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Species interaction between carp species in polyculture system

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Abstract
A three months experiment was conducted to study the species interactions of two carp species in polyculture system under supplemental feeding. Four species of fishes such as silver carp (*Hypophthalmichthys molitrix*), mrigal (*Cirrhina cirrhosus*), catla (*Catla catla*) and common carp (*Cyprinus carpio*) were cultured in four different combinations each containing two species. The combination of silver carp and mrigal in treatment 1, and silver carp and common carp in treatment 2 resulted better growth and production than other two treatments of different combinations of catla and common carp, and catla and mrigal.

Key words: Polyculture, Carp, Species interaction

Introduction

Inland water resources of Bangladesh is considered to be one of the richest in the world both in area and potential for fisheries development (Rahman 1989). We are fortunate to have a vast area of inland water resources such as rivers, beels, canals, ponds and estuaries, from where we get over 72% of total fish production. But the fish production in inland waters decreasing rapidly due to over exploitation of fish resources, adverse effect of flood control structures on the fish habitat, filling of rivers bottom by silt, indiscriminate fishing, and use of over dosage of fertilizers, chemicals and insecticides in agricultural lands, and discharge of industrial pollutant in waterways etc.

In many areas of the country, between seven and nine species of carps of both exotic and native origin are being stocked in the hope of enhancing pond production. Fish farmers are often disappointed at the harvesting time when they find that their most valuable fish like catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhina cirrhosus*), have not grown well and sometimes do not even attain marketable size. Chinese carps like silver carp grows fast, but often face a significantly lower market price than either catla or rohu. In recent studies, Dewan *et al.* (1991), Wahab *et al.* (1991) and Wahab and Ahmed (1992) have clearly indicated that dietary overlap between silver carp and native species, catla and rohu was very high, and the growth and production of the later ones are significantly reduced in polyculture. So an evaluation of other exotic fish with native species based polyculture should be made to understand their effects on the pond

ecology and growth of fish in polyculture. In Israel, Hepher *et al.* (1989) observed fish-fish and fish-environment relationships by stocking common carp and silver carp together in polyculture. Such studies with common carp and native carp for the development of a sustainable polyculture in Bangladesh are long overdue.

Keeping the above facts in mind, the present experiment was undertaken to study the interaction and growth performances of Indian major carps *viz.* catla (*Catla catla*) and mrigal (*Cirrhina cirrhosus*) with exotic carps *viz.* silver carps (*Hypophthalmichthys molitrix*) and common carp (*Cyprinus carpio*).

Materials and methods

Study area

The experiment was carried out in eight experimental ponds, situated at the northern side of the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh.

Preparation of ponds

Embankment of ponds were first repaired and all the aquatic weeds were eradicated manually and mechanically. Then rotenone (20 g/40m^2) was applied to kill all the types of unwanted aquatic organisms including insects and predators. The ponds were sun dried for 10 days, and then limed at the rate of 1.0 kg/40m^2. Cowdung was also used at the rate of 8.0 kg/40m^2. The lime and cowdung were mixed thoroughly with pond bottom soil. The ponds were serially numbered from 1 to 8 for convenience of study.

Pond facilities

The size of the ponds used in this experiment was not equal (Table 1). It varied from 56 to 116 m^2. The water depth was maintained to a maximum of 1.50 m using PVC and overflow pipes on the bank fixed at 1.50 m above the pond bottom, so that excess water could be drained out.

Table 1. Treatments, area of ponds and number of different fishes released

Treatments	Pond number	Area (m^2)	Stocking ratio/pond (1:1/40m^2)
T_1	1	116	Silver carp – 87, Mrigal – 87
	2	101	Silver carp – 76, Mrigal – 76
T_2	3	98	Silver carp – 75, Common carp – 75
	4	56	Silver carp – 42, Common carp – 42
T_3	5	103	Catla – 77, Common carp – 77
	6	112	Catla – 84, Common carp – 84
T_4	7	103	Silver carp – 77, Common carp – 77
	8	56	Silver carp – 42, Common carp – 42

Collection and preparation of feed

Good quality rice bran, wheat bran and soybean oil were used as feed ingredients in this experiment, which were collected from the local market of Mymensingh town. The ingredients were ground into fine particles and then sieved through a sieve of 0.1 mm mesh. All the ingredients were analyzed for their proximate composition and the results are shown in Table 2. The required amount of wheat bran and rice bran were mixed thoroughly with soybean oil at the ratio of 4:4:1. Then the dough were prepared adding certain amount of water. From these dough, several small balls were made before throwing into the pond to feed the fish. The proximate composition of the experimental diet is shown in Table 3.

