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Nursing and rearing of *Macrognathus aculeatus* at different stocking densities in pond culture system

S.M. Farid, M.I. Miah[1], M.A.B. Habib[2], M.M. Hasan[1] and A.K.S. Ahammad[3]
Department of Fisheries, Ministry of Fisheries & Livestock, Bangladesh, Dhaka, [1]Department of Fisheries Management, [2]Department of Aquaculture, [3]Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202.

Abstract: Nursery rearing of *Macrognathus aculeatus* was studied in relation to varying stocking densities for a period of six weeks from 20th July to 2nd September, 2005 in earthen ponds. The growth performances of Tarabaim (ADG, SGR and survival rate) were found to be better at a stocking density of 0.2 million fry/ha when fed diet finely powdered mustard oil cake and rice bran (3:2 ratio) with a protein content of 22.36% than other diets. Stocking density had significant effect on the growth, survival and production of fish fry. The physico-chemical and biological characteristics of water were found to be in optimum ranges for the fish culture. It is clear that survival rate and growth of fry were inversely related with the stocking density. However, results were indicated that the nursery operators may stock *M. aculeatus* at 0.2 million fry/ha for achieving satisfactory growth performance and survival rate during nursing stage.
Key words: Nursing, *Macrognathus aculeatus*, stocking density, growth, fry

Introduction

Tarabaim, *Macrognathus aculeatus* is a common freshwater small omnivorous eel fish of Bangladesh. It is commonly found in natural water bodies i.e. haors, baors, beels, river and flood plains of Bangladesh. Unfortunately, the population of this fish has declined in recent years due to various ecological changes. Now its natural population has been declining very fast. So this fish is considered as a critically endangered species (IUCN, 2000). As such, the species should be protected from being extinct. One of the most effective means to restore its natural population is to apply the artificial propagation techniques to breed the fish in captivity and to release the fingerlings in natural water system. Hence, the development of suitable culture techniques for rearing of fish fry is very important to ensure reliable and regular supply of fingerlings. Successful controlled method of fry nursing and rearing depend on a good knowledge of nutritional and environmental requirement of the larvae (Mollah, 1985). Success in fish culture primarily depends on the quality of fish fry. Production of quality fish fry is a function of genetic make up, stocking density, feeding, water quality management, health care and overall manipulation of culture environment. At present, no information exists on the rearing practices of *M. aculeatus*. Therefore, it is important to generate information and to create data base on production biology of *M. aculeatus* fry and fingerlings under controlled condition. So, the present study has been undertaken to find out the effects of stocking densities on the survival, growth and production of *M. aculeatus* fry; and to find out optimum stocking densities in nursing of *M. aculeatus* spawn.

Materials and Methods

Duration and study area: The experiment was conducted in nine earthen ponds for a period of six weeks from 20th July to 2nd September, 2005 in three treatments with three replications following the completely randomized design in the Field Laboratory Complex of the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh. Three stocking densities of fry viz. 0.20, 0.30 and 0.40 million/ha considering three treatments were maintained. Selection of ponds, pre-stocking, stocking and post-stocking management, analysis of water quality and statistical analysis were done.

Supplementary feeding: Pond conditions were monitored twice a day to observe any abrupt change in the behavior of fishes or colour of water. Supplemental feed consisting of finely powdered mustard oil cake and rice bran (3:2 ratio) with a protein content of 22.36% were given in ponds daily at the rate of 8 kg /0.1 million of stocked fry for the 1st and 2nd week and thereafter it was increased by 2 kg/0.1 million fry/week.

Results and Discussion

Water quality parameters: All the water quality parameters were within the normal or suitable ranges for the culture of M. aculeatus post larvae. The mean values ± SD of temperature (°C), transparency (cm), pH, dissolved oxygen (mg/L), total alkalinity (mg/L), Hardness (mg/L), nitrate-N (mg/L), nitrite-N (mg/L), ammonia-N (mg/L), phosphate-P (mg/L) and chlorophyll a (µg/L) are shown in Table 1. During the period of investigation, no definite pattern of variation in physico-chemical features of pond water was observed. Although weekly fluctuations in the physico-chemical properties were apparent, the differences among the treatments were negligible in most of the cases. This is probably due to the fact that the experimental ponds were similar in shape, size, depth and bottom soil quality as well as the same methodology was followed to prepare them for fish stocking. This agrees with the findings of Zhang et al. (1987) and New (1987). The water qualities parameters as studied in the present investigation were within the desirable range for fish culture (Boyd, 1979).

