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, L. rohita, through family selection

The experimental fish was the improved stock of rohu, *Labeo rohita*, as BFRI-FS F_2 generation that produced from the two improved stocks/lines of F_1 generation. 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. 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. 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. 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.

Therefore, considering mass selection, F_3 improved generation was produced in the breeding season in June-July 2013 through a series of pair mating between selected pair of female and male brood fish (1:1) according to the plan and design. Equal volume of fertilized eggs of about 100 g from each pair of fish were incubated in hapa in hatchery system and maintained as a separate family. A total of 60 families of F_3 progeny family groups were nursed separately in hapas. An approximately 1500 spawn from each family were transferred to a primary nursery units of hapa for 12 weeks. Later on, the number of fry was reduced to 200 and they were transferred to a secondary nursery unit of hapa. During the nursing period the growth performances of progenies of all families were compared and evaluated (Table 1). The number of families was reduced to fifty simultaneously.

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. The family-wise PIT Tagging of fingerlings of F_4 generation could not be performed due to unavailability of PIT Tag Reader remarking the breeding program would be of Rotational Breeding and mass selection to proceed further improvement.

Under this circumstances, the experiments will be followed through carrying out Rotational Breeding and mass selection protocol using the F_4 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 & 31-40 in each group and taking together equal number of fingerlings from each family @#10.

Table 1. Growth performance of fry of F_3 progeny family groups of rohu, *L .rohita* in hapa

Sampling month*	Family 1		Family 2		Family 3	
	Length (cm)	Weight (g)	Length (cm)	Weight (g)	Length (cm)	Weight (g)
01	1.27	0.0211	1.59	0.0522	1.225	0.01945
02	4	0.73235	5.565	1.76315	3.295	0.46485
03	5.215	1.7845	7.62	5.1805	5.8	2.2633
04	5.83	2.335	7.94	5.42	6.025	2.565
05	6.09	2.725	8.055	6.9	6.733	3.617
06	6.285	3.115	9.56	9.17	6.99	4.11
07	7.05	3.89	10.685	12.01	7.995	5.975
08	7.265	4.345	11.155	13.675	8.32	6.155

Sampling month*	Family 4		Family 5		Family 6	
	Length (cm)	Weight (g)	Length (cm)	Weight (g)	Length (cm)	Weight (g)
01	1.145	0.01425	1.315	0.01	1.34	0.0178
02	3.705	0.8209	3.765	0.72355	1.69	0.0548
03	5.42	1.8703	5.42	1.8703	5.6	2.077
04	5.805	2.39	5.57	1.965	5.71	2.63
05	5.84	2.405	5.968	2.768	6.4	3.17
06	6.66	3.345	6.305	2.785	6.57	3.395
07	6.995	3.82	7.735	5.41	7.575	5.405
08	7.77	5.405	8.235	6.235	8.155	6.825

Sampling month*	Family 7		Family 8		Family 10	
	Length (cm)	Weight (g)	Length (cm)	Weight (g)	Length (cm)	Weight (g)
01	1.475	0.051	2.47	0.12215	1.57	0.08495
02	6.11	2.3221	3.51	0.67015	3.485	0.59275
03	7.585	4.385	6.2	3.05645	5.85	2.3386
04	7.625	4.465	6.58	3.275	6.29	2.825
05	8.71	6.98	6.71	4.315	6.85	4
06	10.78	13.88	7.22	4.83	7.42	4.87
07	11.37	14.48	8.21	5.89	8.12	5.165
08	11.435	14.525	8.285	6.47	9.195	8.47

*Note: Sampling month: 1 – 8 (November 2013 - June 2014)

Upgradation of carp broods for quality seed production and dissemination

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Objectives

- To collect wild germplasm and evaluate growth performance within the collected wild germplasms and existing stocks.
- To develop live gene bank with quality broods 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 (500 g) wild breeds of Rohu, Catla and Mrigal (not yet identified) were collected from Halda River, Hathazari; Chittagong on 11th May 2013. Collected spawn were stocked in 15 decimal nursery ponds for primary nursing for one month. Following one month primary nursing the spawn were transferred to secondary nursery ponds and then rearing pond followed the existing rearing protocol. The result of present status of Halda stock given below:

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

Species	Stocking density/ Decimal	Initial weight (g) 7.10.13	Final weight (g) 15.06.14	Daily weight gain g/day
Rohu (*Labeo rohita*)	10	56±7.56	866±8.23	3.24
Catla (*Catla catla*)	10	53±10.56	867±6.34	3.25
Mrigal (*Cirrhinus chirrhosus*)	10	33±4.28	694±13.11	2.64

