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Effect of different stocking ratios on the production and survival of indigenous carps and pangas (*Pangasius hypophthalmus*) in a pond system

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Abstract
The experiment was conducted to find out the appropriate combination of indigenous carps and Thai pangas (*Pangasius hypophthalmus*) for polyculture in respect to growth, survival and production in different farmers ponds under semi intensive rearing system. There were three treatments (T1, T2 and T3) each with four replications. The average size of the ponds varied from 0.8 acre to 1.0 acre with an average depth of water 1.2 m to 1.5 m. Four species were selected for the experiment and stocked the density of 100/decimal with different ratio of carps and pangas. Among the carps only three Indian major carps viz. rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) were selected. The initial stocking weight of rohu, catla, mrigal and pangas was 3.14, 4.20, 3.60 and 6.73 g, respectively. The stocking ratio of rohu, catla, mrigal and pangas were 35:17.5:17.5:30, 30:15:15:40 and 25:12.5:12.5:50 in three treatments. Supplemental feed containing 27.96% crude protein was provided only for pangas at the rate of 8% of their body weight. Feed was supplied in the form of dough twice a day and no feeding tray was used. The average final weight gain of pangas in all treatments was higher than any other species. The average highest final weight gain of pangas (340.10g) was recorded in T2 and lowest in T3 (318.19 g). On the other hand, average highest final weight gain of rohu, catla, and mrigal were found in T1 (250.28, 324.19 and 290.70 g) and lowest in T3 (200.37, 271.59 and 226.53 g). The mean survival rate of pangas varied from 93.36% to 95.17% and for carps 89.00% to 91.07%. The significantly highest total production of fishes was 2627.48 kg/acre/3 months recorded in T1 which was followed by T2 (2553.77 kg/acre/3 months) and T3 (2448.41 kg/acre/3 months) respectively. The FCR values were 1.23, 1.26 and 1.20 for the T1, T2 and T3, respectively. After the economic analysis it has been found the higher net return was (96,337.75 TK/acre/3 months) obtained in T1. So it can be concluded that species T1 (rohu: catla: mrigal: pangas = 35:17.5:17.5:30) is the best species combination for carp and pangas polyculture.

Keywords: Stocking, ratios, production, survival, carps, pangas, pond

Introduction
Polyculture is one of the most important culture techniques to raise fish production. Polyculture is the system in which fast growing compatible species of different feeding habits of same age group are stocked in different proportion in the same pond [1], has been practicing from the very beginning of the fish culture in China and Indian sub-continent. Polyculture may produce an expected good result if the fish with different feeding habits are stocked in proper ratios and combinations [2]. This principle based on the assumption that fish growth is an expression of their reaction to among other things, the source of natural food in the environment [3]. This is why natural food utilization is efficient and thus increase fish yield per unit area [4]. On the other hand, maintain appropriate stocking densities for each species to obtain maximum production and efficiently utilization of natural food [5, 6]. Why not, higher density of a species may affect the growth of another species and lower density of a species may reduce the overall production. Ahmed [7] reported that in species selection for polyculture, primary importance was given to Indian major carps; rohu (*Labeo rohita*), catla (*Catla catla*), and mrigal (*Cirrhinus mrigala*). Sometimes calbasu (*Labeo calbasu*) has been included in the polyculture in the pond culture in Indian sub-continent including Bangladesh.
Thai pangas (*Pangasius hypophthalmus*) has introduced in Bangladesh from Thailand by the Ministry of Fisheries and Livestock (MoLF) in 1990 in consideration of its great aquaculture

potential. *P. hypophthalmus* is well known for its faster growth, easy culture system, high disease resistance and tolerance of a wide range of environmental parameters [8, 9].

