African Journal of Biotechnology Vol. 10(15), pp. 2999-3008, 11 April, 2011
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB10.1979
ISSN 1684–5315 © 2011 Academic Journals

Full Length Research Paper

Evaluation of growth and production of the threatened giant river catfish, *Sperata seenghala* (Sykes) in polyculture with indigenous major carps

M. Aminur Rahman[1]*, A. Arshad[1,2] and S.M. Nurul Amin[2]

[1]Laboratory of Marine Science and Aquaculture, Institute of Bioscience, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
[2]Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

Accepted 9 March, 2011

The giant river catfish locally named guizza, *Sperata seenghala* has significant cultural and economic importance but the fish is now considered as critically endangered due to environmental and man-made interventions in aquatic ecosystem. In order to conserve and rehabilitate this species, an experiment on polyculture of guizza with indigenous major carps was conducted in earthen ponds. Three treatments differing in species ratios and combinations of fish were employed with two replicates each. Treatment-1 (T_1) was stocked with catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*), treatment-2 (T_2) with catla, rohu and guizza (*S. seenghala*), while treatment-3 (T_3) with catla, rohu, mrigal and guizza. Guizza of T_2 was introduced instead of mrigal in T_1 and 50% of mrigal was replaced with guizza in T_3. The stocking density of fish fingerlings in all the treatments was 7500 individual/ha. Fishes in the experimental ponds were fed with supplementary diet comprising of rice bran (50%), mustard oil cake (30%), fish meal (19%) and vitamin-mineral premix (1%). Physico-chemical parameters and plankton populations were within the appropriate levels for aquaculture. Mean growth and survival of catla and rohu were significantly higher in T_2 than in T_3 and T_1. Guizza in T_2 showed higher performances than in T_3, while those for mrigal were higher in T_3 than T_1 ($p < 0.05$). The total gross and net productions of fishes were higher in T_3 than in T_2 and T_1 ($p < 0.05$). This trial is a successful attempt to culture the threatened guizza with major carps in earthen ponds, the findings of which would immensely be helpful towards the development of aquaculture and conservation of this important fish in captive condition.

Key words: Riverine catfish, *Sperata seenghala*, polyculture, earthen ponds.

INTRODUCTION

The giant river catfish (*Sperata seenghala*), locally known as “guizza air” is one of the important bagrid catfish and was once available in rivers, floodplains, inundated swamp fields, ditches, canals and other freshwater areas throughout Afghanistan, Pakistan, India, Nepal and Bangladesh (Jayaram, 1977; Jhingran, 1991; Talwar and Jhingran, 1991; Rahman, 2005). The largest specimen measuring 112.3 cm in length and 10.0 kg in weight was recorded from the Kuliarchar fish landing centre in Kishorganj district of Bangladesh (Rahman, 2005). It has been considered as one of the most admired edible fish among indigenous catfish species due to good taste and high market demand. The fish is carnivorous and subsists on various types of organisms such as fish, frogs, snakes, insects, earthworms, tadpoles, crustaceans and debris (Rahman, 2005). This fish usually spawns twice a year from May to July and from September to November

*Corresponding author. E-mail: aminur1963@gmail.com. Tel: +603-8947-2111. Fax: +603-8947-2101.

Table 1. Species combinations, ratios and stocking densities of fishes in different treatments.

Treatment	Species combination	Species ratio (%)	Stocking density (number/ha)
Treatment 1 (T_1)	*C. catla*	40	3000
	L. rohita	30	2250
	C. mrigala	30	2250
	Total	100	7500
Treatment 2 (T_2)	*C. catla*	40	3000
	L. rohita	30	2250
	S. seenghala	30	2250
	Total	100	7500
Treatment 3 (T_3)	*C. catla*	40	3000
	L. rohita	30	2250
	C. mrigala	15	1125
	S. seenghala	15	1125
	Total	100	7500

in natural condition (Talwar and Jhingran, 1991; Rahman et al., 2005a). Aquaculture of this fish has not been so progressed due to difficulties in spawning, breeding and rearing of broodstocks in captive conditions (Rahman et al., 2005a).

Recently, natural stocks of *S. seenghala* have drastically reduced due to natural and man-made catastrophes, degradation of aquatic environment and the reduction of many wet lands and water areas of Bangladesh. These factors have created a serious problem to their genetic resources and thus, the fish has become gradually endangered (IUCN, 1998; Rahman et al., 2005a). In order to maintain this fish population as well as to conserve their biodiversity, development of suitable techniques for the rearing and culture of *S. seenghala* is very essential. Very few attempts have ever been made for breeding and rearing of broodstock of this fish (Jhingran, 1991; Rahman et al., 2005a), but no systematic information is available on the culture techniques of this important fish.

Polyculture of fish with dissimilar feeding behavior in one pond is preferred when the maximum utilization of all requirements of life takes place without cause any harm to each other and an expected production of fish might be achieved if stocked in proper ratios, densities and combinations (Halver, 1984; Rahman et.al., 2007). Ahmed (1992) reported that, in selecting species for polyculture, primary importance was given to indigenous carps including, rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*) and sometimes calbasu (*Labeo calbasu*). Being native, *Sperata* spp. seems good candidates for aquaculture and in recent years drew an attention to Bangladesh Fisheries Research Institute (BFRI) for evaluating the growth performance under polyculture system. The principal aim of the proposed work was to develop the culture technique of 'guizza' (*S. seenghala*) with indigenous major carps, so that the species can be introduced into commercial aquaculture while conserving this important fishery diversity in captive culture management.