Table 2. Proximate composition of feed ingredients used in the experiment (% dry matter basis)

Ingredients	Dry matter	Crude protein	Crude lipid	Ash	Crude fibre	NFE[1]
Rice bran	90.44	12.40	8.82	10.48	16.34	51.96
Wheat bran	89.24	14.24	5.60	6.24	15.26	58.66

[1]NFE calculated as %NFE=100 - % (moisture + crude protein + crude lipid + ash + crude fibre)

Table 3. Proximate composition and cost of experimental diet used in different treatments

Components	Diet (%)
Dry matter	90.10
Moisture	9.90
Protein	13.80
Lipid	9.08
Ash	9.15
NFE[1]	57.25
Cost (Tk/kg)	5.00

Experimental Design and Procedure

Different species of fish of different feeding habits were stocked to record their interactions, which ultimately focused in respect to feed utilization and their growth. Four species of carps *viz.* catla (*C. catla*), mrigal (*C. cirrhosus*), silver carp (*H. molitrix*) and common carp (*C. carpio*) were used as experimental species in the polyculture system. Ponds were divided into four treatments *viz.* T_1, T_2, T_3 and T_4, each having two replicates. Each treatment was provided with fishes of two species. Complete layout of the experimental system is shown in Table 1. The mean initial weight of catla, mrigal, silver carp and common carp were 1.90, 5.80, 2.20 and 5.81g, respectively. In all the treatments two species were released at the ratio of 1:1. In treatment 1, silver carp and mrigal in ponds 1 and 2, in treatment 2, silver carp and common carp in ponds 3 and 4, in treatment 3, catla and common carp in ponds 5 and 6, and in treatment 4, silver carp and common carp in ponds 7 and 8 were released at the rate of 15,000 fry/ha.

The supplemental feed weighing 5% of total fish body weight was provided two times a day, at 9.00 am and 5.00 pm in all the treatments. For every day feeding, the total amount of feed was divided into two equal volume and each half was applied to the pond as small dough in three places.

Sampling

Fortnight sampling was done randomly using a seine net to observe the fish growth, health condition and also to adjust the feeding rate. Growth of fish in each sampling was measured by weighing the fish using top pan balance. At the end of the experiment, fishes were harvested by seine net followed by draining out of pond water.

Water quality parameters

Some selected important parameters such as temperature, dissolved oxygen and pH of water in the ponds were recorded between 9.00 – 10.00 am in the morning during the study. The temperature and dissolved oxygen of the pond water were determined by DO meter (YSI 58) and pH was recorded by pH meter (Jenway 3020).

Results and discussion

The supplemental feed provides around 20% protein (Table 2) and rest of the protein requirement of fish is supplemented by the live food grown during culture. Fishes of two different species were released in this polyculture system assuming efficient utilization of pond resources, distribution of grazing pressure among feeding niches and levels, and feed wastes from one species can be fed by another (Milstein 1990, Islam *et al.* 1993).

Water quality recorded just before stocking fish and during experiment were within the acceptable ranges for fish culture that agrees with the findings of Islam *et al.* (1993). Water temperature was favourable for the culture system during the experiment. Water transparency was decreased after release of fish fry in the ponds, which might be due to growth of phytoplankton, and little turbidity due to fish movement. Dissolved oxygen and pH were decreased due to decomposition of organic matter after use of feed and other organic matter in the ponds and respiration of fish (Wahab *et al.* 1995).

The results of the present study in the cases of treatments 1 and 2 showed that the growth performance of silver carp was better when cultured with mrigal than cultured with common carp (Table 4). Though both mrigal and common carp are occupants of benthic niche of the ponds, but their growth varied which might be due to species variation, availability of food according to choice and feeding frequency. Similar results observed in the cases of treatments 3 and 4 (Table 5). But the growth of catla in treatment 3 was slightly higher than the same in treatment 4. However, the variations of fish growth were due to the interactions among species (Hepher *et al.* 1989, Dewan *et al.* 1991). In addition, it may be explained that the bottom feeders of benthic niches might have eaten away excess detritus from the pond as food which ultimately improved the environment for herbivorous fishes like catla and silver carp (Islam *et al.* 1993). Again,

mrigal and common carp stirred up the mud which helped recirculation of nutrients from bottom into the water column and enhanced the development of phytoplankton and increased algal production - the major food for catla and silver carp (Milstein 1995a and b, Islam *et al.* 1993). In treatments 3 and 4, total biomass of fishes were not increased satisfactorily. The combination of catla and common carp, and catla and mrigal gave almost similar results. It might be due to scarcity of enough food and algae, which agrees with the findings of Dewan *et al.* (1991).

