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Culture potentials of green back mullet, *Chelon subviridis* (Parse) under different stocking densities in south-western region of Bangladesh

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Abstract
The study was conducted to attempt to evaluate production potentials of green back mullet at on-station of Bangladesh Fisheries Research Institute (BFRI) Brackishwater Station Paikgacha, Khulna management in southern Bangladesh under different stocking densities. As a result, the mullets have high rates of growth, together with that they tolerate wide ranges of environmental parameters, makes them highly attractive for culture purposes. Fingerlings of Green Back Mullet (C. *subviridis*) were stocked at the rate of 60000, 90000 and 120000/ha under treatment-1 (T1), treatment-2 (T2) and treatment-3 (T3) on 01 march 2015. The physico-chemical parameters of water *viz.* transparency, temperature, dissolved oxygen; pH, salinity, alkalinity and ammonia-nitrogen etc. recorded during the study period were found within optimum range. On the basis of mean final weight attained under T1, T2 and T3 were 24.43±1, 23.4±1.70 and 18.87±0.70g, respectively. The highest growth was obtained in T1 and lowest in T3. The mean final weight showed significant difference (P<0.05) in T1 followed by T2 and T3, when ANOVA was performed. The production as well as economic return obtained was very encouraging and culture would add an extra in such way that farmer especially in southern Bangladesh may get a chance to consume them readily than them to the market. So the present study was very important to know the proper stocking densities of the green back mullet to get the optimum production.

Keywords: Green back mullet, brackish water, stocking densities, culture, water quality, management, fish production, Bangladesh

1. Introduction

Green Back Mullet, *Chelon subviridis* have high rates of growth, together with that they tolerate wide ranges of environmental parameters, makes them highly attractive for culture purposes. Green back mullet, *Chelon subviridis* (Val. 1836) earlier known as *Liza subviridis.* That is a brackish water mugilid fish which is distributed in tropical Indo-pacific region. It is a euryhaline and eurythermal fish. This fish is locally known as parse/bata and commonly available in shallow coastal waters, estuaries and mangrove swamps of Bangladesh. The high quality of flesh, high economic value and wide temperature and salinity tolerance capacity make this species popular for aquaculture in the intertidal ponds [1].

There are about 1.5 million ha brackish water *ghers* (large hydrological units protected by embankment with provisions of controlled drainage and irrigation infrastructures connecting with coastal rivers) in the southwest region of Bangladesh [2]. Brackish water aquaculture in Bangladesh is mostly directed to traditional farming of brackish water shrimp, *Penaeus monodon* with or without fin fishes. The culture practice of this fish in the coastal impoundments (locally called *ghers*) of Bangladesh is getting much popularity. At present, the farmers depend upon wild seed for stocking to their *ghers*.

Chelon subviridis has high demand in the national and international market. A lump sum amount of this fish is naturally produced as a wild catch in the *ghers* .It is now imperative to develop a suitable culture technology of this species to increase productivity of the *ghers.* But no potential attempt has yet been taken in this regard. Long back, a few attempts were undertaken by Bangladesh Fisheries Research Institute and studies were conducted on the production performance of this fish with shrimp [3-5] using mullet seed from wild source. Later on, no further attempt was undertaken in this regard for the development of either nursery management or culture technology due to unavailability of seed from artificial sources of this important fish. Realizing the importance of this fish, it has been priority to improve breeding and seed production and to develop culture technology of green back mullet, *C. subviridis*. Therefore, the present study, attempted to evaluate production potentials of green back mullet at on-station of Bangladesh Fisheries Research Institute (BFRI) Brackishwater Station Paikgacha, Khulna management in southern Bangladesh under different stocking densities.

2. Materials and Methods

2.1 Description of the study area and duration

The study was conducted in the pond complex of Bangladesh Fisheries Research Institute, Brackish water Station, Paikgacha Upazilla (22º35.3'N 89º20.2'E), Khulna district, Bangladesh. Pond management of green back mullet was conducted for a period of 5 months (March-July) with three trials (each with 150 days of culture) in 2015 in nine experimental ponds.

