Freshwater Station & Sub-stations

Genetic studies and stock improvement of commercially important carps

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Objectives

- To continue genetic stock improvement of rohu (*Labeo rohita*) through family selection protocol
- To continue genetic stock improvement of silver barb (*Barbodes gonionotus*) through family selection protocol
- Distribution and on-farm trials of improved germplasms of carps

Achievements

Stock improvement of rohu, Labeo rohita through family selection

BFRI F_2 improved stock of Rohu, *Labeo rohita* was the experimental fish produced from the two improved F_1 stocks. The breeding of fish were followed through pair mating of female and male brood. (1:1). The improved F_2 progeny families of rohu, *L. rohita*, were produced according to the designed protocol through a series of nested mating design between selected pair of female and male brood fish (2:1) of the two F_1 generation considering the phenotypic value in weight attainment. Equal volume of fertilized eggs of about 100g from each pair of fish were incubated in hapa in hatchery system and maintained as a separate family.

A total of 70 families of F_2 progeny groups were produced in the breeding trial. The F_2 progeny families were nursed separately in hapas set in a pond. The number of families was reduced to 50 simultaneously. An approximately 1500 spawn from each family were transferred to a primary nursery units of hapa for 10-12 weeks. Later on, the number of fry was reduced to 200 and they were transferred to a secondary nursery unit of hapa. The family groups were reared in these nursery units for 16-20 weeks. The fingerlings of each group were again reduced to 100 individuals per family and transferred to tertiary nursery units of hapa and reared in these nursery units for another 20-24 weeks. During the nursing period the growth performances of progenies of all families were compared and evaluated.

A PIT tag was inserted into peritoneal cavity of each fingerlings of 20-40 g and the tag number was recorded for all the individuals of all the selected families (Table 1 as parts). A 15 fingerlings from each of the selected 40 families were PIT tagged and stocked in communal grow out experimental pond. Another communal pond was also stocked with non-tagged 10 fingerlings from each of the selected 40 families. After communal rearing of one and a half year, the family-wise growth of fish of F_2 generation could not be observed for estimation of Breeding Values (e_BV) due to unavailability of PIT Tag Reader remarking the breeding program would be of mass selection using BEST SELECTED INDIVIDUALS to proceed further improvement.

Female fish, generally, grow faster than their male sibs especially in carps. Therefore, an observation was made in as a typical carp, rohu, in terms of growth of female and male sex, where, the female fish observed to be of 16-20% higher weight (Table 2).

Stock improvement of silver barb, B. gonionotus, through family selection/ or rotational breeding with mass selection protocol

The improved F_4 generation was produced through a series of mating between individuals of selected pair of female and male according to the mating plan list and design on the basis of their estimated breeding values (e_BV) obtained for F_3 generation through BLUP analysis.

In case of unavailable PIT Tag facilities, the experiments will be followed through carrying out rotational breeding protocol using the selected families as 1-40 forming the groups A, B, C and D, taking together equal number of families separately as 01-10, 11-20, 21-30 and 31-40 in each group and taking together equal number of fingerlings from each family @#10.

Table 1. Family wise PIT tagging ID number with weight of individuals of fingrelings reared in communal ponds for growth testing of rohu, *Labeo rohita*

SL No.	Fam. No.	ID No,	Wt. (g)	SL No.	Fam. No.	ID No.	Wt. (g)	SL No.	Fam. No.	ID No.	Wt. (g)	SL No.	Fam. No.	ID No.	Wt. (g)
1	2	23F4	22	1	7	20D0	14	1	14	2D70	10	1	18	1W4C	8
2		22W5	24	2		19D2	14	2		1WC9	12	2		3732	20
3		410D	24	3		42F9	14	3		4A7F	14	3		137B	10
4		43W8	24	4		1500	14	4		2D70	10	4		23F5	10
5		4626	24	5		3959	14	5		4543		5		2B51	8
6		1168	22	6		293B	14	6		4B81	8	6		144F	10
7		1559	20	7		2729	14	7		1D4W	8	7		28B4	10
8		1C5D	24	8		2W81	12	8		49C3	8	8		1BF2	10
9		1B83	16	9		2D72	14	9		3957	10	9		3730	10
10		1FCA	36	10		1B88	14	10		247W	10	10		468F	10
11		1BF0	22	11		1D52	16	11		1W49	12	11		3BFW	10
12		43W5	24	12		2368	18	12		13BC	10	12		27A8	10
13		4201	20	13		43W4	12	13		2587	12	13		3W0D	40
14		33WC	18	14		2CWD	14	14		4766	10	14		36A5	8
15		3A68	18	15		2155	16	15		1DCF	8	15		4B2C	12
1	3	4188	16	1	8	2831	16	1	15	3362	10	1	20	7C3W	42
2		155B	16	2		44CW	12	2		27AD	10	2		5284	60
3		188F	20	3		29C2	14	3		1557	12	3		6FW7	57
4		3F90	16	4		38CF	18	4		49C2	10	4		6F60	36
5		2B55	16	5		12W6	16	5		20D4	10	5		51F4	
6		361C	16	6		15BC	20	6		445C	16	6		648F	60
7		1682	20	7		1450	12	7		282W	10	7		6267	62
8		4620	18	8		33WA	14	8		4090	8	8		55D5	32
9		1824	18	9		4186	18	9		1CD2	10	9		8213	
10		43W2	14	10		12EB	14	10		372W	10	10		4F21	38
11		269B	22	11		3956	18	11		3617	20	11		4A88	38
12		3AWC	18	12		2BD9	20	12		410A	10	12		7FW2	52
13		1404	14	13		3F0C	20	13		4839	12	13		6C1D	38
14		408A	18	14		18FD	14	14		3F91	8	14		4F86	42
15		4838	18	15		2588	14	15		2DFW	8	15		7CA1	
1	6	12W4	26	1	11	6D28	30	1	17	38D2	16	1	21	2DF8	10

Table 2. Observation on variations in weight (kg) of female and male sex in rohu, *Labeo rohita*

Observation	Sex	Measured and calculated values of weight in Kg			Comments
		Mean	SD	CV	
I.	Female	2.11	0,308	14.58	Higher at 16%
	Male	1.82	0.282	15.47	
II	Female	1.96	0.215	11.01	Higher at 20%
	Male	1.64	0.169	10.33	

Upgradation of carp broods for quality seed production and dissemination

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Md. Golam Sajed Riar, SO

Objectives

- To collect wild germplasm and evaluate growth performance within the collected wild germplasms and existing stocks.
- To develop live gene bank with quality brood stocks through implementation of effective breeding plan.
- To produce quality seed of improved breeds and disseminate to the farmers/hatchery and nursery owners/entrepreneurs.

Achievements

Collection of wild breeds and comparative growth study within the collected stocks and existing stock

Halda sources: Five hounded gram wild breeds of Rohu, Catla and Mrigal were collected from Halda River, Chittagong on May 2013. Collected spawn were stocked in 15 decimal nursery pond for primary nursing for one month. Following one month primary nursing the spawn were transferred to secondary nursery ponds and being followed the existing nursery and rearing protocol. The result of the primary nursing of Halda spawn is shown in Table 1.

Table 1. Stocking, survival, species composition and growth of Halda breeds

Collection date	Estimated number	Survival (%)	Species composition (%)				Present status in weight (g)		
11-05-13	500 g (0.05 million)	35	Rohu	Catla	Mrigal	Others	Rohu	Catla	Mrigal
			01	75	19	5	45-75	12-25	20-40

Jamuna sources: Five hounded gram (500g) wild breeds of Rohu, Catla and Mrigal were collected from Jamuna River, Shirajgonj Sader on June 2013. Collected spawn were stocked in 15 decimal nursery ponds for primary nursing for one month. After one month primary nursing the spawn were transferred to secondary nursery pond and being followed the existing nursery and rearing protocol. The result of the primary nursing of Jamuna spawn is shown in Table 2.

Table 2. Stocking, survival, species composition and growth of Jamuna breeds

Collection date	Estimated number	Survival (%)	Species composition (%)				Present status in weight (g)		
05-06-13	500 g (0.08 million)	55	Rohu	Catla	Mrigal	Others	Rohu	Catla	Mrigal
			02	20	10	67	10-30	30-60	20-25

Quality seed production and distribution: BFRI has the improved broodstocks which are used every year for the production of quality seed and distributed to the fish farmers and hatchery owners. Production of BFRI improved carps seed during the on-going breeding seasons (2013) are shown in Table 3. These improved germplasm were distributed to the fish farmers, hatchery and nursery owners from different parts of Bangladesh.

Table 3. Quality seed production during the year 2012-13

Species	Achievement		Comments
	Spawn (kg)	Fingerling (nos)	
Rohu (BFRI improved Rohu)	25.00	-	May-July
Catla (Halda)	20.00	-	April-June
Mrigal (Halda)	15.00	-	April-July
Total	60.0		

Development of seed production and grow-out techniques for endangered fish (*Chitala chitala, Glossogobius giurus and Monopterus* sp.) in Bangladesh

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Objectives

- To develop nursery rearing technique for chital spawn
- To evaluate growth performances of chital fingerlings under different stocking densities
- To develop induced breeding technique for *Glossogobius giurus*
- To develop natural propagation of native eel (*Monopterus cuchia*) and Chinese eel (*M. albus*)
- To refine of growth performances evaluation of native eel (*M. cuchia*) and Chinese eel (*M. albus*)

Achievements

Expt. I. Development of induced breeding technique for Notoptorus chitala

Average weight of *Notoptorus chitala* ranged from 1000-4,200g and auto stocking fish GIFT tilapia were also stocked at a density of 1250/ha in the brood pond. Mola, chanda, small prawn and chapilla were supplied 4 kg/week. For induce breeding intramuscular injections with PG in matured female fishes were administered at the dose of 4, 8 and 11 mg/kg body weight. After administering PG, male and female fishes were released in a mini pond at 3:1 ratio during May to June. Wooden plate, hard brick, Jute mat, bamboo pools and mats were submerged in the pond. In mini pond live feed SIS were supplied @ of 3%

body weight. Breeding activity and spawning of *N. chital* has been observed. After 3-7 days of hormone administered fishes were responded in 11 mg of PG, fishes laid eggs on the surface of having slightly rough wooden plate and stone brick. The fertilized eggs were immediately transferred with substrata to the hatchery and placed in the glass nylon hapa which was inside the cistern. Continuous showering were created for sufficient oxygen. Embryonic development of the fertilized eggs and hatching were quite slow and prolonged. The average diameters of fertilized eggs were 5.1±0.1 mm. The colour of eggs were light brown and turn to reddish colour before hatching. The water temperature in the hapa was 27 to 29^{o}C. For complete hatching it was take time 5-6 days with a heavy yolk sac and after 3-4 days the hatchling exhibited sluggish and limited horigental movement and after some movement the larvae take shelter under the piece of stone. After 10 days of hatching the larvae were transferred in the aluminum tray for proper nursing. Fertilization percentage was identified by visual observation. The yolk sac absorption was noted from its air breathing. Poultry eggs and live rajpunti spawn were supplied up to 22 days. The growth in terms of length and weight of the spawn were measured 7 days interval and shown in Table 1.

Table 1. Growth performance and survival of chital in aluminum tray

Parameters	**Observation time**		
	0 day	**7th days**	**14th days**
Length	1.63±0.115	0.244± 0.031	0.305± 0.031
Weight	0.13±0.165	0.046±0.0025	0.058±0.0076
Survival %	100	100	87.17

Expt. II: Development of induced breeding technique for bale, Glossogobius giurus

For the development of induced breeding technique of bale (*Glossogobius giurus*), breeding trials were initiated during April to May. To determine the required PG extract for ovulation of bale, PG was administered. Four treatments with PG @ 35, 40, 45 and 50 mg/kg body weight in female bale and male fishes were treated with 20 mg/kg body weight in all the treatments. After application of PG male and female (1:1 ratio) fishes were kept together in the hapa according to the dose. Hormone iinjections were applied intramuscular cell of the fish near the 1st dorsal fin above the lateral line. Observation was made on ovulation of the fishes. After 18 hours of injection fishes were partially ovulated at the dose of 40 and 50 mg/kg. Gentle and smooth pressure was applied but finally fishes were not bred.

Expt. III. Growth performances evaluation of native eel (Monopterus cuchia) and Chinese eel

Growth performances of *Monopterus cuchia* and *M. albus* were evaluated for 60 days with 3 replications. After 7 days acclimatization 10/m^3 eel's individuals were stocked in the required hapa (size: 10´ x 6´ x 3´). Initial length and weight of both species were measured before stocking. Water hyacinth was provided as shelter for the eels and also acted as their hiding place. Trash fish and earth warm pest were supplied at 3% body weight of eels at a fixed point. Data on growth performances of *M. cuchia* and *M. albus* are placed in Table 2.

Table 2. Performance of *M. cuchia* and *M. albus* after rearing for a period of 60 days

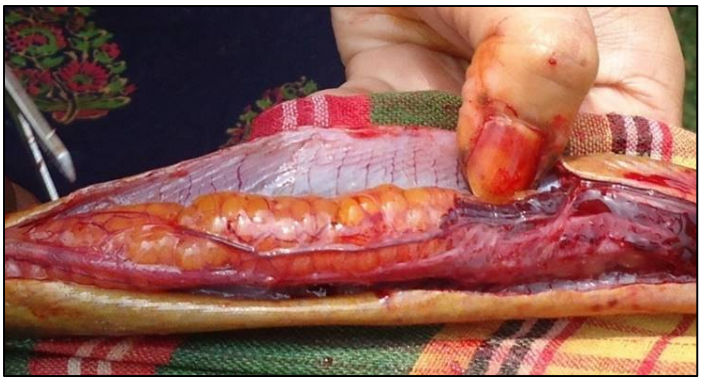
Parameter	***M. cuchia***	***M. albus***
Initial length (cm)	30.89±4.02	25.00±2.93
Initial weight (g)	36.43±5.27	35.60±8.26
Final length (cm)	46.60±4.45	31.74±3.16
Final weight (g)	56.60±6.50	47.2±7.76
Survival rate (%)	100	100
SGR (% per day)	33.61	11.0

Carcass composition: Carcass composition analysis revealed that *M. cuchia* is rich in protein whereas *M. albus* is rich in lipid. Results on carcass composition are given in Table 3.

Table 3. Proximate composition (on dry weight basis) of *M. cuchia* and *M. albus*

Name of the species	Muscle composition	
	Protein	**Lipid**
M. cuchia	17.06	0.88
M. Albus	15.17	1.08

Reproductive biology of *Monopterus cuchia:* Live samples comprised of 10 female *M. cuchia* were collected from January to June, 2012 from natural sources in every month. After collection, the live samples were brought to the laboratory and the gonads of females were taken out through dissection and preserved in Buins fixative for further studies. From physical observation it was found that cuchia ovary has single lobed and cylindrical shaped.



Methods for determining the reproductive biology: Following methods were used to determine the reproductive biology of *M. cuchia*:

- Gonado Somatic Index (GSI)
- Histological study
- Fecundity estimation

a) Gonadosomatic index (GSI): Maximum GSI value was found in the month of June (6.89) which indicate the period of maximum gonadal growth. It was evident from the results that the GSI values increased gradually.

b) Fecundity: Breeding performance depends on different parameters like fecundity, spawning response, fertilization rate, hatching rate, hatching time, size of spawn, yolk sac absorption time, larval survival rate etc. So, to observe breeding performance a study was made on fecundity. From the observation it was found that *M. Cuchia* fecundity was ranged from 334 to 398 and mean 359±22.49.

Histology of gonad

The different development stages of gonad are presented below

Histological structure of gonad was examined and different stages of oocytes as observed indicated that the oocytes develop synchronously. In gonad different developmental stage of oocytes viz. oogonia (OG), early perinucleolus stage (EPN), late perinucleolus stage (LPN), cortical alveoli stage (CA), vitellogenic stage (VG) were distinguished on the basis of appearance of nucleolus. Incase of seasonal breeders these

changes are demarcated in different phases such as immature phases, maturing phases, mature phases, ripe phases, spent phases and resting phase. Most of the oogonia (OG) were found in immature phase which prevailed from January to February. Perinucleolus stage (EPN) and late perinucleolus stage (LPN) was distinguished in maturing phases which prevailed in the month of March to April. Cortical alveoli stage (CA) was found in mature phases which basically prevailed in the month of May and vitellogenic stage (VG) were observed in ripe phase. This phase prevailed from June to July. During the study period spent and resting phase were not seen. Different developmental stage of oocytes are shown in Plate 1

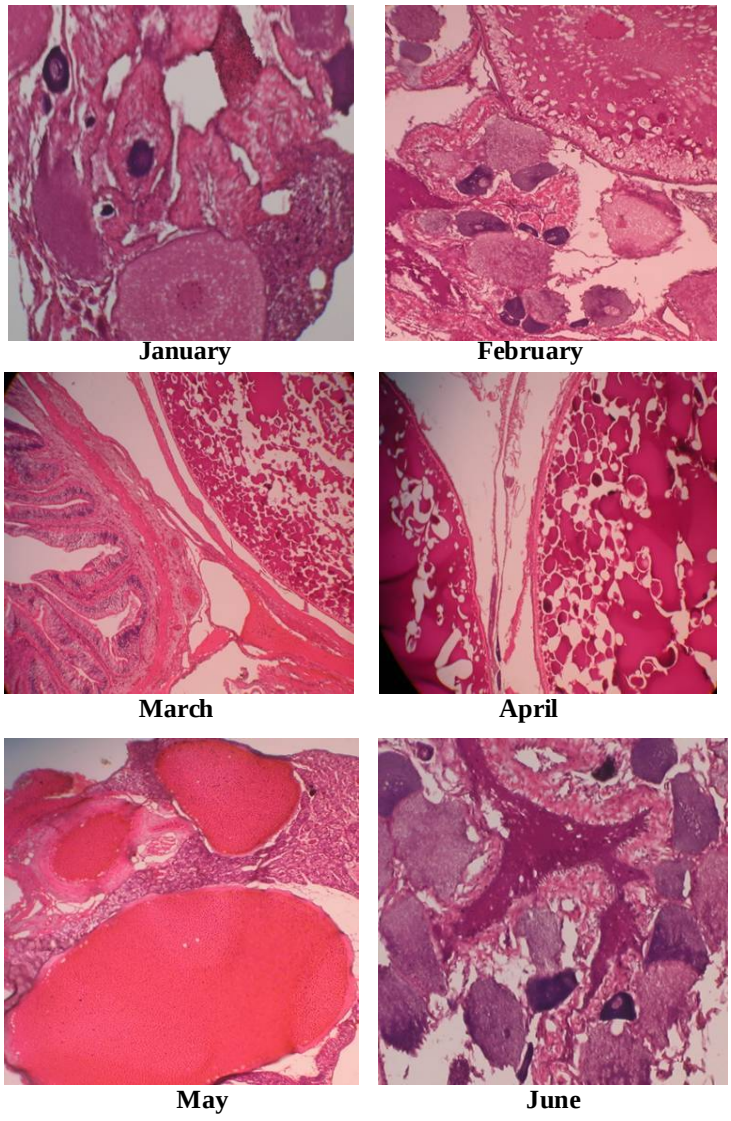


Plate 1. Development stages of gonad in different months.

Stock improvement and dissemination of commercially important tilapia and climbing perch koi through genetic selection

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Objectives

- To continue the stock improvement of BFRI-GIFT strain using family selection protocol
- To improve the stock of Thai koi using brood stock replacement technique
- To evaluate the growth performance of improved BFRI GIFT and Thai koi

Achievements

Stock improvement of BFRI-GIFT strain using family selection protocol

On the basis of breeding values of F-6 generation, the best 60 males have been crossed with 60 females. The range of breeding values of selected males and females were 27.34-54.56 and 23.13-55.27, respectively (Table 1).

Table 1. Breeding values of selected male and female breeders

Sex	Number of breeder	Breeding values
Male	60	27.34 – 54.56
Female	70	23.13 – 55.27

After that, pair of selected female and male breeders (1:1) were stocked in each breeding hapa having an area of 1.0 m^3 in July 2012. After 30 days of stocking, tiny fry from each progeny group were shifted to a series of nursery hapas in a pond. The progeny were fed with floating nursery feed containing 30% protein at the rate of 25% of estimated body weight. In the first week of October, each progeny group 20 male and 20 female fish were selected and tagged them by using Passive Integrated Transponder (PIT). Tagged fishes were stocked in a pond (1000m^2) for communal rearing. After five months of rearing, fish were harvested. After harvesting, breeding values were estimated and family wise breeding were initiated for the production of F-6 generation.

Expt. 1. Evaluation of F-6 generation with founder population of GIFT strain in pond ecology

An experiment was undertaken for evaluating the growth performances of upgraded BFRI-GIFT (T-1) and founder population of GIFT (T-2) in a pond having an area of 400m^2. After pond preparation, in each treatment 500 fry were stocked for communal rearing. The initial mean weight of upgraded BFRI-GIFT (F-6) and founder Population were 2.60 and 2.50g, respectively. Fry of founder population of GIFT strain were marked through cauterization of pelvic fin. Supplementary floating feed (28% crude protein) was applied to the fishes at the rate of 5-20% of estimated body weight at twice a day regularly. Lime was applied in the pond at the rate of 125 kg/ha at monthly interval during the culture period. Fish sampling was done at fortnightly intervals through seine netting and weighing 50 fish to measure the growth, assess the health status and feed adjustment. Fish were harvested through pond drying after four moths rearing. The mean weight of treatment-1 and treatment-2 were 188±5.21 and 135±7.88, respectively. The harvesting weight of F-6 generation of GIFT strain showed 39.25% higher growth (Fig. 1) than that of the founder population (non selected population).

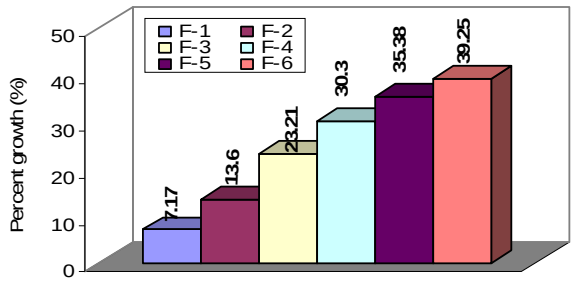

Fig.1: Generation w ise percent w eight gain of BFRI-GIFT

Expt. 2. Stock improvement and mass seed production of newly introduced pure line of Thai koi (Anabas testudineus) through brood stock replacement techniques

The largest 400 individuals (200 male and 200 female) of parental generation were selected and stocked in a breeding pond for the production of F_3 generation. For the production of F_3 generation, the following protocols were followed:

- Fourty breeding hapas (size 2 x 2 x 1 m) were required for this purpose.
- The fishes were mated in 5 pair cross in a single hapa to ensure equal numbers of male and female fish. This activities were completed in four batch breeding
- After breeding, about 20g of hatchlings from each hapa were mixed together and reared in a single nursery pond for 4 weeks.
- As such four nursery pond were maintained where each nursery pond contained 200g larvae (from 10 hapas out of a total of 40 hapas)
- After nursing, 500-600 fry randomly selected from each batch (each nursery pond) and put into the brood stock replacement pond in which 200 pairs of founder brood fish contribute fingerlings in this desired stock.

Expt 3. Comparative growth performances between improved koi (F_3) and average group koi strain at on-farm management

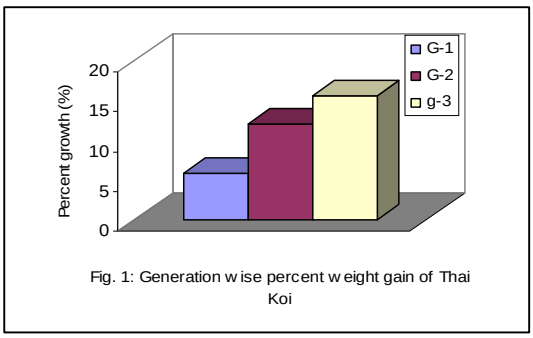

Fig. 1: Generation w ise percent w eight gain of Thai Koi

To compare the growth performance of non selected parental group of Thai koi and improved F-3 generation of Thai koi, an experiment was conducted for a period of three months with three replications during April to June 2013. The fry of koi were stocked in April 2013 at the stocking density of 75,000/ha. There were two treatments with three replicates. Treatment-I was designed with F-3 generation of Thai koi, while treatment-II with non selected parental group of Thai koi. After stocking, the fry were fed 30% crude protein enriched feed at the rate of 5-15% of estimated body weight. After three months of rearing, the fish were harvested. The harvesting means weight of T_1 and T_2 were 94.52±3.42 and 81.77±3.95g, respectively and results were statistically significant ($p>0.05$). The F-3 generation of Thai koi showed 15.59% higher growth than non selected parental group.

Stock improvement and dissemination of Thai pangas *(Pangasianodon hypophthalmus)*

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Md. Shahidul Islam, SSO
Md. Golam Sajed Riar, SO

Objectives

- Stock improvement of pangas through rotational group breeding techniques
- Comparative growth study of improved & existing stocks of pangas
- Quality seed production and distribution of improved breeds

Achievements

Expt. 1. Stock improvement of Thai pangas using rotational group breeding techniques

Founder stock: There are currently two wild stocks of pagasius available for group breeding programs under this project. One wild stock designated as Batch-1 imported from Thailand during the year 2010. The size of the fish was about 3590 ± 125 g which were used in the year 2013 to produce base population. The other wild stock designated as Batch-2 was imported from Vietnam at the end of 2011 having average size of about 1438 ± 33g. The Batch-2 will be used in the breeding protocol during the year 2015. Stock details of collected pangas are shown in Fig. 1 and Table 1.

Thai (Red meat) **Vietnamese (White meat)**

Fig. 1. Two varities pangas (*Pangasianodon hypophthalmus)* stocks

Table 1. Stock details of collected pangas

Origin	Year of collection	Special feature	Widely known	Present av. wt. (g)
Thailand	Oct.' 2010	Wild stock from Mekong River (Red meat)	Thai Pangas/Sutchi	3590 ± 125
Vietnam	Oct' 2011	Wild stock from Mekong River (White meat)	Vietnamese Tra	1438 ± 33

Production of base population: Breeding of pangas (Batch-1) was initiated in July 2013. At the end of the March, 100 pairs of sub-adult brood (above 2.0 kg Male and above 3.0 kg Female) were stocked in BFRI, FS pond complex to become mature. For production of base population at least 60 pairs out of 100 pairs of brood were selected in breeding program and separated them randomly into 4 groups (Group-A, B, C and D). Within the randomly selected groups, 10 pairs (sex ratio of female and male 1:1) of brood were mated separately to make 10 families in each group. All mating of the same group were performed in the same day. From each family, a sub sample of fertilized eggs (100 g fertilized eggs/pair) were taken and incubated in circular units. Spawn from each group were stocked in separate 20 decimal earthen

nursery ponds having 2 replications for each group. From each group, 2000 fingerlings are selected and reared under maintaining separate groups. For brood stock development, fingerling were stocked at the rate of 50 individuals per decimal. Present status of base population in nursing conditions is shown in Table 2.

Table 2. Status of base population of pangas in nursery ponds

Breeding	Status of brood		Group details	Nursing	Stocking of spawn	Present status	
	Female Av. wt (g)	Male Av. wt (g)				Length (cm)	Weight (g)
17-07-2013 Single pair mating, (60 families)	3800 ±178	2400 ± 156	4 groups (15 families made a group , 100 g eggs taken from each family)	20 decimal ponds (2 replications for each group)	21-07-2013 (600 g spawn from each group)	3.54 ±0.22	43 ± 53.83

Development and optimization of feed with probiotics and feeding strategies for commercially important fish farming

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Mr. Mritunjay Paul, SO
Mr. Mohammad Ferdous Siddique, SO

Objectives

- To evaluate the potential of using selected probiotics in the formulated diets for *H. fossilis*
- To investigate the suitability of utilizing restricted feeding in this fish
- To recommend the potential probiotics as feed additives in the formulated diets
- To develop and optimize feeds and feeding strategies in *H. fossilis* farming

Achievements

Three feeding trials in lab and field conditions were conducted to develop and optimize of feeds with probiotics and feeding strategies for *Heteropneustes fossilis* (shing) farming. Two feeding trials on: (1) optimizing feeding regime & dietary protein in *Heteropneustes fossilis* (feeding trail-1) and (2) evaluation of selected probiotics as feed additives in formulated diets for *Heteropneustes fossilis* (feeding trail-2) were conducted in a indoor rearing system of Freshwater Station, BFRI, consisting a series of cylindrical fiber glass tanks (70-L each) for 8 weeks. The follow up feeding trail in pond conditions on: development and optimization of feeds with probiotics in *H. fossilis* farming for 6 months (feeding trail-3) was also investigated.

The same aged uniform size fingerlings of *H. fossilis* were randomly distributed into groups of 50 fish (averaging 3.44 ± 0.07 g) per 70-L fiberglass tank in lab conditions for 8 weeks. Three experimental diets were formulated to contain 25, 30 and 35% crude protein and 17.07, 14.62 and 12.12 kJ g^{-1} gross energy (feeding trial-1). Six treatments, two feeding regimes (restricted and satiation) were offered for each of the three diets (25, 30 and 35% dietary protein level). In restricted feeding, the fish were offered diets at fixed rates 5.0, 4.1 and 3.6% of their body weight of 25, 30 and 35% protein diets respectively to provide approximately the same amount of protein and energy intake in all treatments daily. Feeds supply were adjusted after weekly weighing. The highest weight gain was observed for fish consuming 35% protein with no significant differences ($p>0.05$) between the 30% and 35% protein diets. Fish under satiation

feeding tended to have greater weight gains ($p>0.05$) than restricted fed fish at the same protein level. Fish fed the 30 to 35% protein diets to satiation displayed higher growth rate, while protein utilization was improved when the protein level was below 35% in the diet. Moreover, on the basis of economics, a lower protein level diet giving the same performance should be preferred. The results show that under satiation feeding a 30% protein diet lowers the body fat and improves protein utilization without growth retardation.

The feeding trial was conducted in indoor rearing system with 20 cylindrical fibre glass tanks to in *Heteropneustes fossilis* (1.50 ± 0.06 g) fingerlings for 8 weeks (feeding trial-2). Six experimental diets (iso-nitrogenous and iso-energetic) were formulated to contain 35% crude protein and 18.50 kJ g^{-1} gross energy. Feeds were prepared using locally available fish feed ingredients. The selected five types of probiotics (i) *Bactocell* (lactic acid producing bacteria, *Pediococcus acidilactici*); (ii) *Bacillus subtilis*; (iii) *Levucell* (yeast, *Saccharomyces cerevisiae*) (iv) Mixed (*Pediococcus acidilactici* + *Bacillus subtilis* + *Saccharomyces cerevisiae*) and (v) Navio plus (*Bacillus subtilis* + *Bacillus licheniformis* + *Bacillus megaterium* + *Lactobaciluus acidophilis* + *Lactobacillus plantarum* + *Saccharomyces cerevisiae* were added the diets following the recommended dose by the manufacturers. A control diet was prepared with same feed ingredients without mixing probiotic. Fish were fed the experimental diets in triplicate groups at the rate of 10-8% of their body weight per day adjusted weekly. The results showed that growth rate in terms of mean final body weight, weight gain, percent weight gain of experimental fish fed diets 2-5 were significantly ($p<0.05$) higher than the control diet. The specific growth rate (SGR) in different experimental diets varied between 2.45 and 2.94, with diets 2-5 producing higher (2.94) SGR value. The feed conversion ratio (FCR) values of different experimental diets ranged between 1.77 and 2.54 with diets 2-5 producing the better FCR. Protein efficiency ratio (PER) in different experimental diets ranged between 1.13 and 1.60 and the lowest PER value was obtained with diet 1 (control). Similarly, the higher apparent net protein utilization (ANPU) were also obtained with diets 2-5 while the lowest value was obtained with diet 1. Apparent protein digestibility (APD) values were fairly high ranging from 89.83% to 92.89%. Comparatively higher protein digestibility was observed fish fed diet 2 (92.89%) followed by diet 3. The carcass protein content in different diets ranged between 16.31% and 17.51%. Fish fed diet 2 showed significantly ($p<0.05$) highest protein content and diet 1 the lowest.

