1).

Fig 1: Awareness program of mosquito borne diseases and larvicidal fishes in villager

3. Results

R. daniconius was recorded valuable growth rate in store water tank environment. The weight and length increases during study period in all observed fish. The results of the present study indicate that the initial length and weight increases gradually during six month period where initial length 1.92 cm and weight 0.80g.First two month of September and October fish was not gain major differences of length and weight but during last week of January and February they gain higher body weight. (Table: 1). Growth of fish is normally found to be exponential over periods of six month or less as was found for fry elevate in this study. The best performance in respect of growth and survival was showed by this fish, when reared exclusively on natural live mosquito larvae. The maximum survival rate (100%) and weight gain (20.65g) was observed in *R. daniconius* (Table: 2). The value of all observed physicochemical parameters like average temperature ranges from 18.24 ^{0}C to 27.97 ^{0}C, pH 7.38 to 7.57, DO 4.52 to 7.18 and total hardness 338 to 365 during experimental period (Table: 3).

Table 1: Observational revelation of fish recording to their length and weight in experimental conditions (Cement tanks)

Month	***Rasbora daniconius* (n=10)**	
	Length (cm)	Weight(g)
Stocking	1.92	0.80
September	2.60	1.98
October	2.89	2.33
November	4.68	3.04
December	5.20	4.10
January	5.81	4.68
February	6.38	5.32

Table 2: Growth performance of larvicidal fish

Parameters	***Rasbora daniconius***
Mean initial weight (g)	0.80
Final weight (g)	21.45
Weight gain (g)	20.65
Survival rate (%)	100

Table 3: Physicochemical parameters during the culture period

Month	Parameters	Tanks	APHA (1998)
		Average (4 week)	
September	Temperature	27.97 ^{0}C	28 - 30
	pH	7.57	6.5 - 9.0
	DO*	4.52	5 - 8
	Total hardness*	365	300
October	Temperature	27.21 ^{0}C	28 - 30
	pH	7.50	6.5 - 9.0
	DO*	6.23	5 - 8
	Total hardness*	352.68	300
November	Temperature	24.26 ^{0}C	28 - 30
	pH	7.46	6.5 - 9.0
	DO*	6.12	5 - 8
	Total hardness*	342.68	300
December	Temperature	21.15 ^{0}C	28 - 30
	pH	7.42	6.5 - 9.0
	DO*	7.18	5 - 8
	Total hardness*	338.64	300
January	Temperature	18.24 ^{0}C	28 - 30
	pH	7.38	6.5 - 9.0
	DO*	6.18	5 - 8
	Total hardness*	340.62	300
February	Temperature	24.28 ^{0}C	28 - 30
	pH	7.44	6.5 - 9.0
	DO*	7.14	5 - 8
	Total hardness*	352.72	300

(* = Milli gram per liter)

3.1 Effects of environmental factors on the growth of fingerlings

3.1.1 Temperature

The results clearly indicated that the temperature was significantly affected the growth of *R. daniconius.* Temperature range between 25 ^{0}C to 32 ^{0}C was found suitable for growth but 18 ^{0}C was not helpful for *R. daniconius.* The fish gain 20.65g body weight in cement tank. The comparison of means of body weight in different water temperatures (Table 3) indicated that the water temperature ranges significantly affected the average body weight gain of the fish.

3.1.2 Total hardness

The fish were found to be well adapted to extreme conditions of the hard water. *R. daniconius* was significantly increases body weight between total hardness 338 to 365ppm. The comparison of means of body weight in different water hardness indicated that the water hardness ranges significantly affected the average body weight gain of the fish.

3.1.3 pH

The impact of pH on survival of fish depends on ecological and climatic factors which play an important role in the process of eating of mosquito larvae. The pH value was found to be acceptable range 7.38 to 7.57 for fish culture. Growth rate of all fishes were recorded significant at pH 7.38 to 7.57. The comparison of means of body weight in different pH value (Table 3) indicated that the pH ranges significantly affected the average body weight gain of the fish.

3.1.4 Dissolve oxygen

All fingerlings were successfully grown on DO 4.52 to 7.18 in the tanks environment. The survival rate of *R. daniconius* is 100 % at optimal DO level. The comparison of means of body weight in different DO level (Table, 3) indicated that DO ranges significantly affected the average body weight gain of the fish.

3.1.5 Bivariate analysis of length and weight

The bivariate analysis between weight and length of the fish was statistically investigated in field. The parametric model is as given under (table 4). The analysis of relationship between the two variables (often denoted as X, Y), for the purpose of determining the empirical relationship between them was done. It is simple random sample (SRS) (X_1,Y_1), (X_2,Y_2), (X_3,Y_3). (Xn,Yn).

