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Effect of Different Feed on Larval / Fry Rearing of Climbing Perch, *Anabas testudineus* (Bloch), in Bangladesh: II. Growth and Survival

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Abstract.- A study was conducted to assess the suitability of different larval feeds for larvae/fry of climbing perch, *Anabas testudineus*. The experiment was designed on completely randomized design (CRD) with 4 treatments, each with 3 replications. Four different feeds were tested. The feeds was assigned to different treatments *viz.* T_1 (*Artemia nauplii*), T_2 (tubificid worms), T_3 (rotifer powder) and T_4 (zooplankton). The experiment was continued for a period 28 days. Induced bred larvae (9-day old) were used in the experiment. The water quality variables such as temperature, dissolved oxygen (DO), pH, total hardness, free ammonia, etc. were found within acceptable limit of larval rearing. The larvae fed tubificid worms had significantly highest ($P<0.05$) growth (percent length gain 237.80±2.09, percent weight gain 2040.10±17.82, specific growth rate 13.61±0.01) and survival (61.0±2.0%), followed by *Artemia nauplii*, zooplankton and rotifer powder. Therefore, tubificid worms may be suggested for feeding climbing perch larvae upto stockable size.

Key words: Climbing perch, larval rearing, feed, specific growth rate (SGR), survival rate.

INTRODUCTION

The climbing perch, *Anabas testudineus*, is an important indigenous fish of Bangladesh. The fish is very popular in the country for its delicate taste and flavour. The nutritional and medicinal value of this fish has been recognized from time immemorial (Chandi, 1970). It contains very high amount of physiologically available iron and copper essentially needed for hemoglobin synthesis; besides, it possesses easily digestible fat of very low melting point and good many essential amino acids (Shaha, 1971). Therefore, climbing perch is considered as a valuable item of diet for sick and convalescent. Once, climbing perch was abundantly available in almost all freshwater systems of Bangladesh. However, its population has been declining very rapidly in the recent years. Ten years ago, climbing perch contributed 2.83% of the total pond catch of Bangladesh (DoF, 1992), but off late its share to total pond catch has declined to 0.85% only (DoF), 1999). The reasons for such drastic decline are many, such as ecological degradation, indiscriminate fishing, use of pesticides and fertilizers, destruction of habitats, obstruction of breeding migration, management failure, etc. As natural population of climbing perch is declining fast; planners, policy makers, aquaculturists and fisheries biologists are thinking of its cultivation through intensive farming to sustain and augment its production (DoF, 2002).

Considering the above, climbing perch could, therefore, be a potential candidate for aquaculture in Bangladesh. Despite its very high culture possibility, the species is yet to be brought under farming, largely due to unavailability of seed, since artificial breeding and larval rearing techniques are not standardized in the country. Another problem in the extension of *A. testudineus* cultivation in non-availability of fry and fingerlings from natural sources; since, it is impossible to collect viable quantity of fry and fingerling from wild. Larval rearing technique for the species is yet to be developed. Feed is vital for larval rearing of any fish species. In the larval stage, fish are very susceptible to the feed supplied to them, even if other conditions of rearing are properly maintained (Watanabe *et al.*, 1983). At the stage of first feeding, the larvae of

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many species of fish do not accept any formulated feeds, even if it contains balanced amount of nutrients (Lovell, 1934).

The literature is pretty rich in larval feeding of carps and catfishes (Lovell and Stickney, 1977; Rahman *et al*., 1974; Dabrowski *et al*., 1987; Marte *et al*., 1991; Mollah *et al*., 1998). However, only scanty information is available on larval feeding of *A. testudineus* (Banerji and Prasad, 1974; Doolgindachabaporn, 1988). There is no published report on the effect of larval feed on rearing of *A. testudineus* larvae from Bangladesh. Kohinoor *et al*. (1995) investigated food particle size in relation to mouth size in different larval stages of climbing perch larvae. Therefore, a study on the effect of different larval feeds on growth and survival of climbing perch larvae at their early larval stages would be helpful in developing an appropriate larval rearing technology for the fish. The present paper reports the effects on growth and survival rate of *Anabas testudineus* larvae fed with different larval feeds.

