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Effects of Different Stocking Density of *Amblypharyngodon mola* on Pond Ecology in Monoculture System

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Abstract: This study looked into the effects of varying stocking density of Mola, *Amblypharyngodon mola* on environment and productivity of culture pond of Bangladesh. Nine earthen ponds with an average depth of 1.5 m were randomly allocated in three treatments such as T_1, T_2 and T_3. The mola fish collected locally and released in three stocking densities 145, 000/ha in T_1; 73, 000/ha in T_2 and 36500/ha in T_3. Water quality parameter was acceptable range in all treatments which was shown in earlier by the authors in the same treatments. The mean values of total nitrogen, organic carbon, phosphorus and pH in pond soil fluctuated slightly and remain within the suitable range of fish culture in treatments T_1, T_2 and T_3, respectively. The fortnightly abundance ($\times10^3$ cells L^{-1}) of phytoplankton, zooplankton and abundance of total macro-benthos were significantly different ($p<0.05$) in T_1, T_2 and T_3 treatments respectively. Chironomidae was dominated the macro-benthos community followed by oligochaeta in all the treatments. Soil quality was almost acceptable range in all treatments. The mean harvest weight of mola was significantly ($p<0.05$) higher with the lower stocking density. Considering the net production of mola and environmental condition among the three treatments, T_3 was the best.

Key words: Stocking Density · *Amblypharyngodon mola* · Ecology · Productivity · Culture Pond

INTRODUCTION

Ecology of fishes means interactions between the fishes and their living environment. For sustenance fishes have to completely dependent on the aquatic environment. The ecology of aquaculture ponds consists of a number of interrelated physical, chemical and biological processes. Among them, following three basic processes are important: production, consumption and decomposition [1]. Success or failure of any aquaculture operation depends upon successful water quality maintenance (physical, chemical and biological) of a pond [2]. The physico-chemical characteristics of water body directly or indirectly affect the production of fish and other aquatic organisms in the water body [3, 4]. The reproductive biology of mola is variable and mostly related to climate condition, water quality parameters, size, food availability and habitat. It generally breeds when the environmental conditions are favorable for the survival of offspring [5]. The stocking density of fish is very much related to the growth performances for both mono-culture and poly culture. If appropriate stocking density is not applied, the excellent fish fry do not give good production [6]. The proper stocking density ensures the sustainable fish farming and optimum utilization of feed, maximum production, sound environment, health etc.

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Higher stocking density has many negative impacts such as competition for food and shelter, break out of diseases etc [6]. So, it is important to optimize the stocking density of a fish species to get higher production which has multiple breeding natures in a culture period.

Generally mola is abundant in south East Asia including Myanmar, Pakistan, India, Bangladesh and Afghanistan etc. Small Indigenous Species (SIS) contains high nutritional value along with protein, vitamin-A, iron, calcium, phosphorus etc. and used by most of the people of Bangladesh [7]. Among the SIS, *Amblypharyngodon mola*, locally known as mola, has the highest percentage of vitamin-A with high calcium and iron [6]. The SIS production has declined despite their ability to reproduce in short intervals and can withstand poor environmental conditions. Mazumder *et al.* [8] reported that mola can be cultured with other fast growing and compatible species in small or large water body.

In view of above facts, the present experiment was under taken to understand the effects of stocking density of mola on the ecology of culture pond and determine the suitable density of mola in pond culture.

MATERIALS AND METHODS

Study Area and Period: The study was conducted at the Fisheries Field Laboratory, Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh-2202, Bangladesh.

Stocking of Fish: The experiment conducted in 3 treatments having 3 replicates with similar size and shape (100 m^2, depth: 1.5 m) earthen ponds were used in this experiment and randomly allocated to the treatments T_1, T_2 and T_3. Artificial feed were used twice daily at the rate of 20% of body weight for first 15 days then it was reduced into 10%. The average initial length and weight of mola fingerlings were 1.51±0.48, 1.51±0.42 cm, 1.51 ±0.18cm and 1.50±0.22, 1.50±0.19, 1.50±0.18g respectively in three treatments in T_1, T_2 and T_3. To ensure mono culture of mola, all other undesirable species were eradicated from the experimental ponds. Details pond preparation and water quality monitoring techniques have been described by the same authors [6].