The follow up feeding trail on: development and optimization of feeds with probiotics in *H. fossilis* farming (feeding trial-3) was also conducted in pond conditions. The same aged uniform size (average wt. 3.50 ± 0.07 g) fingerlings of *Heteropneustes fossilis* (shing) were stocked in the ponds at the rate of 5,000 fish/400 m^2 pond (125,500/ha). Four experimental diets (iso-nitrogenous and iso-energetic) were formulated to contain 33.75% crude protein and 16.90 kJ g^{-1} gross energy. Feeds were prepared using locally available fish feed ingredients. The better perform three types of probiotics (i) *Bactocell* (lactic acid producing bacteria, *Pediococcus acidilactici*); (ii) *Bacillus subtilis*; (iii) *Levucell* (yeast, *Saccharomyces cerevisiae*) were added the diets following the recommended dose by the manufacturers. A control diet was prepared with same feed ingredients without mixing probiotic. The bite-sized (2.0 mm) pellet feeds were made from semi-auto pellet machine. Each dietary treatment was conducted in duplicate ponds. Feeding rate was adjusted based on fortnightly sampling of fish. The fish were offered the experimental and control diets, 2 times daily at the rate of 10-5% of their body weight. Significantly higher ($p>0.05$) growth rate in term of final body weight, weight gain and specific growth rate (SGR) were observed for fish fed probiotics containing diets and lowest ($P > 0.05$) the control diet (without mixing probiotic). Food conversion ratio (FCR) values ranges between 2.98 to 3.13 with fish fed probiotics containing diets showing significantly ($p<0.05$) the lower i.e. the better FCR. The total production (kg/ha) of shing for 6 months culture period are 2,675 to 4,015 kg/ha with *Bactocell* containing diet resulting higher production of 4,015 kg/ha. The overall results provide evidence of the potential applicability of probiotics as feed additives for maximizing production with minimizing cost of production of shing farming.

Investigation and identification of causative agents into emerging diseases of fish and development of their control strategies

Researcher: Dr. Nazneen Bagum, SSO
Md. Shirajum Monir, SO

Objectives

- Find out risk factors associated with emerging fish diseases on farm level
- Identification of causative agent(s) for emerging fish diseases outbreak with special reference to *Heteropneustes fossilis*
- Histological changes in different organs of diseased fish
- Development of control strategies to minimize fish mortality using better management practices and eco-friendly chemicals

Achievement

Risk factors on farm level: An interview-based questionnaire survey was carried out in 25 disease affected and 25 disease free farms to study the risk factors associated with outbreaks of emerging fish diseases in five upazilas of Mymensingh. There were 16 relative sources of risk identified from the disease farms. Data showed that the higher relative sources of risk for disease outbreak of higher stocking density, water quality deteriorate, pond connected to other water body, incomplete pond preparation and disease in the previous season in culture ponds were found 92%, 88%, 84%, 72% and 72%, respectively in the disease farm (Table 1). The use of lime and salt regularly in shing farm comparatively found to be low disease outbreak than others. It was also observed that birds carried specific pathogens to the disease free farm and disease outbreak nearest all fish farms.

Table 1. Different risk sources cause fish diseases on farm level

Risk sources	Disease affected farm (N=25)	Disease free farm (N=25)
POND CONNECTION		
High embankment and fencing in pond	8%	68%
Pond connected to other water body (rice field/other pond/ditch)	84%	0%
PRE-STOCKING POND PREPARATION		
Pond drying	28%	80%
Removal of bottom mud	12%	84%
Liming of pond	36%	100%
Incomplete pond preparation	72%	4%
STOCKING		
Low quality fingerlings stock	68%	4%
Higher stocking density	92%	4%
POST-STOCKING MANAGEMENT		
Liming and salting in pond	32%	92%
Use preventive measure for disease control	20%	76%
Black water color (high organic debris)	64%	12%
Deteriorate water quality (Temperature, pH, DO & ammonia)	88%	8%
HYGIENE		
Dried/disinfected of farm nets and equipments	16%	96%
Parasites observed on fish	64%	8%
Disease outbreak by birds	68%	0%
SEASONALLY		
Disease in the previous season	72%	8%

Identification of causative agent(s) for fish diseases outbreak and treatment trials: Emerging diseases causing severe mortality were observed in Shing (*Heteropneustes fossilis)*, Pangasius (*Pangasianodon hypophthalmus*) and Thai koi (*Anabas testudineus*) in different upazillas under Mymensingh district. Ponds size was varied from 15 to 210 decimal in the study area. In December 2012, mass mortality was observed in Catla (*Catla catla*) at Mahamaya Lake in Mirsorai upazila under Chittagong district. Diseased fish were collected and carried to the laboratory for detail study.

i) Shing disease

Clinical signs and symptoms observed: Grayish white spot and slight lesion on skin (Fig. 1), reduce mucus, sometimes eroded lesion in caudal region (Fig. 2), hemorrhage with bacterial and fungal infection, whirling with up and down movement in water and high mortality in short period were observed.

Identified bacteria and parasites: *Aeromonas hydrophila and Pseudomonas* spp. were isolated from the diseased Shing using by API 20 E bacterial diagnostic kit. Parasite *Trichodina* spp. was also found in diseased Shing.

Fig. 1. Grayish white spot on skin

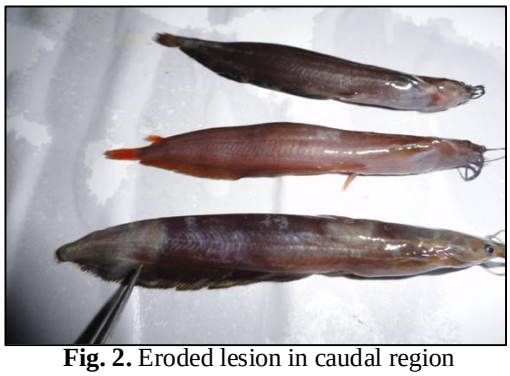

Fig. 2. Eroded lesion in caudal region

Treatment trials in aquarium, mini pond and farmer's pond: Diseased Shing were treated with chlorotetracycline @ 1g + vit.C 1 tab./kg feed for 7 days with water exchange. Again, salt 200 g/dec and lime 200 g/dec were also applied in the aquarium/pond at single dose. Recovery rate was found 50% in aquarium, 45% in experimental mini pond and 35% in farmer's pond.

ii) Pangasius disease

Clinical signs and symptoms observed: External, haemorrhage or inflammation occurs in the skin under the jaw (Fig. 3), on the operculum and belly, infection spreads to the skull and skin, thus creating the hole-in-the-head (Fig. 4), sometimes spinning rapidly in circles and usually followed by death.

Fig. 3. Infection under jaw & the eye region

Fig. 4. Infection in skull

Identified bacteria and parasites: *Edwardsiella ictaluri* was the causative agents that isolated from diseased Pangasius using by API 20 E diagnostic kit. Parasites such as *Dactylogyrus* spp., *Gyrodactylus* spp. *and Trichodina* spp. were also found in the diseased fish.

Treatment trials in aquarium, experimental mini pond and farmer's pond: Diseased Pangasius were treated with oxytetracycline at the rate of 1g + vit.C 1 tab./kg feed for 7 days with water exchange. Again, potassium permanganate was also applied at the rate of 10 g/dec in the aquarium/pond at single dose. Recovery rate was found 50% in aquarium, 46% in experimental mini pond and 38 % in farmer's pond.

iii) Thai koi disease

Clinical symptoms observed: Scale protrusion, deep ulcerative dermal lesion and tail rot were observed in diseased Thai koi.

Identified bacteria and parasites: *Flavobacterium* spp. was isolated from tail and fin rot diseased Thai koi. Parasites such as *Dactylogyrus* spp. and *Trichodina* spp. were also found in the diseased fish.

Treatment trials in aquarium, experimental mini ponds and farmer's pond: Diseased Thai koi were treated with oxytetracyclene at the rate of 1 g/kg + vit.C 1 tab./kg feed for 7 days with water exchange. Again, potassium permanganate was also applied at the rate of 10 g/dec in the aquarium/pond at single dose. Recovery rate were found 48% in aquarium, 40% in experimental mini ponds and 30% in farmer's ponds.

iv) Epidemic eye disease of catla

Clinical signs and symptoms observed: Eyes of the diseased Catla fish were the primary organs affected by the disease (Fig. 5). In early stage of the disease, a reddish color develops in the cornea due to vascularisation, no haemorrage occurs, subsequent, the whole of the cornea turns milky white and becomes opaque (Fig. 6), finally gills fades and float on the surface of the water.

Fig. 5. Infected eye in Catla at primary stage

Fig. 6. Hollow eye-cup punctured walls in Catla

Identified bacteria: Cultures prepared from the infected eyes and optic nerves showed that the etiological agent of the disease was a bacterium, which had been identified as *Aeromonas* sp.

Histological changes in different organs of diseased fish: Histopathological changes of different organs like muscle, gill, kidney and liver of diseased shing, pangasius, catla and Thai koi were observed. Necrosis, vacuum, hemorrhage, pyknosis and fungal granuloma were observed in different organs of diseased fish.

Optimization of stocking density of gulsha, *Mystus cavasius* in cage ecosystem in the River Brahamputra, Mymensingh

Researchers: Dr. A.H.M. Kohinoor, SSO
Md. Moshiur Rahman, SO

Objectives

- To optimize the suitable stocking density of gulsha (*Mystus cavasius*) in net cages,
- To develop improved cage management and feeding technique, and
- To analyze the cost-benefit of cage culture of gulsha

Achievements

Expt. 1. Optimization of suitable stocking density of high valued fish Gulsha (Mystus cavasius) in net cages ecosystem

Preparation of cage: The cages were made by locally available cage materials e.g., iron rod, net of suitable mesh size (1.0 cm), plastic floats, bamboo, plastic ropes etc. The area of each floating net cage was 3.0 m^3. Each cage was covered with another piece of net at the top to prevent escape of fish by jumping and bird predation. The whole structure were fixed with bamboo poles at each corner of the structure by making loop with nylon rope to facilitate easy floating of cages depending on water level.

Experimental design: For optimizing the suitable stocking density of gulsha in net cage, the experimental designs are as follows:

Table 1. Stocking density at different treatments

Species	Treatments	No of replication	Stocking density (m^3)	Stocking size (g)
Gulsha	T_1	3	500	1.04±0.54
	T_2	3	600	1.30±0.29
	T_3	3	700	1.18±0.33

Stocking: Fingerlings of gulsha were stocked in net cages according to the design of experiment during November 2012 for the period of 6 months.

Feeding: Supplementary feed containing 30% crude protein was applied in all cages twice daily at the rate of 5-20% body weight of fish.

Fish sampling: Fish of each cage was sampled at fortnightly interval to monitor their growth as well as feed adjustment.

Water quality parameters monitoring: Water quality parameters such as water temperature (^{0}C), dissolved oxygen (mg/l), pH, and transparency (cm.) were analyzed at two days interval.

Harvesting: Fishes were harvested after 6 months of culture period. During harvest, all fishes were counted and weighed individually from each cage to assess the survival rate and production.

Statistical analysis: Statistical analysis was done to find-out the correlation and impact of different stocking densities on growth and production following the standard statistical package.

The physico-chemical parameters of River Brahmaputra water viz., temperature, transparency, pH, dissolved oxygen and total ammonia of are presented in Table 2. The values of temperature, transparency, dissolved oxygen, pH and total ammonia were 17.0 – 28.0°C, 90 – 104 cm, 5.65 – 7.48 mg/l, 7.69 – 8.00 and 0.00-0.02 mg/l, respectively.The water quality parameters studied during the experimental period were found suitable for fish farming and could not have hampered the normal fish growth.

Table 2. Water quality parameters of River Brahmaputra during experimental period

Parameter	Value
Water Temperature (°C)	17.0 – 28.0
pH	7.69 – 8.00
DO (mg/l)	5.65 – 7.48
Transparency (cm)	90 – 104
Total ammonia (mg/l)	0.00-0.02

On the basis of final growth attained, it was observed that the highest average weight was found in treatment-1. At harvest, the average weights attained by gulsha were 24±2.17, 21.0±3.22 and 19±3.62g, in treatments-1, 2, and 3, respectively. The harvesting weight of treatment-1 was significantly higher ($p<0.05$) than treatment-3 and 2. Whereas treatments 2 and 3 did not show any significant difference. In higher stocking densities, the harvesting weight of gulsha was occurred linearly. The survival rate of fish varied from 52 to 66%. The mean survival rates of gulsha were 66±3.14, 60±4.58 and 52±4.90 in treatments-1, 2, and 3, respectively shown in table-3. The highest survival rate was observed in treatment-1 which followed by treatment-2 and 3. The productions obtained in cages were 7.92±1.53, 7.56±1.82 and 6.5±1.41 kg/m^3 from treatments-1, 2 and 3, respectively. Figure 1 shows that the highest production was obtained from treatment-1 where the lowest in T-3. The production of gulsha in treatments-1and 2 was significantly different ($p<0.05$) from treatment-3.

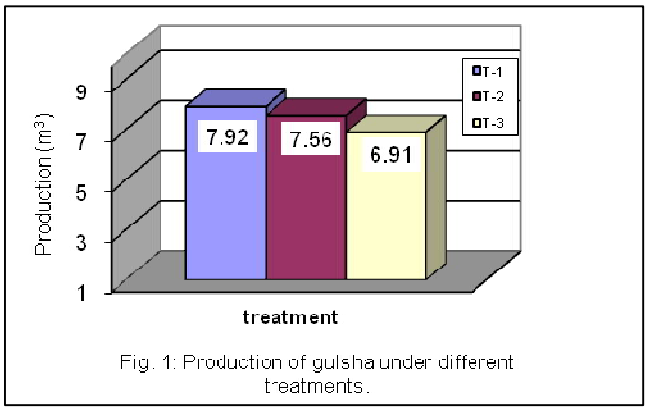

Fig. 1: Production of gulsha under different treatments.

Table 3. Harvesting wt., survival and production of gulsha under different treatments

Treatment	Harvesting wt. (g)	Survival (%)	Production/m3 (kg)
T_1 (500/m^3)	24±2.17[a]	66±3.14	7.92±1.53[a]
T_2 (600/m^3)	21±3.22[b]	60±4.58	7.56±1.82[a]
T_3 (700/m^3)	19±3.62[b]	52±4.90	6.91±1.41[b]

* Dissimilar superscript indicates significant difference at 5% level of probability

The cost and benefit analysis of gulsha in net cages under three treatments are presented in Table 4. Variable costs towards cage preparation, fingerlings, feed and operational costs were taken into consideration while calculating cost of production. Cost and benefit analysis showed that T_1 generated the

highest return over a period of six months of Tk. 4480/cage ($3m^3$) and lowest net return Tk. 1765/ cage ($3m^3$) was found in T_3. The results of the study indicated that the best individual growth, production and net benefit of gulsha was obtained at a density of 500 fish/m^3.

Table 4. Cost and return analysis of fish production under different treatments (Tk./cage)

Inputs	T_1		T_2		T_3	
	Quantity	Cost (Tk.)	Quantity	Cost (Tk.)	Quantity	Cost (Tk.)
Cage preparation($3m^3$)		3000		3000		3000
Fingerling (Nos.)	1500	1500	1800	1800	2100	2100
Feed (kg)	60	2400	68	2720	75	3000
Operational cost		500		500		500
Total cost		7400		8020		8600
Benefits						
Production of Fish: T_1: 23.76 kg/cage; T_2: 22.68 kg/cage and T_3: 20.73 Sell price • Gulsha : Tk.500/kg	23.76	11880		11340		10365
Net benefit/cage		4480		3320		1765

Development of aquaponic techniques in Bangladesh

Researchers: Dr. Masud Hossain Khan, CSO
Dr. Jubaida Nasreen Akhter, SSO
Dr. Md. Khalilur Rahman, PSO
Md. Rayhan Hossain, SO

Objectives

- Production of Genetically Improved Farmed Tilapia (GIFT) with vegetable
- Production of *Anabas testudineus* with vegetable

Achievements

An experiment was conducted in Aquaponic Garden during April to July 2013 at BFRI campus to determine the growth rate and production of Genetically Improved Farmed Tilapia with vegetable. GIFT was reared in circular fiberglass tanks with supplementary feed under a shade system. Shade was made with tin sheet in an open space for free access of sunlight and air. Uniform sized GIFT fingerlings weighing 30.0 ± 2.0 g were stocked at the rate of 60 m^{-3} having 3 replications. Fish were fed with locally available commercial floating feed at the rate of 3% body weight 4 times daily. Indian spinach and green leaf, ladies finger and Indian spinach, and capsicum and green leaf were planted on the tanks holding GIFT in T_1R_1, T_1R_2, and T_1R_3, respectively.

Within 120 days culture period, fish was sampled fortnightly and feeding rate was adjusted accordingly. Under this experiment vegetable or salad was produced simultaneously. Density of vegetable seedling was maintained at 9 m^{-2} and 18 m^{-2} of growing area according to the nature of plant. Sufficient water flow and aeration were provided in each fish tank. Feed-nutrient mixed water was pumped from the fish

holding tank to the vegetable rearing try through a filter and came back to the fish holding tank again. Neither pesticide nor fertilizer was applied to the vegetable seedlings. Water quality parameters such as NH_3, O_2, pH and water temperature was recorded alternate day. Growth and production of fish and vegetable was recorded.

Another experiment was conducted at the same place and time with different fish species from the above. *Anabas testudineus*, an insectivore, was reared in rectangular fiberglass tanks with supplementary feed under a shade system. *Anabas testudineus*. fingerlings averaging 1.5± 0.5 g were stocked at the rate of 80 m^{-3} having 2 replications. Fish were fed with locally available commercial floating feed at the rate of 3% body weight 4 times daily. Green chili, lettuce, green leaf and capsicum, green leaf, green chili were planted on the tanks rearing Anabas *testudineus*. in T_2R_1 and T_2R_2, respectively.

Shade was made with tin sheet in an open space for free access of sunlight and air. Culture period was 120 days in summer month. Fish was sampled fortnightly and feeding rate was adjusted accordingly. Vegetable was produced simultaneously. Seedlings of high yielding variety of vegetable were collected from the local plant-nursery. Density of vegetable seedling was maintained 9 m^{-2} and 18 m^{-2} of growing area according to the nature of plant. Sufficient water flow and aeration was provided in each fish tank. Feed-nutrient mixed water was pumped from the fish holding tank to vegetable rearing try through a filter and came back to the fish holding tank again. Neither pesticide nor fertilizer was applied to the vegetable seedlings. Water quality parameters such as NH_3, O_2, pH and water temperature was recorded alternate day. Growth and production of fish and vegetable was recorded.

Fish were harvested after 120 days of rearing and vegetable were harvested three times during the culture period. Harvesting details are given bellow:

GIFT harvesting

Treatment	**T_1R_1**	**T_1R_2**	**T_1R_3**
Stocking density (m^{-3})	60	60	60
Initial wt. (g)	30	30	30
Av. Final wt.(g)	140	140	145
Total production (kg)	6.7	6.3	5.5
Yield kg m^{-3}	7.9	7.4	6.5
Wt. gain per day (g)	1.0	1.0	1.0
Survival (%)	98	87	73

Anabas sp. harvesting

Treatment	**T_2R_1**	**T_2R_2**
Stocking density (m^{-3})	80	80
Initial wt. (g)	1.5	1.5
Av. Final wt.(g)	40	38
Total production (kg)	3.0	1.3
Yield kg m^{-3}	1.9	0.8
Wt.gain per day (g)	0.3	0.3
Survival (%)	62	27

Vegetable harvesting

Replication	Vegetable	Total Production /Tray(kg) three time	Yield kg m^{-2}	Survival
T_1R_1	Indian Spinach Green leaf	3.0 3.0	2.0 2.0	99 100
T_1R_2	Ladies finger ISL	0.5 1.5	0.4 1.0	99 100
T_1R_3	Chili& Capsicum Green leaf	0.5 2.5	0.4 1.7	98 100
T_2R_1	Chili Green leaf	0.2 2.5	0.13 1.7	98 100
T_2R_2	Chili ISL	0.25 2.0	0.16 1.3	100 100

Water quality parameter of fish tank and vegetable tray

Water quality parameter

Parameter: Fish Tank	T_1R_1	T_1R_2	T_1R_3	T_2R_1	T_2R_2
DO (ppm)	5.6	5.9	5.7	6.7	6.5
pH	7.1	7.2	7.1	7.3	7.3
Alkalinity (ppm)	130	145	140	130	130
Ammonia (ppm)	0.02	0.03	0.02	0.01	0.01

Parameter: Vegetable tray

pH	6.8	6.5	6.3	7.0	6.4
Alkalinity (ppm)	130	130	135	125	130
Temp. 0C	25-30	25-30	25-30	25-30	25-30

Neither pesticide nor fertilizer was applied during culture period. Water quality parameters were within the suitable range for fish culture. Yield of GIFT was recorded as 7 kg/m^3 which was higher than the other aquaponic production in Bangladesh (Rahmatullah *et. al*. 2010). Average daily weight gain was recorded as 1.0g which is satisfactory for GIFT culture in tanks. Yield of *Anabus* sp. was recorded as 1 kg/m^3 which is not satisfactory as compared to the pond culture system. Low production was due to small size of fingerling that caused poor survival rate. Vegetable yield, especially green leaf, was 2 kg/m^2 which is satisfactory for aquaponic system.

Field validation of selected high valued fish culture technologies for maximizing production

Researchers: Dr. Masud Hossain Khan, CSO
Dr. A.H.M. Kohinoor, SSO
Md. Moshiur Rahman, SO

Objectives

- To validate the production technologies of shing (*Heteropneustes fossilis*) and koi (*Anabas testudineus*)
- To validate the production technologies of Gulsha (*Mystus cavasius*) and Pabda (*Ompok pabda*)
- To calculate the benefit cost ratio

Achievements

Expt. 1. Culture of shing (Heteropneustes fossilis) with koi (Anabas testudineus) in farmer's pond

This technology was validated in four farmer's pond at Tangail Sadar and Sirajgong Sadar during October 2012. Prior to stocking, ponds were dried and cleaned for weed and unwanted aquatic animals. After cleaning lime was applied at the rate of 250kg/ha. Five days after liming pond was filled up with up to the depth of 1.0 meter. Fry of shing and koi were stocked at the stocking density of 75,000/ha and 1,25,000/ha, respectively. The mean initial weight of shing and koi were 2.5±0.41 and 1.05±0.49g, respectively. After stocking, fish was fed at a rate of 5-20% of body weight with supplementary feed (30% crude protein). Fish was sampled at fortnightly intervals to determine growth rate as well as feed adjustment. Water quality parameters such as water temperature, transparency, pH, dissolved oxygen (DO) and total alkalinity was analyzed at ten days interval between 09.00 to 10.00 hrs.

The physico-chemical parameters of different ponds of these project area *viz.*, temperature, transparency, pH, dissolved oxygen and total ammonia are presented in Table 1. The values of temperature, transparency, dissolved oxygen, pH and total ammonia were 19.6-30.69°C, 1.20-1.40cm, 4.72-7.55 mg/l, 7.21-8.66 and 0.0-0.02 mg/l, respectively.

Table 1. Water quality parameters of ponds of different culture locations

Parameter	Value
Water temperature (°C)	19.6 – 30.69
Transparency (cm)	1.20-1.40
pH	7.21-8.66
DO (mg/l)	4.72-7.55
Total ammonia (mg/l)	0.0-0.02

After six months rearing, fishes were harvested by repeated seine netting. Total bulk weight and number of fish from each pond was recorded. Survival and gross production of fish of each pond was estimated. Details of growth and production performances are presented in Table 2. The mean harvesting weight of shing and koi in Shirajgonj were 65.12±1.01 and 71.17±2.47g, respectively. The survival rates of shing and koi were ranged from 72-74% and 78-82%, respectively. The high percentage of survival obtained in all species in both areas suggest that such factors as healthy fish, predator free pond, favorable ecological condition, good management etc. were important in influencing survival. The production of shing and koi was 10.6 mt/ha in Shirajgonj. On the other hand, the mean harvesting weight of shing and koi in Tangail were 57.74±0.61 and 72.14±1.76g, respectively where the production of shing and koi in Tangail was 10.55 mt/ha. (Table 2)

Table 2. Stocking density, harvesting weight, survival and production of shing and koi in different location

Culture location	Stocking density/ha		Harvesting Wt. (g)		Survival (%)		Production (mt/ha)	
	Shing	Koi	Shing	Koi	Shing	Koi	Shing	Koi
Shirajgonj	75,000	1,25,000	65.12±1.01	71.17±2.47	72	78	3.5	7.1
Tangail			57.74±0.61	72.14±1.76	74	82	3.16	7.39

The benefit and cost analysis of shing and koi were calculated (Table 3). Variable costs like labour, lime, fingerlings, feed, fertilizers and harvesting costs were taken into account during analyzing the cost of production. Cost and benefit analysis indicated that, in Shirajgonj, the highest net benefit over a period of six months of Tk. 914,000/ha and lowest net return Tk. 822,600/ha was found in Tangail. The production as well as economic return was very encouraging in this technology.

Table 3. Cost and return analyses of fish production in different locations (Tk./ha)

Inputs		**Culture Location (Shirajgonj)**		**Culture location (Tangail)**	
		Quantity	Cost (Tk.)	Quantity	Cost (Tk.)
Pond preparation (lime and labour etc.)			10,000		10,000
Fingerling (Nos.)	Shing	75,000	1,75,000	75,000	1,75,000
	Koi	1,25,000		1,25,000	
Feed (kg)		30,250	12,10,000	30,250	12,10,000
Harvesting cost			15,000		16,000
Labour			70,000		65,000
Total cost			14,80,000		14,76,000
Benefits					
Sell price of Fish • Shing: Tk.400/kg • Koi : Tk.150/kg			23,94,000		22,98,600
Net benefit/ha		9,14,000		8,22,600	

BCR: BCR value indicates whether the technology is either successful or failed. For this technology the BCR value is >1.0. i.e. the technology is economically viable.

Expt. 2. Culture of gulsha (Mystus cavasius) with pabda (Ompok pabda) in farmer's pond

This technology was validated in four farmer's pond at Tangail Sadar, Sirajgong Sadar and Belkuchi during October, 2012 to May 2013. During pond preparation, ponds were dried and cleaned for weed and unwanted aquatic animals then limed at the rate of 250 kg/ha. Five days after liming, water was supplied from shallow tube well to the ponds and filled up to the depth of 1 meter. The prepared ponds were stocked with pabda and gulsha at a density of 37,500 and 75000/ha, respectively. During stocking the mean initial weight of gulsha and pabda fry were 1.78±0.31 and 2.38±0.35g, respectively. Following day after stocking supplementary feed (30% crude protein) was applied at a rate of 5-20% of body weight. Fish sampling was made at fortnightly interval to determine growth rate as well as feed adjustment. Water quality parameters such as water temperature, transparency, pH, dissolved oxygen (DO) and total alkalinity was analyzed at ten days interval between 09.00 to 10.00 hrs.

Table 4 showed the water quality parameters of different ponds *viz*., temperature, transparency, pH, dissolved oxygen and total ammonia. The values of temperature, transparency, dissolved oxygen, pH and total ammonia were 19.6-30.69°C, 1.20-1.40cm, 4.72-7.55 mg/l, 7.21-8.66 and 0.0-0.02 mg/l, respectively.

Table 4. Water quality parameters of ponds of different culture locations

Parameter	Value
Water temperature (°C)	20.05 – 29.54
Transparency (cm)	1.24-1.36
pH	7.16-8.47
DO (mg/l)	5.12-7.89
Total ammonia (mg/l)	0.0-0.01

At the end of the experiment, the fishes were harvested, first by seine netting and then by draining out of the ponds. The harvested fishes were counted and weight was recorded. The growth and production of pabda and gulsha in ponds of two districts are shown in Table-5. After seven months, harvesting mean weight of gulsha and pabda in Shirajgonj were 28.21±0.67 and 36±0.98g, respectively where the total production was 2720 kg/ha. The mean final harvesting weight of gulsha and pabda in Tangail were 29.21±0.54 and 32.01±0.62g, respectively while the total production was 2640 kg/ha. In case of survival rate, gulsha showed better survival than pabda. The survival rate of gulsha ranged from 80-83% while in pabda it was 74-76%. The obtained results of production were very encouraging in contrast to on-station production.

Table 5. Stocking density, harvesting weight, survival and production of gulsha and pabda in different locations

Culture location	Harvesting wt. (g)		Survival (%)		Production (kg/ha)	
	Gulsha	Pabda	Gulsha	Pabda	Gulsha	Pabda
Shirajgonj	28.21±0.67	36.00±0.98	80	76	1700	1020
Tangail	29.21±0.54	32.00±0.62	83	74	1750	890

The cost of production and return from culture of pabda and gulsha were analyzed for evaluating the economic viability (Table 6). While, analyzing cost of production, variable costs towards labour, lime, fingerlings, feed, fertilizers and harvesting costs were taken into consideration. Cost and benefit analysis showed that the highest net benefit Tk. 688,500/ha over a period of seven months in Shirajgonj, whereas the lowest net return of Tk. 657,500/ha in Tangail. In the present study, the production obtained in this study was very encouraging. The endangered small fish like as pabda (*O. pabda*) and gulsha (*M. cavasius*) culture would add financial benefit in the farmer and the fish farmer may get a chance to consume. It was also revealed that the small water bodies may generously be used for small indigenous fish species (SIS) culture, indicating the feasibility of attaining a good production.

Table 6. Cost and return analyses of fish production in different locations (Tk./ha)

Inputs		**Culture Location (Shirajgonj)**		**Culture location (Tangail)**	
		Quantity	Cost (Tk.)	Quantity	Cost (Tk.)
Pond preparation (lime and labour etc.)			10,000		10,000
Fingerling (Nos.)	Gulsha	75,000	1,87,500	75,000	1,87,500
	Pabda	37,500		37,500	
Feed (kg)		7,500	3,00,000	7,500	3,00,000
Harvesting cost			12,000		10,000
Labour			60,000		66,000
Total cost			5,69,500		5,73,500
Benefits					
Sell price of Fish • Pabda: Tk.500/kg • Gulsha : Tk.400/kg			12,58,000		12,31,000
Net benefit/ha		6,88,500		6,57,500	

Fine tuning of freshwater pearl culture technology

Researchers: Arun Chandra Barman, SO
Md. Ariful Islam, SO

Objectives

- Optimization of pearl production in terms of quality and quantity against the number of mantle tissue slices to be inserted into the mussels
- Determination of suitable water level for maximum pearl production
- Refinement of image pearl culture technology
- Dissemination of technology through on-farm trial and training.

Achievement

Experiment was carried out in 3 earthen ponds at Freshwater Station with different culture techniques, such as keeping 2-3 mussels in hanging net, 10-15 mussels in box net at the pond bottom and releasing the mussels (80-100 nos./dec) in water for grazing. After 5 months, maximum growth was obtained from the grazed mussels showing 5-6 pearls having the sizes of 2-3 mm. It is worthwhile to mention here that in our previous study in 1999, it was taken 12-18 months to obtain same size of pearl. Therefore, the promising results should be optimized in order to produce quality pearl in the years to come. About 3000 mussel has being operated through mental tissue operation and 150 mussel being operated through image operation. Maximum 100 mg (average 50mg) weight of pearl was produced in 8 months. Their hapes were round, rice and irregular. Dissemination of technology is going on through farmer's day, training & demo farm.

Determination of efficacy of chemicals and drugs used in aquaculture practices in Bangladesh

Researchers: Dr. Momtaz Begum, SSO
Md Golam Sorower, SO

Objectives

- To determine the effect of chemical and drugs on pond productivity and fish production
- To determine the effective dose of chemicals and drugs on fish production
- To create awareness among the fish farmers/entrepreneurs regarding the toxic effect of chemicals/drugs in aquatic environment.

Achievements

Effects of antibiotics on fish fry health and water quality in cistern condition

Ranges of different water quality parameters of antibiotic treated cistern water have been presented in the Table 1. The variations in values of different water quality parameters were within the acceptable limits of fish culture, without any marked differences among the treatment cisterns.

Table 1. Ranges of water quality values of cistern under three antibiotic treatments

Parameters	Renamycine		Oxysentin		Aquamycine	
	BT	AT	BT	AT	BT	AT
DO (mg/l)	3.28- 3.52	4.68-6.24	4.12-5.98	4.5-6.10	3.99-5.20	5.1-6.5
pH	6.50-6.82	7.48-7.98	6.58-7.90	7.20-7.45	6.0-7.2	7.12-7.5
Total alkalinity (mg/l	80- 95	125-140	85-98	98-111	84-96	111-120
Ammonia (mg/l)	0.32-0.58	0.05-0.08	0.09-0.13	0.03-0.06	0.09-0.11	0.03-0.06
Phosphate (mg/l)	0.22-.32	0.28-0.65	0.22-.32	0.28-0.65	0.22-.32	0.28-0.65
Nitrate (mg/l)	0.10-0.24	0.18-0.30	0.10-0.24	0.28-0.55	0.10-0.24	0.18- 0.83

BT= Before Treatment / AT= After Treatment

The growth and survival data (mean ± sd) of fish under different antibiotic treatments in cisterns are given in Table 2. The antibiotic Renamycin resulted in significantly higher growth and survival but similar to Oxysentin. However, the control ponds, receiving no antibiotics, resulted in the significantly lower growth and survival.