Plankton populations in nursery ponds: The population of planktonic organisms recorded from the water of the experimental ponds has been presented in Table 2. The recorded phytoplankton population comprised of four broad groups viz., Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae. A total number of 29 genera of phytoplankton were recorded from T_1, 28 from T_2 and 27 from T_3. Genera-wise distribution of phytoplankton in different treatments is shown in Table 3. The zooplankton population comprised of two main groups viz., Crustacea and Rotifera. A total number of 11 genera of zooplankton were recorded from T_1 of which seven genera belonged to Crustacea and four to Rotifera. In T_2 and T_3, out 11 genera recorded, seven belonged to Rotifera and four to Crustacea (Table 4).

Table 1. Physico-chemical characteristics of water in the earthen nursery ponds during the experimental period

Parameter	Treatment		
	T_1	T_2	T_3
Temperature (°C)	31.22±0.61 (30.03-32.00)	31.36±0.66 (30.07-32.03)	31.32±061 (30.03-32.00)
Transparency (cm)	25.91±0.46 (25.30-26.30)	26.25±0.24 (25.83-26.63)	26.26±0.31 (25.80-26.67)
pH	7.84±0.17 (7.5-8.07)	7.70±07 (7.5-7.83)	7.70±0.17 (7.55-8.07)
Dissolved oxygen (mg/L)	4.11±0.29 (3.5-4.33)	4.14±0.20 (3.73-4.33)	3.91±0.51 (3.21-4.80)
Alkalinity (mg/L)	129.56±1.80 (126.67-131.67)	127.28±3.33 (120.43-130.60)	127.39±1.41 (125.20-129.30)
Hardness (mg/L)	122.99±2.09 (121.47-125.20)	121.39±1.54 (119.73-123.93)	121.65±1.30 (120.60-123.46)
Nitrate-nitrogen (mg/L)	1.69±0.037 (1.33-2.20)	1.74±0.15 (1.47-1.90)	1.73±0.20 (1.37-1.93)
Nitrite-nitrogen (mg/L)	0.03±0.02 (0.02-0.08)	0.03±0.04 (0.02-0.04)	0.03±0.03 (0.02-0.04)
Ammonia-nitrogen (mg/L)	0.50±0.030 (0.48-051)	0.49±0.03 (0.45-0.53)	0.48±0.03 (0.46-0.53)
Phosphate-phosphorus (mg/L)	0.53±0.05a (0.48-0.60)	0.49±0.06c (0.40-0.57)	0.50±0.03b (0.46-0.53)
Chlorophyll a (mg/L)	121.70±2.41a (115.07-123.83)	119.50±3.71b (117.00-125.20)	117.68±3.04c (111.76-121.13)

Figures with different superscripts in the same row varied significantly (P<0.05), Figure in the parenthesis indicate the range.

Table 2. Average variation of phytoplankton (cell/ml) and zooplankton (organism/L) population under different treatments

Group Name	Treatment		
	T_1	T_2	T_3
		Phytoplankton	
Bacillariophyceae	101.95±0.65a (101.33-103.00)	98.81±1.07b (97.67-100.33)	95.52±0.98c (94.33-97.33)
Chlorophyceae	138.52±1.22a (136.67-140.00)	135.38±1.39b (134.00-138.00)	127.67±1.32c (126.67-130.00)
Cyanophyceae	64.71±0.45a (64.00-65.33)	51.48±1.14c (49.67-52.67)	54.24±0.94b (52.67-55.33)
Euglenophyceae	7.43±0.57c (6.67-8.00)	10.43±0.96a (9.33-12.00)	7.57±0.42b (6.67-8.00)
Total	312.61±55.96a	296.10±54.56b	285.00±52.01c
		Zooplankton	
Rotifera	13.10±0.42a (12.33-13.67)	10.62±0.87b (9.67-12.33)	9.00±0.54c (8.00-9.67)
Cladoceran	7.67±0.67a (7.00-9.00)	7.61±0.49b (6.67-8.00)	6.81±0.47c (6.00-7.33)
Others	3.00±0.27a (2.67-3.33)	2.71±0.45c (2.33-3.67)	2.81±0.33b (2.33-3.33)
Total	23.77±5.05a	20.94±3.99b	18.62±3.14c

Figures with different superscripts in the same row varied significantly (P<0.05), Figure in the parenthesis indicate the range.