MATERIALS AND METHODS

The trial was undertaken at the Freshwater Station, Bangladesh Fisheries Research Institute, Mymensingh (24°42'N; 90°25'E) over a period of 10 months from August 2006 to June 2007. Six earthen culture ponds of 0.032 ha each with a mean water depth 1.5 m, was allocated for this trial. Before starting the experiment, all ponds were completely drained to eradicate aquatic vegetation and unwanted fishes. The pond bottoms were then treated with quicklime (250 kg/ha). After four days of liming, the ponds were filled with underground water and fertilized with cattle dung (2000 kg/ha), urea (25 kg/ha) and triple super phosphate (25 kg/ha) and left for seven days (Rahman et al., 2007). Good quality and healthy fingerlings of major carps including, catla (*C. catla*), rohu (*L. rohita*) and mrigal (*C. mrigala*) and one endangered fish species guizza (*S. seenghala*) were then stocked in the prepared ponds. Three treatments differing in species ratios and combinations of fish (Table 1) were employed with two replicates each. Treatment-1 (T_1) was stocked with catla, rohu and mrigal (4:3:3), treatment-2 (T_2) with catla, rohu and guizza (4:3:3) while treatment-3 (T_3) with catla, rohu, mrigal and guizza ((4:3:1.5:1.5). Guizza of T_2 was introduced instead of mrigal in T_1 and 50% of mrigal was replaced with guizza in T_3. The stocking density of fingerlings in all the treatments was 7500/ha. Initial mean stocking weight of catla, rohu, mrigal and guizza was 13.03 ± 1.06, 10.59 ± 0.60, 10.64 ± 0.92 and 8.40 ± 0.85 g, respectively.

Fishes in all experimental ponds were supplemented with artificial feed comprising of rice bran (50%), mustard oil cake (30%), fish meal (19%) and vitamin-mineral premix (1%) at 3 to 6% of the estimated biomass for two times per day. Food requirement of fishes was adjusted according to weight gains (g) for which 10% of

Table 2. Overall water quality parameters (mean ± SD) with ranges in parentheses.

Parameter	Treatment-1	Treatment-2	Treatment-3
Temperature (℃)	28.14 ± 2.85^{a} (24.20-31.80)	28.21 ± 2.68^{a} (24.30-31.90)	28.25 ± 2.72^{a} (24.40-32.00)
Transparency (cm)	42.65 ± 8.95^{a} (31.50-56.50)	41.88 ± 9.55^{a} (30.0-56.50)	40.94 ± 9.89^{a} (29.50-57.50)
Dissolved oxygen (mg/l)	5.70 ± 1.22^{a} (3.44-7.50)	5.57 ± 1.25^{a} (3.42-7.50)	5.48 ± 1.15^{a} (3.40-7.40)
pH	7.99 ± 0.52^{a} (7.50-8.80)	7.89 ± 0.50^{a} (7.40-8.70)	7.82 ± 0.45^{a} (7.40-8.40)
Total alkalinity (mg/l)	149.45 ± 39.42^{a} (88.50-212.00)	144.37 ± 38.68^{a} (86.50-208.00)	142.35 ± 36.36^{a} (86.00-200.50)
Ammonia nitrogen (mg/l)	0.44 ± 0.32^{a} (0.01-1.24)	0.46 ± 0.35^{a} (0.01-1.30)	0.48 ± 0.36^{a} (0.01-1.32)
Nitrate nitrogen (mg/l)	1.25 ± 0.23^{a} (0.98-1.58)	1.23 ± 0.25^{a} (0.96-1.53)	1.20 ± 0.22^{a} (0.94-1.50)
Nitrite nitrogen (mg/l)	0.025 ± 0.01^{a} (0.016-0.039)	0.024 ± 0.01^{a} (0.015-0.038)	0.023 ± 0.01^{a} (0.014-0.036)
Phosphate phosphorous (mg/l)	1.38 ± 0.75^{a} (0.30-2.80)	1.36 ± 0.72^{a} (0.30-2.76)	1.33 ± 0.70^{a} (0.30-2.72)

Note: Mean values in the same row having the same superscripts are not significantly different ($p > 0.05$).

the fish were measured fortnightly from each of the experimental ponds. Growth parameters such as final weight, weight gain and specific growth rate were monitored monthly from the experimental ponds. Subsequent to stocking, the ponds were treated fortnightly with cow dung, triple super phosphate and urea at the rate of 1500, 50 and 25 kg/ha, respectively till harvesting.

Important water quality parameters such as, temperature (℃), transparency (cm), dissolved oxygen (mg/l), pH, total alkalinity (mg/l), ammonia nitrogen (mg/l), nitrate nitrogen (mg/l), nitrite nitrogen (mg/l) and phosphate phosphorous (mg/l) were analyzed fortnightly following the standard method (APHA, 1992). Plankton samples were collected from each of the experimental pond fortnightly. Ten liters of water were collected at various depths and locations from each pond and then, passed through a fine-meshed plankton net (25 µm). Samples were preserved in buffered formalin (5%) in small vials for further analysis. A Sedgwick-Rafter counting cell (S-R cell, Graticules Ltd.) was used for the quantitative analysis of plankton. The plankton population on 20 randomly selected fields of the S-R chamber was counted under a compound microscope (Olympus, model BH-2) following the methods described in Rahman et al. (2005b, 2007). Plankton density (cells/l) was calculated according to Rahman (1992). Taxonomic identification of both phytoplankton and zooplankton up to genus level was done separately in the laboratory using the keys described in Ward and Whipple (1959), Prescott (1962) and Bellinger (1992).