2.2 Pond preparation

The ponds were prepared by drying, liming the bottom soil (@ 250kg/ha of CaO) and enclosed by fine nylon mosquito net. Then after five days, ponds were filled up with tidal water. Water of the ponds will be treated with rotenone and dipterex, both @ 1.5 ppm to kill all unwanted animals. After removing all dead animals, ponds will be treated with dolomite @ 20 ppm. After five days of liming, water of the ponds will be fertilized with 25 ppm urea and 30 ppm TSP to enhance growth of plankton and waited for a week to allow the water becoming suitable for stocking.

2.3 Stocking of fish

After two weeks of fertilization, fingerlings of Green Back Mullet (C. *subviridis*) were stocked at the rate of 60000, 90000 and 120000/ha under treatment-1 (T1), treatment-2 (T2) and treatment-3 (T3) on 01 march 2015. Before stocking the initial mean weights of the fingerlings were measured using sensitive balance (OHAUS Model CS-2000).

2.4 Feed supply

Fry of mullet will be fed with commercial quality feed (35% protein) @ 15% of estimated fish biomass for the 1st 15 days. The rate of feeding will be gradually reduced with the growth of fish and feed will be supplied @ 3% of fish biomass in the last month of culture. Growth of fishes will be checked fortnightly and feed will be adjusted. During the culture trial, in every month all the ponds were limed at the rate of 125 kg/ha to maintain pH and water qualities.

2.5 Growth measurement

The growths of fishes of all ponds were monitored fortnightly by using random sampling method. At least 50 fishes were sampled with the help of a cast net to measure the growth to assess the health status and for feed adjustment.

2.6 Water quality parameters

The pond environment parameters such as surface water temperature, water depth, transparency, dissolved oxygen and pH was measured weekly using a Celsius thermometer, a graduated pole, a secchi-disk a portable dissolved oxygen meter (HI 9142, Hanna Instruments, Portugal), Salinity by refractometer and a portable pH meter (HI 8424, Hanna Instruments, Portugal). Total alkalinity and ammonia-nitrogen was determined following the titrimetric method according to the standard procedure and methods [6].

2.8 Harvesting of fish

After five months of rearing, the fish were harvested by dewatering the ponds. During harvest, they were counted and individually weighted to assess survival, growth and production. Specific growth rate was estimated as:

SGR (% bw/d) = [In (final weight)-In (initial weight]/culture period (days) x 100.

2.9 Data analysis

Comparison of treatment mean was carried out using one-way analysis of variance (ANOVA), followed by testing of pair-wise differences using Duncan's Multiple Range Test [7]. Significance was assigned at the 5% level ($P>0.05$). All statistical analysis was done by using the SPSS (Statistical Package for Social Science) version-17.5.

3. Results and Discussion

The physico-chemical parameters of water *viz.* transparency, temperature, dissolved oxygen; pH, salinity, alkalinity and ammonia-nitrogen etc. recorded during the study period were found within optimum range. The mean values of water quality parameters in three treatments are presented in Table 1. The observed transparency ranged from 38 to 42 cm with mean values was 39.08±3.48, 29.67±6.27 and 38.42±4.03 in T1, T2 and T3, respectively (Table 1). The transparency of water showed significant difference ($P<0.05$) among the treatments, which might be due to variations in abundance of plankton. According to Boyd [8] (1982) transparency values of about 15-40 cm are appropriate for fish culture, which are strongly supported in this result. The mean depths recorded during the study period were 102.63 to 104.65 cm (Table 1). The mean water temperatures were 26.41±4.39, 27.11±4.15 and 27.31±4.49 ºC in T1, T2 and T3, respectively. However, no significant ($P>0.05$) differences were recognized in their water depth and temperature among the treatments which were within the suitable range for growth of fish in tropical ponds [9, 10].

Table 1: Mean value ± SD of water quality parameters of experimental ponds under three treatments.