MATERIALS AND METHODS

Experimental facilities

The study was carried out in a commercial fish hatchery, Madina Fisheries and Hatchery Complex (Dohar, Dhaka) and Department of Zoology, University of Dhaka, Bangladesh between January 1999 and July 2001. The larval rearing facilities used for this experiment were designed for commercial production of catfishes, *viz. Pangasius sutchi, Clarias batrachus*, etc. Therefore, a part of the hatchery system could be used for the present purpose and certain additional facilities had to be developed in order to facilitate the larval rearing of climbing perch. Twelve plastic bowls (capacity 21-1) were used for larval rearing. The larval rearing bowls had provision for flow through water supply from a concrete overhead tank. Induced bred larvae of climbing perch were used in the present study. *Arteia nauplii* was incubated and hatched in the hatchery. Mixed zooplankton was collected from hatchery's different nursery ponds by bolting silk mesh nets. Tubificid worms were collected from aquarium market of Dhaka City. Rotifer powder (manufactured by Ocean Star Internatioanl Inc., USA. Brand name: Artificial Plankton Rotifer) was collected from a supplier in Dhaka City.

Experimental design

The experiment was laid out following the principle of completely randomized design (CRD) with 4 treatments, each with 3 replications. Induced bred 9-day old larvae were used in the experiment. The experimental larvae were divided into four treatment groups and fed with four different feeds *viz.* T_1 (*Artemia nauplii*), T_2 (tubificid worms), T_3 (rotifer powder) and T_4 (zooplankton). Twelve plastic bowls (21-1 capacity, each), serially arranged on iron frame rack, were used for larval rearing. Each bowl containing 10-1 of water was stocked with eighty (80) larvae. The larvae were fed 5 times a day at 0800 hr, 1200 hr, 1500 hr, 1800 hr and 2100 hr upto satiation and the experiment was continued for 28 days. The water was renewed partially twice daily and debris was siphoned out. The larvae were inspected regularly to recorded mortality, if any.

Sampling procedure

Sampling was done at the beginning and on 28^{th} day of rearing *i.e.* at the termination of the experiment. Measurements were made on 10 randomly caught larvae from each bowl. The length of the larvae were measured by putting the larvae in Petri dish (previously affixed with a graph paper underneath) with little water and recorded in millimeter (mm). The weight of larvae was taken in a pre-weighed (with water) beaker by using a electronic balance (Model A J 100, Metler Company) with an accuracy of 0.0001 g. The following growth parameters were studied to observe the larval growth: percent length gain = Average final length – average initial length / average initial length x 100; percent weight gain = average final weight – average initial weight/average initial weight x 100. Specific growth rate = Ln W_2 – Ln $W_1/T_2 - T_1$ x 100 (Brown 1957). Where, W_2 = Final live body weight (g) W_1 = Initial live body weight (g), $T_2 - T_1$ = Duration of the experiment (day). The number of larvae in each bowl was counted on 28^{th} day *i.e.* at the end of the experiment. The larvae were counted separately from each bowl to find out the survival rate. The following formula was used to calculate percent survival rate: % survival = Number of larvae alive upto 7th day x 100/Total number of larvae stocked. During the experimental period, temperature, dissolved oxygen (DO), pH of water in larval rearing system was monitored regularly. Temperature reading was taken with a Celsius themometer, dissolved oxygen (DO) of water was measured by a digital DO meter (YSI Model 158) and pH reading was taken with the help of a portable pH meter (Jenway, Model 3020).

Statistical analysis

Data are reported as arithmetic mean ± standard deviation (SD). After appropriate transformation (arcsine or logarithm), one way analysis of variance (ANOVA) was applied on the data to assess the treatment effect. When F – values indicated significant difference. Duncan's New Multiple Range Test (DMRT) was employed to discern specific differences among the treatments. All the statistical analyses were done on a computer using statistical software package SPSS (version 7.5).

RESULTS

Effects of different feed on A. testudineus *larvae/fry*

The 9-day old larvae of climbing perch were reared with four different larval feed for a period of 28 days and their length, weight and survival data were recorded. A number of experimental trials were carried out separately during the experimental period, for convenience, the data of different trials were pooled together. Particular attention was given to the trends in the results of the study.