After 10 months of rearing, fish from all the experimental ponds were harvested first by seining and later, by dewatering the ponds. In order to assess growth, survival and production, all the harvested fishes were counted and weighed individually on the pond site. Statistical analyses of all data obtained from the experiment were performed by ANOVA and t-test wherever necessary, using the SPSS version 15.0.

RESULTS

Water quality parameters and plankton monitoring

The mean values and ranges of physico-chemical parameters of pond water are shown in Table 2. Fortnightly differences of water quality parameters were observed, but variations among the treatments were not statistically significant ($p > 0.05$). The mean density of both phytoplankton and zooplankton is shown in Table 3. The phytoplankton population consisted of four major groups: Chlorophyceae (12 genera), Bacillariophyceae (7 genera), Cyanophyceae (5 genera) and Euglenophyceae

Table 3. Mean population density (± SD) of phytoplankton (×10^3 cells/l) and zooplankton (x10^3 individual/l) of the pond water.

Plankton group	Treatment-1	Treatment-2	Treatment-3
Phytoplankton			
Bacillariophyceae	10.75 ± 7.82	11.88 ± 8.42	12.62 ± 9.42
Chlorophyceae	32.85 ± 8.94	36.05 ± 8.85	35.45 ± 10.12
Cyanophyceae	15.52 ± 6.66	13.88 ± 6.75	15.18 ± 6.78
Euglenophyceae	10.38 ± 5.25	10.59 ± 5.42	10.79 ± 5.85
Total phytoplankton	69.50 ± 10.57^a	72.40 ± 12.04^a	74.04 ± 11.44^a
Zooplankton			
Rotifera	4.72 ± 2.33	4.88 ± 2.89	5.15 ± 2.82
Crustacea	2.25 ± 2.12	2.95 ± 2.45	3.32 ± 2.18
Total zooplankton	6.97 ± 1.75^a	7.83 ± 1.36^a	8.47 ± 1.29^a

Note: Mean values in the same row having the same superscripts are not significantly different (p > 0.05).

(3 genera). The zooplankton population comprised of Crustacea (4 genera) and Rotifera (6 genera). Higher density of different groups of phytoplankton and zooplankton were found in T_3 than in T_2 and T_1, which is not significantly different ($p > 0.05$). Chlorophyceae and Rotifera were the most leading groups of phytoplankton and zooplankton in all the treatments throughout the experiment, respectively.

Growth and production of fish

Species-wise monthly growth in terms of weight increment of catla, rohu, mrigal and guizza at different treatments are depicted in Figures 1 to 4. Catla and rohu in T_2 showed higher growth than those in T_3 and T_1, respectively. The Growth patterns of mrigal were considerably higher in T_3 than in T_1, while guizza fish in T_2 showed higher performances than those in T_3 throughout the experiment. At harvesting, mean weight attained by catla, rohu and mrigal were 631.40 ± 2.79, 581.78 ± 2.41 and 446.31 ± 2.23 g in T_1, catla, rohu and guizza were 660.64 ± 2.84, 611.30 ± 3.00 and 349.36 ± 2.17 g in T_2 and catla, rohu, mrigal and guizza were 645.12 ± 3.41, 598.81 ± 3.03, 528.90 ± 2.79 and 292.64 ± 2.46 g in T_3, respectively (Table 4). Mean final weight and weight gain of catla and rohu were higher ($p < 0.05$) in T_2 than the weight attained in T_3 and T_1. Guizza in T_2 showed significantly higher performances in weight than T_3, while mrigal in T_3 was higher than those in T_1. Specific growth rate (SGR %/day) of catla, rohu and mrigal were 1.30, 1.34 and 1.25; catla rohu and guizza were 1.32, 1.36 and 1.25 while those of catla, rohu, mrigal and guizza were 1.31, 1.35, 1.31 and 1.19 in T_1, T_2 and T_3, respectively. Despite no significant differences were recognized among the three treatments, SGR in catla and rohu were a little higher in T_1 than T_2 and T_3. SGR value of mrigal was significantly higher ($P < 0.05$) in T_3 than T_1, while that for guizza was significantly higher in T_2 than T_3. The survival (%) of fishes in each treatment was estimated separately and is shown in Table 5. It is observed that the survival (%) of fishes in all treatments was fairly high and ranged between 85.42 and 91.67%. Survival of catla and rohu were very similar in all the treatments, while those of guizza and mrigal in T_2 (91.67%) and T_3 (91.67%) were significantly higher than the guizza and mrigal in T_3 (86.11%) and in T_1 (85.42%), respectively.

Species-wise and total (gross and net) productions of fishes under three treatments are presented in Table 5. Total gross and net productions of fishes over the 10 month trial were 3726.72 and 3650.23, 3777.71 and 3703.12 and 3788.68 and 3713.37 kg/ha in T_1, T_2 and T_3, respectively. Although, the production in T_3 was slightly higher than in T_2 and T_1, the differences among the three treatments were not statistically significant ($p > 0.05$).

DISCUSSION

Water quality and plankton

The physico-chemical parameters of water in the experimental ponds were observed to be suitable for aquaculture. The water temperature (24.2 to 32.0°C) in the present experiment agrees well with the findings of Wahab et al. (1995). The highest temperature (32.0°C) was recorded during the month of September due to relatively high intensity of sunlight and absence of cloud in the sky and the lowest (24°C) was in December which might be as a result of lower intensity of light and cool weather in winter months. These results agree well with the results obtained by Azim et al. (1995), Kohinoor et al.