Considering the national need of increasing fish production, monoculture of pangas was started but it is limited among some rich farmers for its high investment. Poor farmers have the only ability to feed the pangas population partially in their ponds. Many farmers of our country are very poor and they cannot take a risk for pangas monoculture. In order to minimize the farming risks, carps and pangas polyculture is being practiced by the small farmers. In this system famers are providing feed only for pangas, which is added to carps polyculture with, low stocking density in comparison to monoculture. In this system unused feed can be used by the carps directly as food or it can be used to enhance the plankton abd benthic population which ultimately enhance the carps production

The success of polyculture system lies in the choice of the right combination of fish species [10]. As it is a fact that, polyculture may produce an expected result if the fish with different feeding habits are stocked in proper ratios and combinations. So the present study has a significant importance to generate information to help poor farmers to increase more production through carps-pangas polyculture. Considering the above stated facts, the aspects of present study was conducted the Effect of different stocking ratios on the production and survival of indigenous carps and pangas (*P. hypophthalmus*) in a pond system.

Materials and Methods

Description of the study area and experimental design

The experiment was conducted in farmer's pond under semi-intensive rearing system in Shamgonj under Netrokona district for a period of 90 days 1st June 2003 to 1st September 2003. A total of twelve perennial ponds were divided under three treatments i.e. T1, T2 and T3 each having four replicates. Four species were selected for the experiment and stocked the density of 100/decimal with different ratio of carps and pangas. In case of carp only three Indian major carps were used viz rohu (*Labeo rohita*), catla (*Catla catla*), and mrigal (*Cirrhinus mrigala*). The ratios of rohu, catla, mrigal and pangas in the three treatments were at 35:17.5:17.5:30 (T1), 30:15:15:40 (T2) and 25:12.5:12.5:50 (T3), respectively.

Pond preparation

The average size of the ponds varied from 0.8 acre to 1.0 acre with an average depth of water 1.2 m to 1.5 m. All the ponds were more or less similar shape, size, basin conformation and bottom type. The ponds were flood free rain fed, free from aquatic vegetation and well exposed to sunlight. Each ponds have inlet and outlet to provide water and when needed. After selection, at first broken dikes and holes of all ponds were repaired. After that, all kinds of aquatic vegetation (floating, emergent, submerged and spreading) were removed manually and the branches of all trees on the ponds were trimmed off. The predatory and undesirable fishes were eradicated by netting repeatedly and cleaned by poisoning with rotenone at the rate of 5 ppm. Liming was done immediately after poisoning at the rate of 100.0 kg/acre. Three days after liming, all the ponds were manured with cow dung at the rate of 1000kg/acre. After 5 days of liming, urea and TSP were used in all of those ponds at the rate of 15.0 kg/acre and 7.5 kg/acre, respectively.

Fingerling stocking

Fingerlings were stocked 7 days after application of fertilizer when light plankton bloom was appeared. The experimental carp fry of same size group having average length and weight of 3.14, catla 4.20 and mrigal 3.60 g, respectively were collected from farmers having confirmed that the source of fry was BFRI (Bangladesh Fisheries Research Institute), freshwater station, Mymensingh. Transportation of fry was accomplished in polyethylene bags with oxygen to avoid stress and injury. The fry of pangas was taken from the same farmer but the source was not the BFRI as they don't produce them. The average length and weight of pangas fry were 2.5 inch and 6.69 g respectively. All the fry were acclimatized with experimental pond water in polythene bag and then stocked at 4.00 PM. The species composition is given in the Table 1.

Table 1: Stocking rate of fry in different treatments

Treatments	Species combination	Stocking ratio (%)	Stocking rate/acre
T1	Rohu	35	3500
	Catla	17.5	1750
	Mrigal	17.5	1750
	Pangas	30	3000
T2	Rohu	30	3000
	Catla	15	1500
	Mrigal	15	1500
	Pangas	40	4000
T3	Rohu	25	2500
	Catla	12.5	1250
	Mrigal	12.5	1250
	Pangas	50	5000

Supplementary feeding

Throughout the experiment for the proper growth of fishes supplementary feed was given to pangas at the rate of 8% of their body weight. The feeding was adjusted on the basis of monthly take fish weight. The feed was supplied in the dough form and feeding was done directly without any feeding trays. Half of the ration was supplied at 9.00 AM and remaining half was supplied at 4.00 PM. The composition of experimental feed was wheat bran 20%, rice bran 30%, mustard oil cake 20%, meat and bone meal 20%, wheat 9%, vitamin premix and mineral 1%.