T**able 2.** Growth and survival (mean ±SD) of (*Anabas testudineus*) under different antibiotics treated commercial feed for 60 days in cistern

Growth parameters	Antibiotics			Control
	Renamycine	Oxysentin	Aquamycine	
Av. initial wt. (gm)	1.50 ± 0.14	1.55 ± 0.15	1.55 ± 0.15	1.53 ± 0.11
Av. final wt. (gm)	8.78 ± 0.35^{a}	8.50 ± 0.31^{a}	8.15 ± 0.17^{c}	6.65 ± 0.29^{d}
Av. live weight gain (%)	485.73 ± 7.02^{a}	448.28 ± 8.60^{ab}	434.72 ± 0.28^{c}	334.50 ± 0.24^{d}
Survival rate (%)	92 ± 3.06^{a}	90.00 ± 3.03^{a}	90.23 ± 2.15^{a}	70.15 ± 2.12^{b}
Specific growth rate (%)	2.96 ± 0.55^{a}	2.84 ± 0.54^{ab}	2.83 ± 0.55^{b}	2.45 ± 0.08^{c}

Effects of antibiotics on fish fry health and water quality in pond condition

Ranges of different water quality parameters of antibiotic treated earthen ponds have been presented in the Table 3. The variations in values of different water quality parameters were within the acceptable limits of fish culture, without any marked differences among the treatment ponds. Though there was no remarkable effect of antibiotic treatments of on water quality, the amount of ammonia was low in all ponds after the application of antibiotic.

Table 3. Ranges of water quality values of ponds under three antibiotic treatments

Parameters	Renamycine		Oxysentin		Aquamycine	
	BT	AT	BT	AT	BT	AT
DO (mg/l)	5.40- 5.82	5.68-6.84	5.39-5.88	5.5-6.30	5.30-5.55	5.78-6.5
pH	6.55-7.40	6.48-7.98	6.68-7.60	6.60-7.75	6.5-7.0	6.8-7.5
Total alkalinity (mg/l	98-111	125-140	94-110	95- 112	98-113	111-120
Ammonia (mg/l)	0.06-0.09	0.03-0.04	0.07-0.10	0.03-0.05	0.06-0.11	0.02-0.04

The growth and survival data (mean ± sd) of fish under different antibiotic treatments in earthen pond condition are given in Table 4. It was observed in case of cistern, application of antibiotics has been resulted significantly higher growth and survival ($p<0.05$), compared to without application. The antibiotic Renamycin resulted significantly higher growth and survival but similar to Oxysentin. However, the control ponds, without antibiotics, resulted significantly lower growth and survival.

Table 4. Growth trial of *Anabas testudineus* under different antibiotics treated pond with commercial feed

Parameters	Renamycine	Oxysentin	Aquamycine	Control
Initial Body weight(gm)	6.26±0.27	6.26±0.28	6.26±0.23	6.26±0.29
Final weight Body (gm)	98.30±0. 45[a]	84.45±0. 35[b]	83.10±0.45[b]	73.18 ±0.48[c]
Weight gain (gm)	92.04±0.37[a]	78.55±0.25[b]	77.04±0.38[b]	67.53±0.39[c]
Weight gain (%)	1470.28±0.33	1256.80±0.30	1232.67±0.32	1168.10±0.38
SGR (% day)	2.29±0.35	2.17±0.34	2.16 ±0.36	2.01±0.18
Survival rate(%)	89.25±5.41	88.72±6.09	76.20±4.77	70.34±5.71

Histopathological changes of different organs like muscle, gill, kidney and liver of non-treated ponds were observed. In that cases, necrosis, vacuum, hemorrhage, pyknosis and fungal granuloma observed.

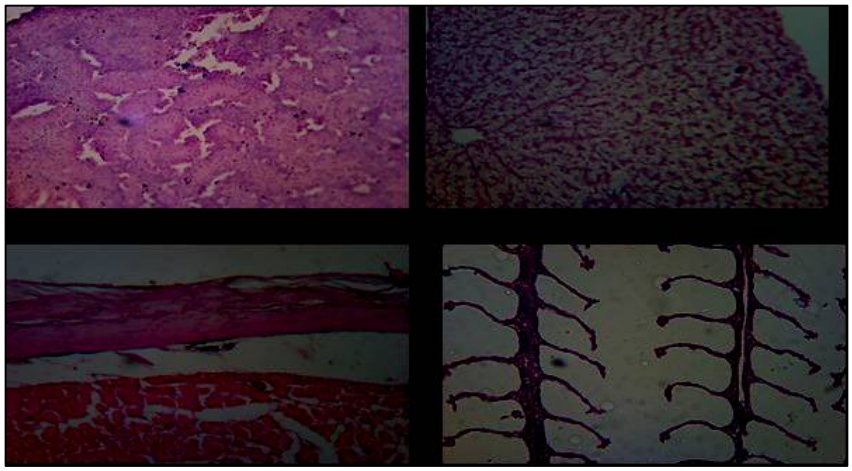

Fig 1. Histological slides of different organs of koi, *Anabas testudineus* from antibiotic treated ponds.

It was observed from the findings of the above two trails that after using antibiotics in all treatments the value of pH alkalinity), dissolved oxygen, ammonia were suitable range and good for fish health and fish culture. Ammonia became reduced due to use of drugs. Fish production also provided higher in Renamycin treated pond than other treated ponds. Histopathological study did not show any negative changes on the organ of fishes. Among all the antibiotics, Renamycin was the best in all aspects (improve fish health and water quality) .Other two drugs (Oxycentine and Aquamycine) resulted more or less same result.

Study on food, feeding habit and breeding biology of commercially important Cuchia species, *Monopterus cuchia*

Researchers: Nilufa Begum, SSO
Md. Mehedi Hasan Pramanik, SO

Objectives

- To study the life cycle and all biological aspect especially food and feeding behavior, fecundity, fertilization and hatching rate of *Monopterus cuchia*
- To develop natural and artificial breeding technique of *M. cuchia*
- To develop aquaculture technology of *M. cuchia*

Achievements

Expt. 1. Brood development and induced breeding

Female averaging 280g and male averaging 190g were collected from the Raktadaha beel of Santahar. Broods were reared in a pond of Floodplain Sub-Station for three month from January to March 2013. Water depth of pond was about 1.0-1.25 m. Experimental pond was fenced by nylon net, bamboo and rope to prevent entering of other creatures. Water hyacinth, helencha and PVC pipes were provided in the pond to create suitable and safe shelter. Live foods like earthworms, moribund fingerling of guchi (*Mastaecmbelus puncalus*), carpio (*Cyprinus carpio*), taki (*Channa punctatus*) and puia (*Lepidocephalus guntea*) were provided at the rate of 3% body weight twice a day.

Female broods averaging 350 g and male broods averaging 230g were selected for induced breeding. Sexual maturity of broods was confirmed by observing the body color and shape of genital organ. Female and male broods were kept for a few hours in separate cisterns. Broods were taken out from the cistern and caught with a piece of wet soft cloth. Female were injected twice while male received single dose. In case of female, time interval between two injections was maintained at 6-12 hours. The male was given single dose at the time of second dose of the female. After that, the injected broods were transferred to the hapa, cistern and pond.

Five black hapas made of smooth and soft cloth were used for creating spawning habitat of *M cuchia*. Hapa was installed in the experimental cisterns. After injection, two males and one female of *M. cuchia* were kept in each hapa. Water hyacinth and PVC pipe were provided for creating shelter. Different dosages of cPGE, HCG and Ovaprim were applied in different hapas (Table 1). Earthworm, dead/moribund Guchi and Puia were supplied as food of injected *M. cuchia*. During the experimental period, mean water temperature (°C), dissolved oxygen (mg/L) and water pH were 28.92±1.39, 6.02±1.10 and 7.98±0.31 respectively.

Table 1. Different doses of hormone used for breeding of *M. cuchia* in hapa

Female	Male
Double dose: 10mg cPGE and 20 mg cPG/kg BW	10 mg cPGE/kg BW
Single dose: 40 mg cPGE /kg BW	15 mg cPGE/kg BW
Double dose: 20mg cPGE + 1000 IU HCG/kg BW and 40 mg cPGE+1500 IU HCG/kg BW	20 mg cPGE/kg BW
Double dose: 25 mg cPGE+1500 IU HCG/kg) and 40 mg cPGE/kg BW	25 mg cPGE/kg BW
Double dose: Ova prim 0.7 mg/kg BW and 20 mg PG/kg BW	Double dose: 30 mg cPGE and 1000 IU HCG/ kg BW

Observations were made on the effect of such hormone treatments. Ovulation was not observed with the female received double doses of 10mg cPGE and 20 mg cPGE/kg BW and the male received 10 mg cPGE/kg BW. Time interval between two injections was 6 hours. Other broods did not respond to other hormones and doses. A female received double doses of 20 mg cPG+1000 IU HCG/kg BW and 40 mg cPG+1500 IU HCG/kg BW and other female received double doses of 25 mg cPG +1500 IU HCG/kg and 40mg cPG/kg BW were died. Time interval between two injections was 12 hours. Death of broods was probably due to high doses of cPGE.

Expt. 2. Induced breeding in cistern

Cistern having a dimension of 2.74x1.82x1.00 m was used to breed *M. cuchia*. Floor and side walls of cistern were covered by soil to create natural habitat like as pond bottom. Due to borrowing nature, *M. cuchia* survive well in contact with soil. Water hyacinth and PVC pipe were provided for creating shelter and hiding place. Two pairs of injected *M. cuchia* were stocked at a ratio of 1:1 in each cistern. Different dosages of cPGE, cuchia PG, Ovaprim and Pregnyl were applied in different cisterns (Table 2). Earthworm, dead/moribund guchi, taki and puia were supplied as food of injected *M. cuchia*. During the experimental period, mean water temperature (°C), dissolved oxygen (mg/L), water pH and total alkalinity (mg/L) were 28.81±0.15, 6.41±1.05, 7.97±0.42 and 190.12±2.46, respectively.

After injection, observations were made to record the effect of hormone treatments. Among the various dosages applied, female received double dose 40 mg cPG+1000IU HCG/kg BW responded positively and released egg. However, the male received a dose of 40 mg cPG/kg BW did not release milt. Ovulation was observed with the female received 3 doses of hormones such as 1st day 80 mg cPG/kg BW, 2nd day 1000 IU Pregnyl/kg BW and 3rd day 500 IU Pregnyl/kg BW. The counterpart male received a dose of 500 IU pregnyl/kg BW on 3rd day. Stripping was done to collect eggs but the eggs were found in liquid conditions. Damage of eggs was probably due to high dose of hormones or high pressure during stripping. Other females and males didn't respond to the hormone treatments and few broods were died.

Table 2. Hormones and their doses used for breeding of *M. cuchia* in cistern

Female	**Male**
Double dose: 50 mg cPG and 20 mg cPG/kg Bw	35 mg cPG/kg BW
Double dose: 40 mg cPG and 30 mg cPG/kg BW	40 mg cPG/kg BW
Single dose: Ova prim 0.8 mg/kg BW	Ova prim 0.3 mg/kg BW
Single dose: 25 mg Cuchia PG/kg BW	10 mg Cuchia PG/kg BW
Triple dose: 1st day 80 mg/kgBW 2ndday1000 IU Pregnyl/kg BW 3rd day 500 IU Pregnyl/kg BW)	3rd day 500 IU Pregnyl/kg BW
Double dose: 40 mg cPG and 1000 IU HCG/kg BW	40 mg cPG/kg BW.

Expt. 3. Induced breeding in pond

A pond having an area of five decimal was prepared by sun drying followed by liming at the rate of 1 kg/dec. After stocking fertilizers were used fortnightly depending on the primary production of the pond. The pond was protected by fencing with nylon net, bamboo and rope. Water hyacinth, helencha and PVC pipes were provided to create suitable and safe shelter. After preparing the pond, fifteen pairs of injected cuchia were stocked in the pond in 1st week of April 2013. Selected dose of Pregnyl was applied to the fish in pond (Table 3). Injected cuchia were fed with spawn of carpio, dead/moribund fry of taki, guchi, puia and earthworms thrice in a week. Feeding rate was 2-3% of body weight. The water quality parameters such as temperature (°C) dissolved oxygen (mg/L), pH and total alkalinity (mg/L) 30.29±1.52, 6.98±1.02, 7.91±0.39, 192.00±2.22, respectively.

As *M. cuchia* breed naturally in May-June during monsoon, attempt was made to collect juveniles during the natural spawning season. Third week of May 2013 pond was dried up to collect larvae of *M. cuchia*. There were ten spawning nests which were identified in the pond near the dyke and larvae were collected from those nests. A total of 3000 larvae were collected from six holes. At the time of collection, yolk sac was not absorbed to about 30% larvae.

Table 3. Hormone used for breeding of *M. cuchia* in pond

Female	Male
Single dose: Pregnyl 1000 IU/kg BW	Single dose: Pregnyl 500 IU/kg BW

Expt. 4. Nursery development of M. cuchia larvae

Collected larvae were stocked in two rearing units. Larvae were stocked at the rate of 1000/m^2 in a cistern having a dimension of 2.74x1.82x1.00 m. A tray having a dimension of 1.0x0.5x0.12 m was also stocked with the larvae at the rate of 1000/m^2. Before releasing larvae, floor and side walls of tray and cisterns were covered by smooth clay soil. Water hyacinth was provided to create suitable shelter for the larvae. Water depth was kept always at 0.45 and 0.12 m in the cistern and tray, respectively. For 1st 3 days, the larvae were fed thrice daily with boiled poultry egg yolk in the morning and next two times with earthworm's juice at the rate of 80-90% of estimated body weight. After 3 days, earthworm pest, zooplankton and chopped tubifex were provided in the morning, noon and afternoon, respectively. The feeding rate was 5-10% of total body weight. Initial mean length (cm) and weight (g) were 4.86±0.24 and 0.0701±0.005 in tray while it was 4.16±0.28 and 0.0702±0.006 in cistern, respectively. After four months of rearing, it was observed that the final mean length and weight of fry in tray were 10.68±1.89 cm and 1.092±0.017g while, the final mean length and weight were 10.78±0.279 cm and 1.025±2.34g in cistern. Survival rate was 80 and 77% in tray and cistern, respectively (Table 4).

Table 4. Growth performance of *M. cuchia* at different habitats

Growth parameters	Tray	Cistern
Initial length (cm)	4.86±0.24	4.16±0.28
Initial weight (g)	0.0701±0.005	0.0702±0.006
Final length (cm)	10.68±1.89	10.78±0.279
Final weight (g)	1.092±0.017	1.025±2.349
Weight gain (g)	1.022±0.241	0.955±0.235
(%) Weight gain	1460.00	1364.28
Survival (%)	80	77
Specific growth rate	0.937	0.876

Adoption of mass seed production and culture techniques of Thai koi (*Anabas testudineus*) and shing *(Heteropneustes fossilis)* in the Northern Region of Bangladesh

Researchers: Dr. Shafiqur Rahman, SO
Md. Shirajum Monir, SO
Maliha Hossain Mou, SO

Objectives

- To adopt breeding techniques and seed production of Thai koi and shing
- To assess the growth and survival of Thai koi and shing fingerlings.
- To adopt monoculture techniques of Thai koi in different aqua-ecological zone in the northern part of the country
- To study the growth and production performances of Thai koi and shing under different culture systems
- Dissemination of quality seed of Thai koi and shing to the local farmers in the region.

Achievements

Development of culture techniques of shing under mono- culture system

An experiment was undertaken in nine experimental mini ponds (each size 0.006 ha) to assess the growth performances, production potentials and highest net benefit of stinging catfish shing, *Heteropneustes fossilis* for the period of seven months from June to December 2012. Three stocking densities were tested with three replications for each, *viz.*, 1,85,000/ha (T_1), 2,00,000/ha (T_2) and 2,25,000/ha (T_3). Physico-chemicals parameters of the pond water were within the suitable level for fish culture.

The results of physico-chemicals parameters in three treatments are presented in Table 1. The mean water temperature was measured 27.94±4.19, 27.42±4.31 and 26.96±4.10 ºC in T_1, T_2 and T_3, respectively. However, there was no significant ($p>0.05$) variation among the treatments. The pH values of the different treatments ponds water were found to be slightly alkaline and pH mean values of 7.62±0.63 (T_1), 7.81±0.62 (T_2) and 7.78±0.05 (T_3) were not statistically significant ($p>0.05$).

Table 1. Physico-chemicals properties of fortnightly samples over the 210 days experiment

Parameters	**Treatment-1 (T_1)** (1,85,000/ha)	**Treratment-2 (T_2)** (2,00,000/ha)	**Treatment-3 (T_3)** (2,25,000/ha)
Temperature(^{0}C)	27.94±4.19^a	27.42±4.31^a	26.96±4.10^a
Water depth (cm)	120.85±15.24^a	121.85±14.89^a	118.74±17.74^a
pH	7.62±0.63^a	7.81±0.62^a	7.78±0.05^a
Transparency (cm)	28.78± 3.70^a	29.11 ±2.62^b	31.93±3.55^c
Dissolved oxygen (mg/l)	4.89±0.74^a	4.34±0.84^b	4.36±0.67^b
Total alkalinity (mg/l)	115.93±28.16^a	109.28±21.43^{ab}	103.07±15.10^b
Ammonia-nitrogen (NH_4-N) (mg/l)	0.08±0.06^a	0.11±0.01^{ab}	0.12±0.12^b

*Mean± SD (Standard deviation); Figures in the same row having the same superscript are not significantly different ($P > 0.05$).

Dissolved oxygen (DO) content was varied from 4.34 to 4.89 mg/l among the treatments. The mean dissolved oxygen (DO) concentrations in T_1 (4.89±0.74 mg/l) was significantly ($p<0.05$) different from the other treatments. However, there was no significant variation between the T_3 (4.36±0.67) and T_2 (4.34±0.84 mg/l). In all the experimental pond water, comparatively lower level of dissolved oxygen as observed that might be due to sampling time where was monitored at about 900-10.00 am.

The growth parameters, survival rate, production and FCR of Shing (*H. fossilis*) in three treatments have been reported in Table 2. The mean final weights of *H. fossilis* at the end of the experiment were 73.34±3.60, 60.78.35±1.57 and 47.75±3.70 g in T_1, T_2 and T_3, respectively. Among the three treatments, significantly ($p<0.05$) the highest mean final weight was recorded in T_1 which was subsequently followed by T_2 and T_3. The figure indicates that the growth rate was always higher in T_1 then followed by T_2 and T_3. The results also indicated that higher growth rate was always observed at lower stocking densities in the experiment.

Table 2. Growth performances, survival and production of Shing (*H. fossilis*) after 210 days rearing

Treatments	Mean initial wt. (g)	Final wt. (g)	SGR (% per day)	Survival (%)	Production (kg/ha)	FCR
T_1	3.74±0.10^a	73.34±3.60^a	1.23±.021^a	71.61±3.17^a	9708.16±421.40^a	2.51±0.04^a
T_2	3.73±0.08^a	60.78±1.57^b	1.16±0.01^b	62.47±2.02^b	7595.99±399.59^b	3.12±0.53^b
T_3	3.74±0.06^a	47.75±3.70^c	1.06±0.04^c	53.62±3.91^c	5760.79±450.76^c	3.93±0.07^c

*Mean± SD (Standard deviation); Figures in the same row having the same superscript are not significantly different ($p > 0.05$).

At the end of the experiment, the SGR (% per day) attained under T_1, T_2 and T_3 were 1.23±0.02, 1.16±0.01 and 1.06±0.04%, respectively. The result of the experiment revealed that significantly ($p<0.05$) the highest SGR value (1.23) was recorded in T_1 while lowest (1.06) was obtained in T_3. The survival rate of *H. fossilis* as recorded in the present study was 71.61±3.17, 62.47±2.02 and 53.62±3.91% for T_1, T_2 and T_3, respectively. In T_1 showed significantly ($p<0.05$) the highest survival (71.61%) while in T_3 showed the lowest (53.62%). The survival rate in the experiment was showed negatively influences by stocking densities. The mean FCR value of T_1, T_2 and T_3 were obtained 2.51±0.04, 3.12±0.53 and 3.93±0.07, respectively. The FCR value of T_1 was found to be significantly ($p<0.05$) lowest which indicates that lower amount of feed was needed to produce one unit fish biomass and highest was found in T_3.

The mean production of *H. fossilis* in T_1, T_2 and T_3 were 9708.16±421.40, 7595.99±399.59 and 5760.79±450.76 kg/ha/210 days, respectively. Significantly ($p<0.05$) the highest production was obtained in T_1 then followed by T_2 and the lowest in T_3. In the present experiment, the total cost of production (BDT/ha) was lower in T_1 (15,32,799) than those in T_2 (15,28,579) and T_3 (15,23,696). The net benefits generated from 210 days culture period was obtained as BDT 28,35,873, 18,89,616 and 10,68,659/ha for T_1, T_2 and T_3, respectively. However, the highest net benefit of BDT 28,35,873/ha was found from T_1 where *H. fossilis* stocked in 1,85,000 individuals/ha. Among the treatments in seven months of culture experiment of Shing (*H. fossilis*), individuals 1,85,000/ha stocking density would be the best recommendation for farmers.

Investigation and diagnosis of commonly occurring fish diseases in Jessore

Researchers: Md. Amirul Islam, SSO
Debashis Kumar Mondal, SO
Md. Shariful Islam, SO

Objectives

- To know/Investigate the present situation of fish diseases in Jessore region
- To diagnose the causative agents and remedy of diseases in fishes
- To know the commonly used drugs and their responses in fishes

Achievements

Study 1. Fish health monitoring in hatcheries, nurseries and grow-out systems

Information on various aspects of fish health issues were collected from 20 hatcheries, 20 nurseries and grow-out systems of Jessore region. Questionnaire was prepared to collect such information. Hatcheries and nurseries had been visited regularly. Questionnaire has developed including type of disease, frequency of occurrence of disease, fish management practice in ponds, feeding management, water management and over all hygienic conditions of hatcheries and nurseries. A hand note has already been developed (in Bengali) and circulated to the hatchery, nursery and fish culture activists.

Types of fisheries activities	No. of farms surveyed
Hatchery	20
Grow-out	15
Nursery	5

Water quality parameters of different hatcheries have been determined by HACH Water Quality Test Kit (Model FF-1). Different types of water quality have already been tested in different 30 farms in Jessore region which are given below in a tabulated form.

Parameter	**Hatchery**	**Nursery & Grow-out**	**Standard Range**
Temp. (^{0}C)	25-37	25.5-37	20-35
DO (mg/L)	5-7.9	6.7-8.1	>4
p^H	7.8-9.2	8.2-9.1	6.5-9
CO_2 (mg/L)	0-20	0-15	<10
NH_3 (mg/L)	0	0-1	<.50
Total Alkalinity (mg/L)	110-220	80-240	HR: 17.1-342 LR: 6.84-136.8

Riverine Station & Sub-Stations

Biomonitoring of the rivers Padma, Meghna and Dakatia

Researchers: Dr. Mohosena Begum Tanu, SSO
Mohammad Ashraful Alam, SO
Akhery Nima, SO
Flura, SO
Md. Istiaque Haider, SO

Objectives

- Physical, chemical and biological assessment of the riverine ecosystem of Padma, Meghna and Dakatia
- Assessment of heavy metal accumulated in soil, water and fishes

Achievements

A comprehensive survey was conducted before initiating the main project work and now two years research work has been completed. This study comprises eight sampling points of Padma, Meghna and Dakatia (Table 1). The purpose of this survey was to identify the spots of the river most prone to pollution.

Table 1. Sampling locations of Padma, Meghna and Dakatia

Name of the river	Name of spots
Padma	Mowa (Monshigonj), Godagari (Rajshahi), Pakshi (Kustia)
Meghna	Chandpur, Meghnaghat (Narayangonj), Bhoirob (Kishoregonj)
Dakatia	Hazigonj (Chandpur), Puranbazar (Chandpur)

Physical, chemical and biological parameters of the selected river spots were studied to understand the status of pollution and deviation from the normal range.

Physico-chemical parameters: Ten physical and nine chemical parameters were studied for all three river spots of Padma, Meghna and Dakatia. The range of the values showed seasonal fluctuation and the deviations among the spots also. Water depth was the most deviated pysical parameter among the study sites ranged from 8.53±2.40 feet (Hajiganj) to 58.03±35.77 feet (Meghna ghat) . Transperancy also varied among the study sites in a wide range which was highest in Hajiganj 176.33±40.80 cm and lowest in Godagari 20.0±21.35 cm some of the parameters deviated from the normal range indicating the gradual fading of the freshness of rivers. The presence of toxic ammonia and lower amount of dissolve oxygen in some spots gives a glimpse of this idea. However, the situation of these rivers are still better than the Buriganga, Sitalakhya and Balu as the values found in the present study are more suitable than the previous study conducted on the aforesaid rivers.

Occurrence of benthos in Padma, Meghna and Dakatia rivers: Among the benthic composition Dakatia was apparently enriched than the Padma and Meghna (Figs. 1- 4). In Padma two genera of benthos under two families were observed dominated by the lepidopteridae and chironomidae family respectively. In Meghna about thirteen genera of benthos under six families were found and here bulimidae was the dominating family immediately followed by the pleuroceridae and lepidopteridae.

About twenty two genera of benthos under nine families were found available in three spots of Dakatia river where bulimidae was the dominating family immediately followed by the viviparidae and pleuroceridae. The presence of macro invertebrates indicates the pollution status of the river. From this context it could be assumed that Dakatia is comparatively polluted than Meghna and Padma. Padma is safer than the rest two rivers. The number of effluent releasing mills, factories and industries on the bank of Padma is lesser than Meghna and Dakatia, this was found during the preliminary survey of project. Hence, the present study also confesses with the above statement.

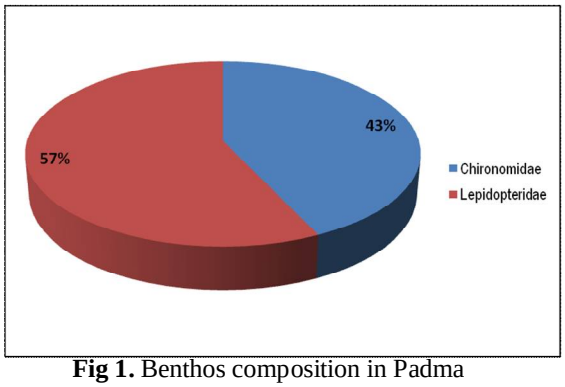

Fig 1. Benthos composition in Padma

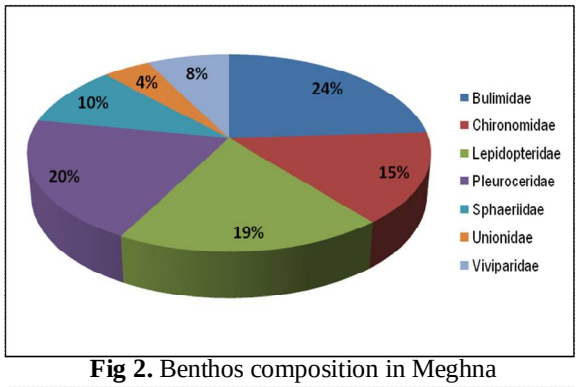

Fig 2. Benthos composition in Meghna

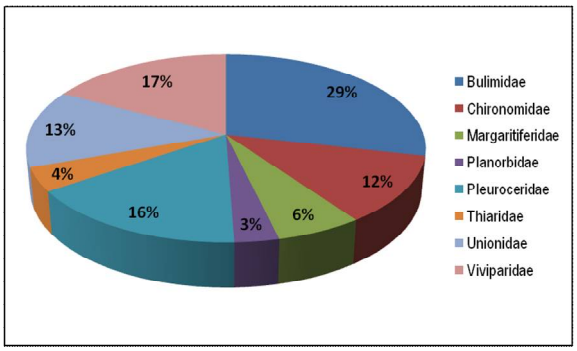

Fig 3. Benthos composition in Dakatia

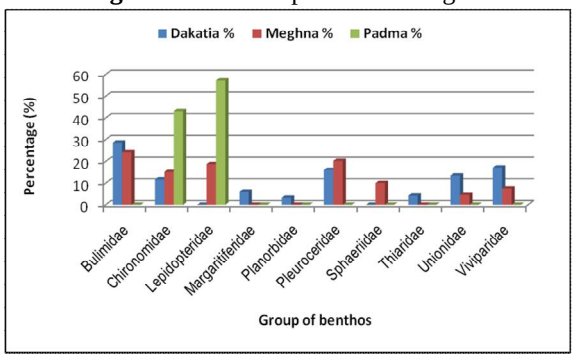

Fig 4. Inter river benthos composition (comparison)

Occurence of plankton in Padma, Meghna and Dakatia: Abundance of plankton in three river systems showed a wide range of variation (Figs. 5-12). More than 40 genera of plankton were identified under 4 families. Among them bacillariophyceae was dominating family in Padma and chlorophyceae was dominating in Meghna and Dakatia respectively. On the contrary, about 12 genera of zooplankton were found under 4 families in Padma, Meghna and Dakatia while rotifer was the dominating family in all three river systems. Average total plankton density (Nos./l) of Padma was (5800±5,483.43) higher than the Meghna and Dakatia. In Meghna average total plankton density (Nos./l) was (2000±1116.54) and in Dakatia it was (5775.0±8688.06). Phytoplankton largely dominated over zooplankton throughout the study period. The mean contribution of phytoplankton was more than 96% in all three rivers and zooplankton contributed the rest.