Jamuna sources: Five hounded gram (500 g) wild breeds of Rohu, Catla and Mrigal were collected from Jamuna River, Matin Shaheber Ghat, Shirajgonj sader, er Shirajgonj on 05th 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 ponds and then rearing ponds followed the existing rearing protocol. The result of present status of Jamuna stock given below:

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

Species	Stocking density/ Decimal	Initial weight (g) 7.10.13	Final weight (g)15.06.14	Daily weight gain (g/d)
Rohu (*Labeo rohita*)	10	27.10±7.11	624±9.45	2.38
Catla (*Catla catla*)	10	44.00±7.7	767±6.34	2.89
Mrigal (*Cirrhinus chirrhosus*)	10	24.23±6.45	457±11.11	1.73

Comparative growth study among Halda and Jamuna stock: After eight month of rearing period we compare the growth of Halda and Jamuna Stock.

Table 3. Comparative Growth Study of Halda and Jamuna Stock

Stocks	Rohu (*Labeo rohita*)	Catla (*Catla catla*)	Mrigal (*Cirrhinus chirrhosus*)	Comments
Daily weight (Halda) g/d	3.24	3.25	2.64	Higher growth were found in Halda compared with Jamuna
Daily weight (Jamuna) g/d	2.38	2.80	1.73	

Development of breeding and rearing technique of crucian carp

Achivement

This experiment consisted of four treatments (T1, T2, T3 and T4) with three replications of each. A total of 32 female and 32 male were selected from the brood rearing ponds. To observe the effective dose for artificial propagation, the females and males were injected with different doses of PG extract. Single dose had been used in treatment-T1 and Double dose had been used in treatments-T2, T3 and T4. After ovulation, eight females and eight males from each treatment were selected for stripping

Table 1. Induced breeding of crucian carp using PG

Treatments	Doses of first injection (mg/kg)		Interval (hr)	Doses of 2nd injection mg/kg	Ovulation time(hr)	Fertilization rate (%)	Hatching period (hr)	Hatchig rate (%)	Water temp (°C)	Comment
	M	F		M	F					T2 showed best result
T1	--	--	--	2	6	-	--	--	20-22	
T2	--	1	6	2	5	90	44-48	78		
T3	--	2	6	2	6	56		45		
T4	--	3	6	2	7	35		30		

Developed an effective nursing system for Crucian carp: Primary nursing were conducted in the month of January to February in 5 decimal ponds and then transferred to 20 decimal secondary nursery ponds and the data of primary and secondary nursing given below:

Table 2. Result of crucian carp primary nursing

Treatments	Stocking density/ decimal	Nursing period (days)	Survival (%)	Initial weight (g)	Final average weight (g) 20.02.14
T1	7,000	30 days	72	0.00285	0.48
T2	10,500		69		0.40
T3	14,000		58		0.36
T4	17,500		48		0.33

Table 3. Result of crucian carp secondary nursing

Treatments	Stocking density/ decimal	Nursing period (days)	Initial averageweight (g) 01.03.14	Final weight (g) 31.04.14	Survival (%)
T1	3,000	60 days	0.48	6.33±0.32	78
T2	4,000		0.40	5.01±0.89	75
T3	5,000		0.36	4.55±0.23	70

Establishment of cryo-milt bank for carps and catfishes

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Objectives

- Developing appropriate collection techniques and transport systems of fish milt
- Cryo-Milt Bank for *Labeo rohita* and *Pangasius hypophthalmus* (*sutchi*)
- Estimation of breeding success of *L. rohita* and *P. sutchi* using cryo-milt

Achievements

A total of 50 sub-adults of *Pangasius hypophthalmus* (*sutchi*) averaging 3.0 kg have been collected from the pond complex of the Freshwater Station, Mymensingh during December 2013. A total of 35 *Labeo rohita* averaging 1.5 kg were also collected from the same pond complex during June 2014 and stocked in the same pond with *P. hypophthalmus.* Sub-adults *P. hypophthalmus* and *L. rohita* were produced by the Freshwater Station through hypophysation from parent stocks of healthy population. Among the 50 *P. hypophthalmus* sub-adults, 35 were female and 15 were male, while number of male and female *L. rohita* were 15 and 20, respectively. During winter months, fishes were fed with commercially available pelleted feed containing about 28% protein at the rate of 1.5% body weight daily while feeding rate was 3% during summer months. During winter months, freshwater from a deep tubewell was supplied weekly to the rearing pond to augment maturation of gonad. Monthly sampling was done to check gonadal development of fishes. Female *P. hypophthalmus* and *L. rohita* were checked by observing external features of abdomen and, colour and shape of genital papillae while their male counterparts were checked by gentle pressing the abdomen to get milt. Last sampling was done on 20 June 2014 when females were found with bulging belly and male with milt. Milt of *P. hypophthalmus* was found less motile than normal. Therefore, it is anticipated that fish will breed in the next month i.e. in July 2014. Due to transfer stress, broods of female *L. rohita* were found weak and exhausted although milt was available in the male. Hence breeding with *L. rohita* trail will be conducted in July 2014.