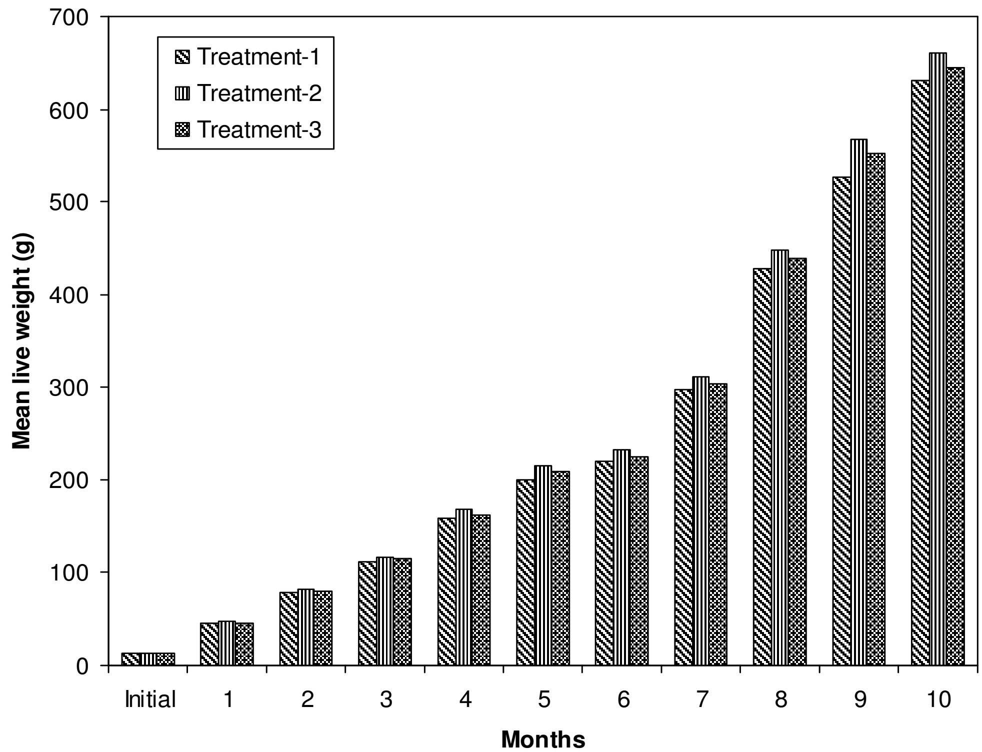

Figure 1. Monthly weight increment of *C. catla* in three treatments over the 10 month experiment.

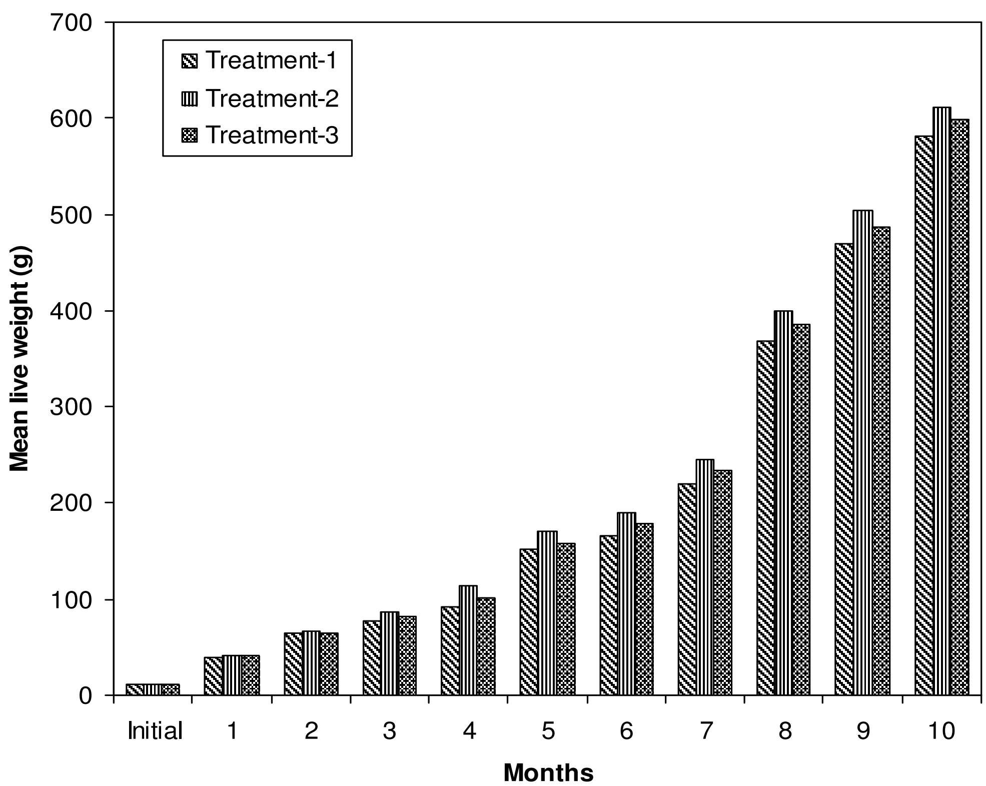

Figure 2. Monthly weight increment of *L. rohita* in three treatments over the 10 month experiment.