Growth

The larvae reared with different feeds attained lengths of 23.52±0.33 (T_1), 26.02±0.16 (T_2), 17.53±0.31 (T_3) and 21.50±0.20 mm (T_4) at the termination of the experiment (Table I), which corresponds to 205.51±4.32, 237.80±2.09, 127.7±3.97 and 179.22±2.60% increases in length, respectively (Table II). The weight of the larvae increased to 122.00±0.87 (T_1), 203.30±0.61 (T_2), 88.55±0.18 (T_3) and 106.33±0.29 mg (T_4) at the end of the experiment (Table I), corresponding to 1256.30±39.80, 2040.10±17.82, 1007.26±26.48 and 1151.05±11.38% increase in weight, respectively (Table II). ANOVA performed on the percent length gain data (Table III) shows a significant difference among different treatments (F = 571.14*; p<0.05). DMRT further revealed that (P<0.05) the highest growth was obtained with tubified worms (T_2), followed by *Artemia nauplii* (T_1), zooplantkon (T_4) and rotifer powder (T_3). ANOVA on percent weight gain data showed (Table IV) a highly significant difference (F = 641323.83*; P<0.05) among the larval groups fed different experimental feeds. As detected by DMRT (P<0.05), larvae fed tubificid worms (T_2) showed significantly higher weight gain, followed by *Artemia nauplii* (T_1) and zooplankton (T_4) and rotifer powder (T_3).

Specific growth rates (SGR) of larvae under different treatment conditions are presented in Table II. SGR followed a similar pattern as observed with length and weight gain data. The larvae attained SGR of 11.79±0.03, 13.61±0.01, 10.64±0.01 and 11.29±0.01 in T_1 (*Artemia nauplii*), T_2 (tubificid worms), T_3 (rotifer powder) and T_4 (zooplankton), respectively. ANOVA performed on SGR data detected a significant difference (Table V, F = 1531.11* P<0.05) among the treatments. As revealed by DMRT (P<0.05) tubificid worms (T_2) ranked first while rotifer powder (T_5) performed poorest among the treatments.

Survival rate

The percent survival rates of larvae were 50.0±1.73 in T_1 (*Artemia nauplii*), 61.0±2.0 in T_2 (tubificid worms), 30.0±1.73 in T_3 (rotifer powder) and 40.0±1.0% in T_4 (zooplankton) (Table II). Survival rates of larvae/fry under different treatment conditions were, therefore, markedly influenced by different larval feeds. A significant treatment effect of different feeds on percent survival data was observed (ANOVA) (Table VI; F = 530.75*; P<0.01). DMRT performed on the data (P<0.05) showed that the best survival was observed in larvae group fed tubificid worms (T_2), followed by *Artemia nauplii* (T_1), zooplankton (T_4) and rotifer powder (T_3). Therefore, it was apparent from the results that growth and survival of larvae/fry of climbing perch fed finely chopped tubificid worms was the best than the other feeds.

Table I.- Gain in length (mm) and weight (g) of *A. testudineus* larvae fed with different feeds (artithmetic mean ± SD).

Treatment	Initial length and weight		Final length and weight			
	Length (mm)	**Weight (mg)**	**Length (mm)**	**Gain in length (mm)**	**Weight (mg)**	**Gain in weight (mm)**
T_1 (*Artemia nauplii*)	7.70±1.15	4.50±1.10	23.52±0.33	15.85±0.33	122.0±0.87	117.50±0.87
T_2 (Tubificid worms)	7.70±1.15	4.50±1.10	26.02±0.16	18.32±0.16	203.30±0.61	198.80±0.61
T_3 (Rotifer powder)	7.70±1.15	4.50±1.10	17.53±0.31	9.83±0.31	88.55±0.18	84.05±0.18
T_4 (Zooplankton)	7.70±1.15	4.50±1.10	21.50±0.20	13.80±0.20	106.33±0.29	101.83±0.29

Table II.- Growth and survival of early larvae of *A. tetudineus* fed with different feeds (arithmatic mean ± SD).

Treatments	**Percent gain in length**	**Percent gain in weight**	**SGR (%/day)**	**Survival rate (%)**
T_1 (*Artemia nauplii*)	205.51 ± 4.32^{b}	1256.30 ± 39.38^{b}	11.79 ± 0.03^{b}	50.00 ± 1.73^{b}
T_2 (Tubificid worms)	237.80 ± 2.09^{a}	2040.10 ± 17.82^{a}	13.61 ± 0.01^{a}	61.00 ± 2.00^{a}
T_3 (Rotifer powder)	127.7 ± 3.97^{d}	1007.26 ± 26.48^{d}	10.64 ± 0.01^{d}	30.00 ± 1.73^{d}
T_4 (Zooplankton)	179.22 ± 2.60^{c}	1151.05 ± 11.38^{c}	11.29 ± 0.01^{c}	40.00 ± 1.00^{c}

1Means having the same superscript in the same row are not significantly different at 5% level of Duncan's New Multiple Range Test.