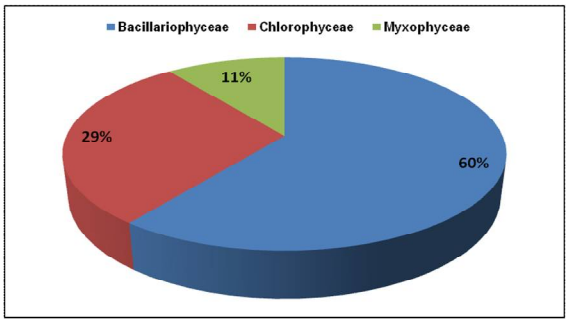

Fig 5. Phytoplankton composition of Padma

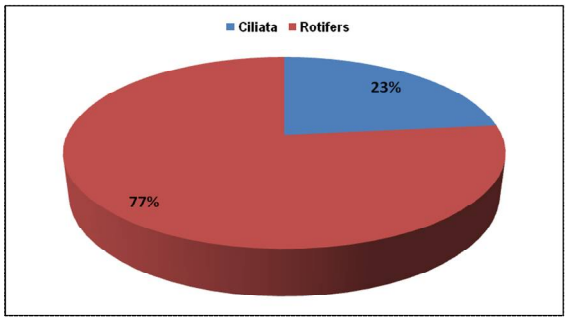

Fig 6. Zooplankton composition of Padma

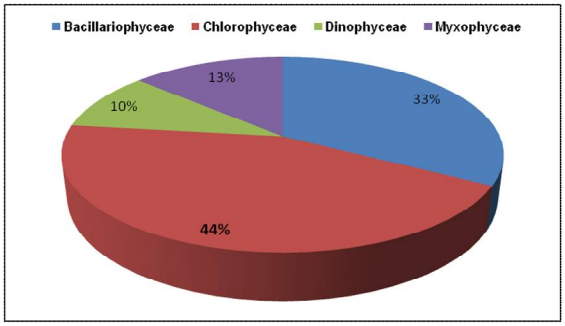

Fig 7. Phytoplankton composition of Meghna

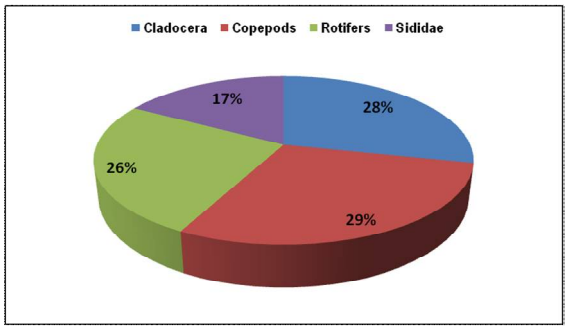

Fig 8. Zooplankton composition of Meghna

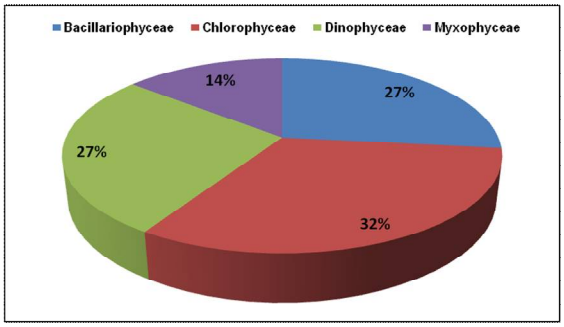

Fig 9. Phytoplankton composition of Dakatia

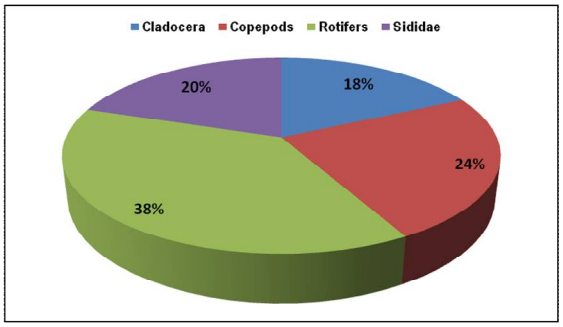

Fig 10. Zooplankton composition of Dakatia

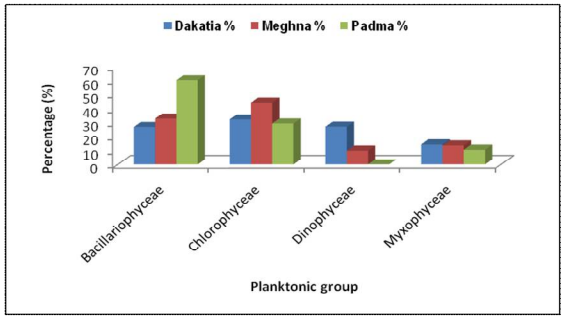

Fig 11. Inter river phytoplankton comparison

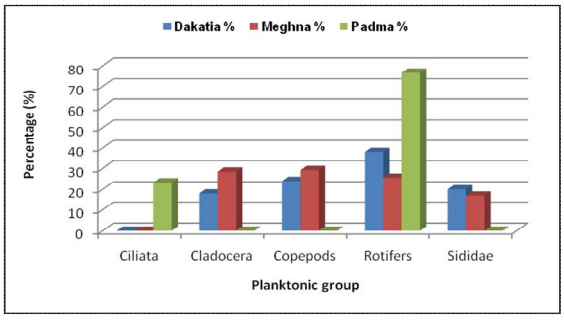

Fig 12. Inter river zooplankton comparison

Occurrence of heavy metal in Padma, Meghna and Dakatia: Among the heavy metals (Pb, Cd, Cr, Cu, Fe, Mn, Zn) the most dominant metal was Fe in both water and sediment followed by Mn. Concebtration of all the heavy metals in the sediments and water of rivers were in acceptable limit**.** Among the heavy metals (Pb, Cd, Cr, Cu, Fe, Mn, Zn) the most dominant metal was Fe in both water and sediment followed by Mn. Concentration of all the heavy metals in the sediments and water of rivers were in acceptable limit. In case of fish concentration of Fe was the highest followed by Zn (Tables 2-4).

Table 2. Heavy metal concentration of water of the rivers Padma, Meghna and Dakatia(ppm)

Location	Pb	Cd	Cr	Cu	Fe	Mn	Zn
Mowa	0	0	0.005	0	0.503	0.018	0.006
Godagari	0	0	0.006	0	0.414	0.004	0.000
Pakshi	0	0	0.004	0	0.390	0.009	0.004
Chandpur	0	0	0.020	0	0.683	0.009	0.004
Meghnaghat	0	0	0.005	0	0.503	0.018	0.006
Bhoirob	0.035	0	0.012	0	0.604	0.008	0.008
Hazigonj	0	0	0.005	0	0.396	0.029	0.002
Poranbazar	0	0	0.007	0	0.342	0.002	0.004
Eachali	0	0	0.004	0	0.222	0.007	0
Mean±SD	0.0±.01	0.0±0.0	0.0±0.0	0.0±0.0	0.45±0.14	0.01±0.0	0.0±0.0
MPC	0.11	0.004	0.08	0.02	N/R	N/R	0.09

Table 3. Heavy metal concentration (ppm) of sediment of the rivers Padma, Meghna and Dakatia

Location	Pb	Cd	Cr	Cu	Fe	Mn	Zn
Mawa	0.026	0.000333	0.186	0.27	266.1667	2.63	2.63
Godagari	0.052333	0.000667	0.24667	0.21	222.5	2.38667	0.4667
Pakshi	0.091	0.002333	0.304667	0.30	312.5	3.16	0.59
Chandpur	0.051333	0.001	1.474667	0.236667	297.3333	2.27	0.5033
Meghnaghat	0.098667	0.002	0.389667	0.26326	326.667	3.63	0.6733
Bhoirob	0.141667	0.004	0.473667	0.336667	385.4333	4.056667	0.8433
Hazigonj	0.06167	0.001333	0.276667	0.173333	243.833	2.76667	0.50
Puranbazar	0.023333	0.000667	0.066	0.06339	47.66667	0.44	0.1111
Echali	0.057	0.001	0.337	0.28	2.91	2.91	0.57
Mean±SD	0.06825± 0.040033	0.001542± 0.001208	0.42725± 0.440724	0.231945± 0.083118	262.8125± 100.8225	2.66± 1.088896	0.789713± 0.772175
MPC	4800	30	1720	73	N/R	N/R	620

Table 4. Heavy metal concentration (ppm)o f sediment of the rivers Padma, Meghna and Dakatia

Location	Pb	Cd	Cr	Cu	Fe	Mn	Zn
Mawa	0.026	0.000333	0.186	0.27	266.1667	2.63	2.63
Godagari	0.052333	0.000667	0.24667	0.21	222.5	2.38667	0.4667
Pakshi	0.091	0.002333	0.304667	0.30	312.5	3.16	0.59
Chandpur	0.051333	0.001	1.474667	0.236667	297.3333	2.27	0.5033
Meghnaghat	0.098667	0.002	0.389667	0.26326	326.667	3.63	0.6733
Bhoirob	0.141667	0.004	0.473667	0.336667	385.4333	4.056667	0.8433
Hazigonj	0.06167	0.001333	0.276667	0.173333	243.833	2.76667	0.50
Puranbazar	0.023333	0.000667	0.066	0.06339	47.66667	0.44	0.1111
Echali	0.057	0.001	0.337	0.28	2.91	2.91	0.57
Mean±SD	0.06825± 0.040033	0.001542± 0.001208	0.42725± 0.440724	0.231945± 0.083118	262.8125± 100.8225	2.66± 1.088896	0.789713± 0.772175
MPC	4800	30	1720	73	N/R	N/R	620

Refinement of cage culture technology of monosex tilapia in the River Dakatia, Chandpur

Researchers: Tayfa Ahmed, SO
Dr. Md. Nurullah, PSO
Md. Robiul Awal Hossain, SO
A.K.M. Shafiqul Alam Rubel, SO

Objectives

- To find out the seed quality and their growth performance of monosex tilapia collected from different sources
- To observe the impacts of commercial probiotics on the health status of nursery reared monosex tilapia
- To investigate the disease infestation and their probable remedial measures in cage culture
- To monitor the water quality during the culture period

Achievements

Growth performance of monosex tilapia of different sources in net cages of Dakatia river, Chandpur

According to the project proposal an experiment was conducted for 120 days in Dakatia river, Chandpur with monosex tilapia fingerlings from 4 June 2012 to 7 October 2012 with different sources of monosex tilapia fingerlings at stocking density of 50/m^3 for all sources. Average weight of stocked monosex tilapia fingerlings from CP Bangladesh Ltd. Mymensingh and Cox's Bazar area were 16.90gm, 18.93gm and 16.71g, respectively. Feeding has been done with pelleted semi-buoyant feed at 5-3% body weight concurrently twice daily. After 120 days, the average production was found 140.97 kg/cage (survival-74.4%) and 118.50 kg/cage (survival 77.6%) and 133.22 kg/cage (survival 76.7%) in T_1, T_2 & T_3, respectively. Highest specific growth rate (SGR %/day) was found 2.10 in T_1, FCR were found 2:1, 2.33:1 and 2:1 in T_1, T_2 & T_3, respectively. However, outbreak of unknown disease during culture period was also noticed. Average weight (gm) of final harvest (120 days), SGR (% day), FCR, survival rate and production of all treatments are shown in Table 1.

Table 1. Growth performance of monosex tilapia of different sources in net cages of Dakatia river, Chandpur

Parameters	Achievements			Remarks
	T1	T2	T3	
Av. wt. at stocking (g)	16.90	18.93	16.71	Outbreak of disease infestation in culture period
Av. final wt. (g)	210.61	169.53	193.07	
SGR (%/day)	2.10	1.83	2.04	
FCR	2.00:1	2.33:1	2.00:1	
Survival (%)	74.4	77.6	76.7	
Production (kg)	140.97	118.50	133.22	

* Sources: T_1-CP Bangladesh Ltd , T_2- Mymensingh & T_3-Cox'sBazar

The water quality parameters were monitored fortnightly in 3 spots of Dakatia river, Chandpur by HACH water test kit (model-FF2). The levels of Dissolve Oxygen (mg/l), Free CO_2 (mg/l), pH, Total Alkalinity (mg/l), Total Hardness (mg/l) were found in suitable ranges in January-October in Dakatia river. The presence of ammonia (mg/l) was also nill in the experimental area (Gunrajdi) and other two spots of Dakatia river. The suitable water quality parameters of Dakatia river indicating the favorable environment for cage culture in the river Dakatia. The water quality parameters of Dakatia river, Chandpur are more or

less similar throughout the year. The average value of water quality parameters in 3 spots of Dakatia river are shown in Table 2.

Table 2. Average values of water quality parameters in 3 spots of Dakatia river

Parameters	**Average value (January-October)**		
	Echali	Roghunathpur	Gunrajdi
Air temperature (mg/l)	27.65	26.66	27.91
Water temperature (mg/l)	25.7	25.3	25.81
SD transparency (cm)	54.2	54.5	53.50
TDS	64.44	60.41	64.75
Turbidity	21.004	19.37	19.88
Dissolve Oxygen (mg/l)	5.816	6.29	6.03
Free CO_2 (mg/l)	4.745	4.09	4.23
pH	7.725	7.82	7.82
Total Hardness (mg/l)	129.439	130.54	129.29
Total Alkalinity (mg/l)	146.192	146.27	147.28
Conductivity	127.34	124.50	121.94
Ammonia (mg/l)	Nill	Nill	Nill

Among three treatments of the experiment T_1 shown the best performance followed by T_3 & T_2, respectively. It may be due to the variation of seed quality among the three (hatcheries) sources of monosex tilapia fry collected for the experiment. So, the quality seed production should be ensured in the tilapia producing hatchery of Bangladesh. The water qualities of cage culture areas of Dakatia River with other two spots were suitable for fish culture during the culture period.

Development of mass seed production technique of *Pangasius pangasius*

Researchers: Akhery Nima, SO
Khondoker Rashidul Hasan, SO
A.K.M. Shafiqul Alam Rubel, SO
B.M. Shahinur Rahman, SO

Objectives

- Optimization of induced breeding technique of *P. pangasius*
- Study of indiscriminate killing of pangas seed in riverine habitat

Achievement

Brood rearing: Old broods as well as new broods of *P. pangasius* are being reared under intensive feeding case in different ponds for their gonadal development. Broods are being reared with commercial semi-buoyant feed @ 3-4% of their body weight daily. Periodic checking of health and disease of broods was done as a routine work. Average weight of pangas brood was 2.5-3.0 kg.

Induced breeding trial: For attempts have been made to breed *P. pangasius*. The breeding trials on *P. pangasius* were conducted by using selected spawners during June and August. Carp pituitary gland extract (cPGE) was used as inducing agent. A total of 6 pairs of spawners were injected. Total amounts of cPGE were split into two doses. One third of total cPGE was injected at 1st injection and two third at 2nd

injection. During the study period o6 female spawners released eggs easily after the 2nd injection. Eggs were fertilized with milt following dry fertilization method. Fertilized eggs did not hatch out after 24 hours at 29-30^{0}c due to poor fertilization of eggs, milt quality/no. of viable sperms in the milt, water quality etc.

Study on indiscriminate killing of pangas: Indiscriminate killing of immature pangas from the Meghna and other river is a burning issue now a day. Therefore a study was conducted under this project to asses the impact of indiscriminate killing of pangus seed. Data was collected through *In Situ* observation in monthly on the much availability of pangas fry/fingerlings and indiscriminate killing of pangas by different gear from some pre-selected points of upper and lower Meghna river *Viz.* Chandpur Sadar, Haimchor, Chor Voirabi, Ramgati (Laxmipur), Hatia, Barishal, Monpura (Bhola), Sureswar (Shoriatpur). Survey was conducted to collect data about the peak season of pangas killing, method of fishing, no of fishers involved in pangas fishing etc. Three types of fishing net (current jal, behundi jal, chorghera jal) and two types of fishing trap (pangas chai) and borshi (hookline) are identified. Among these pangas chai are too much harmful to indiscriminate killing of pangas. Average CPUE of pangas chai in peak season (April-June) 45 kg/ haul. Average length and weight of the pangas fry in the month of November-May was 12-23 cm and 28-76 gm, respectively. Highest killing pressure of pangas fry occurred in November and May of lower Meghna and in May of upper Meghna (Table 1).

Table 1. Monthly avg CPUE (kg/haul) of pangas chai from different places

Month	Barisal	Monpura	Hatia	Haimchar	Charvoirabi	Sureshwar	Chandpur	Ramgati
November	70	91	65	28	30	38	40	42
February	28	27	30	30	33	28	31	33
March	35	40	36	19	24	18	22	14
April	32	36	37	28	38	36	32	26
May	81	101	100	-	48	58	-	38

In view of its growth, increasing demand in the market more study need to be continued for the indiscriminate killing of *P. pangasius* in riverine habitat and its breeding technology in order to produce mass seed of native pangas.

Feasibility of carps fry raising in Kaptai lake creeks

Researchers: A.K.M. Saiful Islam, SSO
S. Sanjib Basak, SO
Kazi Belal Uddin, SO

Objectives

- Study of the survival, growth & economic viability of carp seed raising in the creek.
- To develop a technology package.
- Rationalize findings with those of private entrepreneurs.

Achievements

The experiment was conducted in three suitable creeks of 2.5, 3.0, 2.5 acre at Langadhu Upazilla of Rangamati Hill District. The creeks were constructed by fencing off the mouth of the come with small meshed knotless polythene net that would filled by reservoir backwaters. The structure of fence was built using bamboo, nylon twine and rope, polythene lining and sand bags, etc. For convenience of access and netting site of creek, reclamation including removal of submerged timber logs fastened in the slope and bottom, roots, dense hedges and jungles and all emergent and submerged weeds was done during dry season (March-April) when water level recedes at the lowest and prior to construction of creeks. Repeated netting was done also to remove submerged weeds, unwanted fish and check through and remains of submerged timber log uncleanness. Good quality fry was collected from Raipur government carps hatchery at Laximpur. 8 kg spawn of three important carps species Rui, Catla, Mrigal was collected for the experiment. Five days age spawn was collected in each creek at the rate of 1kg/acre. A mixture of rice bran (50%) and mustard oil cake (50%) was administrated as feed at the rate of 200-50% body weight of the total biomass. The feed was adjusted periodically in accordance with the growth performance of each species. Sampling was done fortnightly. By fine mesh sized net, fry was catch from each creek. Growth, length, weight and health condition was measured by using digital balance, measuring scale and eye estimation.

Monitoring of water quality variable was done on regular basis in every 15 days interval and special emphasis was given on water level. Water quality variables of the creeks were almost same in all creeks and so significant discrimination was observed among them. Dissolved oxygen content and total alkalinity of the ponds were always congenial for the culture of carps (Table 1).

Table 1. Physico-chemical parameters of three different creeks

Month	Water temp (^{0}c)	pH	CO_2 (ppm)	Total Alkalinity (ppm)	Total Hardness	$CaCO_3$ (ppm)	Transparency (cm)	DO (ppm)
April/12	28.5	7.4	2.52	56.19	37.42	21.53	32	5.05
May/12	29.2	7.6	3.24	61.26	51.25	22.31	34	5.67
June/12	29.7	7.8	3.83	47.36	33.31	20.17	39	6.92

The experiment was carried out for 60 days until the fish attain fingerling size. After 60 days trial, all fingerlings were harvested for estimating the feasibility of carp fry raising in Kaptai lake. For this survivality, growth, length, weight, and health condition was analyzed of the final catch. It is revealed from Table 2 that survival rate is satisfactory and growth is excellent after 60th days of rearing of different carp species; Catla: Length- 9.59cm, Weight- 7.72g, Rui: Length- 5.18cm, Weight- 4.01g, & Mrigal.

Table 2. Growth performance of carps fry under poly culture management in three different creeks

Treatment	Stocking density	Creek size (acre)	Carp species	Initial		At 60th day		Survival rate (%)	SGR(%) at 60th days
				Length (cm)	Weight (g)	Length (cm)	Weight (g)		
T1 (Islamabad)	1 kg/acre	2.5	Rui	0.5	0.0033	5.15	4.32	79	5.19
			Catla	0.4	0.0025	12.35	10.14	74	6.01
			Mrigal	0.6	0.004	6.47	4.76	71	5.12
T2 (Hazachara)	1 kg/acre	3	Rui	0.5	0.0033	4.83	3.64	74	5.07
			Catla	0.4	0.0025	8.64	6.46	63	5.58
			Mrigal	0.6	0.004	6.41	3.24	81	4.84
T3 (Vaittapara)	1 kg/acre	2.5	Rui	0.5	0.0033	5.57	4.06	76	5.15
			Catla	0.4	0.0025	7.79	6.57	73	5.69
			Mrigal	0.6	0.004	5.19	3.76	68	4.95

Length- 6.02cm, Weight- 3.92g on an average.

Cage culture of monosex tilapia, Thai sharpunti and Thai koi in Kaptai lake

Researchers: Md. Abul Bashar, SO
Kazi Belal Uddin, SO
S. Sanjib Basak, SO

Objectives

- To identify new fish species suitable for cage culture
- To optimize the suitable stocking density for different fish species
- To determine the appropriate fingerling size at stocking
- Findings should be transferred to the extension agencies

Achievement

During the experimental period 50 cages were installed near the Riverine Sub-Station, Ranganmati and Longadhu Upazila. The sizes of the each cage were 3mX3mX2m. For the making of the cages the material used are-knotless plastic net (mesh size 1.1 cm), plastic drum, bamboo, covering net etc. The fish fingerlings (average initial weight 15g) were stocked @ 30 fish/m^3, 50 fish/m^3, 70 fish/m^3, 90 fish/m^3 as T_1, T_2, T_3 and T_4 respectively. Feeding was done regularly using pelleted semi-buoyant feed @ 5 % of body weight, twice daily for all treatments. Water quality parameters were optimum and no deviation was found among the treatments. Fish sampling was done fortnightly. After 120 days, total fish were harvested and production performance was observed.

Table 1. Growth and survival rate of Thai sharpunti (*Barbonymus gonionotus*) in different treatments

Treatments	**Stocking density (fish/m^3)**	**Initial**		**After 120 days**		**Survival rate (%)**	**SGR (%)**	**FCR**
		Length (cm) ±SD	Weight (g) ±SD	Length (cm) ±SD	Weight(g) ±SD			
T_1	30	9.72±0.35	14.85±0.58	16.67±0.82	91.33±1.40	77.50	1.51	2.77
T_2	50	9.46±0.52	14.40±0.65	15.79±1.00	83.67±1.53	72.80	1.47	2.85
T_3	70	10.01±0.46	15.40±0.72	14.71±1.13	74.67±1.41	71.80	1.32	3.06
T_4	90	9.62±0.28	14.70±0.54	14.43±1.09	66.33±1.72	70.14	1.26	3.28

The average production in each treatment was 1.65 kg/ m^3, 1.52 kg/ m^3, 1.36 kg/ m^3 and 1.18 kg/ m^3 in T_1, T_2, T_3 and T_4 respectively. The average production and the survival rate of T_1 were higher than other treatment. So the stocking density of 30 fish/m^3 can be recommended for the cage culture of Thai Sharpunti (*Barbonymus gonionotus*). Water quality parameters were optimum and no deviation was found among the treatments (Table 2).

Table 2. Water quality parameters of cage culture area

Parameters	Values (mean ± SD)
Air Temp (°C)	29.87±1.60
Water Temp (°C)	28.31±1.44
DO (mg/L)	6.39±0.54
CO_2 (mg/L)	3.14±0.51
pH	7.30±0.54
Total Hardness (mg/L)	42.14±4.93
Total Alkalinity (mg/L)	58.94±5.54
Ammonia (NH_3)	Nill

Impact of brush shelter on the production potentiality of Kaptai lake

Researchers: A.K.M. Saiful Islam, SSO
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Objectives

- To know the species composition that are captured from the brush shelter
- To know the abundance of different fish species in brush shelter

Achievement

During the study period suitable area were selected for brush shelter establishment in Kaptai, Langadu, Barkol and Rangamati sadar upazilla. In every upazilla four brush shelters were established. Among the four brush shelter one was treat as control. In this year one brush shelter were harvested from every upazilla.

Brush shelter was prepared by two types of materials; materials for shed and materials for shelter of fishes. Floating aquatic weeds were used for shed of fishes and branches and roots of different trees were used for shelter of fishes. Long bamboos and nylon rope were used to encircle and fix aquatic weeds, branches and roots of different trees. Feed like wheat bran, rice bran, mustard oil cake, and fermented rice were administered periodically. Attractants like Methi, akangi, fish call powder were used to attract fish before harvesting. Expert fishing team was hired for fishing in brush shelter. Seine net (Juk jal) and oxygen musk were used for harvesting. Before harvesting total area of brush shelter were encircled with a large seine net up to bottom. Then they clear the brushes from the encircled area. Harvesting starts by a cast net to catch large size fishes. For total harvesting slowly reduced the net and catch all of the fishes.

Species composition: Species composition was recorded according to the group and order of fish and prawn during the period of harvesting. Percentage composition of different groups of fish and prawn was estimated from the harvested brush shelter.

Table 1. Species composition from the brush shelter in Kaptai Lake

Group	Order	Local name	Scientific name	Contribution in total production (%)
FISH	Siluriformes	Kajuli	*Ailia coila*	8.82%
		Gulsa	*Mystus cavasius*	7.06%
		Tengra	*Mystus vittatus*	1.62%
		Pabda	*Ompok pabda*	2.50%
		Boal	*Wallago attu*	14.41%
		Air	*Sperata aor*	2.35%
	Cypriniformes	Calibaush	*Labeo calbasu*	20.73%
		Bata	*Labeo bata*	2.06%
	Perciformes	Tilapia	*Oreochromis niloticus*	8.97%
		Shol	*Channa striatus*	8.12%
		Gajar	*Channa marulius*	4.23%
	Osteoglossiformes	Foli	*Notopterus notopterus*	4.56%
		Chitol	*Notopterus chitala*	2.65%
	Synbranchiformes	Baim	*Mastacembelus armatus*	5.15%
	Others (Fish and Prawn)			6.79%

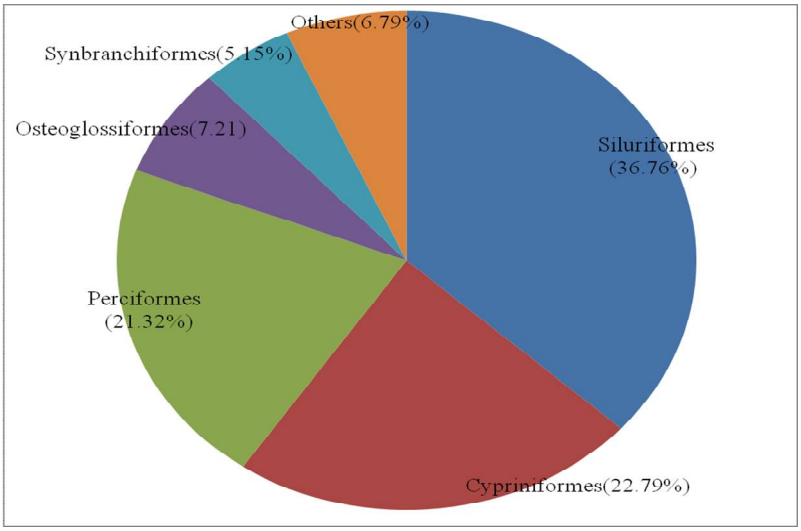

Fig. 1. Percentage composition of different groups of fish and prawn from the harvested brush shelter.

Table 2. Abundance of fishes in brush shelter in different areas of Kaptai lake

Rangamati Sadar	Kaptai	Barkol	Langadu	Abundance
Calibaush	Calibaush	Kajuli	Tilapia	High
Boal	Gojar	Calibaush	Calibaush	High
Kajuli	Shol	Gulsa Tengra	Boal	High
Gulsa Tengra	Gulsa Tengra	Boal	Gulsa Tengra	Medium
Pabda	Tilapia	Pabda	Baim	Medium
Air	Boal	Chitol	Bujuri Tengra	Medium
Shol	Foli	Baim	Shol	Low
Foli	Bujuri Tengra	Air	Foli	Low
Bujuri Tengra	Baim	Foli	Pabda	Low
Gojar	Air	Bujuri Tengra	Air	Low
Chitol	Catla	Bata	Kajuli	Very low
Catla	Rui	Chingri	Rui	Very low
Tilapia	Pabda	Shol	Bata	Very low
Rui				Very low

Changing pattern in limnology of Kaptai lake

Researchers: Md. Abul Bashar, SO
S. Sanjib Basak, SO
Kazi Belal Uddin, SO

Objectives

- To know the present status of physical, chemical and biological parameters in the ecosystem of Kaptai lake

Achievement

The study was conducted in five areas of Rangamati district like i) Rangamati Sadar ii) Kaptai iii) Barkal iv) Langadhu and v) Naniarchar. The sampling of respective areas water body has been done monthly throught the year. Monthly fluctuations, range, mean values (x) and standard deviation (±SE) of different physcio-chemical factors and relationships among the factors are presented in Tables 1-6.

Table 1. Monthly fluctuation of air and water temperature with range and mean ($\bar{x}$) values (±SD)

	Air temp.°C					**Water temp**°C				
Treatments	Mean	S D	SE	Min	Max	Mean	S D	SE	Min	Max
12-Jul	29.02b	0.83	0.24	27.50	30.55	32.95a	17.69	5.11	26.40	89.05
12-Aug	30.89a	1.51	0.43	27.60	32.20	29.12ab	1.28	0.37	26.50	31.20
12-Sep	30.73a	1.30	0.38	28.26	33.00	29.13ab	0.81	0.23	27.85	30.20
12-Oct	30.53a	1.07	0.31	28.80	32.20	28.84ab	1.92	0.55	26.20	31.50
12-Nov	27.43cd	1.01	0.29	26.35	28.90	26.19bc	1.10	0.32	25.20	28.50
12-Dec	25.00e	0.91	0.26	23.20	26.05	25.15bc	0.58	0.17	24.50	26.50
13-Jan	23.13f	2.04	0.59	18.90	25.50	21.78c	1.51	0.44	19.50	23.50
13-Feb	23.22f	1.49	0.43	20.50	25.50	22.64c	1.72	0.50	19.50	24.50
13-Mar	26.60d	1.66	0.48	22.50	28.50	24.87bc	1.50	0.43	21.50	26.50
13-Apr	27.73c	1.02	0.30	26.10	29.50	26.33bc	0.87	0.25	25.12	27.52
13-May	30.59a	0.70	0.20	29.50	31.50	28.93ab	0.74	0.21	27.55	30.50
13-Jun	30.82a	0.67	0.19	29.45	31.85	29.20ab	0.61	0.18	28.60	30.55
Total	27.97	3.08	0.26	18.90	33.00	27.09	5.89	0.49	19.50	89.05
LSD	1.17					4.89				
Level of sig.	**					**				

** significant at 0.01 level. In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

Monthly variation of air temperature ranged from 18.9^{0}C to 33.0^{0}C (x ±SD: 27.97±3.08^{0}C). Highest air temperature (33^{0}C) was recorded in September, 2012 and the lowest (18.9^{0}C) in January, 2012. The fluctuation of water temperature varied from 19.5 to 32.9^0 C (x ±SD: 27.09±5.89^0 C). The maximum water temperature (31.5°C) was recorded in October, 2012 and minimum (19.5^{0}C) in February, 2013 (Table 1). The water temperature values showed close relationship with the air temperature. Water temperature showed almost an increasing and decreasing trend with air temperature. It also showed significant strong positive correlation with the air temperature ($r= 0.863$, $p<0.01$) (Table 6).

Table 2. Monthly fluctuation of pH and CO_2 with range and mean ($\bar{x}$) values (±SD)

	pH					CO_2 (ppm)				
Treatments	Mean	S D	SE	Min	Max	Mean	S D	SE	Min	Max
12-Jul	6.95c	0.57	0.17	6.15	7.59	3.12ab	0.60	0.17	1.61	3.94
12-Aug	7.10bc	0.54	0.16	6.15	7.80	2.95bc	0.44	0.13	2.23	3.47
12-Sep	7.06bc	0.52	0.15	6.27	7.78	2.45c	0.48	0.14	1.88	3.18
12-Oct	7.23abc	0.38	0.11	6.51	7.63	2.93ab	0.54	0.16	2.17	3.90
12-Nov	7.19abc	0.39	0.11	6.42	7.50	2.36c	0.51	0.15	1.63	3.38
12-Dec	7.40abc	0.35	0.10	6.54	7.87	2.63bc	0.38	0.11	2.25	3.61
13-Jan	6.94c	0.53	0.15	6.17	7.75	3.04ab	0.67	0.19	2.22	3.96
13-Feb	7.53ab	0.65	0.19	6.25	8.62	2.99ab	0.54	0.16	2.34	4.18
13-Mar	7.53ab	0.37	0.11	6.78	7.87	2.99ab	0.82	0.24	1.87	4.03
13-Apr	7.29abc	0.61	0.18	6.29	8.15	3.19a	0.59	0.17	2.44	4.32
13-May	7.62a	0.20	0.06	7.18	7.85	3.32a	0.43	0.12	2.76	3.96
13-Jun	7.31abc	0.60	0.17	6.50	8.50	3.13ab	0.51	0.15	2.69	4.18
Total	7.26	0.52	0.04	6.15	8.62	2.92	0.60	0.05	1.61	4.32
LSD	0.46					0.52				
Level of sig.	**					**				

** significant at 0.01 level. In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

The pH of water always found to be alkaline in nature and it varied between 6.15 and 8.62 (x ±SD: 7.6 ± 0.52). In the present investigation, pH showed positive correlation with free CO_2 ($r = 0.252$, $p < 0.05$) (Table 6). Free CO_2 ranged between 1.61 to 4.32mg/l (x ± SD: 2.92 ± 0.60 mg/l). The maximum (4.32 mg/l) value was recorded in April, 2013 and minimum (1.61mg/l) in July, 2012 (Table 2). In the present investigation free CO_2 showed inverse correlation with dissolved oxygen ($r = -0.398$, < 0.05) (Table 6).

The value of total alkalinity was found to fluctuate from the minimum of 44.24 mg/l to the maximum of 70.5 mg/l (x±SD: 59.45±6.71mg/l). The highest value was recorded in March (70.5 mg/l 2013 and the lowest in January (44.04 mg/l) 2013(Table 3). In the present study total alkalinity showed a strong positive correlation with total hardness ($r = -0.300$, $p < 0.01$) (Table 6). Total hardness varied from 23.8 to 56.0 mg/l with mean value of (x ±SD: 43.08±5.51mg/l). The highest amount of hardness was recorded in November, 2012 and the lowest in March, 2013 (Table 3).