Collection of milt and motility examination and preservation: Mature and healthy male brood fishes were selected to collect milt. Milt sample were expelled from the male fish by gentle abdominal pressure and collected into a clean and dry tube of 5 ml capacity. Contamination of sample with blood, water, urine or the feces were avoided as these contaminants significantly reduce the milt quality and cause poor post-thaw sperm motility. The milt samples were primarily placed in sealed ice box for 2-3 minutes then it was stored in a normal freezer for 20 minutes at 0 to 4^0C and then milt was stored in a deep freezer at -15^0C. Before storage, cryo-diluent was prepared. Dimethyl-sulphoxide (DMSO) was used as cryo-protectant and phosphate buffered saline was used as extender. Cryo-diluents solution was prepared by mixing 75% phosphate buffered saline, 10% DMSO and 15% skimmed milk. This composition was homogenously mixture by vortex mixture. Milt was stored in 5 ml cryo-tubes. Cryo-tubes were leveled as A, B and C for storing 4, 8 and 12 hours, respectively. The milt was mixed with the solution at the ratio 1:1(v/v); and stored in 5 ml leveled cry-tubes. This cry tubes ware gently shaken to allow milt to properly mix with solution, and then carry those cryo-tubes by ice box. Leveled cry-tubes ware placed in the refrigerator for 15 min to reduced their temperature to 4°C before fast freezing in the freezer. Then this tubes ware storage in the -15°C deep freezer.
In the thawing process, this cryo tubes ware first transferred into refrigerator for 20 min to allow the milt to thaw from -15°C to 4°C inside the refrigerator. There after, they ware transferred at room temperature and allowed to stand 5 min before mixing with female aggs.

The sperm motility rates of the freshly collected semen sample were evaluated prior to cryopreservation. Sperm motility of fresh milt was recorded as 95%.

Thawing and fertilization: Samples of milt were removed from the deep freezer. The 5 ml tube was hold in a water bath at a temperature of 37-40°C for around 7-10 seconds. As a general rule, samples are thawed when air bubbles within the straw can move freely within the liquid. Thawed milt was added to the eggs of *Pangasius hypophthalmus* and thoroughly mixed. After approximately 5 minutes, water was added to water-harden the eggs.

Short-term preservation with ice and fertilisation: Healthy male of *Pangasius hypophthalmus* and *Labeo rohita* were selected during peak breeding season. Male breeders were hypophysed with cPGE at the rate of 2 mg per kg of body weight to get milt easily. Milt was collected after 6 hrs of hypophysation. Mill was collected from the male by stripping into several ice cold sterilized tubes. Separate tubes were used for *P. hypophthalmus* and *L. rohita*, respectively. Sterilised tubes containing milt were stored in ice box for 2, 4 and 8 hours. Motility of Spermatozoa was assessed by a microscope. Motility rate of *Pangasius hypophthalmus* ranged between 5 and 50% and fertilisation rate varied between 1 and 40%, respectively. Hatching rates were very poor that ranged between 0 and 20% (Table 1).

Table 1. Details of experiment with preserved milt and fresh eggs of *Pangasius hypophthalmus*

Expt. No	Fresh eggs	Preserved milt (Hours)	Motility (%)	Fertilisation (%)	Hatching rate (%)
1	*Pangasius hypophthalmus*	2	50	40	20
2	*Pangasius hypophthalmus*	4	30	20	5
3	*Pangasius hypophthalmus*	8	5	1	0

Experiments were also conducted with short-term preserved milt and fresh eggs of *Labeo rohita*. Motility rate of *Labeo rohita* ranged from 5 to 40% while fertilisation rate varied between 1 and 20%, respectively. Poor hatching rates were recorded with the short-term preserved milt of *L. rohita* that ranged between 0 and 15% (Table 2).