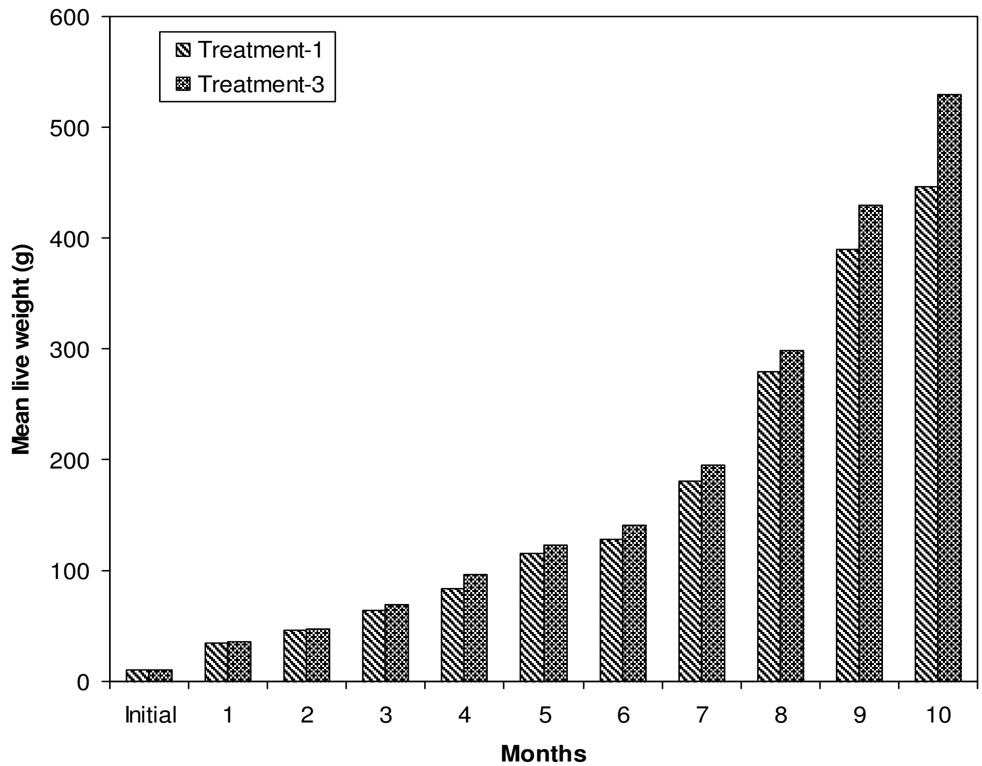

Figure 3. Monthly weight increment of *C. mrigala* in treatments 1 and 3 over the 10 month experiment.

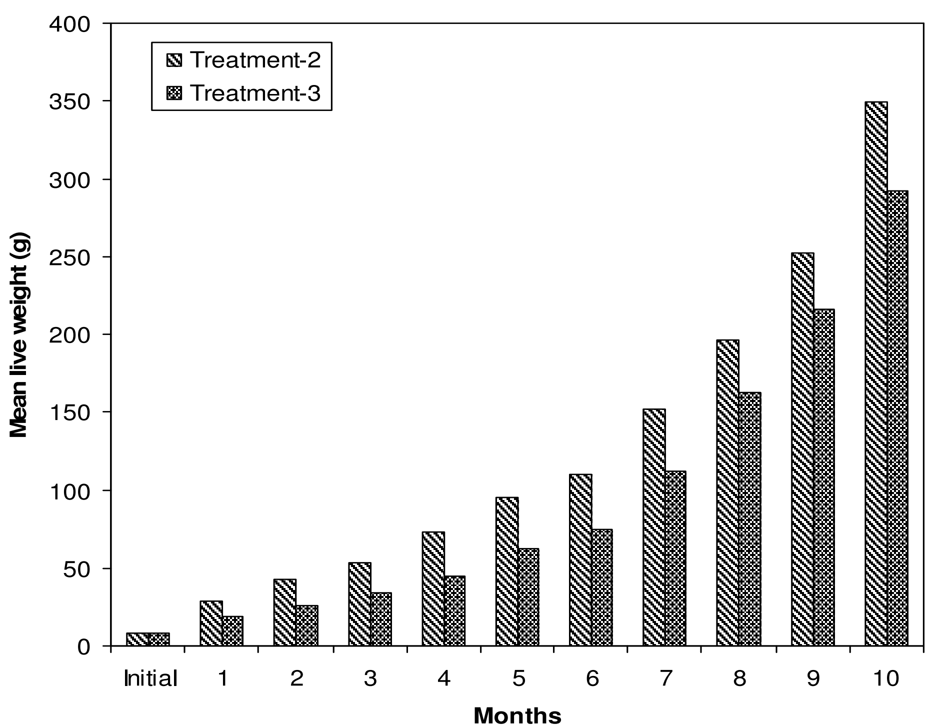

Figure 4. Monthly weight increment of *S. seenghala* in treatments 2 and 3 over the 10 months experiment.

Table 4. Mean (± SE) growth performances of fish in different treatments over the 10 month experiment.

Parameter	Treatment		
	T_1	T_2	T_3
Initial weight (g)			
C. catla	13.03 ± 1.06^a	13.03 ± 1.06^a	13.03 ± 1.06^a
L. rohita	10.59 ± 0.60^a	10.59 ± 0.60^a	10.59 ± 0.60^a
C. mrigala	10.64 ± 0.92^a	-	10.64 ± 0.92^a
S. seenghala	-	8.40 ± 0.85^a	8.40 ± 0.85^a
Final weight (g)			
C. catla	631.40 ± 2.79^c	660.64 ± 2.84^a	645.12 ± 3.41^b
L. rohita	581.78 ± 2.41^c	611.30 ± 3.00^a	598.81 ± 3.03^b
C. mrigala	446.31 ± 2.23^b	-	528.90 ± 2.79^a
S. seenghala	-	349.36 ± 2.17^a	292.64 ± 2.46^b
Weight gain (g)			
C. catla	618.37 ± 2.79^c	647.61 ± 2.84^a	632.09 ± 3.41^b
L. rohita	571.19 ± 2.41^c	600.71 ± 3.00^a	588.22 ± 3.03^b
C. mrigala	435.82 ± 2.02^b	-	518.26 ± 2.79^a
S. seenghala	-	340.96 ± 2.17^a	284.24 ± 2.46^b
Specific growth rate (%/day)			
C. catla	1.30 ± 0.01^a	1.32 ± 0.01^a	1.31 ± 0.01^a
L. rohita	1.34 ± 0.01^a	1.36 ± 0.01^a	1.35 ± 0.01^a
C. mrigala	1.25 ± 0.01^b	-	1.31 ± 0.01^a
S. seenghala	-	1.25 ± 0.01^a	1.19 ± 0.01^b

Note: Figures in the same row having the same superscript are not significantly different ($p > 0.05$).