Table 3. Monthly fluctuation of Total alkalinity and Total hardness with range and mean ($\bar{x}$) values (±SD)

	Total alkalinity (ml)					Total hardness				
Treatments	Mean	S D	SE	Min	Max	Mean	S D	SE	Min	Max
12-Jul	62.62ab	4.44	1.28	55.82	67.41	44.51ab	4.03	1.16	36.10	49.10
12-Aug	54.64c	4.21	1.22	45.50	58.61	37.87c	4.64	1.34	33.55	44.00
12-Sep	58.26bc	3.97	1.15	52.04	66.58	43.50ab	5.72	1.65	33.80	54.00
12-Oct	59.11bc	3.81	1.10	55.80	66.89	42.37abc	7.16	2.07	23.80	49.54
12-Nov	60.28ab	5.00	1.44	54.31	68.75	47.33a	4.94	1.43	41.80	56.00
12-Dec	53.96c	15.17	4.38	6.62	66.30	43.92ab	4.41	1.27	34.40	49.80
13-Jan	61.82ab	4.04	1.17	57.20	67.22	43.98ab	4.83	1.39	32.40	49.50
13-Feb	61.44ab	5.02	1.45	52.40	70.00	44.86ab	4.25	1.23	38.72	54.80

13-Mar	65.20a	3.92	1.13	59.00	70.50	40.85bc	7.53	2.17	25.60	52.50
13-Apr	61.66ab	5.04	1.45	54.05	69.30	43.32ab	2.11	0.61	38.42	45.20
13-May	56.90bc	4.12	1.19	52.56	66.08	41.91bc	7.26	2.10	23.80	55.18
13-Jun	57.46bc	5.29	1.53	44.24	65.66	42.51abc	2.95	0.85	35.24	46.75
Total	59.45	6.71	0.56	6.62	70.50	43.08	5.51	0.46	23.80	56.00
LSD	5.71					4.89				
Level of sig.	**					**				

** significant at 0.01 level. In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

Table 4. Monthly fluctuation of $CaCO_3$ and Transparency with range and mean ($\bar{x}$) values (±SD)

	$CaCO_3$ (ml)					**Transparency (m)**				
Treatments	Mean	S D	SE	Min	Max	Mean	S D	SE	Min	Max
12-Jul	40.42a	5.84	1.69	33.10	47.60	0.97d	0.13	0.04	0.79	1.19
12-Aug	33.76bc	4.44	1.28	24.20	42.80	1.70c	0.45	0.13	1.13	2.55
12-Sep	29.95cd	6.31	1.82	22.60	42.90	1.60c	0.27	0.08	1.12	1.98
12-Oct	27.97cd	3.52	1.02	22.20	32.90	2.06ab	0.33	0.09	1.65	2.99
12-Nov	28.09cd	5.30	1.53	21.95	36.80	2.04ab	0.42	0.12	1.65	2.90
12-Dec	32.10bcd	7.72	2.23	23.35	43.00	2.09ab	0.48	0.14	1.50	2.89
13-Jan	30.21cd	7.20	2.08	23.10	43.71	2.29a	0.32	0.09	1.99	2.92
13-Feb	36.97ab	7.37	2.13	24.20	44.40	2.25a	0.53	0.15	1.50	3.18
13-Mar	30.50cd	6.38	1.84	23.15	42.40	2.05a	0.36	0.11	1.67	2.81
13-Apr	31.37cd	7.28	2.10	23.68	42.80	2.43a	0.39	0.11	2.05	2.93
13-May	26.53d	4.28	1.24	22.40	34.40	2.25a	0.57	0.16	1.41	3.46
13-Jun	29.93cd	6.70	1.93	22.28	44.20	1.62c	0.62	0.18	0.89	2.33
Total	31.48	7.04	0.59	21.95	47.60	1.94	0.57	0.05	0.79	3.46
LSD	5.75					0.40				
Level of sig.	**					**				

** significant at 0.01 level . In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

The value of $CaCO_3$ was found to fluctuate from the minimum of 21.95 mg/l to the maximum of 47.60 mg/l (x±SD: 31.48 ±7.04 mg/l). The highest value was recorded in July (47.60 mg/l) 2012 and the lowest in November (21.95 mg/l) 2012. Transparency varied from 0.79 to 3.46 m with mean value of (x ± SD: 1.94± 0.57). The highest transparency was recorded in May, 2013 and the lowest in July, 2012 (Table 4).

Table 5. Monthly fluctuation of Dissolved Oxygen (DO) with range and mean ($\bar{x}$) values (±SD)

	DO (ml)				
Treatments	Mean	Std. Deviation	Std. Error	Minimum	Maximum
12-Jul	6.68ab	0.68	0.20	5.66	7.55
12-Aug	6.34bc	0.49	0.14	5.29	6.92
12-Sep	6.52abc	0.41	0.12	5.89	7.15
12-Oct	6.53abc	0.25	0.07	6.20	6.96

12-Nov	6.80a	0.55	0.16	6.23	7.84
12-Dec	6.34bc	0.51	0.15	5.83	6.99
13-Jan	6.20c	0.40	0.12	5.52	6.81
13-Feb	6.10c	0.55	0.16	5.28	6.97
13-Mar	6.42abc	0.46	0.13	5.88	6.96
13-Apr	6.40abc	0.43	0.13	5.83	7.00
13-May	6.49abc	0.35	0.10	6.03	6.93
13-Jun	6.10c	0.56	0.16	5.01	7.05
Total	6.41	0.51	0.04	5.01	7.84
LSD	0.45				
Level of sig.	**				

** significant at 0.01 level .In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

The value of Dissolved Oxygen was found to fluctuate from the minimum of 5.01 mg/l to the maximum of 7.84 mg/l (x ± SD: 6.41 ± 0.51 mg/l). The highest value was recorded in November (7.84 mg/l) 2012 and the lowest in June (5.01 mg/l) 2013 (Table 5). It also showed significant strong positive correlation with the air and water temperature (r= 0.358, 0.482, p<0.05) (Table 6).

Table 6. Correlation among physico-chemical parameters of Kaptai Lake
(Values are shown as r=coefficient correlation)

	Air temp.°C	Water temp°C	pH	CO_2 (ppm)	Total alkalinity (mg/l)	Total hardness (mg/l)	$CaCO_3$ (mg/l)	Transparency (m)	DO (mg/l)
Air temp.°C	1								
Water temp°C	.863(**)	1							
pH	-.111	-.275	1						
CO2 (ppm)	.081	.122	.252	1					
Total alkalinity (mg/l)	-.374	-.247	-.049	.196	1				
Total hardness(mg/l)	-.447	-.237	-.119	-.416	.300	1			
CaCO3 (mg/l)	-.259	.158	-.277	.165	.219	.063	1		
Transparency (m)	-.018	-.233	.637(*)	.366	-.162	-.088	-.559	1	
DO (mg/l)	.358	.482	-.242	-.398	.137	.296	-.114	-.048	1

** Correlation is significant at the 0.01 level .* Correlation is significant at the 0.05 level .

Socio economic condition of different local fishing communities centering on Kaptai lake

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Objectives

- To determine the socio economic indicators of fishing community centering on Kaptai Lake.
- To explore social mobility among different fishing communities of Kaptai Lake area.
- To Find out the possible risks in terms of livelihood of local fishing community and adaptive strategies to mitigate those risks.

- To explore the causes of occupational transformation and pressure in fisheries sector.
- To examine the existing conflicts against the livelihood among the stakeholder depending on Kaptai Lake fisheries resources.

Involvement of fishers in fishing activities varied in three study locations. Fifty percent of the fishermen were involved in fishing between 10 to 20 years in all three locations, while 26.67%, 13.33% and 6.67% fishermen were involved between 40 to 50 years, less than 10 years and 30 to 40 years in Sadar, Kaptai and Longdhu. Only a few fishermen (3.33%) were involved in fishing between 20 to 30 years in all study area (Table 1).

Table 1. Experience of the fishermen with fishing activities

Range of years involved in fishing	% fishermen involved in Sadar	% fishermen involved in kaptai	% fishermen involved in Longdhu	% Average
<10	10	20	10	13.33
10-20	50	50	50	50.00
20-30	00	00	10	03.33
30-40	00	00	20	06.67
40-50	40	30	10	26.67

The fishermen depended on fishing, varied with capability and quantity of catch fish almost year round. Once the fish was naturally abundant and was sole business and income source for their livelihood. In the present study, it was found that majority of fishermen (63.33%) caught fish for 5 to 10 hours, while 23.33% fishermen caught fish between 10 to 15 hours and 13.33% fishermen caught fish more than 15 hours (Table 2).

Table 2. Duration of fish catch by the fishermen before ten years

Range of time (Hours)	Sadar	Kaptai	Longdhu	% Average
05 -10	60	80	50	63.33
10 -15	30	10	30	23.33
>15	10	10	20	13.33

From the present study, it was observed that 16.67% fishermen caught fish less than 5 kg per day in all locations, while 40% fishermen caught fish between 5 to 10 kg per day and 23.33% fishermen caught fish between 10 to 15 kg per day and rest (20%) caught fish 15 to 20 kg per day (Table 3).

Table 3. Amount of catch fish per day by the fishermen before ten years

Amounts (kg)	Sadar	Kaptai	Longdhu	% average
<5	20	10	20	16.67
05 - 10	30	50	40	40.00
10 – 15	20	30	20	23.33
15 – 20	30	10	20	20.00

Loss of fish species was occurring rapidly due to different climatic hazard and man made intervention. So, ultimately catch fish reduced as for during the present investigation. In the present study, it was found that 33.33% fishermen caught fish between 0.5 to 1.5 k per day in Sadar Kaptai and Longdhu, while 23.33% fishermen caught fish between 1.5 to 2.5 k per day, 20% fishermen caught fish between 2.5 to 3.5

k per day; 13.33% fishermen caught fish between 3.5 to 4.5 k per day and rest 10% caught fish more than 4.5 k per day (Table 4).

Table 4. Amount of fish fish catch per day by the fishermen at present

Amounts (kg)	Sadar	Kaptai	Longdhu	% Average
0.5 - 1.5	40	30	30	33.33
1.5 - 2.5	20	20	30	23.33
2.5 - 3.5	20	20	20	20.00
3.5 - 4.5	10	20	10	13.33
> 4.5	10	10	10	10.00

In the present study, it was found that 13.33% fishermen caught fish less than ten species, 16.67% between ten to fifteen species, 33.33% between fifteen to twenty species and rest 36.66% between twenty to twenty five species caught before ten years, whereas presently, the figure was 50%, 23.33%, 16.66% and 10% respectively (Table 5).

Table 5. Fish species usually caught before ten years and at present by the fishermen

No. of species	**Sadar**		**Kaptai**		**Longdhu**		**% Avarage**	
	B	P	B	P	B	P	B	P
< 10	10	40	10	50	20	60	13.33	50.00
10 -15	10	30	20	20	20	20	16.67	23.33
15- 20	40	20	30	20	30	10	33.33	16.67
20- 25	40	10	40	10	30	10	36.67	10.00

B= Before; P= Present

Most of the fishermen were found to be engaged in agricultural activities in lean season. It was found that agricultural activities were main secondary profession (46.67%) and other common profession was day labour (26.67%), petty business (20%) and contact fish catching (6.67%). However, fishing was main occupation of the fishermen before ten years. Presently, they were found to be vulnerable to climate change which caused loss of life, damage of infrastructure and economic assets and adverse impacts on live and livelihoods. During the study period it was found that most of the fishermen changed their forefathers' occupation to maintain their family (Table 6).

Table 6. Secondary occupation to cover the family expenditure by the fishermen

Secondary occupation	% secondary occupation in Sadar	% secondary occupation in Kaptai	% secondary occupation in Longdhu	% Average
Agriculture	40	50	50	46.67
Day labour	20	30	30	26.67
Petty Business	20	20	20	20.00
Contact fish catching	20	00	00	06.67

Less rainfall and prolong drought was the main cause of fishes decline in the study area. Before ten years, fishing was main occupation to carry on their family expenditure but at present, most of the fishermen changed their occupation and they faced to vulnerable condition and adversely impacts on lives and livelihoods of fishermen communities. From the study it was found that most of the fishermen were engaged in agricultural activities in lean season. Agricultural activities were secondary profession and other most common profession was day labour.

Brackishwater Station

Captive breeding and seed production of selected estuarine finfish

Researchers: Dr. S.B. Saha, CSO
Md. Farajul Kabir, SO

Objectives

- To optimize the hormones and dosages in breeding of *Liza parsia*.

Achievements

Optimizing hormones and their doses in breeding of Liza parsia

The experiment was conducted from November'12 to February 2013. For the study, three types of hormones *viz*., carp pituitary extract, human chorionic gonadotropin (HCG) and a synthetic gonadotropin releasing hormone analogue (SGnRH) commercially known as "Ovaprim" were used. The doses of different hormones are shown below in the experimental design (Table 1).

Table 1. Experimental design

Types of hormones	Doses per kg body wt of fish			
	T_1	T_2	T_3	T_4
Carp pituitary extract (mg)	3	4	5	6
Ovaprim (ml)	1.0	1.5	2.0	2.5
HCG (IU)	2500	3000	3500	4000

Collection and rearing of broods: Matured males and females of *Liza parsia* were collected from the on station ponds and adjacent *ghers* and stocked in one of the on-station ponds. Salinity of brood pond was 10-18 ppt. Other water quality parameters *viz*., pH (8.2-8.5), total alkalinity (120-135 mg/l) and dissolved oxygen (4.5-7.5 mg/l) were congenial for brood rearing. Broods were fed twice daily with commercial pellet feed (30% protein).

Preparation of water and breeding tank: For preparation of saline water (25 ppt) for breeding, 120 ppt brine was collected from salt bed and brackishwater (6 ppt) was collected from on station ponds, filtered with cartridge filter and preserved in the cistern. Brackish water was bleached @ 25 ppm for disinfection. After three days, vigorous aeration was provided to reduce the action of chlorine. Finally, water was treated with sodium thiosulphate to neutralize residual chlorine. For disinfection, brine was treated with 10 ppm formalin and kept undisturbed for three days. Then brine was mixed with brackishwater in a separate tank to prepare 25 ppt saline water. This water was provided with aeration and kept preserved for further use. Requisite amount of prepared water was transferred to a circular concrete tank (2m dia x 1m depth). Temperature of water in the tank was raised from 19^{o}C to 26^{o}C by electric heater fitted with thermostat. A submersible pump (0.5 HP) was fitted in the tank in such a way to circulate water.

Selection of broods: For breeding purpose, matured males and females were collected from the brood rearing pond and selected on the basis of their morphological criteria. The selected broods were acclimatized with the prepared 25 ppt water in cement cistern for 24 hours. The selected female broods were 40~79 cm in total length and 74~90g in weight while the males were 20~37 cm and 40~50g.

Administration of hormone: The broods were administered with requisite amount of hormone as mentioned in the experimental design. In both male and female, a single dose of hormone was injected in deep muscle at the base of the dorsal fin.

Rearing in the breeding tank: After administration of hormone, fish with female: male (1:2) was kept in the breeding tank. A continuous current flow with an interval of one hour was maintained for 34 hrs and then stopped for creating calm situation for pairing of the fish.

Observation: No spawning performance was observed except one occasion in fishes administered with ovaprim@2.0 ml/kg. The spawning activity appeared to continue first after 35~36 hours post injection. The active male surrounded by couple of females maintaining a position slightly behind the female and later took parallel position. The first release of a small number of eggs stimulated the male to release spermatozoa. The female then responded with a jerk and release huge eggs, while spawning males stayed besides females close to the tail and fertilized released eggs as soon as those scattered. The fertilized eggs were observed under microscope and after six hrs of fertilization, it was found that development of fertilized eggs was stopped before formation of the embryo (blastula stage). In all other cases, no courtship or spawning was observed.

Development of nursery management and culture technique of *Mystus gulio*

Researchers: Dr. S. B. Saha, CSO
Mollah N. S. Mamun Siddiky, SO

Objectives

- To develop nursery management technique of brackishwater catfish (*Mystus gulio*)
- To develop production technique of brackishwater catfish (*Mystus gulio*)

Achievements

Study 1. Comparative efficacy of different fertilizers on the production of fry of brackishwater catfish (Mystus gulio) in nursery ponds

The study was carried out in nine nursery ponds of 60 m^2 each following the experimental design as given in Table 1.

Table 1. Experimental design

Treatments	Name of fertilizer and dose
T1	Cattle dung @ 5 tons/ha
T2	Urea @ 50 kg/ha & TSP @ 60 kg/ha
T3	Cattle dung @ 2.5 tons/ha, urea @ 25 kg/ha and TSP @ 30 kg/ha

The ponds were prepared by drying, liming soil with CaO @ 250 kg/ha and then filling with tidal water up to 100 cm. Pond water was treated with dolomite @ 20ppm. After 5 days of liming, particular pond was fertilized with respective fertilizer and dose as given in the experimental design. Five days after

fertilization, by which time sufficient planktons were developed, dipterex @ 1 ppm was spread over the water surface to kill aquatic insects and big sized zooplanktons like cladocerans and copepods. Twenty four hours after spreading of dipterex, four days old hatchlings (average length, 05 mm) of catfish were stocked uniformly @ 250 Nos/m^2 in all ponds on 15 May 2013. From the second day of stocking, fish fries were fed twice daily @ 6 kg/million of hatchlings which was raised to 10 kg from the 6^{th} day of stocking. Subsequently, feed was increased by 5 kg/million hatchlings every five days. Subsequent to stocking of hatchlings, the ponds were being fertilized regularly at seven days intervals with one fourth of the initial dose of fertilizer.

Growth and well being of the fries were checked at weekly intervals. Physico-chemical parameters of water *viz*., temperature, salinity, transparency, pH, dissolved oxygen and alkalinity were determined and plankton samples were analyzed at four days interval. Temperature and salinity of water during study period were 29.0-35.0^oC and 7.0-8.5 ppt and almost same in all ponds. As shown in Fig. 1a, transparency of water was initially higher in all ponds and gradually decreased with the progress of culture period. Low transparency of 27-59 cm was recorded in ponds fertilized with cattle dung only (T1). Transparency was 27-66 cm and 32-72 cm in ponds fertilized with inorganic fertilizers (T2) and mixture of organic and inorganic fertilizers (T3). pH of water of all the ponds was congenial for nursery rearing and varied from 7.9-9.1 (Fig. 1b). Alkalinity was almost same (180-182 mg/l) in all ponds during stocking and some variations among different treatments were observed with the progress of culture period. However, total alkalinity of water was 182-197 mg/l, 161-188 mg/l and 180-188 mg/l in T1, T2 and T3, respectively. Morning dissolved oxygen was always congenial for normal survival of fish fry in all ponds. As shown in Fig. 1d, concentration of dissolved oxygen was 3.1-5.1 mg/l, 3.25-4.8 mg/l and 3.1-5.4 mg/l in T1, T2 and T3, respectively. Concentration of both phyto- and zoolplankton was highest in ponds fertilized with organic manure only and increased with the progress of culture period. Phytoplankton counts (No/l) were 4.40-6.00 x 10^4, 3.40-5.60 x 10^4 and 2.50-6.00 x 10^3 (Fig. 2a) and zooplankton counts (No/l) were 2.25-4.70 x 10^3, 2-3.45 x 10^3 and 2.1-3.14 x 10^3 (Fig. 2b) in T1, T2 and T3, respectively.

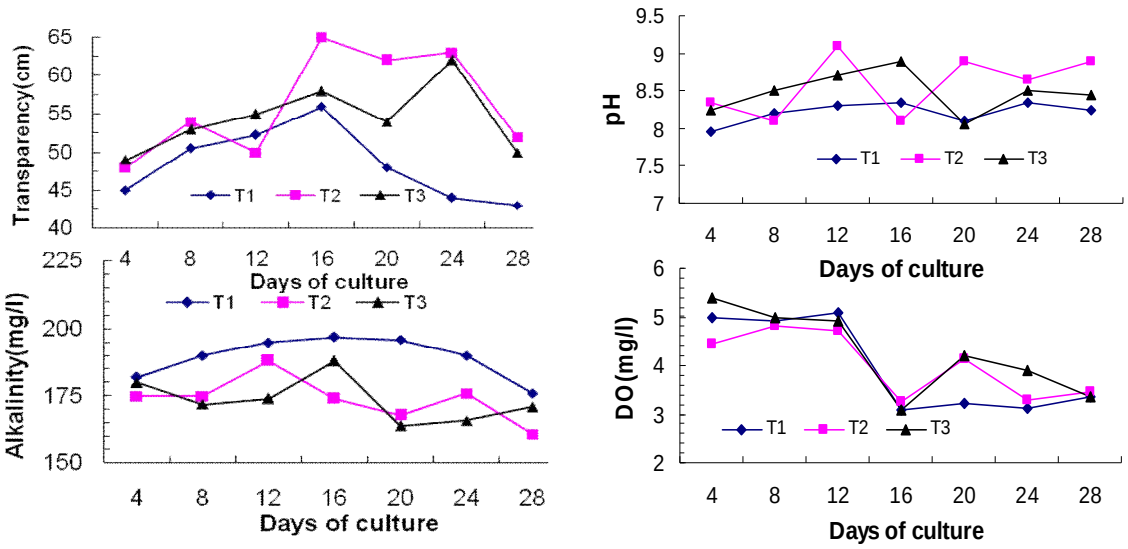

Fig. 1. Variation in some water quality parameters of the ponds used for nursing hatchlings of *Mystus gulio* at different fertilizer treatments (T1, cattle dung @ 5 t/ha; T2, urea @ 50 kg/ha + TSP@ 60 kg/ha; T3, cattle dung @ 2.5 t/ha + urea @ 25 kg/ha + TSP @ 30 kg/ha).

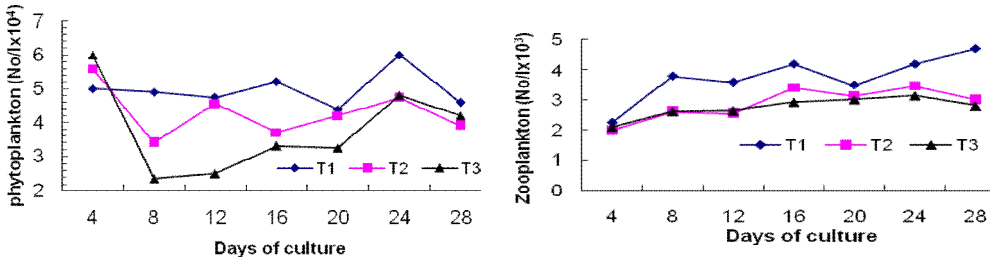

Fig. 2. Concentration of phyto- and zooplankton of the ponds used for nursing hatchlings of *Mystus gulio* at different fertilizer treatments (T1, cattle dung @ 5 t/ha; T2, urea @ 50 kg/ha + TSP@ 60 kg/ha; T3, cattle dung @ 2.5 t/ha + urea @ 25 kg/ha + TSP @ 30 kg/ha).

After four weeks of nursing, the growth of fries was recorded as 4.40cm, 2.87cm and 3.60cm in T1, T2 and T3 respectively (Table 1). Among the growth rates, the highest was obtained in ponds fertilized with only organic fertilizers and the differences among different treatments were significant. Again, in terms of weight (g), the highest growth of fry, 0.70±0.05 g was recorded from the ponds fertilized with organic fertilizers only while growth of fry was 0.40±0.05 g and 0.58 ± 0.025 g produced in ponds treated with only inorganic fertilizer and mixture of inorganic and organic fertilizer, respectively. However, mean survival of the stocked fries was highest of 64.07±1.72% in ponds fertilized with only organic fertilizer (T1), which was significantly higher than that 53.27±0.96 % in ponds fertilized with only inorganic fertilizers (T3). Survival of fry in ponds with mixture of inorganic and organic fertilizers was 58.62±0.37. The findings in the present study corroborates with the findings of the previous year where performance of organic fertilizer for production of *Mystus gulio* was better.

Table 1. Growth and survival of *Mystus gulio* under different treatments

Treatments	Replications	Final length (cm)	Final wt (g)	Survival (%)
T1 (Cattle dung @ 5 t/ha)	R1	3.80	0.65	62.45
	R2	4.50	0.70	63.90
	R3	4.90	0.75	65.87
	Mean	4.40±0.56^{a}	0.70 ± 0.05^{a}	64.07± 1.72^{a}
T2 (Urea @ 50 kg/ha &TSP @ 60 kg/ha)	R1	2.70	0.35	52.23
	R2	2.80	0.40	53.45
	R3	3.10	0.45	54.12
	Mean	2.87±0.21^{b}	0.40±0.05^{b}	53.27±0.96^{b}
T3 (Cattle dung @ 2.5 t/ha, urea @ 25 kg/ha and TSP @ 30 kg/ha)	R1	3.50	0.55	58.28
	R2	3.60	0.58	58.55
	R3	3.70	0.60	59.02
	Mean	3.60±0.10^{c}	0.58 ± 0.02^{c}	58.62±0.37^{ab}

Study 2. Production of brackishwater catfish (Mystus gulio) in monoculture management at different stocking densities

For the study, three stocking densities viz. 8, 12 and 16 Nos/m^2 were tried each with two replications in earthen ponds of 500 m^2 each. The ponds were prepared by drying, liming (CaO @ 250 kg/ha) and then filling with tidal water up to 100 cm. Water of the ponds were treated with rotenone @ 1.5 ppm to kill all unwanted animals. After removing all dead animals, ponds were treated with dolomite @ 20 ppm. After five days of liming, water of the ponds were fertilized with 25 ppm urea, 30 ppm TSP and 1 ton/ha cattle dung and the ponds were made ready for stocking. After seven days of fertilization, required quantity of one month old fries of catfish was stocked in all ponds on 28 June'13. The stocked fishes are being fed with commercial pellet feed (25% crude protein) @ 4-6% of estimated fish biomass. Growth of fishes is being checked fortnightly for the adjustment of feed. Physico-chemical parameters of water *viz*., transparency, temperature, pH, dissolved oxygen and alkalinity are being determined as mentioned in study I.

After 65 days rearing, growth of fishes was 6.15-6.30g, 7.45-10.05g and 7.15-9.40g in ponds at 8, 12 and 16/m^2 density, respectively. After five months of rearing, fishes will be harvested from all ponds and production will be estimated and compared.

Improvement of management practice for increasing production of shrimp (*Penaeus monodon*) in extensive system

Researchers: Dr. S.B. Saha, CSO
Md. Farajul Kabir, SO

Objectives

- To assess the ecological status of shrimp (*Penaeus monodon*) ghers and adjacent waterbodies
- To improve the productivity of shrimp (*P. monodon*) ghers.

Achievements

Assessment of culture status of shrimp ghers in extensive system

Study areas: Three farmers' *ghers* have been selected for the study. The particulars of the selected *ghers* have been given in Table 1. Information on the preparation of *ghers*, stocking, post stocking management, harvest and income from these *ghers* are being collected by regular visit of the *gher* and noted from the dairy supplied to the farmer. Physicochemical and biological characteristics of the selected *ghers* are being recorded by *in situ* and laboratory analysis following standard methods at monthly interval.

Table 1. Particulars of the selected *ghers*

Particulars	Gher 1	Gher 2	Gher 3
Location	Swarankhali, Paikgacha, Khulna	Kadakati, Asasuni, Satkhira	Betbunia, Paikgacha, Khulna
Area (m^2)	6500 m^2	3,960 m^2	10,560 m^2
Bottom	Uneven	Uneven	Uneven
Source of water	Canal connected with river	Canal connected with river	Canal connected with river

Culture practice: Production practices including preparation of *ghers* and application different inputs by the farmers are being observed closely and recorded. The collected information is presented in Tables 2 and 3. All three farmers dried their *ghers* before filling with water, treated soil with lime and fertilized soil (except one farmer). The farmers applied lime and fertilizer to the *ghers* according to their choice and capacity. No treatment of water was done. All three farmers followed multi-stocking and multi-harvesting culture practice. No post stocking management was done by the farmers.

Table 2. Preparation of *ghers* and stocking up to 30 June

Particulars	***Gher* 1**	***Gher* 2**	***Gher* 3**
Pond drying	Dried	Dried	Dried
Soil liming	60 kg/ha CaO	75 kg/ha CaO	120 kg/ha CaO
Soil fertilization	Cow dung: 300kg/ha TSP: 18 kg/ha Urea:18 kg/ha	No	TSP: 25 kg/ha Urea: 25 kg/ha MOC: 20 kg/ha
Killing of predatory fish	No	No	No
Water liming	No	No	No
Water fertilization	No	No	No
Stocking pattern	Multi stocking	Multi stocking	Multi stocking
First Stocking	22 February 2013	02 February 2013	12 February 2013
Stocking density (No/m^2)	1^{st} : 2/m^2 2^{nd} : 2/m^2 3^{rd} : 2/m^2 4^{th} : 2/m^2 $5^{th:}$ 2/ m^2	1^{st} : 2/m^2 2^{nd} : 1/m^2 3^{rd} : 2/m^2 4^{th} : 1/m^2 $5^{th:}$ 2/ m^2	1^{st} : 3 /m^2 2^{nd} : 2/ m^2 3^{rd} : 3/ m^2 4^{th} : 2/ m^2 $5^{th:}$ 3/ m^2

Table 3. Post stocking management of *ghers*

Management activities	**Gher 1**	**Gher 2**	**Gher 3**
Water liming	No	No	No
Water fertilization	No	No	No
Water Exchange	No exchange but refill during spring tide period	No exchange but refill during spring tide period	No exchange but refill during spring tide period
Harvest	Multi harvest using trap	Multi harvest using trap	Multi harvest using trap

Physicochemical characteristics of water: The water quality characteristics *viz*., temperature, transparency, pH, salinity, free carbon dioxide, alkalinity, dissolved oxygen and inorganic nutrients (ammonia, nitrate and phosphate) of three selected *ghers* are being determined monthly. Temperature, transparency, pH, salinity, free carbon dioxide, alkalinity and dissolved oxygen are determined *in situ*.. The collected physicochemical parameters up to 130 days of rearing are presented in Table 4.

Table 4. Water quality characteristics of the selected *ghers* up to 130 days of culture

Parameters	**Gher 1**	**Gher 2**	**Gher 3**
Temperature (^oC)	32^oC-34^oC	29 ^oC-32^oC	30 ^oC-33^oC
Salinity (ppt)	10-19	10-20	11-20
Depth (cm)	34-46	37-50	30-49
Transparency (cm)	34-46	37-50	30-49
pH	8.5-9.6	8.2-9.0	8.4-8.9
Free CO_2 (mg/l)	00	00	00
Alkalinity (mg/l)	140-160	180-240	180-240
Dissolved oxygen (mg/l)	11.3-16.4	12-18	13-16

Biological characteristics of water: The quality and quantity of phytoplankton and zooplankton of the selected ghers were estimated monthly following standard methods (Cupp, 1943; Newell and Newell, 1973; Santhanam and Srinivasan, 1994) and presented in Table 5. Most common phytoplanktons are *Scenedesmus*, *Cyclotella*, *Coscinodiscus*, *Spirulina* and *Synedra* and that of zooplanktons are rotifers, nauplius larvae, clodocerans and copepods. All three selected *ghers* were mostly filled with aquatic weeds and filamentous algae and heavy growth of algal mat was observed in *gher* 1.

Table 5. Biological characteristics of the selected *ghers* up to 130 days of culture

Plankton	Gher 1	Gher 2	Gher 3
Phytoplankton	15.2x 10^2-20.8 x 10^2/l	12.2 x 10^2-18.2 x 10^2/l	16.7 x 10^2-22.3 x 10^2/l
Zooplankton	0.72 x 10^2-1.2 x 10^2/l	0.62 x 10^2-1.1 x 10^2/l	0.42 x 10^2-0.90 x 10^2/l
Aquatic weeds	Throughout the *gher*	Throughout the *gher*	Throughout the *gher*
Algal mat	Throughout the *gher*	Poor	Poor

Physicochemical characteristics of soil: Surface soil of shrimp *ghers* was collected twice in February and June. Collected soil samples were air-dried and processed for analysis. pH, total nitrogen, potassium, phosphorus, calcium, copper, iron, manganese, zinc and organic carbon of the collected soil samples were analysed in the laboratory of SRDI, Khulna and data have given in Table 6.