Measurement of Soil Nutrients: Soil organic carbon was determined by dry combustion method with Leco-C-200 Carbon Analyzer and total nitrogen of the soil samples was determined by Micro-Kjeldhal method following sulphuric acid (H_2SO4) digestion. Available phosphorus of the soil samples was extracted by Ammonium floride (NH_4F) Extraction method. The pH of the soil was measured electro-chemically using a glass electrode pH meter (HANNA instrument, model- HI 921 ON ATC).

Identification of Plankton and Benthos: Plankton and benthos were identified using standard keys and an electronic microscope (Binocular microscope with digital camera, model No: XSZ21-05DN).

Statistical Analysis: One-way ANOVA (Analysis of Variance) and DMRT (Duncan’s Multiple Range Test) were done by using the SPSS (Statistical Package for Social Science) version-11.5. Differences were considered significant at an alpha level of 0.05 ($p<0.05$). Means were given with standard deviation (± SD). Duncan's tests were used to test the results of multiple ranges for comparisons of averages.

RESULTS

In case of same pond water the authors previous resulted that transparency, pH, alkalinity, NH_3-N, NO_3-N, NO_2-N, PO_4-P and chlorophyll-*a* changed slightly among the treatments which were not significant except temperature, DO, NH_3-N in T_1, T_2 and T_3 respectively.

Soil quality is important to the fish farming because it releases nutrients and balance the pH in extensive and semi-intensive fish farm that utilizes earthen ponds. In this study soil quality of pond bottom was measured during harvesting of fish. The soil quality parameter pH was varying from 6.51 to 6.6, 6.57 to 6.6, 6.78 to 6.98 and mean values 6.59±0.07, 6.61±0.07, 6.89±0.10 in T_1, T_2 and T_3 respectively. Better soil pH was observed in treatment T_3 because water quality was good and less humus was deposited in pond bottom. The total nitrogen was found from 0.11 to 0.12, 0.12 to 0.13, 0.13 to 0.13 and mean values were 0.11±0.01, 0.13±0.00 and 0.13±0.01 percent respectively in T_1, T_2 and T_3. The values of organic carbon vary from 1.21 to 1.25, 1.30 to 1.45, 1.27 to 1.46 where mean value were 1.23±0.02, 1.40±0.02 and 1.36±0.09 percent in T_1, T_2 and $T_{3,}$ respectively. Phosphorus were vary from 5.56 to 7.16, 4.59 to 6.63, 5.66 to 8.01 whereas mean value 6.30±0.81, 5.49± 1.04 and 6.62±1.23 ppm respectively inT_1, T_2 and T_3 (Table 1). There was significant difference between $T_{1,}$ T_2 and T_3 in case of

Table 1: Mean (±SD) values of soil quality parameters recorded in different treatments

	Treatments			
Components	T_1	T_2	T_3	ANOVA Sig.
Total-N (%)	0.11±0.01	0.13±0.01	0.13±0.00	NS
Organic C (%)	1.23±0.02	1.40±0.02	1.36±0.09	NS
Phosphorus (ppm)	$6.30±0.81^b$	$5.49± 1.04^c$	$6.62±1.23^a$	*
pH	$6.59±0.07^a$	$6.61±0.07^a$	$6.89±0.10^b$	*

NS = Values are not significantly different (P<0.05)

* = Values with different superscripts in the same row indicate a significant difference (P<0.05)

Table 2: Mean (±SD) fortnightly abundance ($\times 10^3$ cells L^{-1}) of phytoplankton with their different groups under three treatments.