(1998) and Rahman et al. (2007). Highest transparency was evident in September and the lowest after fertilization, probably resulting from the presence of higher plankton population and suspended organic matter in water column (Rahman et al., 2007). Wahab et al. (1994) recorded transparency depth ranging from 15.0 to 74.0 cm in mixed culture ponds. Dissolved oxygen (DO) levels (3.4-7.5 mg/l) in the experimental ponds agree well with Wahab et al. (1995) and Rahman et al. (2007), who recorded the DO concentrations ranging from 2.7 to 7.2 mg/l and 3.2 to 7.3 mg/l, respectively in polyculture ponds. However, the DO concentration in the experimental ponds was within the satisfactory levels for fish culture (Boyd, 1982; Kohinoor et al., 1998; Rahman et al., 2005b, 2007). The range of pH values in the present study were from 7.40 to 8.80, indicating good productive condition of the ponds. The observed pH values followed the similar trends as the findings of Hossain et al. (1997) and Rahman et al. (2007) who found the pH ranges of 6.70 to 8.30 and 7.10 to 8.25, respectively in the polyculture ponds.

The observed alkalinity values (86 to 212 mg/l) in the experimental ponds indicate the medium to higher productivity status of the pond water (Boyd, 1982). Similar results were also obtained by Rahman and Rahman (2003) and Rahman et al. (2005b, 2007) in fish nursery and rearing ponds. The availability of phosphate-phosphorous (PO_4-P) is recommended as an important element in aquatic productivity. The phosphate-phosphorous ranged between 0.30 and 2.80 mg/l, was very closer to the values reported by Rahman (1992) and Rahman et al. (2007). However, the phosphate-phosphorous level in this study was within the suitable array for aquaculture production. The nitrate-nitrogen (NO_3-N) concentration ranged between 0.94 and 1.58 mg/l was found to be more or less similar to those obtained by Islam et al. (2002) and Rahman et al. (2007). The amount of nitrite-nitrogen (0.014 to 0.039 mg/l) was in the appropriate levels for rearing of fishes in earthen ponds as reported by Boyd (1982), Islam (2002), Islam et al. (2002) and Rahman et al. (2007). Concentration of ammonia-nitrogen (0.01 to 1.32 mg/l) in the culture ponds is low compared with those reported by Dewan et al. (1991), who recorded the values between 0.05 and 6.20

Table 5. Mean survival and production of fish in different treatments over the 10 month experiment.

Parameter	Treatment		
	T_1	T_2	T_3
Survival (%)			
C. catla	89.07 ± 2.21^a	90.63 ± 2.95^a	89.59 ± 2.95^a
L. rohita	90.28 ± 1.97^a	91.67 ± 1.97^a	90.98 ± 0.98^a
C. mrigala	85.42 ± 2.95^b	-	91.67 ± 3.92^a
S. seenghala	-	91.67 ± 1.96^a	86.11 ± 3.93^b
Gross production (kg/ha)			
C. catla	1687.11 ± 49.30	1796.23 ± 66.70	1733.91 ± 66.19
L. rohita	1181.79 ± 30.61	1260.88 ± 33.20	1225.73 ± 19.42
C. mrigala	857.82 ± 33.86	-	545.49 ± 26.25
S. seenghala	-	720.60 ± 19.86	283.55 ± 15.32
Total gross production (kg/ha)	3726.72^a	3777.71^a	3788.68^a
Net production (kg/ha)			
C. catla	1652.30 ± 48.44	1760.81 ± 64.95	1698.90 ± 65.03
L. rohita	1160.28 ± 30.14	1239.04 ± 32.73	1204.05 ± 19.19
C. mrigala	837.65 ± 32.77	-	534.51 ± 25.78
S. seenghala	-	703.27 ± 19.54	275.91 ± 15.66
Total net production (kg/ha)	3650.23^a	3703.12^a	3713.37^a

Figures in the same row having the same superscript are not significantly different (p > 0.05).

mg/l. In monoculture ponds, Kohinoor et al. (2001) found 0.01 to 1.55 mg/l ammonia-nitrogen, which were very similar to the results of the present study. Nevertheless, the present ammonia-nitrogen level in the rearing ponds was not toxic to the cultured fishes (Kohinoor et al., 2001; Islam et al., 2002; Rahman et al., 2007).