Table 2. Details of experiment with preserved milt and fresh eggs of *Labeo rohita*

Expt. No	Fresh eggs	Preserved milt (Hours)	Motility (%)	Fertilisation (%)	Hatching rate (%)
1	*Labeo rohita*	2	40	20	15
2	*Labeo rohita*	4	20	10	1
3	*Labeo rohita*	8	5	1	0

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

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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

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 in the BFRI, FS hatchery. One wild stock designated as Batch-1 imported from Thailand during the year 2010 and the size of the fish about 3590±125g which were used in the year 2013 to produce base population. And the other wild stock designated as Batch-2 imported from Vietnam at the end of 2011 having average size of about 1438±33g which will be used in the breeding protocol in the year 2015. Stock details of collected pangas are shown in Table 1.

Table 1. Stock details of collected pangas

Origin	**Year of collection**	**Special feature**	**Widely known**	**Present status (Weight range) (g)**
Thailand	Oct.' 2010	Wild stock from Mekong River (Red meat)	Thai Pangas/Sutchi	3500-5000 g
Vietnam	Oct' 2011	Wild stock from Mekong River (White meat)	Vietnamese Tra	2500-4000 g

Production of base population: Breeding of pangas (Batch-1) was initiated in 17 July 2013. At the end of the March, 200 pairs of immature brood (above 2.0 kg Male and above 3.0 kg Female) were stocked in BFRI, FS pond complex to mature them for breeding. For production of base population at least 60 pairs out of 200 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 group, 15 pairs (sex ratio of female and male 1:1) of brood were mated separately to make 15 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 circcular units and spawn from each group were stocked in separate 20 decimal earthen nursery ponds (replicated for each group). From each group, 5000 fingerlings were selected and reared under maintaining separate groups. 40% mortality was occurred in rearing ponds so that 3000 fingerlings were available for stocking in grow-out ponds. For brood stock development, fingerlings were stocked at the rate of 50 individuals per decimal. Present status of base population in rearing conditions is shown in Table 2.

Table 2. Present status of base population of pangas in rearing pond

Group	Pond size (Dec.)	SD (Nos)	Initial (15-12-13)		Up to date (15-06-2014)	
			Length (cm)	Weight (g)	Length (cm)	Weight (g)
A	20	1500	14.23 ± 0.43	25.6 0 ± 3.49	30.12 ± 0.43	351.56 ± 5.78
B	20	1500	14.21 ± 0.35	25.00 ± 2.03	29.21 ± 0.35	345.00 ± 6.89
C	20	1500	15.28 ± 0.59	28.80 ± 2.73	31.28 ± 0.59	360.32 ± 7.77
D	20	1500	14.35 ± 0.60	27.30 ± 3.23	30.35 ± 0.60	347.10 ± 5.35

Comparative growth study of improved & existing local stocks of pangas: For evaluation of growth performance of each generation, comparative growth trial were conducted using fingerlings from group pure Thai pangas with existing/local stocks of pangas in the farmers field of Mymensingh and Barishal region. The stocking density was maintained 80 fingerlings/decimal and the fish will be feed commercially available peleted feed at the rate of 3% body weight daily. The fish was sampled at monthly intervals to assess growth performance and adjust the feed ration. After 6 months the fish was harvested and data was compiled.

Table 3. Comparative growth trial of pure Thai pangas (BP) and local stock

Stock	Initial weight (g) 01.03.14	Final weight (g) 15.06.14	Trial period (day)	Daily weight gain (g)/d	Comments
Pure Thai pangas	48.56±3.56	464.67±7.89	105	3.43	Pure Thai pangas (BP) showed 7 to 9% higher growth compare to local Thai stock
Local stock	50.34±6.45	430.56±8.33	105	3.14	

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

Achievement

Stock improvement of BFRI-GIFT strain using family selection protocol

Setting of breeding hapa: Breeding hapas (60 nos.) were installed in a breeding pond (1000 m^2) for producing F-7 generation. Prior to install the breeding hapas, pond was dried and exposed to sun light for five days. Lime was applied at the rate of 250kg/ha in the pond bottom after hapa installation. After three days of liming, pond was filled up with deep tube well water at the depth of 1.0 meter

Breeding in hapa: A total of 2212 fish of the F-6 generation were harvested. The weight of male and female were 199.31±35.23 and 156.78±22.63g, respectively. General linear model analysis indicated that there was significant difference ($p< 0.001$) in body weight between the two sexes, where the males were substantially heavier than the females (Table 1).