Parameter	Treatment-1	Treatment-2	Treatment-3
Temperature(0C)	26.41±4.39^a	27.11±4.15^a	27.31±4.49^a
Water depth (cm)	104.65±10.45^a	103.63±11.35^a	102.63±12.45^a
pH	8.61±0.41^a	8.53±0.43^a	8.46±0.36^a
Transparency (cm)	39.08±3.48^a	29.67±6.27^a	38.42±4.03^a
Dissolved oxygen (mg/l)	4.95±1.11	4.59±1.47	4.32±1.31
Salinity(mg/l)	13.42±3.6	13.42±3.6	13.42±3.6
Alkalinity (mg/l)	91.67±14.54^a	91.5±18.92^a	91.3±17.83^a
Ammonia-nitrogen (mg/l)	0.1±0.058^a	0.13±0.045^a	0.14±0.049^a

*Figures in the same column with different superscripts are significantly different ($P>0.05$).

The mean values of pH were 8.61±0.41 in T1, 8.53±0.43 in T2 and 8.46±0.36 in T3, and there were no significant differences among the treatments (Table 1). The pH values of pond water under different treatments were found to be alkaline. According to Swingle [11] pH 6.5 to 9.0 is suitable for pond culture which agreed to the present study. The mean dissolved oxygen (DO) concentrations in the morning hours were significantly ($P<0.05$) higher in T1 (4.95±1.11 mg/l) than those obtained in T2 (4.59±1.47 mg/l) and T3 (4.32±1.31 mg/l) (Table 1). Comparatively lower level of dissolved oxygen as observed in the experimental ponds appeared to be related to sampling time where the dissolved oxygen was monitored at about 9.00-10.00 am. At this time, dissolved oxygen remains lower in concentration. Rahman *et al.* [9] have reported that dissolved oxygen content of a productive pond should be 5.00 mg/l or more. The values in present experiment were around 5.0.

Mean total alkalinity levels in T1, T2, T3, were 91.67±14.54, 91.5±18.92 and 91.3±17.83 mg/l, respectively. Total alkalinity was significantly ($P<0.05$) highest in T1 followed by T2 and lowest in T3 (Table 1). The variations in total alkalinity in all the treatments were within the productive range for aquaculture ponds [12, 13]. Ammonia-nitrogen contents in T1 (0.1±0.058), T2 (0.13±0.045), T3 (0.14±0.049 mg/l) showed increasing trends and T1 showed lowest level and differed insignificantly ($P<0.05$) from T2, T3 (Table 1). The amount of ammonia-nitrogen obtain in this study is comparatively lower than the result reported by Dewan *et al.* [14] and Kohinoor *et al.* [15]. However, the present level of ammonia-nitrogen content in the experimental ponds is not lethal to the fishes [12].

Table 2: Mean abundance of plankton (x10^3 cells/l) in pond waters under three treatments.

Phytoplankton group	Treatment-1	Tratment-2	Treatment-3
Bacillariophyceae	17.42 ± 4.34^a	25.917 ± 12.80^b	35.86 ± 12.99^c
Chlorophyceae	22.42 ± 9.66^a	33.111 ± 11.47^b	44.028 ± 18.16^c
Cyanophyceae	8.11 ± 3.37^a	13.42 ± 5.34^b	16.64 ± 3.79^c
Euglenophyceae	4.64 ± 4.44^a	7.53 ± 4.54^b	10.22 ± 2.27^c
Total Phytoplankton	52.78 ± 11.21^a	79.78 ± 23.00^b	105.19 ± 34.00^c
Crustacea	2.78 ± 1.73^a	5.00 ± 3.46^b	7.11 ± 3.31^c
Rotifera	3.889 ± 1.96^a	6.194 ± 3.10^b	9.194 ± 4.21^c
Total zooplankton	6.72 ± 2.75^a	11.39 ± 5.70^b	16.31 ± 6.98^c

*Figures in the same column with different superscripts are significantly different ($P>0.05$).