Usually, the higher the plankton availability the higher is the productivity of pond water. The mean values of phytoplankton in the experimental ponds were $69.50 \pm 10.57\times10^3$, $72.40 \pm 12.04\times10^3$ and $74.04 \pm 11.44\times10^3$ cells/l and those of zooplankton were $6.97 \pm 1.75\times10^3$, $7.83 \pm 1.36\times10^3$ and $8.47 \pm 1.29\times10^3$ individual/l in T_1, T_2 and T_3, respectively. Although, no significant differences ($p > 0.05$) in phytoplankton and zooplankton densities were recognized among the three treatments, plankton abundances in T_3 were slightly higher than in T_2 and T_1, respectively. The higher density of phytoplankton than zooplankton populations in the experimental ponds might be attributable to regular fertilization with organic and inorganic fertilizers and surplus unused supplementary feeds (Islam, 2002; Keshavanath et al., 2002; Rahman et al., 2005b). Rahman et al. (2007) recorded phytoplankton numbers of 64.36 to 70.54×10^3 and those of zooplankton as 5.57 to 6.89×10^3 individual/l in polyculture ponds, which were very similar to the present study. In contrary, Wahab et al. (1994) found phytoplankton and zooplankton numbers ranged from 2 to 8×10^5 cells/l and 2 to 3.2×10^4 individual/l, respectively. Kohinoor et al. (1998) found the density of phytoplankton as 21.67×10^4 cells/l and that of zooplankton as 5.2×10^4 individual/l, which were much higher than the densities obtained in the present study. The reason behind this might be attributable to the reality that the rate of fertilizers used by the stated authors was higher than those used in the present experiment.

Growth and production of fish

Growth in terms of final weight and weight gain of catla and rohu were significantly higher ($P < 0.05$) in T_2 than in T_3 and T_1, while those for guizza and mrigal were higher ($P < 0.05$) in T_2 and T_3 than the values obtained in T_3 and T_1, respectively. So growth trends of catla, rohu and mrigal were probably not affected when cultured with guizza. The reasons might incorporate proper utilization of feeds and less competition for space and habitat owing to the bottom living and carnivorous mode of life of guizza (Rahman et al., 2005a).

The mean SGR (%/day) values of catla, rohu, mrigal and guizza in different treatments were ranged between 1.30 and 1.32, 1.34 and 1.36, 1.25 and 1.31 and 1.19 and 1.25, respectively. Similar results were also obtained by Hossain et al. (1997) when polyculture of different fishes was accomplished in ponds through feeding and fertilization. Rahman et al. (2007) reported that, SGR of catla, rohu, mrigal and mahseer in different treatments under polyculture system were 1.09 to 1.12, 1.13 to 1.14, 1.10 to 1.12 and 1.15 to 1.16, which are lower than those of the present study.

The mean survival of fishes in the present study was ranged from 85.42 to 91.67%. Similar high survival rates were obtained by Rahman et al. (2007) when polyculture of mahseer with native major carps was practiced in earthen ponds. There were no significant differences ($P > 0.05$) in the survival rates of catla and rohu among the treatments. Although, the survival (%) of guizza and mrigal were statistically significant ($P < 0.05$), the overall higher survival of all species indicate that guizza were not competing with other fishes for food and habitat.

In the present study, the gross and net productions of fishes were 3726.72 and 3650.23, 3777.71 and 3703.12 and 3788.68 and 3713.37 kg/ha in T_1, T_2 and T_3, respectively. Among the treatments assessed, production of fish was the highest in T_3 and the lowest in T_1, while those in T_2 were very closer to the productions obtained in T_3. It might be due to the appropriate species ratios and combinations, replacement of mrigal with guizza and proper utilization of supplementary and natural food, especially phytoplankton and zooplankton. Similar trends of productions were also obtained by Rahman et al. (2007), while mahseer was reared with indigenous major carps under polyculture system. Uddin et al. (1994) obtained a total production of 3,415 kg/ha/year from polyculture of major carps with Thai sharpunti. Similarly, Mazid et al. (1997) found a total production of 3,600 kg/ha/year from mixed culture of major carps and Chinese carps in earthen ponds. Kohinoor et al. (1999) found a mean production of 2,566 kg/ha/six months in polyculture of Thai sharpunti with exotic carps including mirror carp and silver carp using low-cost feeds. The total productions of fish obtained from the present study were higher than those of the mentioned studies and were within the array of desired production. Growth and production of catla and rohu followed the similar trends in all the three treatments. It is probably due to the reality that, they did not compete among themselves for food and habitat. In this study, guizza was experimentally introduced in polyculture system to observe its effects on the production of indigenous major carps (rohu, catla and mrigal). Expected production was found in treatments 2 and 3 showing no harmful effect of guizza on the production and growth performances of indigenous major carps.

Finally, it could be concluded that polyculture of guizza increases the total production of indigenous major carps due to higher growth performances and survival rates. Also, no negative effect of guizza was observed on major carps in respect of overall growth and production. Therefore, indigenous guizza should be considered as a suitable species for culture in combination with major carps in ponds. This study represents the first successful attempt to culture the critically endangered guizza with major carps in captive condition. Although, *S. seenghala* is going to be extinct from the natural habitats, the findings of the present study would have greater implications for the development of aquaculture, management and conservation of this important fishery. Further studies are also recommended to find out more appropriate ratios, combinations and stocking densities of indigenous major carps with guizza in polyculture system.

REFERENCES

Ahmed M (1992). Status and potential of aquaculture in small water bodies (ponds and ditches) in Bangladesh. ICLARM Tech. Rep. 37: p. 36.

APHA (1992). Standard Methods for the Examination of Water and Waste-water. American Public Health Association, 1015 Eighteenth street, N.W. Washington, D. C. 20036, p. 1134.

Azim ME, Talukder GS, Wahab MA, Haque MM, Haq MS (1995). Effect of liming and maintenance of total hardness levels on fish production in fertilized ponds. Progress Agric. 6(2): 7-14.

Bellinger EG (1992). A key to common algae: Freshwater, estuarine and some coastal species. The Institution of Water and Environmental Management, London, U.K. p. 138.

Boyd CE (1982). Water Quality Management for Pond Fish Culture. Elsevier, The Netherlands. p. 318.