Table 1. Harvesting body weight of male and female during communal rearing

Sex	Number of records	Weight (g)	Co-efficient of variation (%)
Male	1103	199.31±35.23	17.67
Female	1109	156.78±22.63	14.43

The best 60 males and 60 females were selected on the basis of breeding values of F-6 generation for the production of F-7 generation. The range of breeding values of selected males were 31.32 to 54.56, while in case of females, the values were 25.34 to 54.01 (Table 2). A pair of selected female and male breeders (1:1) was stocked in each breeding hapa on 15, May 2013.

Table 2. Breeding values of selected male and female breeders

Sex	**Number of animals**	**Breeding values**
Male	60	31.32 to 54.56
Female	60	25.34 to 54.01

Nursing in hapa: Three hundred tiny fry from each progeny group were shifted to a series of nursery hapas after 40 days of stocking (25 June 2013). Supplementary feed were supplied to the fry at the rate of 25% of estimated body weight. After one month nursing, progeny of each family were shifted to secondary nursery hapas.

Rearing in hapa: Again each progeny group (200 fry) will be shifted to 60 rearing hapa in 8 August 2013 (plate 2). Supplementary feed (Nursery feed) will be applied in all the hapas at the rate of 15% of estimated biomass.

Pond preparation for communal rearing: For rearing of tagged fish, a pond having an area of 1000 m^2 was selected. The selected pond was dried and treated with lime at the rate of 250 kg/ha. Then lime treated pond was filled up with underground water. After three days, pond was fertilized with Urea and TSP at the rate of 25 and 12.5 kg/ha, respectively.

Tagging and communal rearing: In the first week of October 2013, 20 male and 20 female of each progeny group fish have been selected and tagged them by using Passive Integrated Transponder (PIT). Tagged fishes stocked in a pond (1000m^2) for communal rearing. During tagging, tag number, body weight and total length have been recorded. Supplementary feed (Floating feed) containing 28% crude protein are being applied 6 days in a week for the tagged fishes at the rate of 8% of estimated body weight. Fish are being sampled at monthly interval to know the growth as well as feed ration adjustment. After five months of rearing (i.e. end of February, 2013), fish were harvested. After harvesting, breeding values were estimated through SAS programme.

Evaluation of F-7 generation with founder population of GIFT strain in pond ecology

For evaluating the growth performances of upgraded GIFT (T-7) and non selected GIFT population (offspring of fonder population) of GIFT (T-2) were carried out during July to October 2013 in a pond having an area of 400 m^2.

Stocking of fingerling: A pond was prepared with lime and inorganic fertilizer at the rate of 250 and 37.50 kg/ha, respectively for this experiment. There were two treatments: treatment-1 was designed with upgraded BFRI-GIFT (F-7) while treatment-2 with founder population (offspring of fonder population). In each treatment 500 fry were stocked for growth evaluation. Progeny of the selected fish were produced from 60 single pair matings in separate hapas. Fry of upgraded BFRI-GIFT (F7) were stocked together with the progeny of the founder population (offspring of fonder population) in a pond for communal rearing. The Fry of treatment-2 (T-2) were marked through cauterization of pelvic fin.

Post stocking management: Fish were fed with supplementary feed containing 30% crude protein ration 2.0 times/day. Feeding rate was initially 15% of total body weight per day and was subsequently reduced to 13, 11, 9 and 7% on days 01, 30, 60, 90 and 120, respectively. At fortnightly interval, lime was applied in the pond at the rate of 5.0 kg ha^{-1} during the culture period.

Fish sampling : Fish were sampled at fortnightly intervals by seine net and weighing 50 fish to measure the growth, assesses the health status and feed adjustment.

Month wise sampling data of two treatments are shown in Table 1. The month wise sampling data of Treatment-1 (F-7 generation) was always higher than treatment-2. After four months rearing, the final cumulative mean weights were recorded at 198.23±36.99 and 138.44±20.29g in Treatments- 1 and 2, respectively (table 3). The harvesting weight of treatment-1 was significantly ($P<0.05$) higher than that treatment-2. The harvesting weight of the selected GIFT (F-7 generation) was 43.19% higher than that of treatment-2 (Figure 1). In regard to survival rate, 87% was observed in treatment-2, while 91.8% in

treatment-2. The F7 generation of GIFT showed higher survival than the offspring of founder stock of GIFT.