The mean abundance of different groups of plankton is shown in Table 2. Phytoplankton population in this study mainly comprised four major groups- Chlorophyceae, Cyanophyceae, Bacillariophyceae, Euglenophyceae, and zooplankton had two groups- Crustacea and Rotifera. Among phytoplankton groups, Chlorophyceae was the most dominant group and Euglenophyceae was the least abundant group as observed during the study period. Among zooplankton, Rotifera was the most dominant in terms of both numbers and genera compared to Crustacean. Mean values of total phytoplankton were 52.78±11.2; 79.78±23.00 and 105.19±34.00 X 10^3 cells/l in T1, T2, T3, respectively and showed significant ($P<0.05$) difference among the treatments. The mean values of total zooplankton were 6.72±2.75, 11.39±5.70 and 16.31±6.98 X 10^3 cells/l, respectively and showed significant ($P<0.05$) difference among the treatments. The plankton population in the study showed to be more or less similar with the findings of Wahab *et al.* 12]. The highly abundant plankton population in T3 than in T2 and T1 might be due to presence of excess uneaten feeds and the left over feed enhanced the production of plankton in the ponds.

Table 3: Growth performances of Green Back Mullet (*C. subviridis*) under three different stocking densities.

Treatment No (stocking densities)	Initial weight(g)	Final weight (g)	SGR (%per day)	Survival (%)	Production (kg/ha)	FCR
Treatment-1 (60,000/ha)	1.4 ± 0.1^a	24.43 ± 1^a	1.91 ± 0.07^a	90^a	1319.51 ± 58.27^a	1.8 ± 0.23^a
Treatment-2 (90,000/ha)	1.45 ± 0.05^a	23.4 ± 1.7^a	1.85 ± 0.01^a	86.03^a	1735.28 ± 83.12^b	1.9 ± 0.12^a
Treatment-3 (120,000/ha)	1.47 ± 0.04^a	18.87 ± 0.7^b	1.7 ± 0.02^a	81.83^b	1656.1 ± 5.57^c	$2.2\pm.26^b$

*Figures in the same column with different superscripts are significantly different ($P>0.05$).

The growth rates of *C. subviridis* under different stocking densities are shown in Table 3. On the basis of mean final weight attained under T1, T2 and T3 were 24.43±1, 23.4±1.70 and 18.87±0.70g, respectively. The highest growth was obtained in T1 and lowest in T3. The mean final weight showed significant difference ($P<0.05$) in T1 followed by T2 and T3, when ANOVA was performed. The fortnightly sampling weight of *C. subviridis* under different stocking densities is shown in Figure 1 which indicates that the growth rate was always higher in T1 than T2 and T3. Higher growth rate was attained at lower stocking densities and vice versa which has the similarity with the findings of some authors [16, 17].

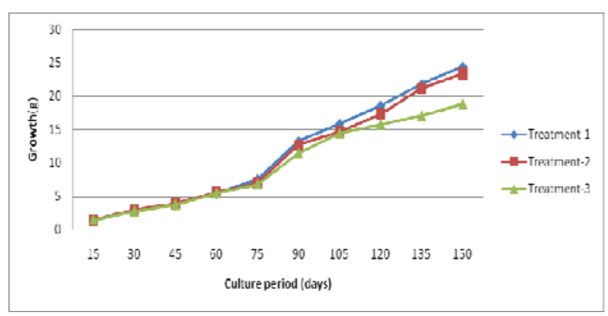

Fig 1: The fortnightly sampling weight of *C. subviridis* under different stocking densities.

The SGR (%) values were more or less same in all the treatments and which showed in significant difference among the treatments. The survival rate of *C. subviridis* was found to vary with the stocking densities. The highest survival (90%) was obtained in T1, where the density was 60,000/ha. and the lowest (81.83%) was obtained in T3, the density was 1, 20,000/ha (Table 3). The differences among the treatments were found to be significant ($P<0.05$). The stocking densities of mullets discussed by many workers are not helpful for comparison as they have been discussing based on polyculture systems wherein mullet formed one of the components. In the present study, on monoculture system, the stocking density was followed from Yashouv previous work [18]. Where he had experimented with in the case of M. *cephalus* under monoculture systems in Israel was 50000/ha for *Liza vaigiensis* and 20000 to 40000/ha for *V. seheli* in contrast to the stocking density of 1850/ha. Chen [19] followed a stocking density of 4000 to 10000/ha in the monoculture of M. *cephalus.* In the experiments in the brackishwater fish farm at Kakdwip, stocking densities of 12500, 20000 and 40000/ha for M. *parsia* and 6000/ha for *M. tade* were employed in monoculture system [20, 21]. Comparing these different stocking densities, ours was on a much higher side, which may be the reason for the slower growth we have recorded in the present study.