Table 4: Bivariate analysis of length and weight

Statistics	*R. danconius*
SE	0.084476
t	17.49
Correlation	0.9935
R- square	0.987089

R. daniconius - Weight = -3.967631+1.4772715* Length

3.1.6 Field

The statistical analysis has revealed that there are positive and highly significant correlations (0.9935) between length and weight of *R. daniconius*. The regression was significant at 5% level of probability. If the length of *R. daniconius* is increased by 1 cm the weight of fish is enhanced by 1.48gms. Further this model shoulders 98 per cent of the variation in weight due to length (Table 4)

3.1.7 Distribution pattern of length and weight of *R. daniconius*

The distribution of length pattern was observed Q_1 = 2.8175 (25%), Q_2 =4.94 (50%) and Q_3 = 5.9525 (75%) in the tanks. The mean and the range were observed 4.5933 and 2.9727 to 6.2138 respectively. The coefficient variation was 33.61 per cent. The distribution of weight pattern for this fish was observed Q_1 = 0.2242 (25%), Q_2 = 3.57 (50%) and Q_3 = 4.85 (75%) in the tanks. The mean was 2.9351 and the range was 0.5845-5.2858. The coefficient variation was 76.31 per cent.

4. Discussion

The growth bar of this study demonstrated a gradual phase of growth in all the treatments. However, at points where the treatment growth bars space could be due to recorded low speed growth. For instance, growth of fish in treatments decline in the month October and November and assumed a gradual increasing growth till the experiment was terminated. Growth of fish is normally found to be exponential over periods of six month or less [36] as was found for fry elevate in this study (Figure 2).

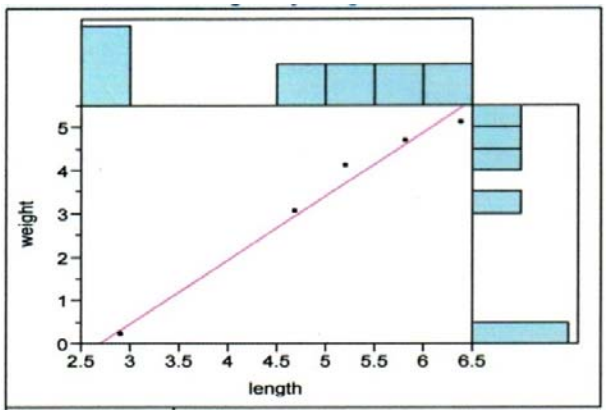

Fig 2: Length and weight performance of *Rasbora daniconius*

Intraspecific variation in fish can be expressed in their morphological, physiological or biochemical characteristics [24] as well as in the growth rate [17, 20, 21]. As the maturation age of the fish fingerling increased, so did the variation in size of the fish group. In addition, the size frequency distribution of the fingerling was found to be twisted to the left. The variations in body weight frequently deviate from the normal distribution of fish populations due to additional individuals which possess malformations, or poorer than normal growth rates [24]. Crowding effects were also ruled out since preliminary experiments had shown that stocking rates of up to seven times that of the standard set for the study did not affect growth rates of similar sized fish. Social interaction was taken to be a possibility, being known to potentially induce stress in the fish [40, 42] and consequently suppress feeding activity and growth [6]. The survival rate and growth performance of fingerlings were found highly positive of *Rasbora daniconius* (table 2). The statistical analysis has revealed that there are positive and highly significant correlations (0.9942) between length and weight. The regression was significant at 5% level of probability in cement tanks. The best performance in respect of growth and survival, exhibited by fingerlings in this study, when reared exclusively on natural live prey substantiates the reports of [37, 38, 35]. The different homemade feed like whole-wheat bread, vegetable peelings and alternative live feeds like water fleas, Tubifex or sludge worm, mosquito larvae and chopped earthworm were useful for fish culture [16]. The efficacy of four types of feed (Living Tubifex, Dried Tubifex, Dried Daphnia and prepared granulated feed) were reported in the rearing of *Poecilia reticulata*. They found that the living Tubifex was the best feed for guppy for increasing the growth and colouration and utilized the living organisms more efficiently than the artificial diet [27].

The present study has also demonstrated that *R. daniconius* successfully survived in cement tank environment with the control of mosquito's vectors. Growth rate was found to increase significantly as feeding rates increased from 0% to 5% body weight (BW)/day [28]). They also found significant increase in growth rate of adult fish as temperature was increased from 18 ^{0}C to 23 ^{0}C offered feed @ of 4% of wet body weight of the fish twice/day [23]. The mortality rate, final mean weight, daily weight gain, and feed conversion ratios were significantly different among rearing systems [29]. These differences were due to the relevant physical and chemical characteristics of the three different rearing systems [22]. The increasing rearing density in fry *O. niloticus* resulted in heterogeneous growth rates. They also reported that feed conversion ratios, specific growth and survival rates were not affected by different stocking densities. The best result was found in growth and survival of *Cyprinus carpio* larvae with cultured live prey organisms [3, 5].

5. Conclusion

There are several disadvantages of using larvivorous fish of *Gambusia affinis* when stocked in waters outside their native range, often causes serious negative ecological impacts like as threat to native communities, resource competition, habitat alteration *etc*. *Rasbora daniconius* is an indigenous local larvicidal fish that can be used in many countries where biological control have been implemented. Many of these countries, however, have limited resources making efficient production techniques of the fish critical. It is an important contribution in the search of implementation of biological control of mosquitoes larvae. Biological control is expected to play an increasing role in vector management strategies of the future.

6. Acknowledgment

I am very thankful to Dr. H.N. Khare Department of Zoology Maharaja College Chhatarpur, Dr. S.S. Mishra Principal Scientist and Dr. Amitabh Chandra Dwivedi Senior Research Fellow Central Inland Fisheries Research Institute, Allahabad for their assistance during the experiment.

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