Water quality parameters and plankton abundance

The water quality parameters of pond water such as temperature, pH and dissolved oxygen was measured by a portable DO meter (Lurton, Model 5510) and recorded at monthly interval in the morning at 9 Am to 10 AM. Temperature was measured by Celsius thermometer and pH recorded with the help of a pH meter (Model-445, UK). Plankton abundance in the experimental ponds was also estimated monthly intervals. Ten litters of water samples were collected from different depth of the pond and preserved with 10% buffered formalin for 7 days to settle down the plankton at the bottom and then concentrated by draining out the upper portion of the sample through siphoning to 15 ml in plastic vials for subsequent studies.

For the quantitative study of plankton, a drop of the concentrated plankton sample was taken by a dropper and then on the Lund chamber [11], a simple counting chamber for nanoplankton. After pouring the sample, counting chamber was covered with a cover slip so as to eliminate the air bubbles and left to stand for a few minutes to allow the plankton to settle down. Then counting chamber was placed under an electric binocular microscope and the plankton was counted. The mean number of plankton was recorded and expressed numerically per liter of water of each pond. The qualitative analysis of plankton was done according to Ward and Whipple [12], Prescott [13] and Bellinger [14].

Evaluation of growth performances

After every 30 days of interval, ten fishes of each species from every pond were caught and weight was done to evaluate following growth parameters:

Weight gain (g) = Mean final weight (g) - Mean initial weight (g)

Specific Growth Rate

$$\text{SGR (\% per day)} = \frac{\ln \text{final weight} - \ln \text{initial weight}}{\text{Number of experimental days}} \times 100$$ [15]

$$\text{Food conversion ratio (FCR)} = \frac{\text{Feed fed (dry matter)}}{\text{Live weight gain}}$$

Fish harvesting, survivals and production

After 90 days of culture, all the fishes were harvested by netting repeatedly with seine net from each pond and then counted species wise to estimate survival rate and yield of fishes.

$$\text{Survival rate (\%)} = \frac{\text{No. of fish harvested}}{\text{No. of fish stocked}} \times 100$$

Production = No. of fish harvested × Mean final weight

Economic analysis

Economic analysis was done to estimate the net profit from carp-pangas polyculture system. The approximate cost of each diet was calculated on the basis of Mymensingh local market price (2003) of the entire ingredient used. The cost of leasing ponds was not included in the total cost. The cost of different dietary ingredients, cost per kg diet and cost of different fingerlings used in the experiment has been presented in the Table 4, 5, and 6, respectively.

Statistical analysis

The data obtained from different treatments were tabulated and analyzed by using a statistical package program by one way ANOVA and then significant variations of mean values of growth, survival and yield among the treatments were confirmed by Tukey test following the key given by Zar [16].

Results

The water quality parameters such temperature and pH were studied during the period of experiment which were presented in Table 2. The values of water temperature under different ponds were varied from 31.17 to 31.70 ºC throughout the experiment. The maximum water temperature (31.70 ºC) was recorded in August in T1 and the lowest temperature (30.60 ºC) was recorded in June in T2. The highest pH value was recorded in July (7.45) in T1 and the lowest value was recorded in August (7.05) in T3. The highest dissolved oxygen was recorded in T1 (5.81 mg/l) in the month of June and lowest in T3 (5.36 mg/l) in the month of August.

Table 2: Monthly variation of temperature, pH and dissolved oxygen in different treatments

Parameters	Treatments	June	July	August
Temperature (ºC)	T1	31.2±0.06	31.47±0.05	31.7±0.08
	T2	31.17±0.10	31.45±0.06	31.65±0.06
	T3	31.22±0.05	31.55±0.06	31.62±0.05
pH	T1	7.38±0.02	7.45±0.02	7.42±0.01
	T2	7.31±0.01	7.37±0.01	7.34±0.02
	T3	7.27±0.02	7.30±0.01	7.11±0.02
Dissolved oxygen (mg/l)	T1	5.72±0.15	5.48±0.19	5.64±0.09
	T2	5.51±0.12	5.43±0.08	5.70±0.07
	T3	5.42±0.06	5.49±0.10	5.39±0.09

Plankton population

Monthly variation of phytoplankton and zooplankton was recorded and presented in Table 3. The total planktonic organisms mainly composed of 4 groups of phytoplankton including Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae and 2 groups of zooplankton including Cladocera and Rotifera. The highest abundance (91.8×10^3/L) of total phytoplankton was found in the month of August in T1 and the lowest abundance (56.7×103/L) of phytoplankton was found in the month of June in T3. On the other hand, the highest abundance (0.12×103/L) of zooplankton was found in the month of July in T1 and the lowest abundance (0.05×103/L) was found in the month of July in T3. The average highest plankton was recorded in T1 (84.28±6.93) and lowest in T3 (60.82±6.93).