Table 4: Costs and benefits analyses of Green Back Mullet (*C. subviridis*) production in 1-ha earthen ponds for culture period of 150 days.

Items	**Treatments (stocking densities)**		
A. Cost	Tratment-1 (BDT) (60,000/ha)	Tratment-2 (BDT) (90,000/ha)	Treatment-3 (BDT) (120,000/ha)
Pond preparation	4,800	4,800	4,800
Fingerlings	60,000	90,000	1,20,000
Feed (BDT 60.00/kg)	1,42,560	1,97,790	2,18,592
Harvesting cost	4,500	4,500	4,500
Labour	20,000	20,000	20,000
Total costs	2,31,860	3,17,090	3,67,892
B. Gross benefit			
Sell price of *C. subviridis*	3,30,000	4,33,750	4,14,000
Net benefits (B-A)	98140	116660	46,108

*Sell price of *C. subviridis* fixed by the Institute was BDT 250/kg (Tratment-1, Tratment-2 and Treatment-3).

The mean FCR value of T1, T2 and T3 were 1.8, 1.9 and 2.2. The FCR value of T1 & T2 was found to be significantly lower than and T3. A simple cost-benefit analysis is shown in Table 4. The cost of production was higher in T3 (BDT 3, 67,892/ha) and lower in T1 (2, 31,860/ha). The net profit generated from 150 days culture period was calculated as BDT 98140; 1, 16,660 and 46,108/ha for T1, T2 and T3, respectively. The highest net profit of BDT 1, 16,660 /ha was obtained from T2 where *C. subviridis* stocked in 90,000/ha. The calculated production of *C. subviridis* T1, T2 and T3 were 1319.51, 1735.28 and 1656.1 kg/ha and which showed in significant difference among the treatments. Productions of 480 kg/ha without and 750 kg/ha with supplementary feed consisting of rice bran and mustard oilcake in 180 days and 800 kg/ha/140 days with mixed feed of rice polishings, vegetable peels, mustard oilcake and fish meal have been recorded for *M. parsia* in monoculture system in the brackishwater fish farm of CIFRI P [22]. Using of high quality feeds may be the cause of much production in present study than previous study.

The growth, survival and production rates were lower in 1981-82 experiments was apparently due to the entry of *Tilapia,* perhaps in their very early stages, despite the filtering of the water pumped into the ponds. Siddik & Khan [23] have analyzed the cost and benefit of Monosex Tilapia (*Oreochromis niloticus*) monoculture system and got the net benefit of BDT 69.277.32/ha/6 months where fish were fed formulated feed. Kohinoor *et al*. [24] got the net benefit BDT 32,919 to 42,291/ha/6 months in monoculture of *Mystus cavasius*. In another study, Kohinoor *et al*. (1993) have found that monoculture of rajpunti (*Puntius gonionutus)* gave a net benefit BDT 68,135 to 75,028/ha/6 months. In the present study, the net benefit was higher than the above findings. The production as well as economic return obtained was very encouraging and culture would add an extra in such way that farmer especially in southern Bangladesh may get a chance to consume them readily than them to the market.

4. Conclusion

Green Back Mullet (C. *subviridis*) is an attractive and popular species to the people of Bangladesh due to its delicious and nutritious food value. But due to different natural and man-made hazards the availability of green back mullet is in endangered condition. But so far there is no established culture technique of green back mullet in Bangladesh especially in the southern region of Bangladesh. There are many factors that affect the production of green back mullet. Stocking density is one of the most important factors for the production of green back mullet. So the present study was very important to know the proper stocking densities of the green back mullet to get the optimum production.

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