Table 3. Sampling weight of fish in two treatments

Sampling month	Treatment-1 (g)	Treatment-2 (g)
Initial	4.16±0.79	4.28±0.61
30-July, 2013	41.04±4.53	36.12±4.36
30-August, 2013	82.28±7.47	65.76±7.83
30-September, 2013	134.72± 13.33	102.84±9.24
30-October, 2013 (harvesting weight)	198.23±36.99	138.44±20.29

Stock improvement of Thai koi (A. testudineus) through brood stock replacement techniques (F_4)

Stock improvements of Thai koi (*A. testudineus*) through Brood Stock Replacement techniques (F4), the following methodologies were followed for the production of F-4 generation:

Stocking of selected fry: Thai koi spawn were nursed in four nursery ponds during May to June 2013. After nursing, 500 selected fry from each nursery pond were stocked in two prepared rearing pond during August 2013. The initial mean weight Thai Koi was 3.45±0.72g. As such 2000 fry of Thai Koi were reared in two nursery ponds.

Post stocking management The fry of Koi were fed with supplementary feed (containing 30% protein) at 8-10% of estimated body weight. Lime and table salt are being applied in all the rearing ponds at the rate of 50 and 125 kg/ha, respectively. Freshwater from deep tube well are being supplied to the ponds at three days interval to maintain average water depth upto 1.0 meter. The fish were sampled at fortnightly interval to adjust the feeding rate. The sampling weights of Thai Koi in different rearing ponds are shown in Table 4. After seven months of rearing, the sampling weight of fish in Ponds-1, and 2 are 101±4.22 and 103±5.21, respectively.

Table 4. Sampling weight of Thai koi in different rearing ponds

Month	Sampling weight (g)	
	Pond-1	Pond-2
August	15±1.66	19±1.78
September	28±2.62	33±2.10
October	56±2.3	60±2.55
November	65±3.10	68±3.32
December	69±3.5	72±4.12
January	74±2.95	75±3.40
February	79±4.52	81±4.1
March	101±4.22	103±5.21

Induced breeding of Thai koi for the production of F-4 generation through brood stock replacement technoque

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_4 generation. For the production of F_4 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 20 gm 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.

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

To evaluate the growth performance of non selected parental group of Thai koi and improved F-4 generation of Thai Koi, an experiment was conducted for a period of four months with three replications during April to May. The fry of koi were stocked in March 2014 at the stocking density of 75,000/ha at Dhokhola village, Gouripur, Mymensingh. There were two treatments with three replicates. Treatment-I was designed with F-4 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 101.16±4.56 and 83.20±3.95g, respectively and results were statistically significant ($p>0.05$). The F-4 generation of Thai Koi showed 21.58% higher growth than non selected group.

Development of seed production and grow-out techniques for endangered fish species (*Chitala chitala, Monopterus cuchia and Tor putitora*) in Bangladesh

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Objectives

- To evaluate the growth performance of *C. chitala* spawns under different stocking densities
- To evaluate growth performance of *C. chitala* fingerlings with low stocking densities
- To develop induced breeding technique for *M. cuchia*
- To develop controlled breeding technique for *M. cuchia*
- To observe the growth performance of *M. cuchia* using different feeds

Achievements

Expt. 1. Evaluation the growth performance of C. chitala spawns under different stocking densities

The experiment was conducted in hapa ecology for a period of 30 days. Three stocking density of *C. chital* spawn, such as T_1: 100; T_2: 200 and T_3: 300//m^2 were tested with 2 replications for each. Initial length and weight of *C. chitala* spawn was 2.15±0.01cm and 0.084±0.02. In all Treatment live fish spawn and zooplankton were applied. The growth performances of *C. chitala* spawn are presented in Table 1.

Table 1. Growth performance of chital spawn after 30 days rearing

Treatments	Initial length (cm)	Initial weight (g)	Final length (cm)	Final weight (g)	SGR (%)	Survival rate (%)
T_1=100/m^2	2.15 ±0.01	0.084 ±0.02	5.11±1.17	^{a}1.44 ±0.62	7.47	^{a}91.33±5.13
T_2=200/m^2			4.97±1.14	^{b}1.28 ±0.86	6.07	^{a}88.33±8.14
$T_{3=}$300/m^2			4.93±0.37	^{c}1.16 ±0.70	5.75	^{a}86.67±8.74

Expt. 2. Evaluation the growth performance of C. chitala with low stocking densities

This experiment was conducted in ponds for a period of 3 months. Three stocking density of *C. chital* fingerling, such as T_1: 250; T_2: 750 and T_3: 1250/ha was tested. After preparing the experimental ponds, GIFT tilapia brood was stocked @ 20,000 ha^{-1} at sex ratio 2:1 (female: male) and SIS in all treatments. Brood tilapia and SIS were fed with supplementary feed. After 3 months rearing the growth performance of Chital were 414.33±24.01, 369.33±14.01 and 358.00±12.53g in T1, T2 and T3, respectively. Details results are shown in Table 2.