Table 3: Monthly variation of plankton groups (×10^3/L) during the study period

Plankton croup	T1			T2			T3		
	June	July	August	June	July	August	June	July	August
Bacillariophyceae	9.45	6.75	8.10	6.75	4.05	13.50	10.80	14.85	8.10
Chlorophyceae	47.25	48.60	51.30	33.75	39.15	42.20	28.35	36.45	44.85
Cyanophyceae	20.25	24.30	28.35	17.55	21.60	14.85	16.20	6.75	10.80
Euglenophyceae	1.35	2.70	4.05	2.70	1.35	4.05	1.35	2.70	1.35
Total phytoplankton	78.30	82.35	91.80	60.75	66.15	74.60	56.70	60.75	64.80
Cladocera	0.03	0.05	0.05	0.03	0.05	0.03	0.03	0.02	0.03
Rotifera	0.05	0.07	0.05	0.03	0.05	0.05	0.05	0.03	0.03
Total zooplankton	0.08	0.12	0.10	0.07	0.10	0.08	0.08	0.05	0.07
Total plankton	78.38	82.47	91.90	60.82	66.25	74.68	56.78	60.80	64.87
Average plankton	84.28±6.93			67.29±6.99			60.82±6.93		

Growth performance and production of fishes

The mean initial weight (g), final weight (g), weight gain (g), specific growth rate (SGR, % per day), survival rate, Food conversion ratio (FCR) and the total production of fishes (kg/acre/ 90 days) during the study period were recorded and presented in Table 4. There was no significant difference in initial weight of experimental fish species under different treatments. The average growth rate of fishes in all treatments shows more or less rapid growth at the beginning but it reduces as the time progress. The average highest final weight of pangas (340.10) was recorded in T3 and then followed by T1 (318.19 g) and T2 (323.23 g). On the other hand, the average final weight of rohu (250.28 g), catla (324.19 g) and mrigal

Table 4: Growth performance and production of fish in different treatments during the study period

Parameters	T1	T2	T3
Initial weight (g)			
Rohu	3.14±0.24	3.20±0.29	3.10±0.22
Catla	4.20±0.08	4.16±0.11	4.10±0.10
Mrigal	3.60±0.18	3.45±0.13	3.50±0.21
Pangas	6.73±0.12	6.65±0.17	6.71±0.09
Final weight (g)			
Rohu	250.28±4.52	203.20±5.39	200.37±6.82
Catla	324.19±5.26	310.77±7.31	271.59±3.48
Mrigal	290.70±5.96	250.72±3.82	226.53±3.20
Pangas	318.19±3.81	323.23±7.12	340.10±8.21
Weight gain (g)			
Rohu	247.14±3.14	200.00±5.12	197.27±5.82
Catla	319.99±4.54	306.61±7.15	267.49±3.12
Mrigal	287.10±4.58	247.27±3.42	223.03±3.48
Pangas	311.48±3.49	316.58±6.98	333.37±7.95
SGR (% per day)			
Rohu	4.86±0.21	4.64±0.13	4.59±0.09
Catla	4.83±0.17	4.68±0.11	4.56±0.12
Mrigal	4.81±0.13	4.75±0.12	4.53±0.08
Pangas	3.87±0.15	4.32±0.10	4.36±0.10
Survival rate (%)			
Rohu	92.41±0.92	91.82±0.89	91.31±0.96
Catla	92.42±0.65	92.00±0.52	91.92±0.61
Mrigal	90.72±0.71	90.12±0.57	89.95±0.62
Pangas	87.87±0.88	88.71±0.82	89.12±0.79
Food conversion ratio (FCR)			
	1.23±0.02	1.25±0.01	1.20±0.05
Species wise production (kg/acre/90 days)			
Rohu	774.05±9.75^a	540.51±18.08^b	445.26±18.89^c
Catla	510.13±21.90^a	413.28±13.19^b	297.57±4.15^c
Mrigal	447.63±10.43^a	330.47±6.56^b	250.70±1.51^c
Pangas	895.67±25.87^c	1269.51±40.39^b	1453.88±9.72^a
Total Production (kg/acre/90 days)	2627.48±56.81^a	2553.77±71.99^b	2448.41±18.89^c