Table 6. Physicochemical characteristics of surface soil of selected shrimp ghers

Parameters	Gher 1		Gher 2		Gher 3	
	February	June	February	June	February	June
pH	7.8	8.1	8.1	8.0	7.0	8.1
Total nitrogen (%)	0.149	0.096	0.129	0.109	0.152	0.118
Potassium (mili/100g)	1.50	1.36	1.30	1.38	1.70	1.33
Phosphorus (µg/g)	12.87	11.85	20.14	16.31	3.76	12.31
Calcium (mili/100g)	10.05	16.12	18.04	17.79	6.42	17.00
Copper (µg/g)	6.72	5.87	7.14	7.18	9.00	7.18
Manganese (µg/g)	17.74	13.48	59.40	50.60	16.81	48.70
Zinc (µg/g)	0.89	0.22	0.50	0.54	1.26	0.41
Organic carbon (%)	2.58	1.64	2.23	1.87	2.62	2.04

Harvest: Generally farmers harvested shrimp by bamboo trap (locally called *charu*) during new moon and full moon period. Harvest of shrimp in different occasions are given in Table 7.

Table 7. Harvest of shrimp from different *ghers* up to 30 June 2013

Particulars	Gher 1	Gher 2	Gher 3
ABW (g)	22-25	18-20	20-22
Harvest (kg/pond)	35+45+40+38=158	34+16+25+28 = 103	55+62+50+45=212
Harvest (kg/ha)	243.07	260.10	200.75

Application of probiotics for increasing production of tilapia (*Oreochromis niloticus*) in brackishwater system

Researchers: Dr. S.B. Saha, CSO
Subrina Khatun, SO

Objectives

- To evaluate the effect of dietary supplementation of commercial probiotics on growth and production of Nile tilapia (*Oreochromis niloticus*) in brackishwater environment.
- To determine the efficacy of probiotics for the improvement of the culture environment in tilapia (*Oreochromis niloticus*) production system in the brackishwater environment.

Achievements

Effect of dietary supplementation of commercial probiotics on Nile tilapia (Oreochromis niloticus) production system in the brackishwater environment

The study was conducted in eight ponds of 1000 m^2 each of the Bangladesh Fisheries Research Institute, Brackishwater Station, Paikgacha with the experimental design as given in Table 1.

Table 1. Experimental design

Treatments	Probiotics	Mode of application	Stocking density (No/m^2)	Replications
T1	Safegut (*B. subtilis, B. licheniformis, L. sporogrnrs, S. boulardii, S cerevisiae, Asdpergillus oryzae, A. niger,* Vit. B1 & B6, coated vit. C and some enzymes)	Dietary supplementation	5	2
T2	Zymetin (*Bacillus mesentericus, Streptococcus faecalis, Clostridium butyricum*)			
T3	Probio-Aqua (*Rhodopseudomonas palustris* & some basic media)			
T4	No probiotics (control)			

Ponds were prepared by drying, liming (CaO@ 250 kg/ha) and then filling with tidal water up to a depth of one meter. Water was treated with rotenone @ 1.5 ppm to kill predatory and weed fishes. The water of the ponds was treated with dolomite @ 20 ppm and fertilized with urea and TSP @ 2.5 ppm and 3.0 ppm, respectively. Monosex tilapia fry (ABW, 0.15 g) was stocked in the in-pond nursery made of nylon net fastened in bamboo frame on 1st April 2013. Fishes were fed with floating tilapia feed (Mega feed). After fifteen days of rearing in the in-pond nursery, fishes were released to the whole pond by up-folding the nylon net. Fishes were fed with the probiotics mixed feed following the experimental design as given in Table 1. Growth of fishes was monitored at weekly interval and feed was adjusted accordingly. Water quality parameters *viz.*, temperature, depth, salinity, transparency, pH and alkalinity were being determined at weekly interval and dissolved oxygen were determined frequently in the morning. The population of total heterotrophic bacteria (THB) of water and soil of the ponds were monitored fortnightly by plate count method. For testing of protein digestibility, feces of fishes from different treatments was

collected and dried for further analysis. After 105 days of culture, fishes from all ponds were harvested by complete draining and growth and production in different treatments were assessed.

Temperature of water was 28.0-33.5^{o}C and almost same in all ponds. Depth of water was maintained at a level of one meter in all ponds. As shown in Fig. 1a, salinity of water was also almost same in all ponds. Salinity of water was 12 ppt during stocking and increased to highest level 13-14 ppt at 40-45 days of culture and again gradually decreased to 11 ppt at the end of culture period. Transparency of water was initially higher in all ponds and gradually decreased with the progress of culture period (Fig. 1b). pH of water of all the ponds was congenial for culture and varied from 7.7-9.0 (Fig. 1c). Alkalinity was almost same (116-196 mg/l) in all ponds (Fig. 1d). Initial level of morning dissolved oxygen (DO) was 4.30-5.50 mg/l which decreased to less than 1 mg/l at the later part of the culture period. At this level of low DO, no mortality of tilapia was observed.

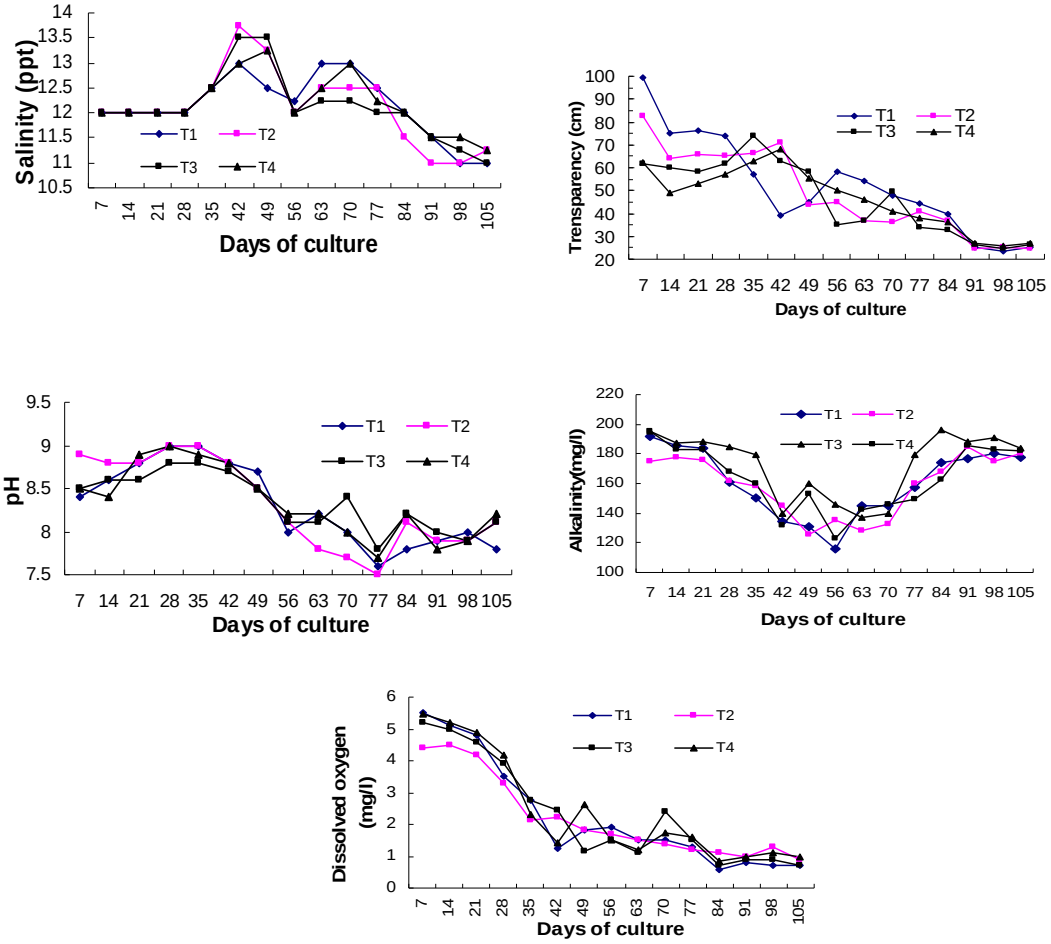

Fig. 1. Variation in some water quality parameters of the experimental ponds.

Bacterial population was higher in probiotics treated ponds in comparision to that of control pond and highest bacterial count was observed in both water and soil of pond where tilapia was fed with safegut treated feed (Table 2).

Table 2. Estimation of total heterotrophic bacteria (THB) in different treatments.

Treatments	Probiotics	Water	Soil
		THB (CFU/ml)	THB (CFU/g)
T1	Safegut	5.20-15.60 x 10^3	7.40-18.20 x 10^4
T2	Zymetin	4.15-11.20 x 10^3	7.60-16.10 x 10^4
T3	Probio-Aqua	3.80-9.00 x 10^3	8.46-12.60 x 10^4
T4	No probiotics	4.70-7.40 x 10^3	7.30-11.50 x 10^4

As shown in Table 3, average production of tilapia was highest of 7793.65 kg/ha in T3, where tilapia was supplied with Probio-aqua treated feed followed by 7786.62kg/ha in T1 where tilapia was fed with safegut treated feed, 7225.11kg/ha in T2 where tilapia was fed with zymetin treated feed and 6869.63kg/ha in T4 where no probiotics was used. Though average growth of tilapia was significantly highest in ponds where tilapia was fed with safegut, no significant difference in production was observed among different treatments. However, further study is needed for conclusion.

Table 3. Production performance of tilapia in different treatments after 105 days of culture

Treatments	ABW (g)	Survival (%)	Production (kg/ha)	FCR
T1 Safegut	202.25[a]	77.00[a]	7786.62	1.22
T2 Zymetin	167.50[b]	86.27[ab]	7225.11	1.20
T3 Probio-Aqua	173.00[b]	90.10[b]	7793.65	1.15
T4 No probiotics (control)	163.00[b]	84.29[ab]	6869.63	1.25

*Figure with same superscript indicates no sigficant difference

Optimization of modified extensive culture technique brackishwater shrimp (*Penaeus monodon* Fab.)

Researchers: Dr. S.B. Saha, CSO
Azhar Ali, SO
Subrina Khatun, SO

Objective

- To standardize the rate and methods of application of different inputs for shrimp (*Penaeus monodon*) culture.

Achievements

Standardization of dose of chlorine for improving sanitation of shrimp (Penaeus monodon) culture ponds in modified extensive system

The experiment was conducted in 12 ponds of 1000 m^2 each of Bangladesh Fisheries Research Institute, Brackishwater Station following the design as given in Table 1.

Table 1. Design of the experiment

Treatments (T)	Dose of chlorination	Application frequency	Replications	Stocking density
T_1	No chlorination	Monthly	3	$5/m^2$
T_2	3 ppm			
T_3	6 ppm			
T_4	9 ppm			

The ponds were prepared by treating soil with lime (Quick lime:dolomite 3:1) @ 250 kg/ha and then filled with tidal water up to a depth of 1.0 m. After that, all animalcules were killed and removed from the pond. The buffering capacity of water of the ponds was strengthened by applying dolomite @ 15 ppm. The pond water was fertilized with urea, TSP, and MoP @ 2.5 ppm, 3.0 ppm 1.0 ppm, respectively. Fermented molasses were applied to the pond water @ 5ppm to develop colour of water to check penetration of sunlight. After production of sufficient plankton, required quantity of PCR tested PL20 was stocked to the respective pond on 27 March, 2013. The stocked shrimps were fed with commercial feed (Saudi-Bangla shrimp feed).

Feed was applied by spreading and adjusted fortnightly after sampling with cast net. The load of total heterotrophic bacteria and total coliform of water was checked as indicator of sanitation. The estimation of bacterial load was done before and after two hours and two following successive days after every application of chlorine. Total heterotrophic bacteria were counted by pour plate technique method and total coliform by most probable count (MPN) method. Primary productivity of the ponds was monitored before and after two hours and two following successive days after every application of chlorine following classical dark and light bottle method. Basic water quality variables (*viz*., depth, temperature, salinity, pH, transparency, free carbon dioxide, dissolved oxygen and alkalinity) were determined at fortnight intervals following standard methods**.** To maintain undisturbed ecology of the ponds, no water was exchanged. Only the evaporated water was replenished with the water of the adjacent canal. Health of the stocked shrimps was checked almost daily through check tray. After 120 days of culture, shrimps were harvested by complete draining of water and production was estimated.

Data on water quality parameters are shown in Table 2 indicates that the recorded water quality parameters were congenial for culture of shrimp. Higher temperature of surface water was recorded during April-May period. As depth of water was maintained around 1 meter, no stress in shrimp was observed in spite of high surface water temperature. Lower salinity was recorded during stocking and salinity increased with the progress of culture period. This is due to replenishment of evaporated water with the higher saline water of the adjacent Shibsa river. Morning dissolved oxygen and alkalinity were sufficient enough for the normal growth of shrimp. Primary productivity and bacterial count were determined to evaluate the impact of chlorination on pond environment. As shown in Table 3, there is no significant change in productivity where chlorination was not done. But chlorination reduced both gross primary productivity and net primary productivity. Reduction in productivity increased with the increase in chlorine dose. Total bacterial load reduced after application of chlorine (Table 4)

Table 2. Water quality variables of ponds under different treatments

Water quality	**Treatments**			
	T_1	T_2	T_3	T_4
Depth (cm)	100 - 110	98 - 110	95 - 108	96 -107
Transparency (cm)	35 - 45	20 - 40	25 - 45	30 - 45
Temperature (^oC)	31 - 35	31 - 35	31 - 35	31 - 35
Salinity (ppt)	6 - 15	6 - 15	6 - 15	6 - 15
pH	7.8- 9.4	7.8 - 9.6	7.9 - 9.6	8.0 - 9.4
Morning dissolved oxygen (mg/l)	3.6-8.8	3.8-6.6	4.6-7.2	4.8-7.8
Evening dissolved oxygen (mg/l)	6.3-10.2	6.8-11.6	7.7-10.1	6.6-10.4
Alkalinity	90 – 164	80-220	75 - 210	66 - 200

Table 3. Change in primary productivity after chlorination at different dose

Dose of chlorination	Gross primary productivity			Net primary productivity			Respiration		
	Before chlorination (g C/m^3/d)	Change (%)		Before chlorination (g C/m^3/d)	Change (%)		Before chlorination (g C/m^3/d)	Change (%)	
		After 2 hr.	After 2 days		After 2 hr.	After 2 days		After 2 hr.	After 2 days
No chlorination	1.800	+1.33	+2.22	1.350	-7.40	+0.29	0.450	+27.53	+8.00
3 ppm	1.675	-25.37	-31.34	1.225	-26.53	-59.35	0.450	-22.22	+44.89
6 ppm	1.900	-28.68	-53.57	1.250	-24.00	-68.00	0.650	-39.23	-15.38
9 ppm	1.800	-34.88	-67.53	1.250	-28.00	-91.84	0.550	-47.81	-12.36

After chlorination at 3-9 ppm about 82-85% total bacterial load was reduced. But after days, bacterial load again started to increase. Load of total coliform also reduced drastically after application of chlorine at the same rate.

Table 4. Change in bacterial load of water after chlorination at different doses

Dose of chlorination	Total heterotrophic count			Total coliform		
	Before chlorination (CFU/ml)	Change (%)		Before chlorination (CFU/ml)	Change (%)	
		After 2 hr.	After 2 days		After 2 hr.	After 2 days
No chlorination	$45x10^3$	+2.22	+8.89	294	+2.04	+1.36
3 ppm	$52x10^3$	-81.94	-61.11	300	-89.00	-88.33
6 ppm	$44x10^3$	-83.53	-16.00	300	-92.00	-93.53
9 ppm	$46x10^3$	-84.78	-67.39	300	-97.00	-97.00

Production performance of shrimp under different treatments has been furnished in Table 5. After 120 days, mean growth of shrimp was almost same (17.90-19.50g) in all treatments. Mean survival of shrimp was 77.16±4.41% in ponds without chlorination. This survival is almost same with that of 77.09±4.26% in ponds treated with 3.00 ppm chlorine. But survival of shrimp is significantly reduced to 63.61% in ponds with 6.00 ppm chlorine and 64.25% in ponds treated with 9.00 ppm chlorine. This might be due to

the fact that after application of chlorine at 6-9 ppm dose, some moulted shrimps were found dead at the periphery of the pond. Production of shrimp was 730.73 kg/ka in ponds without chlorination, followed by 689.91 kg/ha in ponds with 3 ppm chlorination showing no significant difference. But at 6-9 ppm chlorination, production of shrimp was significantly reduced to 612.64-610.94 kg/ha. This might be due to low survival in these two treatments.

Table 5. Production performance of shrimp ((*Penaeus monodon*) in different treatments

Treatments	Replications	Final Wt (g)	Survival (%)	Production (Kg/ha)
T1 (No chlorination)	R1	20.24	81.50	824.78
	R2	17.93	72.68	651.57
	R3	18.52	77.32	715.9
	Average	18.89±1.20[a]	77.16±4.41[a]	730.73±87.55[a]
T3 (3 ppm chlorination)	R1	18.18	72.40	658.12
	R2	18.18	80.72	733.74
	R3	17.35	78.14	677.86
	Average	17.90±0.50[a]	77.09±4.26[a]	689.91±39.22[ab]
T2 (6 ppm chlorination)	R1	19.50	62.61	610.50
	R2	18.64	60.88	567.41
	R3	19.60	67.35	660.00
	Average	19.25±0.53[a]	63.61±3.35[b]	612.64±46.33[b]
T4 (9 ppm chlorination)	R1	18.28	61.25	559.83
	R2	19.60	67.35	660.00
	R3	19.12	64.12	612.99
	Average	19.00±0.66[a]	64.24±3.25[b]	610.94±50.12[b]

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Development and evaluation of artificial feed for mud crab (*Scylla serrata*) fattening

Researchers: Azhar Ali, SO
Md. Farajul kabir, SO

Objectives

- To evaluate different commercial aquaculture diets in crab fattening practices.
- To develop low cost artificial diets from local ingredients.
- To determine the efficiency of plant originated protein as a replacement of animal originated protein in crab feed.
- To develop sustainable crab fattening practices with maximum profit.

Achievements

The study was conducted in two earthen ponds of 1000 m^2 each of Bangladesh Fisheries Research Institute, Brackishwater Station following the design as given in Table 1.

Table 1. Design of the experiment

Treatments	Feed details	Replication
T1	100% animal (trash fish) protein	3
T2	75% animal protein + 25% plant protein	3
T3	50% animal protein + 50% plant protein	3
T4	25% animal protein + 75% plant protein	3
T5	100% plant protein	3

For the experiment, formulation of feed for each treatment was done by Pearson's square method using different feed ingredients as shown in the table 2. The selected ponds were dried. One pond was divided into nine compartments and another pond into six compartments of 60 m^2 each by erecting screen made of bamboo slits. Soil of each compartment was treated with CaO @ 250 kg/ha. After three days, the pond was filled with tidal brackishwater up to 100 cm. Water of the ponds was treated with dolomite @ 20 ppm. After 7 days of liming, the compartments were equally fertilized with urea and TSP @ 2.5 ppm each. After five days of fertilization, when sufficient planktons were grown, non-gravid female crabs (ABW, 150-160g) were stocked six days of rearing (DOR) and then at three days interval. For checking gonad development, 10% of the stocked crabs were collected from each compartment by bait and scoop method. Per cent development of gonad of each crab was checked against light and recorded. The average of development of gonad has been presented in the result. After 12 days of rearing, all crabs were harvested by dewatering the pond and development of gonad was recorded.

Table 2. Formulation of different feeds

Treatments	Protein source	Feed ingredients	% of ingredients	Protein level (%)	
				Ingredients	Total
T1	100% animal (trash fish) protein	Chopped tilapia	100.0	20.30 (wet basis)	20.30 (wet basis)
T2	75% animal protein + 25% plant protein	Fish meal	29.80	16.09	41.68
		Protein concentrate	14.90	8.94	
		Meat and bone meal	14.90	7.15	
		Soybean meal	26.38	9.50	
		Vitamin and minerals	2.00	--	
		Binder (molasses/artificial)	12.00	--	
T3	50% animal protein + 50% plant protein	Fish meal	35.23	19.01	38.01
		Soybean meal	52.77	19.00	
		Vitamin and minerals	2.00	--	
		Binder (molasses/artificial)	10.00	--	
T4	25% animal protein + 75% plant protein	Protein concentrate	8.84	5.30	33.80
		Soybean meal	79.16	28.50	
		Vitamin and minerals	2.00	--	
		Binder (molasses/artificial)	10.00	--	
T5	100% plant protein	Soybean meal	88.00	31.68	31.68
		Vitamin and minerals	2.00	--	
		Binder (molasses/artificial)	10.00	--	

Gonad development performance of crabs has been shown in Table 3. After six DOR, 60% gonad of the stocked crabs was developed in T1 where crabs were fed with 100% animal (trash fish) protein feed, 55% in T2 where crabs were fed with (75% animal protein + 25% plant protein) feed, 50% in T3 where crabs were fed with (50% animal protein + 50% plant protein) feed, 50% in T4 where crabs were fed with (25% animal protein + 75% plant protein) feed and 55% in T5 where crabs were fed with (100% plant protein) feed. After 12 DOR, 100% gonad in all crabs was fully developed in all treatments. Survival of crabs was 93.69%, 85.92%, 86.66%, 90.73% and 88.87% in T1, T2, T3, T4 and T5, respectively.

Table 3. Fattening performance of crabs (*Scylla serrata*) using different feeds

Treatments	Replications	Gonad development (%)			Survival (%)	Cost o feed (Tk./kg)
		6 DOR*	9 DOR	12 DOR		
T1 (100% animal protein)	R1	65	90	100	93.31	70.00
	R2	55	80	100	92.22	
	R3	60	85	100	95.55	
	Average	**60**	**85**	**100**	**93.69**	
T2 (75% animal protein + 25% plant protein)	R1	55	85	100	85.55	65.25
	R2	50	80	100	84.44	
	R3	60	75	100	87.77	
	Average	**55**	**80**	**100**	**85.92**	
T3 (50% animal protein + 50% plant protein)	R1	50	75	100	96.66	60.75
	R2	55	80	100	77.77	
	R3	45	70	100	85.55	
	Average	**50**	**75**	**100**	**86.66**	
T4 (25% animal protein + 75% plant protein)	R1	55	80	100	96.66	55.25
	R2	45	70	100	82.22	
	R3	50	75	100	93.33	
	Average	**50**	**75**	**100**	**90.73**	
T5 (100% plant protein)	R1	60	80	100	84.44	52.75
	R2	50	75	100	88.88	
	R3	55	85	100	93.31	
	Average	**55**	**80**	**100**	**88.87**	

*DOR, days of rearing

Shrimp Research Station

Development of nursery feed for shrimp (*Penaeus monodon*)

Researchers: Dr. Md. Shahidul Islam, SSO
Md. Mahmudur Rahman, SO
Md. Khairul Islam, SO

Objectives

- To develop artificial diets for bagda post-larvae using locally available ingredients
- To develop nursery management technique in Hapa system in pond condition
- To determine the FCR & SGR for bagda nursing in pond condition

Achievements

An experiment was conducted to study the efficacy of four different feeds viz., Feed-1: Comprising of fish meal 45%, dhaincha seed meal 40%, rice polish 5%, wheat bran 5%, wheat flour 4% and vitamin & minerals 1% , Feed -2: fish meal 45%, soya-bean meal 25%, rice polish 12.5%, wheat bran 12.5%, wheat flour 4% and vitamin & minerals 1%, Feed -3: fish meal 32%, soya-bean meal 32%, mustard oil cake 20%, rice polish 5%, wheat bran 6%, wheat flour 4% and vitamin & minerals 1% and Feed-4: Mega Nursery Feed (Commercial). All the four feeds were iso-proteineus containing 40% of protein.

Expt. 1. Efficacy of formulated feed for bagda nursing in laboratory condition

The growth trial was conducted at the Shrimp Research Station in aquarium water (≤10 ppt.). The trial was conducted with four treatments each with three replications. Treatment-1 was assigned for Feed-1 (T_1), Treatment-2 (T_2) for Feed-2, Treatment-3 (T_3) for Feed-3 and Treatment-4 (T_4) for Feed-4 (Commercial feed).The glass aquarium were provided with aeration and 50% water was exchanged daily. Feed was supplied at the rate of 10% of the total biomass twice a day. Faecal matter of PL was removed by siphoning once a day in the morning before feeding.

Growth rate: Post larvae of shrimp (*P. monodon)* average body weight of 0.005g were collected from Cox`s Bazar and stocked at rate of 5 PLs/L aquarium fed on the Feed-1, Feed-2, Feed-3 and Feed-4 (Commercial feed). Sampling was done at PL_{20}, PL_{30} and PL_{40} for measurement of growth and survival. After 30 days culture, the highest growth performance of 0.0954±0.0006g and the lowest of 0.0844±0.0029g were recorded in post larvae supplied with Feed-3 (consisting of fish meal 32%, soya-bean meal 32%, mustard oil cake 20%, rice polish 5%, wheat bran 6%, wheat flour 4% and vitamin & minerals 1%) and Feed-1 (fish meal 45%, dhaincha seed meal 40%, rice polish 5%, wheat bran 5%, wheat flour 4% and vitamin & minerals 1%) respectively. The increase in growth rate of PL is shown in Fig-1.The highest specific growth rate of 6.40 and the lowest food conversion ratio of 1.52 were also observed in T_3. Different growth parameters of PL with different feeds are shown in Table 1.

Table 1. Growth performance of PL using different feeds in Aquarium System

Treatments	Initial wt. (g)	Final wt. (g)	SGR* (% days)	FCR	Survival rate (%)
T_1 (feed-1)	0.005	0.0844±0.0029	6.13	1.68	48.3
T_2 (feed-2)	0.005	0.088 ±0.0008	6.24	1.61	50.2
T_3 (feed-3)	0.005	0.09±0.0006	6.40	1.52	55.7
T_4 (commercial feed)	0.005	0.0899±0.0015	6.27	1.55	52.5

**SGR=Specific Growth Rate

Survival rate: The initial stocking density of the post larvae was 175 in each treatment and the average post larvae were 84.5, 87.8, 97.4, and 91.8 during harvest. At the end of rearing the survival rate of PL were found 48.3%, 50.2%, 55.7% and 52.5% in treatment T_1, T_2, T_3 and T_4 respectively. So, the survival rate was comparatively higher in T_3 than T_1, T_2, and T_4.

Water quality parameters: Water quality parameters of the aquarium water containing PL stocks were studied (Table-2).Water temperature ranges from 25-27^{o}C. The P^H of all aquarium water was always alkaline and ranged from 7.2-7.8 (Table-5). In all treatments dissolved oxygen concentration ranged between 5.5-6.8 mg/l. Water salinity was 8 ppt that showed similar value in all treatments. The average value of ammonia was higher in T_4 (0.045mg/L) than the values recorded in T_1, T_2 and T_3 and no significant difference was observed among the treatments. The lowest value was obtained in T_3.

Table 2. Water quality parameters as recorded from aquarium in laboratory condition

Parameters	Treatments				
	T_1	T_2	T_3	T_4	Source water
Temperature (^{0}C)	25-27^{0}C	25-27^{0}C	25-27^{0}C	25-27^{0}C	29.5
P^H	7.5	7.7	7.4	7.9	7.2
Salinity (ppt)	8	8	8	8	8
DO (mg/l)	6.3	6.5	6.8	6.2	5.5
NH_4 (mg/l)	0.030	0.034	0.026	0.045	0.006

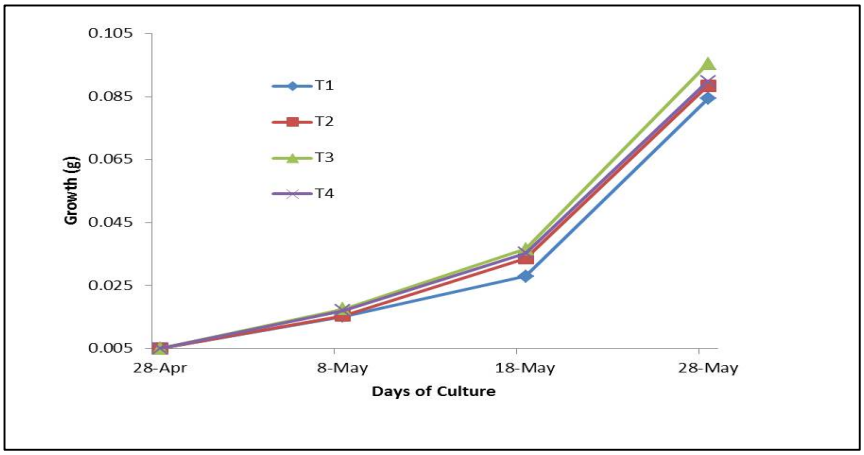

Fig. 1. Growth rate of PL using different feeds.

Expt. 2. Efficacy of formulated feed for Bagda nursing in pond condition

In order to determine growth and survival rates of *P. monodon* post larvae in pond condition rearing experiment was carried out in glass nylon net hapa using hatchery-produced post larvae (PL_{10}). Twelve

hapa (Each $4m^3$) was installed in pond. The fertilization was applied with cow dung (100ppm), urea (2ppm) and superphosphate (2ppm) for primary production in pond also. Post larvae were fed on the formulated Feed-1, Feed-2, Feed-3 and Feed-4 (Commercial feed). The trial was conducted with four treatments each with three replications. Treatment-1(T_1) was assigned for Feed-1, Treatment-2 (T_2) for Feed-2, Treatment-3 (T_3) for Feed-3 and Treatment-4 (T_4) for Feed-4 (Commercial feed). Feed was supplied at the rate of 10% of the total biomass twice a day.

Growth rate: The shrimp PL of average body weight of 0.005g stocked at rate of 500 Pl/m^2 and reared for a period of 40 days. After 40 days culture, the growth performance of 0.3120±0.010g, 0.3567±0.017g, 0.4328±0.045g and 0.3934±0.015g for Feed-1 (T_1), Feed-2 (T_2), Feed-3 (T_3), and Feed-4 (T_4) (Commercial feed) respectively. The highest growth performance of 0.4328±0.045g obtained from Feed-3 (fish meal 32%, soya-bean meal 32%, mustard oil cake 20%, rice polish 5%, wheat bran 6%, wheat flour 4% and vitamin & minerals 1%) and the lowest of 0.3120±0.010g was recorded in post larvae supplied with Feed-1 (fish meal 45%, dhaincha seed meal 40%, rice polish 5%, wheat bran 5%, wheat flour 4% and vitamin & minerals 1%) respectively. The highest specific growth rate of 6.45 and the lowest food conversion ratio of 1.35 were also observed in Feed-3 (T_3). Different growth parameters of PL with different feeds are shown in Table 3.

Table 3. Growth performance of PL using different feeds in Hapa System

Treatments	Initial wt. (g)	Final wt.(g)	SGR* (% days)	FCR	Survival rate (%)
T_1 (feed-1)	0.005	0.3120 ±0.010	5.98	1.50	62.8
T_2 (feed-2)	0.005	0.3567±0.017	6.17	1.41	65.7
T_3 (feed-3)	0.005	0.4328±0.045	6.45	1.35	73.4
T_4 (commercial feed)	0.005	0.3934±0.015	6.31	1.39	69.6

**SGR=Specific Growth Rate

Survival rate: The initial stocking density of the post larvae was 2000 in each in treatments and the average post larvae were 1256, 1314, 1468 and 1392 during harvest. At the end of rearing the survival rate of PL were found 62.8%, 65.7%, 73.4% and 69.6% in treatment T_1, T_2, T_3 and T_4 respectively. So, the survival rate was comparatively higher in T_3 than T_1, T_2, and T_4. The increases in growth rate of PL are shown in Fig 2.

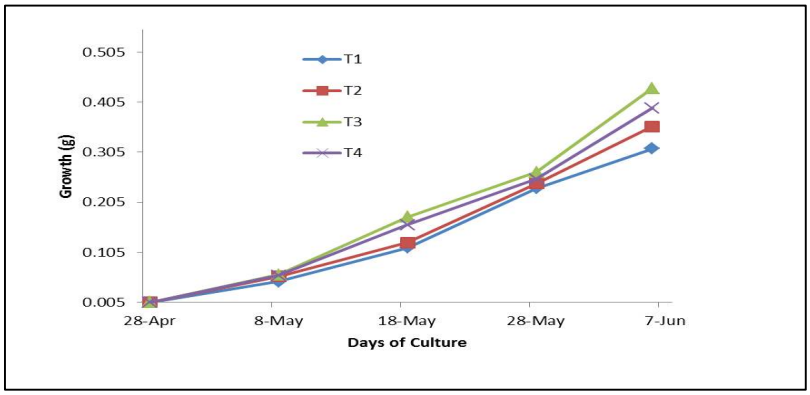

Fig. 2. Growth rate of PL using different feeds

Water quality parameters: Water quality parameters such as temperature, dissolve oxygen, P^H, salinity and ammonia were recorded by weekly sampling during the study period. The average values of water

quality parameters are presented in Table-4. There were no remarkable variation in water temperature, dissolve oxygen, salinity, PH and ammonia under the four treatments.