Table III.- ANOVA table for percent length gain *A. testudineus* larvae fed with different feeds.

Source of variation		**Sum of squares**	**df (Degree of freedom)**	**Mean sum of squares**	**F (Calculated)**	**F (Tabulated)**
Percent length gain	Between treatments	19507.09	3	6502.36	571.14*	4.07
	Within treatments	91.07	8	11.4111.38		
	Total	19598.17	11			

*Significant at 5% level.

Table IV.- ANOVA table for percent weight gain of larvae fed with different feeds.

Source of variation		**Sum of squares**	**df (Degree of freedom)**	**Mean sum of squares**	**F (Calculated)**	**F (Tabulated)**
Percent length gain	Between treatments	1923971.49	3	641323.83	953.58*	4.07
	Within treatments	5380.34	8	672.54		
	Total	1929351.83	11			

*Significant at 5% level.

Table V.- ANOVA table for specific growth rate of *A. testudineus* larvae fed with different feeds.

Source of variation		**Sum of squares**	**df (Degree of freedom)**	**Mean sum of squares**	**F (Calculated)**	**F (Tabulated)**
Percent length gain	Between treatments	14.81	3	4.93	1531.11*	4.07
	Within treatments	2.580E-02	8	3.225E-03		
	Total	14.89	11			

*Significant at 5% level.

Table VI.- ANOVA table for survival rate of *A. testudineus* larvae fed with different feeds.

Source of variation		Sum of squares	df (Degree of freedom)	Mean sum of squares	F (Calculated)	F (Tabulated)
Percent length gain	Between treatments	1592.25	3	530.75	193.00*	4.07
	Within treatments	22.00	8	2.75		
	Total	1614.25	11			

*Significant at 5% level.

Table VII.- Physico-chemical conditions of water in larval rearing system under different treatments (arithmetic mean ± SD).

Parameters	T_1 (*Artemia nauplii*)	T_2 ((Tubificid worms)	T_3 (Rotifer powder)	T_4 (Zooplankton)
Temperature (°C)	28.0±1.0	28.0±1.0	28.0±1.0	28.0±1.0
pH	7.1±0.3	7.4±0.5	7.2±0.4	7.0±0.6
DO (mg/l)	5.6±0.4	5.4±0.7	5.7±0.8	5.8±0.9
Total hardness (mg/l)	114±5.00	114±6.00	114±7.00	116±6.0
Free NH_3 (mg/l)	0.021±0.001	0.023±0.001	0.025±0.001	0.022±0.001

Physico-chemical conditions of water of the rearing system

The physico-chemical parameters of water of the experimental system are shown in Table VII. Temperature ranged 28±1°C, pH between 7.0 and 7.4, DO 5.4 and 5.8 mg/l, total hardness between 114 and 116 mg/l and free ammonia between 0.021 and 0.025 mg/l.

DISCUSSION

The growth and survival rates of larvae/fry were highly influenced by different larval feeds. As evident from Table I and II, percent length gain, percent weight gain, specific growth rate and survival rate of climbing perch larvae/fry fed live feed (tubificid worms, *Artemia nauplii* and zooplankton) were significantly higher than those fed non-live feeds (rotifer powder). Among the live feeds, finely chopped tubificid worms performed best with regard to growth parameters studied (percent length gain 237.80, percent weight gain 2040.10 and specific growth rate 13.61), whereas, poorest growth was observed in the larvae fed with rotifer powder (percent length gain 127.7, percent weight gain 1007.26 and specific growth rate 10.64). Similarly, survival rates were also influenced significantly by different feeds used and the highest rate of survival (61%) was obtained by tubificid worm (Table II). Better performance of live feed on growth and survival of climbing perch larvae has also been demonstrated in a number of studies. Pal *et al.* (1977) studied the effect of six feeds (wheat flour, rice bran, soybean powder, prawn meal, zooplankton and cooked egg) on growth and survival of 2-day old larvae of climbing perch and reported that larvae fed egg yolk showed poorest growth, whereas live feed gave relatively better growth and survival.