	Treatments			
Plankton groups	T_1	T_2	T_3	ANOVA Sig.
Bacillariophyceae	$21.1±7.74^{ab}$	$18.67±3.59^b$	$29.1±8.38^a$	*
Chlorophyceae	$33.07±19.35^b$	$42.5±11.43^b$	$59.27±18.75^a$	*
Cyanophyceae	$13.8±8.32^b$	$24.43±6.73^a$	$30.16±12.77^a$	*
Euglenophyceae	4.1±1.54	2.42±1.68	2.61±1.55	NS
Total Phytoplankton	$72.07±36.95^b$	$88.02±23.43^b$	$121.14±41.45^a$	*

Table 3: Mean (±SD) fortnightly abundance ($\times 10^3$ cells L^{-1}) of zooplankton and total plankton with their different groups under three treatments

	Treatments			
Plankton groups	T_1	T_2	T_3	ANOVA Sig.
Rotifers	$4.67±4.85^b$	$4±1.21^b$	$7.9±2.22^a$	*
Crustacea (Nauplius)	2.33±1.49	2.5±1.26	3.63±2.62	NS
Cladocera	5±3.12	6.53±4.01	7.23±3.29	NS
Copepods	$2.2±1.05^b$	$2.41±1.35^a$	$3.5±1.56^a$	*
Total Zooplankton	$14.2±10.51^b$	$15.44±7.83^b$	$22.26±9.69^a$	*
Total Phytoplankton	$72.07±36.95^b$	$88.02±23.43^b$	$121.14±41.45^a$	*
Total plankton	$86.27±33.16^b$	$103.46±27.21^b$	$143.4 ±31.51^a$	*

NS = Values are not significantly different (*P*<0.05)

* = Values with different superscripts in the same row indicate a significant difference (P<0.05)

Table 4: Mean (±SD) fortnightly abundance of Macro- benthos under three treatments

	Treatments			
Benthos groups	T_1	T_2	T_3	ANOVA Sig.
Chironomidae	$347.62± 256.99^b$	$487.73±277.82^a$	$425.36± 356.56^c$	*
Oligochaeta	375.17± 227.86	404.74±209.34	411.88± 248.27	NS
Mollusca	312.15± 105.11	346.67±143.72	355.53± 213.21	NS
Unidentified	59.34± 17.52	77.09± 35.46	65.19± 31.33	NS
Total	$1094.28±456.23^b$	$1316.23±412.57^a$	$1257.96± 537.56^b$	*

NS = Values are not significantly different (*P*<0.05)

* = Values with different superscripts in the same row indicate a significant difference (P<0.05)

Phosphorus and also significant difference observed in treatments T_1 and T_2 with T_3 in pH when ANOVA was performed. The phosphorus and pH was good in treatment T_3 than T_1 and T_2 which insured the better production of living organisms of pond. There was no significance differences observed in total nitrogen and organic carbon among the experiments.

Effects on Primary Production: There are four groups of phytoplankton were found which included 9 genera of Bacillariophyceae, 22 of genera Chlorophyceae, 6 genera of Cyanophyceae and 2 genera of Euglenophyceae and also two unidentified species were found from study pond during study period. In this investigation vice-versa relationship were found between Chlorophyceae and Euglenophyceae. Total phytoplankton found to vary from 55 to 112, 43 to 138 and 95 to 175 in T_1, T_2 and T_3 treatments, respectively. The fortnightly abundance ($\times 10^3$ cells L^{-1}) of phytoplankton was found with mean values 72.07±36.95, 88.02±23.43 and 121.14±41.45 (Table 2). Total phytoplankton individuals (indiv.) were cooperatively higher in T_3 than T_1 and T_2. Among the phytoplankton Chlorophyceae was the dominant groups in all the treatments. *A. mola* is a omnivorous fish species that is why better fish production was found in treatment T_3. In case of abundance of total phytoplankton there was significant difference (P<0.05) between treatments T_2 and T_3 with T_1.

Fig. 1: Pictures of Amblypharyngodon mola

Effects on Secondary Production: Sixteen genera of zooplankton which included six genera of rotifers and nine genera of crustacean were also identified in present study. Among the zooplankton Cyclops, Diaphanosoma and Nauplius larvae (crustaceae) and Brachionus, Asplanchna, Trichocerca, Polyarthra and Filinia (rotifera) were the dominant genera and mean values of zooplankton found 14.2±10.51, 15.44±7.83 and 22.26±9.69 in T_1, T_2 and T_3 treatments, respectively (Table 3). The significant difference observed in the treatments T_3 with T_1 and T_2 for zooplankton. The total zooplankton production was higher in treatment T_3 than T_2 and T_1 because of better water quality and proper stocking density of fish.