Growth and production of fish: Data on growth and production of fish fry are presented in Tables 6.5 to 6.7. Mean final length of fry was found to be 70.50, 68.50 and 57.50 mm in T_1, T_2 and T_3, respectively (Table 5). The net gain in length of *M. aculeatus* in T_1, T_2 and T_3 were found to be 61.15±0.69, 56.18±0.08 and 50.46±0.34 mm, respectively. Mean final weight attained by *M. aculeatus* fry was found to be 5.78, 4.31 and 3.54g in T_1, T_2 and T_3, respectively (Table 6). The net yield of *M. aculeatus* as obtained from T_1, T_2 and T_3 were 2192.69, 1436.54 and 1182.03 kg/ha, respectively (Table 7). The average survival of *M. aculeatus* fry after six weeks of rearing was found to be 70.50, 65.50 and 50.40% in T_1, T_2 and T_3, respectively (Table 7). Growth parameters of fry were significantly ($P < 0.05$) higher in T_1 than other treatments except SGR (Table 7). The growth in length and weight of fry was shown in Fig. 1 and 2. It is evident from data in Tables 5 and 6 that the fry attained an average size of 70.50 mm in length and 5.78 g in weight in ponds with lowest stocking density of 0.70 million/ha (T_1), while the fry had attained an average size of 68.50 mm in length, 4.31 g in weight in ponds stocked with 0.80 million/ha (T_2), and 57.50 mm in length, 3.54 g in weight in ponds with 0.90 million/ha (T_3) (Tables 5 and 6). It is clearly indicated that maximum growth in weight was exhibited by the fry at the lower stocking density of 0.70 million/ha; while growth rate gradually declined with the increase in density, showing a negative correlation between density and growth. Considering all the growth parameters, T_1, was found to be the best among the three treatments.

The fish in T_1 showed the highest gain in both length and weight over treatment T_2 and T_3. Fish in T_1, (Table 6) had the highest average daily weight gain (0.12 g), specific growth rate (16.65), highest survival rate (70.5%) and FCR (1.05). The present observation agrees well with the finding of Saha et al. (1988b) who observed increased growth of rohu fry by feeding rice bran and mustard oil cake. Stocking densities as high as 1.0 to 2.0 million spawn/ha could be practiced in well manured fed ponds (Jhingran, 1982). The stocking density had significant effect ($P < 0.01$) on the growth and survival of *M. aculeatus* fry. The highest gain in both length and weight of fry was observed in T_1, the lowest one was recorded in T_3 (Table 4). The survival rate of fish of T_1 was significantly ($P < 0.05$) higher than that of *M. aculeatus* fry of T_2 and T_3 (Table 7). Survival rate was relatively lower in T_3, which was stocked with 0.90 million fry/ha. The reason for reduced survival rate of fish fry in T_2 and

T_3 seemed to be related higher stocking density of fry, food competition and scarcity of space in the experimental ponds. The highest mortality and poor survivality was observed in T_3 which seemed to be due to limited space and high population density.

Table 3. List of phytoplankton recorded from the nursery ponds

Major item group	Taxa under each group	Treatments		
		T_1	T_2	T_3
Chlorophyceae	*Ankistrodesmus*	√	√	√
	Botryococcus	√	√	√
	Chlorella	√	√	√
	Ceratium	√	√	√
	Characium	√	√	√
	Clasterium	√	√	√
	Cosmarium	√	√	√
	Gonotozygon	√	√	√
	Scenedesmus	√	×	√
	Selanastrum	×	√	×
	Pediastrum	√	√	√
	Tetraedron	√	√	×
	Crucigenia	√	√	√
	Oocystis	√	√	√
	Volvox	√	√	√
	Zygnema	√	×	√
	Nitzchia	×	√	×
Bacillariophyceae	*Actinella*	√	√	√
	Cyclotella	√	√	√
	Fragilaria	√	√	√
	Frustularia	√	√	√
	Navicula	√	√	√
Cyanophyceae	*Apahanocapsa*	√	√	√
	Anabaena	√	√	√
	Chroococcus	√	√	√
	Gomphospheria	√	√	√
	Merismopedia	√	√	√
	Mycrocystis	√	√	√
	Oscillatoria	√	√	√
Euglenophyceae	*Euglena*	√	√	√
	Phacus	√	×	×

Indicates presence (√) and indicates absence (×)

Table 4. List of zooplankton recorded from the nursery ponds

Major item group	Taxa under each group	Treatments		
		T_1	T_2	T_3
Rotifera	*Asplanchan*	√	√	√
	Brachionus	√	√	√
	Filinia	√	√	√
	Keratella	√	√	√
	Trichocerca	√	√	√
	Lecane	√	√	√
	Polyarathra	√	√	√
Crustacea	*Diaptomus*	√	√	√
	Ceriodaphnia	√	√	√
	Moina	√	√	√
	Bosmina	√	×	×

Indicates presence (√) and indicates absence (×)

The growth rate of fry to fingerlings and to adult was influenced by stocking density where available food and space played the major role. However, Brockway (1950), Kawamoto (1961), Swingle (1968) and Lakshmanan et al. (1971) opinioned that besides food, density dependant factor also plays a prominent role in influencing the growth and survival rates. Tripathi et al. (1979) and Uddin et al. (1988) stocked rohu spawn at an average rate of 10 million/ha and 3 million/ha and obtained an average survival of 80.73% and 73.30%, respectively which was more or less similar to this study. Saha et al. (1988b) found 76% survival rate of *Labeo rohita* fry after 21 days when reared at a density of 1.25 million/ha in earthen ponds.