Table 4. Weight of different fish species in Treatments 1 and 2 in various sampling dates

	Treatment 1				Treatment 2			
Pond	Pond 1		Pond 2		Pond 3		Pond 4	
Fish species	H.M.	C.M.	H.M.	C.M	H.M.	C.C1	H.M.	C.C1
Initial Wt.	2.20	5.80	2.20	5.80	1.90	5.80	1.90	5.80
	±0.2	±0.40	±0.20	±0.40	±0.25	±0.40	±0.25	±0.40
Sampling date	13.64	13.60	14.41	13.50	27.30	16.03	9.51	15.14
15 days	±0.84	±1.52	±2.56	±1.14	±2.68	±1.35	±1.32	±1.59
30 days	40.47	19.79	44.05	16.03	70.13	36.55	33.12	34.70
	±5.16	±2.97	±4.13	±1.85	±1.07	±3.80	±3.73	±2.65
45 days	61.80	27.01	71.37	24.57	80.62	60.61	51.56	17.09
	±2.31	±3.00	±6.01	±3.90	±5.83	±5.62	±2.69	±1.92
60 days	75.37	39.35	97.20	41.80	122.20	59.25	83.00	39.00
	±6.65	±1.95	±5.67	±3.93	±7.5	±3.58	±3.82	±3.37
75 days	160.00	63.20	153.57	40.00	152.00	92.80	125.16	49.80
	±9.63	±6.95	±7.18	±5.42	± 7.2	±4.01	±4.63	±2.28
90 days	165.51	68.15	183.18	62.93	154.67	95.32	172.29	126.11
	±10.57	±5.86	±11.5	±8.71	± 7.9	±7.17	± 8.13	±11.41

H.M.= *Hypophthalmichthys molitrix*, C.M.= *Cirrhina cirrhosus*, C.C1= *Cyprinus carpio*

Table 5. Weight of different fish species of treatments 3 and 4 in various sampling dates

	Treatment 3				Treatment 4			
Pond	Pond 5		Pond 6		Pond 7		Pond 8	
Fish species	C.C.	C.C1.	C.C.	C.C1	C.C.	C.M	C.C.	C.M.
Initial Wt.	1.90	8.50	1.90	8.50	1.90	5.80	1.90	5.80
	± 0.25	± 0.40	±0.40	±0.40	±0.25	±0.40	±0.25	±0.40
Sampling date	13.92	19.64	13.93	18.78	12.96	12.09	6.18	7.59
15 days	±1.81	±1.33	±0.71	±1.47	±4.33	±1.78	±1.14	±2.11
30 days	35.11	17.41	25.42	18.92	23.21	30.05	16.47	14.21
	±3.80	±0.62	±3.02	±2.05	±3.05	±2.01	±1.78	±5.12
45 days	43.87	26.72	37.71	31.37	38.60	30.82	24.39	35.46
	± 6.56	±3.23	±3.66	±3.17	±4.02	±2.84	±5.01	±4.83
60 days	63.50	37.60	51.40	49.33	42.00	42.77	47.00	38.75
	± 4.57	±4.52	±2.19	±5.26	±6.05	±4.20	±5.35	±4.50
75 days	78.20	37.00	71.00	53.33	76.00	70.83	60.88	62.00
	±5.69	±4.09	±3.46	±5.66	±2.00	±3.18	±0.43	±2.46
90 days	81.38	52.27	67.75	61.39	79.64	84.40	80.57	93.14
	±6.77	±10.11	±0.72	±5.33	±3.91	±6.77	±1.51	±7.63

H.M.= *Hypophthalmichthys molitrix*, C.M.= *Cirrhina cirrhosus*, C.C.= *Catla catla*, C.C1= *Cyprinus carpio*

From the results, it is concluded that the combination of silver carp and mrigal, and the combination of silver carp and common carp gave better growth and production than other two combinations.

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