Figures in the same row with same superscripts are not significantly different (*p*>0.05)

(290.70 g) were found in T1 and then followed by T2 and T3 as rohu (203.20 g and 200.37 g), catla (310.77 g 271.59 g) and mrigal (250.72 g and 226.53 g), respectively. The highest weights gain for pangas (333.45 g) was recorded in T3 then it was followed by T1 (311.48 g) and T2 (316.50 g). Rohu, catla and mrigal showed highest final growth, weight gain, specific growth rate (% per day) and survival rate in T1 than T2 and T3. On the other hand, pangas showed highest final growth, weight gain, specific growth rate and survival rate in T3 than T1 and T2. The highest FCR value was found inT2 and the lowest value was found in T3 but there was no significant (*p*>0.05) difference among FCR value under different treatments. The FCR values were 1.23, 1.26 and 1.20 for the T1, T2 and T3, respectively.

After 90 days of culture, significantly highest production was recorded in T1 (2627.48 kg/acre) than T2 (2553.77 kg/acre) and T3 (2448.41 kg/acre), respectively. Rohu, catla and mrigal showed highest production in T1 than T2 and T3 but pangas showed highest production in T3 than T1 and T2, respectively. However, the result indicates that highest production was found when there were highest carps in the combination.

Economic analysis

Economic analysis was done to estimate the net profit from such type of polyculture operation and has been presented in Table 5. The cost of leasing of ponds was not included in this analysis. After 90 days of culture, the highest net profit (BDT 96338 per acre) was obtained in T1 and the lowest (BDT 73318 per acre) was in T3. Comparatively highest capital was invested in T3 but lowest in T1 as higher number of pangas was stocked in T3.

Table 5: Economic analysis of fish production in different treatments at end of the study period

Investment (Item)	Amount (TK.)/acre/3 months		
	T1 (BDT)*	T2 (BDT)	T3 (BDT)
Lime and fertilizer	2,100	2,100	2,100
Fingerlings cost	4,825	4,850	4,875
Feed cost	14,839	21,360	23,620
Operation cost	1,765	2,295	2,481
Total cost	23,529	30,605	33,076
Gross income	119,867	112,927	106,394
Net profit	96,338	82,322	73,318

*BDT 80.00 = 1US $

Discussion

Water quality parameters and plankton abundance

Environmental parameters play an important role in fish production. In the present study the water temperature, pH and dissolved oxygen were recorded as environmental parameters. The range of temperature varies from 30.6 to 31.7 °C in every treatment throughout the experiment and found that they were within the limit of congenial for the growth of fish. Similar results were reported by Rahman *et al.* [17], Dewan *et al.* [18], and Ali *et al.* [19]. Throughout the study period the range of pH was found to be near neutral (7.05) to slightly alkaline (7.45) in every pond. The optimum pH range for carp culture in ponds is 6.5 to 9.0 [18, 20]. The lowest pH value was observed in T3 due to the higher organic matter accumulation on the pond bottom derived from the feed used for pangas. The dissolved oxygen (DO) was lower in T3 where stocked with a high density of pangas compared to T1 and T3. This might be due to decomposition of access feed of pangas in the pond bottom. Ali *et al.* [21] recorded dissolved oxygen ranging from 5.61 to 6.03 mg/l in polyculture of shing in seasonal ponds. Similar results were also reported by Rahman *et al.* [22], Ali *et al.* [23], Kohinoor *et al.* [24], Uddin [25] and Monirozzaman and Mollah [26] in various fish culture ponds. The oxygen content in the experimental ponds was within the good productive range.