Table 5. Growth in length (mm) *M. aculeatus* post-larvae/fry after six weeks of rearing under different treatments

Treatment	Stocking density (million/ha)	Length gain (mm)							Net gain (mm)
		Initial	1st week	2nd week	3rd week	4th week	5th week	6th week	
T1	0.70	6.10±0.01	16.29±0.14	31.33±0.10	38.62±0.12	49.49±0.22	60.48±0.12	70.5±0.51a	61.15±0.69a
T2	0.80	6.10±0.01	15.38±0.13	29.45±0.16	35.46±0.03	43.49±0.30	54.48±0.40	68.5±0.22b	56.18±0.08b
T3	0.90	6.10±0.01	13.30±0.21	23.52±0.14	29.74±0.22	35.15±0.26	49.64±0.35	57.5±0.25c	50.46±0.34c

Figures with different superscripts in the same column varied significantly (P< 0.05)

Table 6. Growth in weight (g) of M. aculeatus post-larvae/fry after six weeks of rearing under different treatments

Treatment	Stocking density (million/ha)	Length gain (mm)							Net gain (mm)
		Initial	1st week	2nd week	3rd week	4th week	5th week	6th week	
T1	0.7	0.003±0.00	0.06±0.01	0.470.02	1.67±0.01	2.17±0.02	3.16±0.04	5.78±0.03a	4.98±0.04a
T2	0.8	0.003±0.00	0.05±0.02	0.39±0.01	1.38±0.02	1.98±0.01	2.670.02	4.31±4.31b	3.21±0.01b
T3	0.9	0.003±0.00	0.03±0.01	0.21±0.01	1.28±0.03	1.31±0.02	2.56±0.04	3.54±0.02c	2.67±0.03c

Figures with different superscripts in the same column varied significantly (P< 0.05)

Table 7. Average daily weight gain (ADG), specific growth rate (SGR), food conversion ration (FCR), survival rate and production of *M. aculeatus* fry at different stocking density

Parameters	Treatment		
	T1	T2	T3
Final weight (g)	4.98±0.04a	3.21±0.01b	2.67±0.03c
ADG (g)	0.12±0.00a	0.08±0.00b	0.06±0.00c
SGR	16.65±0.02	16.61±0.01	16.17±0.02
FCR	1.05±0.04a	1.05±0.02a	1.99±0.05b
Survival rate (%)	70.50±1.69a	65.50±0.51b	50.40±0.89c
Production (kg/ha)	2192.69a	1436.54b	1182.03c

Figures with different superscripts in the same row varied significantly (P< 0.05)

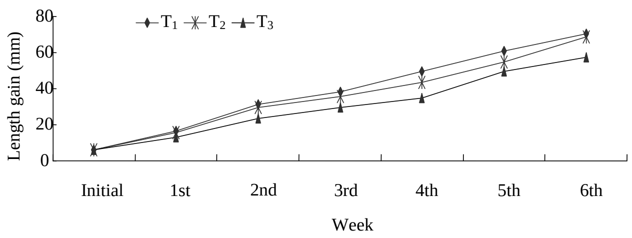

Fig. 1. Weekly gain in length (mm) of *M. aculeatus* fry at different density

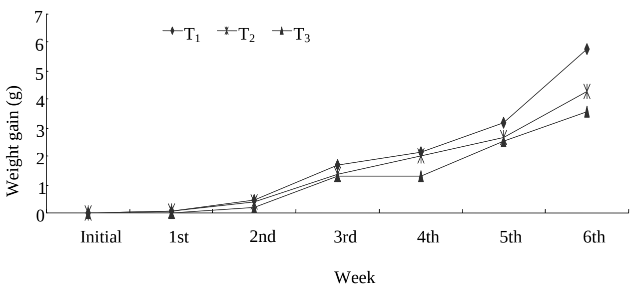

Fig. 2. Weekly gain in weight (g) of *M. aculeatus* fry at different density

In the case of *Puntius gonionotus* density dependent effect on growth and survivality was clearly pronounced (Kohinoor et al., 1994b). Islam et al. (1999) found maximum growth (8.67 g) of mirror carp fry by feeding mustard oil cake, rice bran and fish meal. Hossain (2001) stocked *Cirrhinus reba* spawn at the rate of 5 million/ha and obtained moderate survival rate (53.50%) and maximum growth (47.0 mg) within 12 days of culture by applying mustard oil cake only. It is clear that survival rate and growth of fry were inversely related with the stocking density. The nursery operators may stock *M. aculeatus* at 0.2 million fry/ha for achieving satisfactory growth performance and survival rate during nursing stage.

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