Table 4. Water quality parameters as recorded from hapa in pond condition

Parameters	**Treatments**			
	T_1	T_2	T_3	T_4
Temperature (^{0}C)	28-30^{0}C	28-30^{0}C	28-30 ^{0}C	28-30 ^{0}C
P^H	8.5	8.4	8.5	8.5
Salinity	4.5	4.5	4.5	4.5
DO mg/l	4.6	4.6	4.7	4.6
NH_4 mg/l	0.032	0.035	0.034	0.035

Water temperature recorded in hapa during the culture period was within the range of 28-30^{0}C. Water P^H found from hapa was 8.4-8.5 with no remarkable variation among the treatments. No change in salinity levels of hapa water was noticed during the experimental period and was prevailed 4.5 ppt. The values of DO content in T_1, T_2, T_3 and T_4 were found to range from 4.60-4.70 mg/l but there was no significant difference among the four treatments. Same values of DO content (4.60 mg/L) was recorded in T_1, T_2 and T_4. The values of ammonia (0.032- 0.035 mg/l) were within the suitable range and there were no conspicuous variations among the treatments.

Impact of probiotics on prawn (*Macrobrachium rosenbergii*) production

Researchers: Dr. Md. Shahidul Islam, SSO
Md. Mahmudur Rahman, SO
Dr. Khan Kamal Uddin Ahmed, CSO

Objectives

- To evaluate the impact of probiotics on growth and production of prawn (*M. rosenbergii*).
- To evaluate the economic feasibility of production of prawn with or without added probiotics.
- To study the soil and water quality parameters of the experimental ponds.

Achievements

Role of different types of probiotics in pond ecosystem, in prawn (*Macrobrachium rosenbergii*) health and prawn production. The experimental design was based on two types of probiotics using with different doses and manners at same stocking densities as shown in Table 1.

Table 1. Experimental design of research work

Treatments	Stocking density (No./ha)	Application of probiotics	
		Probiont type	Dose
T_1 (Super Ps)	25,000	Broadcast all over the ponds (mixed with clay)	40 ml/de/10 days
T_2 (Super biotic)	do	Broadcast (mixed with feed)	10-20 g/de/day
T_3 (Super Ps + Super biotic)	do	Broadcast	15 g + 20 ml/de

Selected probiotics (Super Ps and Super biotic, manufactured by Charoen Pokphand Foods (Public) Co.

Ltd, Thailand and imported by M/S Pranti Trading (Dealer of CP Products), 23 Natun Bazar Lanceghat Road, Khulna) had applied at a different doses of 40 ml/de at 10 days intervals, 10-20 g/de/day and 15 g + 20 ml/de from DOC 1, respectively in the ponds under Treatment 1, 2 and 3. The artificially manufactured probiotics (beneficial bacteria), *Bacillus* sp. (recommended by manufacturer at strength of 10^9 CFU/g) had been administered in the ponds. The experiment was set in 9 on-station ponds having an area of 0.052—0.075 ha.

The experimental ponds were dried up and re-excavated. The soil of ponds were treated with lime (CaO) @ 250 kg/ha. After liming, tidal water was taken into the ponds up to a depth of 50-60 cm. All the unwanted animals of water were removed using phostoxin Tablets @ 1.5 nos./decimal. After three Tablets applying, lime was again used @ 25 kg/ha. Pond's water was then fertilized with TSP and urea (2:1) @ 37.5 kg/ha. After production of plankton, juveniles of prawn were stocked according to the experimental design (Table 1). On March 5-25, 2013 the juveniles (ABW, 3.0 g) were stocked in all the ponds. Prawn was fed with Quality feed (gold plus-grower) @ 5 % of total biomass twice daily.

The population of total heterotrophic bacteria (THB) of pond water and sediment could not be estimated monthly interval due to autoclave was not in good condition. After repairing the clave, number of heterotrophic bacteria would be determined folling the methodology.

A total of 9 water quality parameters vis. temperature, water depth, dissolved oxygen, pH, salinity, ammonia, nitrate, total alkalinity and transparency were monitored fortnightly intervals. Notable variations in parameters were not found among the three treatments. Values of different water parameters are displayed in Table 2. Soil samples from each pond were collected. Samples were then air-dried and ground to a fine powder and preserved in airtight polythene bags. Then the samples were sent to Soil Resources Development Institute (SRDI) Laboratory, Daulotpur, Khulna for analyzing of organic matter, salinity, pH, nitrogen, phosphorus and potassium. Variations of soil parameters vis. pH, salinity, organic matter, total nitrogen, phosphorus and potassium are given in Table 3.

Growth of prawn was measured fortnightly and feed was adjusted. After 180 days of husbandry, all prawn from each pond were harvested. As shown in Table 4, growth, survival and production of prawn were recorded. Higher survival (84%) of prawn was found in T_2 followed by 81.9% in T_3 and 76.9% in T_1. Mean body weight of prawn in T_2 was the highest of 70.6 g which was significantly ($p<0.05$) different from those of T_3 (62.3 g) and T_1 (55.4 g). Food conversion ratio (FCR) was lower (2.71) in T_2 than these of 3.20 in T_1 and 2.92 in T_3. Higher production (1,210.4 kg/ha) of prawn was recorded in T_2 than those of T_3 (1,130.46 kg/ha) and T_1 (940.3 kg/ha). The findings obtained from the study revealed that higher growth, survival and production of prawn were found from the ponds treated with super biotic probiotics than the other probiotics treated ponds.

Table 2. Water quality parameters (mean ± SD with range) as recorded from the different treatments ponds during the study period

Parameters	Treatments		
	T_1 (Broadcast all over the ponds mixed with clay)	T_2 (Broadcast mixed with feed))	T_3 (Broadcast all over the ponds)
Water depth (cm)	106.2±26.19 (49.4~139.0)	98.6±22.18 (48.5~130.6)	107.5±24.20 (53.4~141.7)
Temperature (^oC)	30.6±2.21 (28.2~35.8)	30.7±2.18 (28.1~35.6)	30.6±2.20 (28.2~35.6)
Salinity (ppt)	2.56±1.8 (0.0~5.0)	2.56±1.8 (0.0~5.0)	2.56±1.8 (0.0~5.0)
Dissolved oxygen (mg/L)	7.1±2.30 (4.9~12.4)	7.0±1.95 (4.9~9.9)	6.9±2.08 (4.9~10.9)
pH	8.36 (7.8~8.7)	8.40 (7.8~8.8)	8.34 (7.8~8.6)
Transparency (cm)	36.21±5.13 (29.3~44.0)	35.60±5.21 (30.0~44.7)	36.13±6.30 (28.0~46.7)
Total alkalinity (mg/L)	151.10±23.2 (108.3~179.0)	153.9±22.6 (101.3~175.0)	145.2±23.76 (102.7~172.0)
NO_3-N (mg/L)	0.002±0.001 (0.001~0.006)	0.003±0.001 (0.001~0.005)	0.003±0.001 (0.001~0.007)
NH_4-N (mg/L)	0.031±0.014 (0.01~0.07)	0.023±0.012 (0.01~0.05)	0.031±0.014 (0.01~0.05)

Table 3. Mean values (ranges in parenthesis) of soil sediment quality as recorded from the probiotics treated ponds under different treatments during the study period

Parameters	Treatments		
	T_1	T_2	T_3
pH	7.79±0.08 (7.7~8.1)	7.90±0.05 (7.8~8.1)	7.76±0.07 (7.7~8.0)
Salinity (Ec) (dec/m)	12.89±3.75 (8.65~18.12)	12.77±3.63 (8.73~17.96)	13.18±4.21 (8.81~18.15)
Organic matter (%)	2.11±0.20 (2.00~2.29)	2.21±0.11 (2.15~2.40)	2.08±0.17 (2.10~2.23)
Total nitrogen (%)	0.127±0.008 (0.119~0.137)	0.129±0.006 (0.126~0.140)	0.122±0.005 (0.115~0.125)
Phosphorus (µg/g soil)	10.33±2.73 (8.21~14.02)	11.73±3.10 (9.71~15.68)	10.0±2.55 (7.95~13.76)
Potassium (m.eq/100 g soil)	0.93±0.03 (0.90~0.98)	0.98±0.04 (0.94~1.10)	0.89±0.03 (0.87~0.90)

Table 4. Growth, survival and production (mean ± SD) of *Macrobrachium rosenbergii* in different treatments during the culture period

Particulars	Treatments		
	T_1	T_2	T_3
Stocking density (no./m^2)	2.5	2.5	2.5
Stocking size (g)	3.0±1.65	3.0±1.74	3.0±1.80
Harvesting size (g)	55.4±2.71 [c]	70.6±9.52 [a]	62.3±12.10 [b]
Survival (%)	76.9±2.18 [b]	84.0±1.20 [a]	81.9±1.26 [a]
FCR	3.20	2.71	2.92
Production (kg/ha)	940.3±25.41 [b]	1210.4±30.25 [a]	1130.46±35.45 [a]

Figures with different superscript in the same row differ significantly ($p<0.05$)

Investigation into soil-water characteristics of shrimp farms under existing culture practices

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Objectives

- To observe and evaluate the effects of different soil-water parameters under different culture systems
- To identify and assess the concentration and variation of different groups of phytoplankton and zooplankton
- To assess the extent of salt intrusion in soil under different culture systems

Achievements

Water quality parameters: The recorded mean water quality parameters in all experimental ghers throughout the experimental period are shown in Table 1. Temperature is one of the most important physico-chemical parameter, which directly influences the physical, chemical and biological nature of water body. The water temperature at the experimental ghers varied between 25°C~32°C during the experimental period which is conducive to the growth of shrimp. pH in water generally regulates considerably the water chemistry. The pH of water at the experimental ghers varied between 7.9 and 9.4 during the experimental period. Highest pH was observed in extensive culture system than those of improved extensive and semi-intensive culture system. Dissolved oxygen and ammonia were recorded within a range from 4.15~7.1 mg/l and 0~0.2 mg/l, respectively (Table 1) in the experimental ghers, which was found productive. Differences in the variation of temperature, pH, dissolved oxygen and ammonia among the three culture systems were observed.

The maximum salinity was recorded in T_1 (8 ppt), the minimum salinity was observed in T_2 and T_3 (1 ppt) during the experimental period. Average salinity was 5.12±0.74 ppt, 4.83±2.32 ppt and 2.91±1.7 ppt in T_1, T_2 and T_3, respectively. The mean value of alkalinity was the highest in T_3 (176.91±8.87), the lowest in T_1 (151.27±22.02) (Table 1). Significant differences ($P>0.05$) in salinity and alkalinity found among three culture systems.

Table 1. Water quality parameters of different culture systems during the experimental period

Parameters	Extensive (T_1)	Improved extensive (T_2)	Semi-intensive (T_3)
Temperature (^oC)	28.51±2.02	28.95±1.7	29.73±1.61
pH	8.66±0.3	8.52±0.13	8.15±0.14
DO (mg/l)	5.12±0.74	5.45±1.23	5.18±0.37
Salinity (ppt)	6.67±1.29	4.83±2.32	2.91±1.7
Alkalinity (mg/l)	151.27±22.02	172±14.03	176.91±8.87
Ammonia (mg/l)	0.08±0.04	0.083±0.04	0.1±0.06

Soil characteristics: The recorded mean soil parameters in all experimental ghers throughout the experimental period are shown in Table 2. Differences in the variation of different soil parameters among three culture systems were observed.

The value of organic matter was found 3.5±0.89 %, 3.24±0.85 % and 3.95±1.65 % in T_1, T_2 and T_3, respectively. The mean value of pH was the highest in T_1 and T_3 (7.64), the lowest in T_2 (7.58). The mean value of soil salinity was maximum in T_1 (12.96±4.4 ds/m), than those of T_2 (12.07±2.33 ds/m) and T_3 (10.71±3.26 ds/m). The salinity differs from each treatment due to location of the experimental area and the content of salinity in water. The mean value of phosphorus was the highest in T_3 (14.05±7.5 µg/g), than those of T_2 (11.48±3.06µg/g) and T_1 (9.58±3.56 µg/g). Average total nitrogen was recorded 0.19±0.05 %, 0.18±0.04 % and 0.202±0.08 % in T_1, T_2 and T_3, respectively. The maximum potassium was recorded in T_1 (4.49 m.eq./100g), the minimum was observed in T_3 (0.21 m.eq./100g) during the experimental period.

Table 2. Soil characteristics (Mean ±SD with range) of different culture systems

Parameters	Extensive (T_1)	Improved extensive (T_2)	Semi-intensive (T_3)
Org. matt. (%)	3.5±0.89 (1.47-5.36)	3.24±0.85 (1.97-5.78)	3.95±1.65 (1.45-6.64)
pH	7.64±0.29 (7-8.2)	7.58±0.29 (7-8.1)	7.64±0.43 (6.5-8.5)
Salinity (EC) (ds/m)	12.96±4.4 (5.58-24.87)	12.07±2.33 (8.92-17.11)	10.71±3.26 (5.4-19.13)
Phosphorus (µg/g)	9.58±3.56 (4.22-18.33)	11.48±3.06 (6.71-18.22)	14.05±7.5 (5.91-34.5)
Total N_2 (%)	0.19±0.05 (0.085-0.313)	0.18±0.04 (0.114-0.33)	0.202±0.08 (0.084-0.389)
Potassium (m.eq./100g)	0.99±0.56 (0.46-4.49)	0.92±0.23 (0.54-1.33)	0.70±0.29 (0.21-1.3)

Salt intrusion: The salinity of soil was found higher in the experimental areas compare to low saline zone of Mollahat upazila under Bagerhat district. Range of soil salinity was 5.58-24.87 ds/m, 8.92-17.11 ds/m and 5.4-19.13 ds/m in T_1, T_2 and T_3 respectively (Table. 2) compare to (0-12 ds/m) in Mollahat upazila of Bagerhat district. So the content of salt increased into the soil of the experimental areas than Mollahat upazila.

Investigation into shrimp/prawn diseases and their control strategies

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Objectives

- Investigation of emerging diseases
- To identify the causative agent/agents for mass larval mortality and delayed molting issue

Achievements

Investigation into emerging disease being one of the important mandate of Shrimp Research Station, disease team was much concerned about the recent but consequent larval mortality in the prawn hatchery since last 3 years and get involved in detailed investigation of the hazard. Under the programme 9 (nine) renowned hatcheries of Khulna, Satkhira and Bagerhat (Table 1) have been surveyed and sample was collected for further investigation.

Table 1. Hatcheries surveyed under the programme

District	Investigation point
Bagerhat	BRAC hatchery, Jalalabad hatchery. Khanjahan Ali hatchery, BFRI-SRS hatchery
Khulna	Rupsha hatchery, Sundarban hatchery, Khulna hatchery, Modhumoti hatchery
Satkhira	Bismillah hatchery

From the preliminary investigation a group of pathogenic agents** (Table 2 and 3) have been taken into consideration. Further investigation is carrying on inferring the causative agent.

Table 2. Idiopathic disease

Disease	**Symptoms**
IMN Idiopathic muscle necrosis	Whitish colour of muscular tissues becoming necrotic with reddish appearance; affects all life stages
MCD Mid cycle disease	Affects larvae which exhibit lethargy, reduced feeding and growth; spiralling swimming
EED** Exuvia entrapment disease (also named)	Presence of localized deformities, and failure to complete moulting. Quite all stages, and particularly late larval stages

Table 3. Probable causative agents (viral and bacterial)

Disease	**Agents**
Macrobrachiumhepatopancreatic parvovirus (MHPV)	Parvo-like
MacrobrachiumnipponensisReovirus (MnRV)	MnRVReoviridae
White tail disease**	MrNV + XSV
IHHN **	IHHNV Densovirus
Monodonbaculovirus (MBV) infection	MBV Baculovirus
Vibriosis**	*Vibrio fuvialis, V. alginolyticus*and *V. cholerae non-01 , V. harveyi*

Other than the hatchery issue, WSSV infection in the shrimp firm was the second objective of the study. To figure out the optimum condition for WSSV proliferation challenge trial has been carried out following the protocol developed in the study at the year 2011-12. An hundred our post challenge observation was done to understand the mortality pattern of shrimp (Table 4).

Table 4. Mortality pattern of shrimp at different salinity and temperature during post challengeobservation

	Salinity	**2**	**2**	**2**	**6**	**6**	**6**	**10**	**10**	**10**	**Total**	**% of Total**
	Temp	**24**	**28**	**32**	**24**	**28**	**32**	**24**	**28**	**32**		
Hours	**0-5**										0	0%
	6-11		2								2	3%
	12-17	1	2				1				4	5%
	18-23	1	1		1		2			1	6	8%
	24-29	2	3		2	2					9	11%
	30-35		2	3							5	6%
	36-41	3		1				1	2		7	9%
	42-47	2		2							4	5%
	48-53	2		1							3	4%
	54-59	1		1	3	1	3	2	3	1	15	19%
	60-65		2					1			3	4%
	66-71							2			2	3%
	72-77										0	0%
	78-83			1	2	3			2	4	12	15%
	84-89										0	0%
	90-95					1	2		1	1	5	6%
	96-101					2				1	3	4%
	Total	12	12	9	8	9	8	6	8	8	80	100%
	% of Total	15%	15%	11%	10%	11%	10%	8%	10%	10%	100%	

Irrespective to temperature, salinity level 10 gives lowest death, but irrespective to salinity, temperature level 32 gives lowest death (Table 5). Salinity level 10 and temperature level 24 gives the best result among all combinations, but salinity level 2 and temperature level 24 or 28 gives the worst cases. Thus it looks the low-low combination is more devastating, and high salinity and low temperature give the best result. Any other combinations, such as high-high, low-high gives mixed results. In total, salinity 10 and temperature 24 gives the lowest death rate.

Table 5. Mortality pattern at different combination of salinity and temperature level

Temp	**salinity**			**Total**
	2	**6**	**10**	
24	12 (15%)	8 (10%)	6 (8%)	26 (33%)
28	12 (15%)	9 (11%)	8 (10%)	29 (36%)
32	9 (11%)	8 (10%)	8 (10%)	25 (31%)
Total	33 (41%)	25 (31%)	22 (28%)	80 (100%)

Without following any specific trend, the data shows mixed result for different combination of temperature and salinity level. However, low salinity causes to more death in earlier period and high salinity prolong the death, but temperature shows the similar pattern for any ranges. Figure 11-12 gives the data all together. In total, 54-59 hours is the time for most death which followed by 78-83 hour time period. For any single period of time, 78-83 hour time period shows highest death rate at the combination

of salinity level 10 and temperature level 32. Based on the correlation test (Table 6), it is found that salinity shows significant negative correlation with few specific frequency of time period for death of shrimp, such as 12-17, 24-29, 30-35, 42-47, 48-53, and for total hour time period. However, temperature shows significance positive correlation only for 90-95 hour time period.

Table 6. Pearson correlation of Salinity and Temperature at different hours

Hour	Salinity	Sig. (2-tailed) Salinity	Temp	Sig. (2-tailed) Temp	N
0-5	-	-	-	-	-
6-11	-.433	.244	0.000	1.000	9
12-17	-.596^	.090	0.000	1.000	9
18-23	-.204	.598	.204	.598	9
24-29	-.589^	.095	-.471	.200	9
30-35	-.638^	.064	.383	.309	9
36-41	-.132	.735	-.396	.291	9
42-47	-.655^	.056	0.000	1.000	9
48-53	-.612^	.080	-.204	.598	9
54-59	.516	.155	-.129	.741	9
60-65	-.204	.598	-.204	.598	9
66-71	.433	.244	-.433	.244	9
72-77	-	-	-	-	-
78-83	.481	.190	.289	.451	9
84-89	-	-	-	-	-
90-95	.397	.290	.596^	.090	9
96-101	.204	.598	.204	.598	9
full	-.808*	.008	-.073	.851	9

* and ^ indicates significant at 1% and 10% level

Further statistical test for Tuckey test and ANOVA says no significant differences for among the temperature or salinity level between the group and among the group.This study also performed Monte Carlo simulation for probability assessment. The data were tested for two tailed and run 10,000 trails. Based on the simulation, among all of the combination, salinity 10 withtemperature 24 gives the lowest mortalityfrequencyfollowed bythe combination of salinity 2 withtemperature 32 level,and salinity 2 withtemperature 24. At the 95% confidence level the probable value of mortality frequency of timingwould be 2.49, 2.86, and 2.99 respectively, whereas the mean value is 1.51, 1.514, and 1.721. For all of the three cases the minimum frequency of occurring death is zero, but the maximum rate is 3.58, 4.68, and 4.3. Though the maximum value of salinity 2 withtemperature 24 is lower than salinity 2 withtemperature 32 level, their probability of occurring is vice versa.Thus, salinity 10 withtemperature 24 would be the best possible combination to reduce the mortality as well as the timing of death of shrimp.

Assessment of hazardous antibiotics and pesticides in shrimp and fish of Bangladesh

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Objectives

- Detection and determination of insecticides (DDT, heptachlor and dichlorovos) in dry fish at winter and rainy season
- To investigate naturally occurring antibiotic metabolites in shrimp/prawn in Khulna and Bagerhat region.

Achievements

Investigation of naturally occurring antibiotic metabolites in shrimp/prawn

Shrimp is one of the most important export products which contribute an important portion for earning foreign currency of Bangladesh. Now-a-days various hazardous antibiotics and pesticides are used for its production and processing which causes failure of achievement the international quality of the product. On the other hand dry fish becoming an important part of our domestic fish consumption and also earning foreign currency by export. The experiment was conducted for identification and quantification of banned antibiotics as well as Nitrofuran and chloramphenicol metabolites in shrimp which are applied by farmers for controlling bacterial diseases during their rearing periods. For detection and quantification of Nitrofuran metabolites and chloramphenicol total 33 samples of shrimp were analyzed. Samples were collected from Rampal, Mongla and Bagerhat sadar upazilla of Bagerhat district. Total 5 samples were positive for Nitrofuran metabolites of which 4 and 1 sample were respectively from Bagerhat sadar and Mongla upazilla. All of the positive sample's concentration were in the acceptable range one (4.56ppb) from bagerhat sadar upazilla. No chloramphenicol was detected in any of samples.

Table 1. Available nitrofurans metabolites and chloramphenicols from shrimp farms

Treatments	No of samples analyzed	No. of detection	Antibiotics and its metabolites					Maximum level (ppb)
			AOZ (ppb)	AMOZ (ppb)	AHD (ppb)	SEM (ppb)	CAP	
T_1(Rampal)	11	_	ND	ND	ND	ND	ND	AHD, AMOZ, AOZ, SEM = 1ppb (Action level=0.5 ppb)
T_2(Mongla)	11	1	ND	ND	ND	0.202	ND	
T_3(Bagerhat)	11	4	0.95 0.158	2.01	ND	ND 4.56 0.934	ND	

AOZ-Furazolidone, AMOZ-Furaltadone , AHD- Nitrofurantoin, SEM-Nitrofurazone,*ND-Not Detected

Determination of insecticide residues in dry fish

Dry fish commonly known as SUTKI (in Bengali) is low cost dietary protein source and is used as a substitute of fish at the scarcity of fresh fish. About 15% of fishes are cured for mass people consumption at the scarcity of fresh fishes in Bangladesh. It is also a very favorite food item among Bangladeshi people and has a very good market demand besides fish and seafood products. Sundry is a common practice by the dry fish producing industries in the remote coastal isolated islands and in inland where

chilling and freezing facilities are lacking. Dried fish products are generally stored in a dump warehouse either at the site or nearby coastal towns. During the storage period, sometimes fishers use insecticides to prevent dry fishes from insect infestation whatever they are getting within their reach. For protection of dry fish from infestation, fishermen and drier use mixture of insecticides. However, these insecticides are health hazard both for users and for consumers and have long- term potential health risk. In the present study, we have considered only marine fishes and shrimp. Therefore, there is very less probability of environmental bioaccumulation of DDT, Dichlorovos and Heptachlor in these fish species. By physical inspection of the sampling sites (Chittagong, Najirattek, Khoruskhul, Khulna and Cox's Bazar etc.) where the fishes are drying and processing by the anglers, we have observed that some anglers used some poisons (insecticides) without label or label with improper instruction. Samples were collected from Khulna New market (Station 1), Moilapota (Station 2) and Khalispur (Station 3), Najirartek (Station 4), Khuruskhul (Station 5), Borobazar (Station 6) Chittagong Asadgonj (Station 7), Reajuddin Bazar (Station 8), Newmarket (Station 9). Four commercially available species of dry fish species namely Ribbon fish (*Lepturacanthus savala*), Bobay duck (*Harpodon nehereus*), Chinese pomfret (*Pampus chinensis*) and Shrimp (Mixed species) were collected from each market. These dry fish species were selected for this experiment due to their greater market demand and availability. Total numbers of sample were 36. The control fishes samples (not used any insecticides for drying fishes) were collected from khattoli village which is known as pesticides free dried fish village located in kaptai upazilla under Rangamati district.

Table 2. Pesticides in dried fish and their concentration

Location	Insecticides		Species				
			Bombyduck (loittya)	Ribbon fish (Churi)	Chinese pomfret (Rupchanda)	Prawn (Chingri)	Maximum acceptable level (µg/kg)
Cox'sbazar	Dichlorovos	CX-1	ND	ND	31.561	ND	Dichlorovos-5000 Heptachlor-300 DDT-5000
		CX-2	139.660	223.288	415.277	ND	
		CX-3	896.284	2027.115	699.827	162.296	
	Heptachlor	CX-1	51.728	66.152	31.688	27.437	
		CX-2	119.684	74.586	115.161	60.210	
		CX-3	71.236	ND	548.69	26.365	
	DDT	CX-1	29.611	20.214	38.805	15.527	
		CX-2	14.216	58.252	45.369	56.094	
		CX-3	262.185	209.185	58.365	161.739	
Chittagong	Dichlorovos	CH-1	149.577	33.914	222.881	111.834	
		CH-2	ND	9.670	ND	3.56	
		CH-3	ND	ND	ND	ND	
	Heptachlor	CH-1	ND	34.464	17.185	88.174	
		CH-2	4.771	46.318	40.944	56.03	
		CH-3	5.464	8.369	318.206	2.306	
	DDT	CH-1	17.286	5.646	27.058	18.282	
		CH-2	18.200	16.744	51.140	79.056	
		CH-3	874.966	140.398	879.365	3.779	
Khulna	Dichlorovos	Kh-1	ND	3.821	2.156	000	
		Kh-2	5.67	7.265	89.360	56.021	
		Kh-3	ND	ND	ND	ND	
	Heptachlor	Kh-1	ND	ND	56.235	ND	
		Kh-2	23.256	105.563	215.630	562.214	
		Kh-3	0.401	ND	2.510	0.900	
	DDT	Kh-1	ND	ND	ND	ND	
		Kh-2	ND	256.23	58.365	586.356	
		Kh-3	13.10	3.612	250.320	21.6	

ND-Not detected, µg/Kg-ppb, FDA &EPA Safety Levels in regulation and Guidance, CX1-Najirartek, CX2-Khoruskhul, CX3-Borobazar, CH1-Asadgonj, CH2-RiazuddinBazar, CH3-Bohoddarhat, KH1-Newmarket, KH2-Moylapota, KH3-Khalispur

A little studies of DDT in the dry fish of Bangladesh have been carried out. The present study have been undertaken in order to provide the preliminary information on the concentration of DDT in dry fish and to investigate their contamination level. The results obtained from the samples from nine different sampling sites are alarming for the consumers of Bangladesh. Most of the samples contained DDT is shown in Table 1. The mean concentration of DDT in the samples of Bombay duck collected from 9 Station was ranged from13.7 - 874.35 ppb (except for Station 1, 2 and 4).

Table 3. Concentration of DDT (in ppb) in dry fish samples collected from nine different sampling sites (Mean concentration ± Standard deviation)

Dry fish	Station-1 (Khulna)	Station-2 (Moilapota)	Station-3 (Khalispur)	Station-4 (Nagirartek)	Station-5 (Khuruskhul)	Station-6 (Borobazar)	Station-7 (Asadgonj)	Station-8 (Reajuddin Bazar)	Station-9 (Chittagong Market)
Bombay duck	ND	ND	13.7±0.58	ND	14.09±0.12	261.89±0.52	17.42±0.61	874.35±0.97	17.99±0.67
Chinese pomfret	2.81±0.31	58.01±0.74	250.47±1.0	38.27±0.92	45.17±0.21	58.32±0.19	26.27±0.72	877.82±1.5	50.95±0.34
Ribbon fish	ND	253.68±2.45	3.73±0.31	20.62±0.77	58.24±0.08	209.13±0.15	7.19±1.49	141.43±1.1	16.28±0.43
Shrimp	ND	585.97±0.62	21.39±0.35	15.42±0.26	56.16±0.07	161.67±0.13	20.84±2.67	4.27±0.49	78.78±0.54

*ND=Not detected Value= mean of triplicate analysis ± sd

All samples of Chinese Pomfret collected from 9 different stations contained DDT residues were ranged from 2.81-877.82 ppb respectively. The mean concentration of Ribbon fish from the sampling stations were ranged from 3.73-253.68 ppb (except for station-1). The range of DDT use in shrimp sp. was ranged from 4.27-585.97 ppb respectively. The range of DDT use in all samples was 2.81-874.35 ppb. Among the samples (except station 1, 2, 4 for Bombay duck and station - 1 for both Ribbon fish and Shrimp sp.) the DDT was found comparatively lowest in chinese pomfret from station-1 and highest in bombay duck from station - 8. The comparisons of DDT concentration of different station among the various species are presented in the Fig. 1.

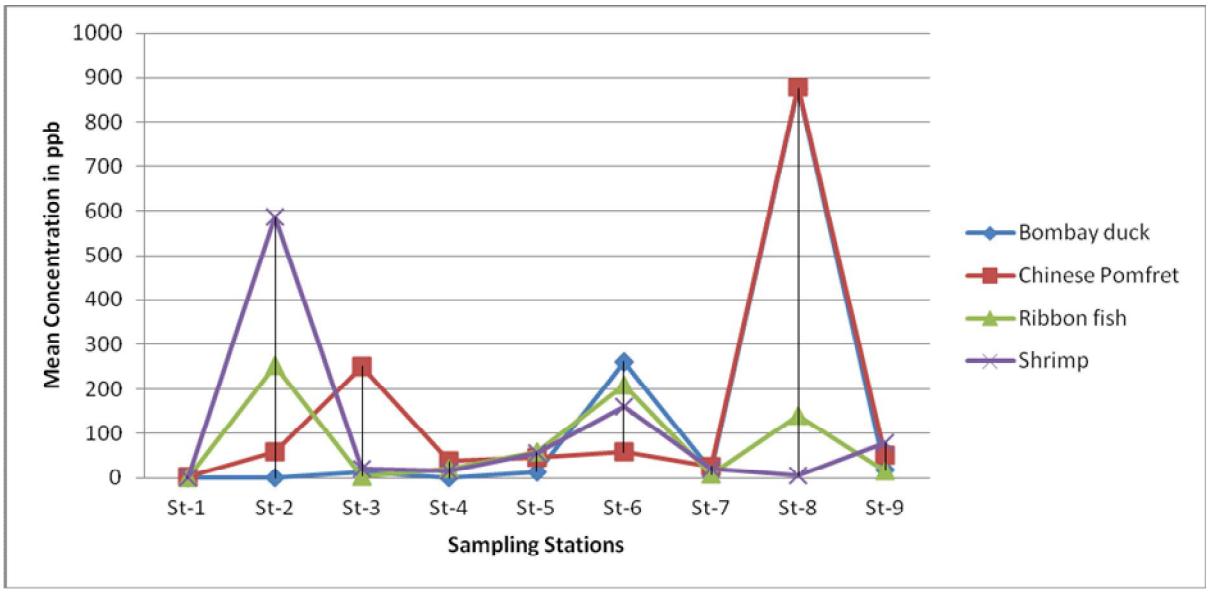

Fig. 1. Comparisons of DDT concentration among different types of dry fishes collected from nine sampling sites.

Marine Fisheries & Technology Station

Location-wise seasonal catch assessment of shark and trawl fisheries in Bangladesh

Researches: Ehsanul Karim, SO
Md. Shahzad Kuli Khan, SO
Md. Mozammel Haque, SO
Dr. Md. Enamul Hoq, CSO

Objectives

- Monthly location-wise catch assessment of shark fisheries in Bangladesh
- Assessment of abundance and species diversities of sharks, skates and rays
- Time series catch assessment for each of the fishing grounds for each type of trawlers
- Improvement of the data recording of the trawl catch by motivation and hands-on training
- Formulation of the future data recording, resources assessment and management strategies.