Table 2. Growth performance of chital, *C. chitala* fingerlings after 3 months rearing

Treatments	Initial weight (g)	Final weight (g)	Survival rate (%)
T_1 (250 ha^{-1})	50.31±10.46	^{a}414.33 ±24.01	^{a}43.33 ±32.99
T_2 (750 ha^{-1})		^{a}369.33 ±14.01	^{a}37.77 ± 25.14
T_3 (1,250 ha^{-1})		^{b}358.00 ±12.53	^{b}26.67 ±9.42

Expt. 3. Development of induced breeding technique for M. cuchia

For development of induced breeding technique, *M. cuchia* having weight range of 250-300g were collected from different area of Mymensingh during July-August 2013. After collection, the fish were stocked in cistern (1:1 ratio). Brood *M. cuchia* were fed with supplementary feed fish paste, earth warm, live fish and snail. Induced breeding trials were initiated during Mid April 2014 with administering PG and HCG as inducing agents. Two trials were conducted during breeding season. In first trial PG was administered for female 35, 40 & 45 mg and for male 10 mg per kg body weight. HCG was administered 1000 IU per kg body weight of female. In second trial PG was administered for female 10mg per kg body weight as first dose. After 6 hours interval PG was administered for female 20mg and male 10 mg per kg body weight as second dose. After administration of inducing agent, male and female fishes were kept in cistern according to dose application.

Expt. 4. Development of controlled breeding technique for M. cuchia

The experiment was conducted in pond and cistern ecology. In cistern ecology helencha were used as shade and shelter. In pond ecology polythine was used in the pond bottom. In both ecologies soil 1feet soil layer was used. Three replications were maintained for both ecologies. Mature male and female eels were stocked at 1:1 ratio. In cistern ecology supplementary feed, fish paste was supplied at the 3-5% of estimated body weight. In both ecologies live fish, snail earth warm used as supplementary feed. Breeding activity of cuchia in cistern was keenly monitored but not bred in cistern ecology but *M. cuchia* propagated in pond ecology

Expt. 5. Growth performances of M. cuchia using different types of feed

The experiment was conducted for a period of 120 days from March to June 2014 in cistern ecology with three treatments each having three replications. Mud eels 30.50±2.98 was stocked in each treatment at a density of 10/m^2 and fed with different feeds at the rate of 5% body weight was applied once in a day. In treatment 1, 2 and 3 fishes fed with 100 % fish paste, 60 % fish paste with 40% atta, and live fish and snail, respectively. Aquatic weed, helencha was used as shelter. Details results are shown in the following Table 3.

Table 3. Growth performance of *M. cuchia* using different types of feed

Treatments	Initial wt. (g)	Final wt. (g)	SGR (%)	Survival rate (%)
T_1	30.50 ±2.98	^{a}124.63 ±20.27	1.17	^{a}95.33 ±8.08
T_2		^{a}111.38 ±15.86	1.11	^{a}92.67 ±6.43
T_3		^{b}103.13 ±10.08	1.02	^{a}90.33 ±4.51

Optimization of stocking density of pabda (*Ompok pabda*) in cage ecology in the River Brahamputra, Mymensingh

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

Objectives

- To optimize the suitable stocking density of pabda (*O. pabda*) in net cages,
- To analyze the cost-benefit of cage culture of pabda

Achievements

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.

Installation of cages in the river: 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 pabda in net cages, the experimental designs are as follows:

Species	Treatment	No of replication	Stocking density/m^3
Pabda	T_1	3	300
	T_2	3	350
	T_3	3	400

Fingerlings of pabda were stocked in net cages according to the design of experiment during November 2013 for the period of 6 months. The initial weight of pabda in T1, T2 and T3 were 3.12±0.62, 3.20±0.50

and 3.16±0.42g, respectively. Supplementary feed containing 30% crude protein was applied in all cages twice daily at the rate of 5-15% body weight of fish. Fish of each cage was sampled at fortnightly interval to monitor their growth as well as feed adjustment. Water quality parameters such as water temperature (^{0}C), dissolved oxygen (mg/l), pH, transparency (cm.) and total ammonia (mg/l) were analyzed at two days interval. 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.