In another study with the same fish larave, Doolgindachabaporn (1988) also observed poor growth and survival of egg yolk fed larvae. The results from studies with other fish larvae also support the findings of the present study. Fermin and Boliver (1991) reported that the specific growth rate of *Clarias macrocephalus* larvae fed live feed was higher than those fed non-live food. Bairage *et al.* (1988) tested the effect of *Artemia nauplii*, zooplankton and a formulated artificial feed on *Clarias batrachus* larvae for a period of four weeks and found live feed (*Artemia nauplii*) as the best feed with regard to growth and survival. According to Rahman *et al.* (1974), the growth and survival of the larvae of *C. batrachus* was better in larvae fed tubificid worms than those fed non-live feeds, egg yolk in particular. Haque and Barua (1989) found that non-live feeds (fish meal and wheat flour) were not at all suitable for the larvae of *Heteropneustes* *fossilis*, while live food (tubificid worms) resulted in the best growth and survival. Ghyeas (1998) studied the effects of three feeds *viz.*, tubificid worms, a formulated feed and a commercial nursery feed on growth and survival of *Heteropneustes fossilis* larvae. In this case also, growth and survival of larvae fed tubificid worms gave the best result. Kestemont and Statmans (1992) reported best survival rate, growth and feed utilization of *Phoxinus phoxinus* larvae when reared on *Artemia nauplii*. According to Hirano and Hanyu (1990) all developmental stages of *Clarias gariepinus* can adapt to artificial feeds, however, the best growth was obtained by larvae fed on live feed. Comparatively better performance in growth and survival of fish larvae fed live feed was also observed by Wilson (1991) in turbot (*Scophthalmus maximus*), milkfish (*Chanos chanos*), stripped bass (*Morone* spp.) and barramundi (*Lates calcarifer*). Kanazawa (1991) also commented that live feed is preferable for larval nutrition than non-live feeds.

The better performance of the live feed, tubificid worm in particular, has been explained in many publications, although the exact cause is not well understood. It appears that a number of factors could be involved. The higher growth and survival rate of larvae fed live feeds might be due to greater ability of larvae to efficiency synthesis protein from live feed. On the other hand, the lower growth and survival rate of the larvae fed non-live feeds (rotifer powder and egg yolk) was perhaps associated with deficiency of some essential components, such as amino acids and fatty acids. Dabrowski (1984) and Dabrowski *et al*. (1987) reviewed the feeding of fish larvae, and pointed out that fish larvae are susceptible to dietary deficiency in more spectacular ways than juveniles and adults, he noted that amino acids in live foods are catabolized at a lower rate and therefore used to a greater extent for protein synthesis than amino acids from artificial diets. In the present study, the use of rotifer powder and egg yolk was also associated with some additional problems. It was observed that cleaning of unused portion of egg yolk and rotifer powder from the rearing system was very difficult. Moreover, egg yolk and rotifer powder became rotten readily in rearing system with consequent deterioration of water quality, thus probably resulted in bacterial growth and increased mortality. On the other hand, tubificid worms, which was applied in finely chopped form, did not offer any such problems. It was also observed that in case of rotifer powder and egg yolk the cleaning process also contributed to the death of some larvae.

The physical and chemical qualities of water in different treatment are reported in Table VII. Water temperature did not differ significant ($F = 1.02$, $P<0.05$) among the treatments. The mean water temperature remained with in 28.0±1.0°C, a temperature within the range for optimum larval rearing (Boyd, 1982). Dissolved oxygen concentration remained within the range of 5.7±0.8 to 5.8±0.9 ppm and did not vary significantly ($F=2.01$, $P<0.05$) among the treatments. Generally, pH was found around 7.0±0.6 to 7.4±0.5, being favourable for larval growth (Stirling, 1985). There was no significant variation in the total hardness of different ponds, the hardness values were found between 114±5.00 and 116±6.0 ppm, a range suitale for rearing of climbing perch larvae (Doolgindachabaporn, 1988). Free ammonia did not exceed 0.025 ppm and never reached to harmful level for larvae.

Considering the above, it may, therefore, be concluded that live feed is suitable for rearing larvae/fry of climbing perch and finely chopped tubificid worms could be considered as the best feed for 9-day old larvae up to stockable (fry) size.

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