Abundance of plankton in fish culture ponds indicates its higher productivity. The average number of plankton recorded in the present study, ranged from 60.82 × 10^3/L to 84.28 × 10^3/L. Plankton population in the present study is lower than that reported by Azim and Wahab [27] and Bhandari [28] who used fertilizers with supplemental feed. Ali *et al.* [21] recorded more or less similar number or plankton when they cultured shing with tilapia and silver barb in earthen ponds. Plankton population increased with the experimental period and attained it maximal in the later part of the experimental period because of enrichment of nutrient in water by regular fertilizing with Urea and TSP and also organic matter from feed decomposition.

Growth performance and production of fishes

After completing of the experiment over a period of 90 days, pangas showed the maximum final weight gain (333.37±7.95 g) in T3. In T1 the growth of pangas was also lower than T1 and T2. This might be due to the fact that in T1 a competition aroused between carps and pangas for feeding and pangas become suppressed by carps. Hossain [29] showed the similar results of lower growth when stocked fish at more than 100/decimal.

Growth performance of carps in T1 was higher than T2 and T3, respectively. This might be due to the combination effect which stimulate the metabolic rate of carps and reduce the competition among the species. In all treatments catla attained the highest growth than mrigal and rohu. The result of final weight gain of catla in the present study was higher than the result reported by Bhandari [28]. This might be due to the low stocking density of catla that reduces the competition of its own biological niche. As a result feeding rate was increased. The growth rate of mrigal was higher that of rohu. It might be due to the effect of available benthos on the organic matter of pond bottom for mrigal. Jhingran [20] also quoted that the bottom feeder fish like mrigal prefer decayed form of organic matter. The specific growth rate of carps (rohu, catla and mrigal) showed highest SGR in T1 than T2 and T3 but pangas showed highest SGR in T3 (4.36±0.10) than T1 (3.87±0.15) and T2 (4.32±0.10). The SGR value of pangas in different treatments ranged between 3.87 to 4.36%. SGR values obtained in the present study are similar to that obtained by Hossain *et al.* [30] and Salimullah [31]. The survival rate of carp species in different treatments was fairly high. This might be due to application of both fertilization and supplementary feed. The mean survival rate of pangas varied between 87.87 to 89.12%. Hossain [29] recorded almost similar survival rate for pangas in his study. In case of carps the mean survival rate ranged between 89.95 to 92.42%. Wahab *et al.* [32] found survival rate of above 85% of all fish species in polyculture of Indian major carps. Species wise survival rate in different treatments shows very little variations. The survival of fishes in the present study is higher than that reported by Azim and Wahan [27]. The FCR values were 1.23, 1.26 and 1.20for T1, T2 and T3, respectively. The FCR values were lower than the values obtained by Rahman [33]. It might be due to the reason of contribution of natural food and extra carps production.

The production carps species showed significantly higher ($p<0.05$) production in T1 than T2 and T2. But pangas showed significantly higher ($p<0.05$) production in T3 than T1 and T2. So, the result indicated that the total production of fishes varied in different treatments in the experiment. Treatment 1 showed highest production (2627.48±56.81 kg/acre/90 days) than that of T2 and T3. Kanak [34] found the gross production of 2623kg/ha over the period of six months. This might be due to the reason of his poor feeding rate (3% of total body weight daily) of pangas.

Economic analysis

During the economic analysis, it has been found that the net profit was higher in T1 (96,338 TK/acre/90 days) than T2 and T3. Alam *et al.* [35] recorded that the net profit of TK 52,055-87,641/ha/7 months in different polyculture system involving exotic and native major carps. A slightly lower profit of TK 40,060/ha in 100 days with Indian major carps and Thai sarpunti with supplemental feeding of mustard oilcake and rice bran (1:1) was reported by Bhandari [28].

Conclusion

Pangas polyculture with carps in ponds is not new thought in Bangladesh. Farmers are being practiced this type of polyculture but there is no sufficient scientific information on different ratios of carps and pangas polyculture. The present study has a significant importance to know the appropriate ratios of carps and pangas when cultured in polyculture in a pond system. So, it can be concluded that stocking density of 100/decimal of rohu, catla, mrigal and pangas at the rations of 35:17.5:17.5:30 might be recommended as the best composition for carps pangas polyculture

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