Achievement

Shark fishery in Bangladesh is not a target fishery; its availability is incidental as by-catch but it has a great importance to the marine ecosystem. So, BFRI came forward by realizing its necessity and made an attempt to conduct the studies on the biodiversity and catch assessment of shark fisheries in Bangladesh starting from the year 2010-11. Major shark landing sites throughout the coastal belt of Bangladesh including Cox's Bazar, Chittagong, Barisal, Pirojpur, Borguna, Pathorghata, Patuakhali, Kuakata, Bagerhat and Dubla Islands were visited fortnightly or monthly considering lunar cycle and catch and landing information i.e. catch in weight and size in length were collected using four types of data sheets. Sample were identified and analyzed in landing station & laboratory. Most of the samples were preserved in specimen jar using 10% formalin and shelved in the Museum at MFTS, Cox's Bazar. Collected other information will be assessed to evaluate the lunar and seasonal impact. Finally, the annual catch for each of the species will be assessed for each of the landing sites. The systemic arrangement and other information about the species listed were done with the help of different working papers, journals and books - Mustafa M.G.(1996), Rahman A.K.A(1995), Verma P.S (1994), Ahmed & Sarkar (1984), Hussain (1970), Field Guide to Fin fishes of Sundarban by Huda M.S. and Haque M.E. (2003), Studies of the chondrichthyes fauna – the Journal of Noami, vol-5, No-1 and 2, 1988, Management of shark fisheries in to Indian Coastal State, F. Hanfee-1988 and others available literatures consulted and the data were compiled and analyzed both manually and with the help of MS Excel program.

Landing analysis

The collected data which was starting from July, 2012 to June, 2013, a total of 1009.2mt of shark species were landed in all data collecting areas. Out of the total landings, true sharks contributed about 183.5mt, skates contributed about 84.1mt and the remaining 741.6mt contributed by rays (Table 1). In percentage compositions, the rays contributed the major bulk of the total landings (73.46%) followed by true sharks (18.14%) and the remaining 8.3% was contributed by the skates. It was also observed that from landing data (Table 2), highest landing of sharks found in Cox'sBazar area (35%) followed by Chittagong, Dubla Island, Kuakata and Barisal area.

Table 1. Total landings and groupwise percentage

Groups	Total landings	Contribution (%)
Sharks	183.5	18.14%
Skates	84.1	8.3%
Rays	741.6	73.46%

Table 2. Estimation of total stock and standing crop of sharks, skates and rays

Groups	Yield (Y)	Total mortality (Z)	Natural mortality(M)	Fishing mortality (F)	Exploitation rate (E)	Total stock P=Y/E(mt)	Standing crop P'=Y/F(mt)
Sharks	183.5	4.87	3.83	1.04	0.56	327.7	176.44
Skates	84.1	3.22	2.29	0.93	0.24	350.41	90.43
Rays	741.6	1.64	0.92	0.72	0.32	2317.5	1030.0



Gears and crafts

Sharks are mainly caught by artisanal fishery. In all data collecting area it was observed that among the all elasmobranches, true sharks are mainly caught by shark net (modified gill net) followed by hooks & lines and rays are mainly caught by hooks & lines or longlines but the major bulk composition of rays Hook & line or Long lines contributed most of the catches followed by Shark net and SBN. But in Barisal region max. are caught by Gillnet (Lakkha jal). These gears are used onboard of a wooden mechanized boat and sharks harvested mostly as by-catch.

Catch per unit effort (CPUE): The average overall CPUE including all species and sharks was 254.25 kg/boat/day, whereas in case of elasmobranch only it was 19.54 kg/boat/day. On the other hand, catch is higher in the month of Dec.-March in relation with effort. The highest CPUE was found in January-March quarter for both cases. Finally seasonal abundance of elasmobranchs were found maximum in the January-March quarter and it was above 35% of the total catch.

Estimation of stock: In the year of 2012-13, from the yield (Y) and exploitation rate (E), the total stock of Sharks, skates and rays were calculated as 327.6t, 350.41t and 2317.5t respectively. From the yield (Y) and fishing mortality (F), the standing crop (P') of sharks, skates and rays were estimated as 176.44, 90.43t and 1030.0t respectively. In case of sharks yield was higher than the standing crop, it is felt that minimize the fishing effort would have resulted in maintaining optimum production. In case of skates and rays, as the yield of these groups below the standing crop, it is felt that marginally higher effort would have resulted in higher production of the species during 2012-13.

Length-weight relationship (LWR): The parameters of the length-weight relationships for the 24 fish species (n=5669) are shown in Table 03 and species those were represented by few individuals (n<10) i.e. whale shark and bull shark were excluded from the analysis. Information on the kind of growth (isometric

or allometric) of each species is provided in Table 3. The parameter *b* ranged from 2.71 for Dog shark (*Scoliodon laticaudus*) to 3.50 (Table 03) for Sharp nose Guitar fish (*Rhyncobatus granulatus*) with a mean value of 3.138 ± 0.02 and the median value ranged between 3.06 and 3.34.

Table 3. Length-Weight relationship and regression parameters of sharks, skates and rays

Species name	Nos.	Length (cm)			Weight (g)		Regression parameters				Growth
	n	*Min*	*Max*	*Type*	*Min*	*Max*	*a*	*b*	*S.E(b)*	r^2	
Sharks											
Dog shark	1560	22.0	76.0	TL	139.0	4356.0	0.0095	2.710	0.016	0.956	N
Tiger shark	22	30.0	46.0	TL	620.0	5307.0	0.0124	3.164	0.151	0.956	I
Silky shark	57	34.0	94.0	TL	370.0	7980.0	0.0003	3.043	0.102	0.959	I
Milk shark	158	32.0	103.0	TL	181.0	9550.0	0.0006	3.252	0.050	0.965	P
Hammer head shark	364	28.0	162.0	TL	242.0	9890.0	0.0025	2.992	0.043	0.948	N
Spear tooth shark	32	52.0	130.0	TL	700.0	15960.0	0.0010	3.391	0.074	0.986	P
Black shark	235	39.0	112.0	TL	604.0	11200.0	0.0050	2.951	0.026	0.983	N
Zebra shark	13	53.0	93.0	TL	539.0	4850.0	0.0016	3.232	0.256	0.935	P
Saw shark	19	65.0	59.0	TL	706.0	16780.0	0.0177	3.015	0.109	0.955	I
Skates											
White spotted guitar fish	481	61.0	111.0	TL	780.0	35980.0	0.0005	3.480	0.054	0.916	P
Sharp nose guitar fish	419	36.0	104.0	TL	130.0	31290.0	0.0004	3.500	0.050	0.957	P
Rays											
Sharp snout sting ray	354	24.5	32.0	FL	951.0	17643.0	0.0158	3.060	0.051	0.910	I
Kite ray	98	21.0	56.0	FL	845.0	12406.0	0.0172	3.027	0.005	0.986	I
Cow tail stingray	184	20.0	66.0	FL	861.0	26020.0	0.0388	2.856	0.010	0.940	P
Gangetic sting ray	170	30.0	80.0	FL	205.0	16520.0	0.0043	3.166	0.035	0.980	P
Dwarf sting ray	650	25.0	69.0	FL	239.0	14120.0	0.0085	3.069	0.019	0.990	I
Leopard whipray/Haush	117	48.0	98.0	FL	1818.0	13670.0	0.0453	2.778	0.050	0.964	N
Bleeker's whipray	178	13.0	48.0	FL	303.0	21060.0	0.0115	3.075	0.015	0.972	I
Long tail butterfly ray	86	37.0	89.0	FL	270.0	5110.0	0.0058	3.022	0.041	0.930	I
Short tail butterfly ray	67	23.0	53.0	FL	263.0	2192.0	0.0046	3.284	0.043	0.972	P
White spotted whip ray /Eagle ray	166	17.0	46.0	FL	891.0	19230.0	0.0121	3.007	0.027	0.971	I
Brown electric ray/numb fish	142	24.5	74.0	FL	438.0	92070.0	0.0003	3.315	0.099	0.963	P
Black spotted electric ray	91	18.0	53.0	FL	469.0	8753.0	0.0197	2.841	0.039	0.890	N
Devil ray /Bat ray	47	34.0	60.0	FL	620.0	11120.0	0.0084	3.172	0.111	0.937	P

n= sample size; min. and max. = minimum and maximum length (cm) and weight (g) recorded; TL = total length and FL= fork length; *a* and *b* = parameters of the weight–length relationship: $W = aL^b$; *S.E.* = standard error of *b*; r^2 = the coefficient of determination, Growth (I=isometry, P= positive allometry, N= negative allometry).

The coefficient of determination (r^2) ranged from 0.890 for Black spotted electric ray/numbfish *(Narcine teimlei)* to 0.990 for Dwarf Stingray (*Himuntura walga*). Sixteen species had r^2 values between 0.95 and 0.98 while seven r^2 values were <0.95. All regression values were highly significant ($p<0.001$). Ten species showed positive allometric growth, five showed negative allometric growth and nine isometric growths (Table 4). It indicates the different growth status of different species in different months.

Trawl catch data of fish/shrimp/squid

Simultaneously, the trawl catch data compilation (Table 4) and analysis are starting in this year which is collected from Marine Unit, DoF, Chittagong. Separate analysis was conducted for each type of the trawlers, such as Shrimp Trawlers, White Fish Trawlers, Mid-water Trawlers, Demersal Trawlers, Purse Seiner and Squid Jigger. In the following year, catch per unit effort (CPUE) will be estimated in terms of catch/trawler/hour for all fishing days of the year for each species/group of fish/shrimp. Then the CPUE will be reassessed for seasonal variations and for the impacts of lunar cycle. Finally, catch trends and stock status for each of the species/group of fish will be analyzed statistically and compared with the information available in TrawlBase, the database of the trawl catch of the Bay of Bengal.

Table 4. Catch data of fish/shrimp/squid by trawling

Sl. No	Types of trawler	Active trawler	Average fishing days/trawler/year	Total Catch (mt)			Daily Fishing Effort (kg/day/trawler)		
				Fish	Shrimp	Squid	Fish	Shrimp	Squid
1	Shrimp	33	125	1785.53	2131.62	0	433.80	517.89	0
2	Fish	64	130	41361.32	48.43	0	4986.29	5.84	0
3	Trial	09	119	4878.87	0.55	0	4555.44	0.51	0
4	Modern fishing	10	121	5548.81	3.42	0	4612.48	2.84	0
5	Demersal	11	151	10488.75	11.25	0	6314.72	6.77	0
6	Mid water	35	93	7110.54	16.41	0	2191.23	5.06	0
7	Squid jigger	3	205	0	0	22.04	0	0	393.66
8	Perch seiner	0	0	0	0		0	0	0
	Total	165		71173.82	2211.68	22.04			

Development of culture technique and utilization of seaweed

Researchers: Mohammed Ashraful Haque, SO
Md. Shahzad Kuli Khan, SO
Md. Mozzammel Hoque, SO
Dr. Md. Enamul Hoq, CSO

Objectives

- Development of seaweed culture technique in Bangladesh
- Investigate the nutritious value of seaweeds.
- Utilization of seaweeds by producing value added products.

Achievement

Seaweed abundance study

Abundance of seaweed observed in the following places during November 2012 to April 2013. Comparatively more seaweed abundance was found in Western part, Southern tip of Cheradip and Eastern part (surrounding the Coast-guard/Navy point) in Saint Martin Island. Seaweed was found in the following places in outside of Saint Martin.

- ✓ Shilkhali/Shaplapur coast, Teknaf, Cox's Bazar
- ✓ Jailla para, Shahparirdip,Teknaf, Cox's Bazar
- ✓ Bakkhali river estuary, Nuniarchara, Cox's Bazar

Seaweed sample collection & identification

Seaweeds were collected from the Saint Martin's Island during full moon and new moon from November 2012 to March 2013. About 45 seaweed species collected and preserved at BFRI, MFTS laboratory for further study. Identified seaweed species are:

1. *Hypnea cornuta*
2. *Sargassum crassifolium*
3. *Sargassum cristaerfolium*
4. *Caularpa racemosa*
5. *Caularpa microphysa*
6. *Caularpa taxiifolia*
7. *Padina fraseri*
8. *Enteromorpha intestinalis*
9. *Colpomenia sinuosa*
10. *Hydroclathrus clathratus*
11. *Dictyota dichotoma*
12. *Colpomenia perigrina*
13. *Peyssonellia* sp.
14. *Messophyllum* sp.
15. *Callophyllis* sp.
16. *Laurrencia* sp.
17. *Helimeda* sp.
18. *Ulva* sp.
19. *Gracilaria* sp.
20. *Porphyra* sp.

Seaweed culture technology development

Within collected and identified seaweed species, economically important *Hypnea cornuta*, *Caularpa racemosa*, *Sargassum* sp. and *Pudina fraseri* were selected for culture experiment in Saint martin island. Seaweed seeds (small segment of live seaweed) were collected from different areas of Saint Martin Island and attached with coconut rope nets with red cotton fiber during extreme low-tide period. Density of seaweed seed were 25-28 seed/m^2. Culture experiment site was Coast Guard point, Saint Martin Island, Teknaf, Cox's Bazar. Date of culture experiment set up was 14 January, 2013 and closed at last week of April, 2013.

Horizontal net: Net design and size: Square- 2m× 2m. Net material was coconut fiber rope. Four corners of the nets were tied with rocks. Three (03) replications were trialed for each species.

Vertical net: Net materials used: Coconut rope, Styrofoam float and earthen weight. Size and structure of net:

- ➢ Rectangular: 6m ×1m. Sinker - earthen weight. Upper corner of the nets were tied with rocks.
- ➢ Rope line with half circle: Height 1.45m, Length: 6 m, Sinker- earthen weight. 3 replications for each species.

Production of seaweed: After 15 days of transplantation of seaweed seeds and cultured seaweed species were partially harvested and observed new buds were grown. After then partial harvesting were done fortnightly. The growth of seaweed can be said as an example of geometric progression, where the weight or size of seaweed increases with common multiplier or rate. The species is particularly tenacious with fast growth rates, high reproductive rates and an ability to spread vegetatively through micro propagation. Seaweed biomass was evaluated for each species separately. The highest weight specific growth rate was found in *Sargassum sp*. from 5.5% to 5.9% per day, followed *Caularpa racemosa* from 4.9%to 5.4% per day, *Padina fraseri* from 3.2% to 3.8% and the lowest weight specific growth rate in *Hypnea cornuta* from 0.52% to 0.80% respectively.

Proximate/Nutritional analysis study

To assess the nutritional qualities of seaweeds, the proximate compositions eg. Protein%, Lipid%, Carbohydrate%, Moisture%, Ash% and Fiber% of cultured 04 seaweed species were analyzed. Proximate compositions of cultured seaweed species is shown in Table 1.

Table 1. Proximate compositions of four cultured seaweed species

Seaweed	Protein %	Lipid %	Moisture %	Ash %	Fiber %	Carbohydrate %
Hypnea cornuta	12.65	0.28	24.45	11.40	2.02	49.20
Caulerpa racemosa	15.66	0.27	24.72	14.58	1.94	42.83
Sargassum sp.	7.73	0.27	18.58	13.41	2.65	57.36
Pudina fraseri	12.47	0.23	25.16	12.90	3.51	45.73

Seaweed ecology study

Data of different environmental parameters were studied and recorded every month beside the seaweed collection which was shown in Table 2.

Table 2. Water quality parameters of seaweed culture areas in Saint Martin Island

Month	Location	Tide level	Salinity (ppt)	pH	DO (mg/l)	Water Temp.
Dec. 2012	Abokash point	Low tide	32	8.5	6	25^0 c
	Galachipa	Low tide	32	8.0	7	25^0 c
	Coast Guard point	Low tide	31	8.5	7	25^0 c
	Cheradip	Low tide	31	8.5	7	25^0 c
Jan. 2013	Coast Guard point	Low tide	32	8.0	7	26^0 c
Feb. 2013	Coast Guard point	Low tide	32	8.5	6	28^0 c
Mar. 2013	Coast Guard point	Low tide	32	8.5	7	29^0 c
April 2013	Coast Guard point	Low tide	32	8.2	7	29^0 c

Seaweed product development study

After cleaning, fresh *Caularpa racemosa* was used as a salad ingredients. To get table form of raw dried seaweed repeated screening and washing were done for isolating the non-target seaweed species and to clean the sand and other unwanted particles. Processed *Hypnea* and *Padina* were used as Salad. Seaweed (*Hypnea)* powder was used in Soup, Pizza and Cake etc. These food products were consumed by the researchers and other peoples. The flavors and tests of these seaweed food products were good.

Development of broods for mass seed production of striped mullet, *Mugil cephalus*

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Md. Shahzad Kuli Khan, SO

Objectives

- Examination of reproductive biology of the striped mullet
- Selection of suitable diet(s) for the brood stock of striped mullet
- Development of brood stocks for induced breeding of striped mullet.

Achievement

Brood rearing in on-campus saline ponds

A total of 100 numbers of sub-adult/adult striped mullet weighing 400g each in average have been rearing in two saline water ponds of Marine Fisheries & Technology Station, Cox's Bazar. This rearing was a continuation of the brood rearing started with the adjusted salinity by using brine up to 12-15ppt and hopefully the fish will grow up to mature adult by the end of this year.

The salinity is being maintained by using brine/crude salt upto 7-8ppt, before the availability of seawater which is brought by truck from the nearby sea shore. Salinity was maintained to 12-15ppt after adding seawater. Two types of feeds used in two ponds, i.e. (1) Handmade containing 30-32% Protein and (2) Pellet Feed (Niribili Tilapia Feed having 30% Protein), both feed fed @ 3% of their body weight. Paddle wheels were used for oxygenation and mixing the water time to time to keep the water quality up to the mark. Fluctuations of temperature, dissolved oxygen and pH were within the optimum limits of striped mullet's rearing condition. The fish looks very healthy and hopefully it will show the external features of sexual maturity in the coming December, 2013 to February, 2014. Collection of wild live broods are going on and also PG collection & gonadal study of Mullets were done after collecting live/dead mullets from wild. Pond reared mullets were fed farm made and pellet feeds and growth data were recorded (Table 1).

Table 1. Growth of Mullets in pond fed with home made and pellet feeds

Observation	Pond-1 (Farm made)	Pond-2 (Pellet)
Initial stocking of Mullets (no)	50	50
Initial average weight of Mullets(g)	400	450
Final no. of Mullets	26	32
Final av. weight of Mullets (g)	1040	1215
FCR	3.4	3.3

Gonadal development of Mullets

In case of gonadal development study, Mullets of body weight 850-2200g collected from MFTS ponds were dissected, kept into the vial with 10% formalin and then sent it to the Histology laboratory of Fisheries Faculty, BAU or Marine Fisheries Institute, Chittagong University. After a total of 3 years rearing some significant gonadal development was noticed (Table 02).

Table 2. Observation of dissected Mullets of three years old for gonadal development

Weight range of Mullets (g)	**Pond-1 (**987-1130)	**Pond-2 (**1085-1340)
Condition of fish	Healthy	Healthy
Intestinal fat	Not so much	Not so much
Ovary	Developed 30-40% of fish	Developed 40-50 % of fish
Testis	Some development in Jan-Feb (winter season)	Some development in Jan-Feb (winter season)
Eggs	Exists and absorbed in March,13	Exists and absorbed in March,13
Semen	Slightly exists and absorbed in March,13	Slightly exists and absorbed in March,13

Length-Weight data and gonadal study (histological test) observation of wild and pond cultured striped mullets (*Mugil cephalus*) for brood development were recorded (Table 3).

Table 3. Reproductive biology of pond reared Mullets

Month	**Total wt**	**Total L**	**Gonad wt**	**GSI value**	**Maturity (%) & stages**
Dec,12	1.63 Kg	60 cm	64 gm	3.92	Developing
Jan,13	1.75 Kg	64 cm	85 gm	4.86	Yolk granule stage
Feb,13	2.2 Kg	70 cm	181 gm	8.30	Close to mature yolk stage (80%)

Previtellogenia oocytes (>80µm) and some evidence of atresia indicates MFTS-Pond cultured Mullets were 80-90% matured.

Fig. 1. Gonadal development of Mullets in the month of January, 2013.

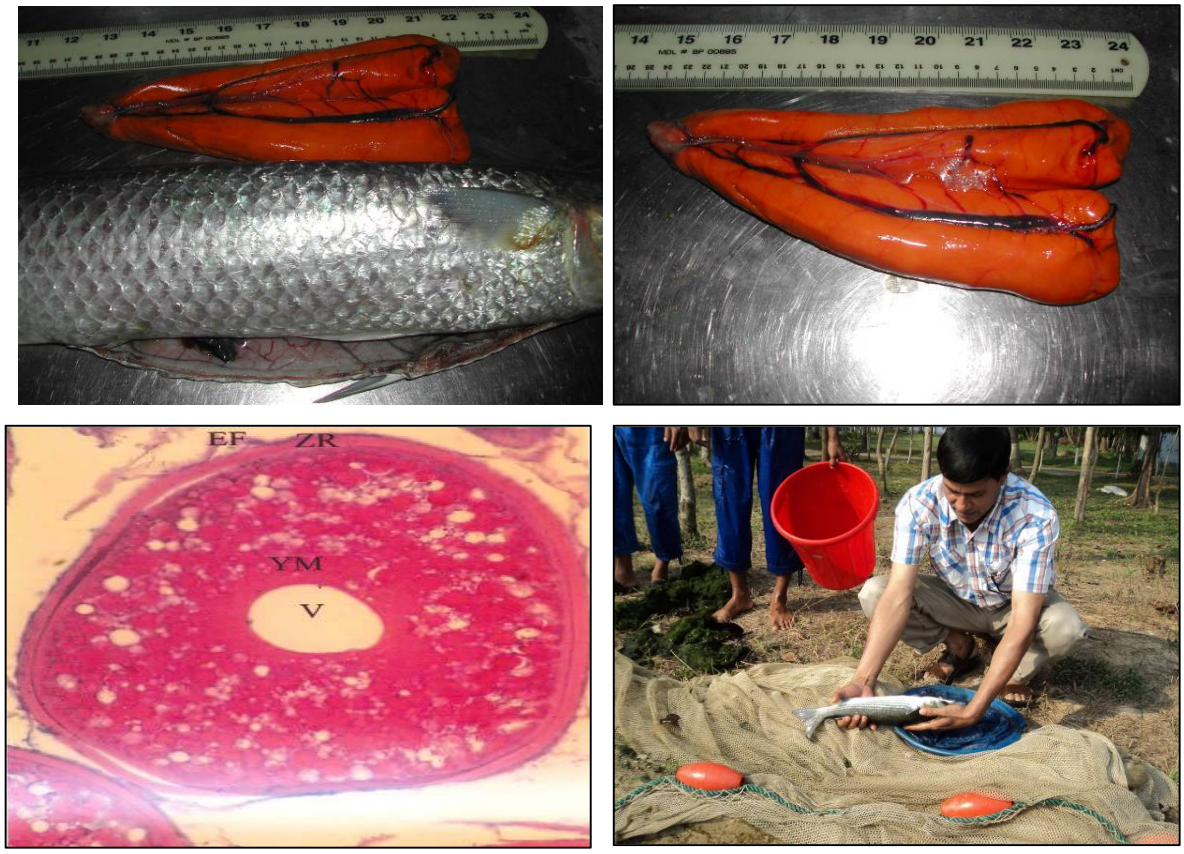

Fig. 2. Gonadal development of Mullets in the month of February, 2013.

So, from the above result, it is clear that striped mullets are winter breeder; early winter to late winter is it's high time of breeding. From the histological study it was observed that the broods were in the nearly final stage of maturity. Attempt was made for induced breeding of pond reared brood but response less because of not fully maturation of mullets.

Factors causing emerging shrimp diseases and development of their health management strategies

Researchers: Dr. Md. Zahirul Haque, SSO
Mohammed Ashraful Haque, SO
Md. Mozzammel Hoque, SO

Objectives

- Assessment of the present status and seasonal variation of WSSV infection in shrimp using PCR technique.
- Diagnosis of bacterial diseases of shrimps in hatchery.

Achievement

Detection of WSSV in tiger shrimp brood stocks, nauplii and post larvae

Tiger shrimp brood (a tip of pleopod, after spawning), nauplii, shrimp larvae (Early PL, Mid PL and PL-15) were collected from three hatcheries. Tiger shrimp DNA was extracted according to the protocol of IQ 2000 WSSV detection and prevention system. For WSSV detection nested PCR method was used following the PCR protocol of IQ 2000 WSSV detection and prevention system at the laboratory of Marine Fisheries and Technology Station, Cox's Bazar.

WSSV status in tiger shrimp brood in hatcheries of Cox's Bazar

A total number of 79 samples of Tiger shrimp brood were tested in PCR laboratory of Marine Fisheries and Technology Station, Cox's Bazar. The PCR tested result are in Table 1.

Table 1. PCR test for WSSV infection of brood tiger shrimp

Month	No. of brood	Positive	Negative	% of Positive
January, 2013	10	6	4	60
February, 2013	12	8	4	66.67
March, 2013	13	8	5	61.53
April 2013	44	36	8	80.0
Total	79	58	21	73.4

From the data of PCR test, it was found that in case of tiger shrimp brood highest WSSV prevalence was found 80% in the month of April, 2013 and lowest WSSV prevalence was found 60% in the month of January, 2013. Average WSSV infection in brood tiger shrimp was found 73.4%.

WSSV status in tiger shrimp nauplii in hatcheries of Cox's Bazar

A total number of 188 samples of Tiger shrimp nauplii were tested in PCR laboratory of Marine Fisheries and Technology Station, Cox's Bazar. The PCR tested results are in Table 2.

Table 2. PCR test for WSSV infection in tiger shrimp nauplii, produced in hatchery

Month	No. of nauplii test	Positive	Negative	% of Positive
January, 2013	25	9	16	36
February, 2013	27	10	17	37
March, 2013	33	13	20	39.4
April 2013	103	57	46	55.3
Total	188	89	99	47.3

From the data of nauplii, it was found that highest WSSV prevalence was 55.3% in the months of April 2013 and lowest was 36% in the month of January, 2013. Average WSSV infection in tiger shrimp nauplii was found 47.3%.

WSSV status in tiger shrimp post larvae in hatcheries of Cox's Bazar

A total number of 188 samples of Tiger shrimp post larvae were tested in PCR laboratory of Marine Fisheries and Technology Station, Cox's Bazar. The PCR tested results are in Table 3.

Table 3. PCR test for WSSV infection in tiger shrimp post larvae, produced in hatchery

Month	No. of PL test	Positive	Negative	% of Positive
January, 2013	17	-	17	0
February, 2013	14	-	14	0
March, 2013	50	-	50	0
April 2013	54	12	42	22.2
Total	135	12	123	8.9

From the PCR tested data of PL, it was found that highest WSSV prevalence was 22.2% in the month of April, 2013 and lowest was 0% in the month of January, February and March 2013. Average WSSV infection in tiger shrimp post larvaei was found 8.9%.

Bacterial study: Samples of tiger shrimp post larvae and waters were collected from two hatcheries and plated onto agar plates containing thiosulphate citrate bile salt (TCBS) agar medium. Average Vibrios count was between 2.9 x 10^2 to 1.2 x 10^3 cfu/ml. The average count of green colonies (produced by luminous bacteria) was ranged between 5.1 x 10^1 to 5.8 x 10^2 cfu/ml. The study revealed that the Vibrios densities was below lethal level as mentioned Vibrios lethal dose for *Penaeus monodon* post larvae was 2.6 x 10^3 cfu/ml.

Factors causing emergent fish/shrimp diseases study: The physico-chemical parameters were observed in shrimp ghers fortnightly for four months from March 2013 to June 2013 and data were recorded. It observed that shrimp in ghers become susceptible to disease with fluctuation of temperature, sudden fall of salinity due to freshwater runoff and malnutrition etc. Acidic soil $p^{H/}$/acid sulphate soil is also a factor causing emerging shrimp disease in hilly area ghers. Temperature range of shrimp ghers was 27^0 -32^0 c, salinity varies from 4-30 ppt, $p^{H/}$ range was 5.5-8.5.

Improvement of dried fish production system by using BFRI Fish Dryer

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Objectives

- Standardization of procedure and materials for packaging to increase shelf-life in storing and marketing of the products produced by the BFRI Fish Dryer.
- Standardization of organoleptic, nutritional and microbial aspects of each of the post production steps of the products produced by the BFRI Fish Dryer.
- Formulation of a pricing and marketing channel for the products produced by the BFRI Fish Dryer.

Achievement

Three types of transparent packaging materials, *viz.* Normal Polythene, Celluloid (0.6 mm) polythene (glass polythene) and Plastic containers were tested for different periods of time and their suitability in all aspects were assessed for three species, Bombey Duck, Silver Pomfret and Ribbon fish separately. The quality of dried Pomfret, remains in good condition considering the external appearance and other organoleptic characteristics for about three months in all the three types of materials. Out of three

packaging materials best quality was observed with Celluloid and the lowest quality was observed with polythene.

Proximate composition was analyzed to assess the nutritional qualities in different shelf-life for Bombay Duck, Silver Pomfret and Ribbon fish separately just before packed. The nutritional quality was same initially in three packaging materials.

Table 1. Proximate composition of dried fish, produced by BFRI Fish dryer just before packed in different packaging materials (% moisture basis)

Packaging materials	Fish species	% Moisture	% Lipid	% Crude protein	% Ash	% Crude fiber	% Carbohydrate
Just before packed	Silver Pomfret	16.71	18.80	59.04	5.17	0.10	0.18
	Ribbon fish	16.18	16.79	61.16	5.18	0.23	0.46
	Bombey Duck	17.29	14.36	61.01	6.84	0.15	0.35

From the study it is found that the protein content was 59.04% in Silver pomftret, 61.16% in Ribbon fish and 61.01% in Bombay duck.

Table 2. Proximate composition of dried fish, produced by BFRI Fish dryer in different packaging materials at middle stage (60 days after packaging) of experimental storage period (% moisture basis)

Packaging materials	Fish species	% Moisture	% Lipid	% Crude protein	% Ash	% Crude fiber	% Carbohydrate
Normal polythene	Silver pomfret	17.5	18.8	57.0	6.0	0.55	0.15
	Ribbon fish	19.5	16.0	57.64	6.2	0.26	0.40
	Bombay duck	20.0	12. 3	59.5	6.9	0.28	1.02
Celluloid bag	Silver pomfret	17.2	16.0	59.04	6.5	0.80	0.46
	Ribbon fish	18.35	16.2	59.01	5.7	0.4	0.34
	Bombay duck	20.0	13.2	59.5	6.5	0.3	0.50
Plastic container	Silver pomfret	18.5	14.8	58.5	7.5	0.45	0.25
	Ribbon fish	20.8	16.2	56.5	6.0	0.30	0.20
	Bombay duck	20.4	12.9	59.3	6.4	0.40	0.60

Table 3. Proximate composition of dried fish, produced by BFRI Fish dryer in different packaging materials at final stage (120 days after packaging) of experimental storage period (% Moisture basis)

Packaging materials	Fish species	% Moisture	% Lipid	% Crude protein	% Ash	% Crude fiber	% Carbohydrate
Normal polythene	Silver Pomfret	21.5	16.3	56.5	5.05	0.51	0.14
	Ribbon fish	21.8	15.5	56.39	5.7	0.26	0.35
	Bombay Duck	23.8	11. 3	57.5	6.9	0.28	0.22
Celluloid bag	Silver Pomfret	19.74	15.50	58.0	6.1	0.26	0.40
	Ribbon fish	20.65	15.2	58.21	5.4	0.30	0.24
	Bombay Duck	21.25	13.1	58.5	6.5	0.25	0.40
Plastic Container	Silver Pomfret	20.65	13.8	57.5	7.5	0.35	0.20
	Ribbon fish	21.8	15.2	56.5	6.0	0.30	0.20
	Bombay Duck	23.2	12.9	57.1	6.4	0.30	0.10

From the study it is found that better organoleptic, nutritional quality and increased shelf-life of dry fish observed in celluloid (0.6 mm) than polythene and plastic jar.

Water reconstitution study: Water reconstitution properties were assessed for every 30 minutes interval for different shelf-life of dried fishes.

Research Progress 2013-14