Effects on Macro-benthos Production:

Macro-Benthos Population Included in Four Major Groups: chironomidae, oligochaeta, mollusca and unidentified groups. The mean abundance of total macro-benthos was found 1094.28±456.23, 1316.23±412.57 and 1257.96±537.56 in T_1, T_2 and T_3 respectively (Table 4). Oligochaeta and Mollusca do not show any significance difference (P<0.05) but Chironomidae showed significance difference (P<0.05) when Anova was performed. Oligochaeta production was higher in treatment T_3 than T_2 and T_1 which is also responsible for good production of mola.

DISCUSSION

Knowledge of proper stocking density and pond ecology are essential for the sustainable mola fish production. The mean abundance of plankton individuals was higher in treatment T_3 for proper stocking density.

The bottom soil of pond or other water bodies contains various type of nutrient which is required for fish production continuously. Average values of total nitrogen, organic carbon, Phosphorus and pH were found 0.11±0.01%, 0.13±0.00% and 0.13±0.01%; 1.23±0.02%, 1.40±0.02% and 1.36±0.09%; 6.30±1.23ppm, 5.49± 1.23ppm and 6.62±1.23ppm; and 6.59±0.07, 6.61±0.07 and 6.89±0.10 in T_1, T_2 and T_3, respectively. Jhingran [9] reported that sediment pH below 6.5 gives poor production and pH in the range of 6.5–7.5 indicates average to high production. The range of pH (6.59-6.89) of the present study was productive. Jhingran [9] reported that organic matter reserve when less than 0.5% considered too low, 0.5 –1.5% considered average and 1.5–2.5% highly productive. Organic carbon content of sediments was observed by Kumar *et al*. [10] which varied from 0.01 to 1.46% at near shores water in India. Present findings of Phosphorus coincided with Saha *et al*. [11] who recorded phosphorus 0.8 to 27.0 ppm from assam *beel*. So, it is concluded that ranges of soil parameters were in a productive range.

The production of phytoplankton influenced of zooplankton growth an also important component of the microbial food web, the flux of material to the seafloor, would be reduced [12]. According to Ahmet [13] zooplankton organisms are important for aquatic ecosystem and it is also important especially for fish fry nourishment of culture pond.

The fortnightly abundance ($\times 10^3$ cells L^{-1}) of phytoplankton was found to vary from 55 to 112, 43 to 138 and 95 to 175 and average values were 72.07±36.95, 88.02±23.43 and 121.14 ± 41.45 in T_1, T_2 and T_3 treatments, whereas average zooplankton 14.2±10.51, 15.44±7.83 and 22.26±9.69 respectively. Kohinoor *et al.* [14] recorded phytoplankton range from 22.50 to 27.83 and 5.20 to 6.34 ($\times 10^3$ cells L^{-1}) in case of zooplankton population which is lower than the present study. Wahab *et al.* [15] recorded phytoplankton population in culture pond ranging from 2.0 to 320 ($\times 10^3$ cells L^{-1}) which was similar to the present study.

The mean abundance of total maco-benthos in present study was found 1096.30±458.20, 1310.62±429.77 and 1261.23±540.60 in T_1, T_2 and T_3 treatments, respectively. Asadujjaman *et al.* [16] reported 10688.89±98 (indiv.m^{-2}) macro-benthos at Hatiya and Nijhum Dweep island of Bangladesh which is higher than the present study may be it was differed due to open and closed water ecosystem.

Above all environmental parameters in this experiment were within the suitable range. However, plankton production was higher in T_3 as a result the mola production was better in T_3 than other treatments as because mola production was higher in T_3 that might be one cause of optimum stocking density of fish. Therefore, 37, 300/ha stocking density for mola were the best among the three tested densities in this experiment.

CONCLUSION

The stocking density of fish in a culture pond has direct influence on water quality, pond sediment and productivity that proved in this experiment again. Among the three tested densities of mola higher production and comparatively good water quality and others important parameters was observed in T_3 where density of fish was lower. Hence, it can be concluded that fish stocking density has a meaningful effect on pond ecology.

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