Dewan S, Wahab MA, Beveridge MCM, Rahman MH, Sarker BK (1991). Food selection, electivity and dietary overlap among planktivorous Chinese and Indian major carp fry and fingerlings grown in extensively managed, rainfed ponds in Bangladesh. Aquacult. Fish. Manage. 22: 277-294.

Halver JE (1984). Special methods in pen fish husbandry. Akademiai Nyomda, Budapes. p.146.

Hossain MA, Ahmed M, Kamal M, Islam MN (1997). Mixed culture of fishes in seasonal ponds through fertilization and feeding. Bangladesh J. Fish. Res. 1(2): 9-18.

Islam MS (2002). Evaluation of supplementary feeds for semi-intensive pond culture of mahseer, *Tor putitora* (Hamilton). Aquaculture, 212: 263-276.

Islam MS, Dewan S, Hussain MG, Hossain MA, Mazid MA (2002). Feed utilization and wastage in semi-intensive pond culture of mahseer, *Tor putitora* (Ham.). Bangladesh J. Fish. Res. 6: 1-9.

IUCN Bangladesh (1998). List of threatened animals of Bangladesh. Paper presented in the special workshop on Bangladesh Red Book of Threatened Animals, 22 February 1998, Dhaka. p. 13.

Jayaram KC (1977). Aid to identification of siluroid fishes of India, Burma, Sri Lanka, Pakistan and Bangladesh, 1. Bagridae. Rec. Zool. Surv. India. Occasional Papers, 8: 1-41.

Jhingran VG (1991). Fish and Fisheries of India, 3rd edn. Hindustan Publishing Corporation, Delhi, India, p. 727.

Keshavanath P, Gangadhar B, Ramesh TJ, Van Rooij JM, Beveridge MCM, Baird DJ, Verdegem MCJ, van Dam AA (2002). The effects of periphyton and supplemental feeding on the production of the indigenous carps *Tor khudree* and *Labeo fimbriatus*. Aquaculture, 213: 207-218.

Kohinoor AHM, Islam ML, Wahab MA, Thilsted SH (1998). Effect of mola (*Amblypharyngodon mola* Ham.) on the growth and production of carps in polyculture. Bangladesh J. Fish. 2(2): 111-126.

Kohinoor AHM, Islam MS, Begum N, Hussain MG (1999). Production of Thai sharpunti (*Puntius gonionotus* Bleeker) in polyculture with carps using low-cost feed. Bangladesh J. Fish. Res. 3: 157-164.

Kohinoor AHM, Wahab MA, Islam ML, Thilsted SH (2001). Culture potentials of mola (*Amblypharyngodon mola*), chela (*Chela cachius*) and punti (*Puntius sophore*) under monoculture system. Bangladesh J. Fish. Res. 5(2): 123-134.

Mazid MA, Zaher M, Begum NN, Ali MZ, Nahar F (1997). Formulation of

cost effective feeds from locally available ingredients for carp polyculture systems for increased production. Aquaculture, 151: 71-78.
Prescott GW (1962). Algae of the Western Great Lakes Area. Wm. C. Brown Co., Inc., Dubuque, Iowa, p. 946.
Rahman AKA (2005). Freshwater fishes of Bangladesh, 2nd Edn. Zoological Society of Bangladesh, Department of Zoology, University of Dhaka, Dhaka, p. 394.
Rahman MR, Rahman MA (2003). Studies on the growth, survival and production of calbasu (*Labeo calbaus* Ham.) fry at different stocking densities in primary nursing. Bull. Fac. Sci., Univ. Ryuyus, Japan, 76: 245-255.
Rahman MA, Uddin, KMA, Zaher M (2005a). Development of artificial breeding techniques for long-whiskered catfish, *Sperata aor* and giant river catfish, *Sperata seenghala* of Bangladesh. Bangladesh J. Fish. 9(1): 11-12.
Rahman MA, Mazid MA, Rahman MR, Khan MN, Hossain MA, Hussain MG (2005b). Effect of stocking density on survival and growth of critically endangered mahseer, *Tor putitora* (Hamilton) in nursery ponds. Aquaculture, 249: 275-284.
Rahman MA, Rahman MR, Rahman MS (2007). Evaluation of growth and production of the mahseer, *Tor putitora* (Ham.) in polyculture with indigenous major carps. pp. 161-175. In Siraj SS, Christianus A, Kiat NC, De Silva SS (ed). Mahseer: The Biology and Conservation. Malaysian Fisheries Society Occasional Publication No. 14. Kuala Lumpur, Malaysia.
Rahman MS (1992). Water Quality Management in Aquaculture. BRAC Prokashana, Dhaka, Bangladesh, p. 84.
Talwar PK, Jhingran AG (1991). Inland Fishes of India and Adjacent Countries, vol. 1. A.A. Balkema, Rotterdam.
Uddin MS, Miah MS, Alam MS (1994). Study on production optimization through polyculture of indigenous and exotic carps. Bangladesh J. Train. Dev. 7(2): 67-72.
Wahab MA, Islam MT, Ahmed ZE, Haq MS, Haque MA, Biswas BK (1994). Effects of frequency of fertilization on the pond ecology and growth of fishes, Bangladesh Agricultural University, Mymensingh, Bangladesh. Res. Prog. 9: 410-419.
Wahab MA, Ahmed ZF, Islam MA, Rahmatullah SM (1995). Effect of introduction of common carp, *Cyprinus carpio* (L) on the pond ecology and growth of fish in polyculture. Aquat. Res. 26: 619-628.
Ward HB, Whipple GC (1959). Freshwater Biology. John Willey and Sons Inc., New York, p. 1248.