The physico-chemical parameters of River Brahmaputra water viz., temperature, transparency, pH, dissolved oxygen and total ammonia of are presented in Table 1. The values of temperature, transparency, dissolved oxygen, pH and total ammonia were 16.5 – 29.0°C, 86 – 107 cm, 5.05 – 8.41 mg/l, 7.21 – 8.85 and 0.00-0.02 mg/l, respectively.

Table 1. Water quality parameters of River Brahmaputra during experimental period

Parameter	Value
Water Temperature (°C)	16.5 – 29.0
pH	7.21 – 8.85
DO (mg/l)	5.05 – 8.41
Transparency (cm)	86 – 107
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 pabda were 28±2.51, 25±1.32 and 22±3.42g, in treatments-1, 2, and 3, respectively. The harvesting weight of treatment-1 was significantly higher ($p<0.05$) than treatment-3. In higher stocking densities, the harvesting weight of pabda was occurred linearly. The survival rate of fish varied between 56 to 65%. In treatment-1, the highest survival rate was observed. The productions obtained in cages were 5.46±1.49, 5.16±1.85 and 4.92±1.74 kg/m^3 from treatments-1, 2 and 3, respectively. The highest production was obtained from treatment-1, which differed significantly ($p<0.05$) from treatment-3.

Table 3. Harvesting wt., Survival, and Production of pabda under different treatments

Treatment	**Harvesting wt. (g)**	**Survival %)**	**Production/m^3 (kg)**
T_1 (300/m^3)	28±2.51	65±3.10	5.46±1.49
T_2 (350/m^3)	25±1.32	59±4.08	5.16±1.85
T_3 (400/m^3)	22±3.42	56±3.91	4.92±1.74

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

Researchers: Dr. Md. Zulfikar Ali, SSO
Mritunjay Paul, SO

Objectives

- To evaluate the effect of selected probiotics on growth, feed efficiency, nutrient utilization and body composition in *Oreochromis niloticus*
- To investigate the suitability of utilizing restricted feeding in this fish
- To develop and optimize feeds and feeding strategies in *Oreochromis niloticus* farming

Achievements

A series of feeding trials were conducted to develop and optimize of feeds with probiotics and feeding strategies for *Oreochromis niloticus* farming. Two feeding trials on: optimizing feeding regime & dietary protein (feeding trail-1) and evaluation of selected probiotics as feed additives in formulated feeds (feeding trail-2) in *Oreochromis niloticus* 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 *Oreochromis niloticus* for 5 months (feeding trail-3) is also in progressing. Details of technical progress of the feeding trials are described below briefly.

Optimizing dietary protein level and feeding regime in Oreochromis niloticus

The same aged uniform size fingerlings of *Oreochromis niloticus* were randomly distributed into groups of 50 fish (averaging 1.55 ± 0.07 g) per 70-L fibre glass tank for feeding trail-1. Three experimental diets were formulated to contain 20, 25 and 30% crude protein and 12.12, 14.62 and 17.07 kJ g^{-1} gross energy. The diets had P/E ratio of 17.75 mg protein per kJ GE and lipid to carbohydrate ratio (L/CHO ratio) g/g of 0.42 was fixed on the basis of results obtained from previous studies (optimize P/E ratio and L/CHO ratio) and to meet determined requirements for maximum growth of this species. Composition of the experimental diets and their proximate analyses are shown in Table 1.

Six treatments, two feeding regimes (restricted and satiation) were offered for each of the three diets (20, 25 and 30% dietary protein level). In restricted feeding, the fish were offered diets at fixed at of 10.0, 8.0 and 6.6% of their body weight of 20, 25 and 30% protein diets respectively to provide approximately the same amount of protein and energy intake in all treatments daily. Feeds supply were adjusted after fortnightly weighing. Growth and feed response parameters are shown in Table 2. The highest weight gain was observed for fish consuming 30% protein with no significant differences ($p>0.05$) between the 25% and 30% 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 25 to 30% protein diets to satiation displayed higher growth rate, while protein utilization was improved when the protein level was below 30% in the diet. The results show that under satiation feeding a 25% protein diet lowers the body fat and improves protein utilization without growth retardation. This indicates that satiation-feeding of a diet containing 25% protein is suitable for *Oreochromis niloticus* under these conditions.

Table 1. Formulation and proximate composition of the experimental diets (% dry weight) for *Oreochromis niloticus*

Diet no. **(% protein)**	**1** **(20% CP)**	**2** **(25% CP)**	**3** **(30% CP)**
Ingredients			
Fishmeal/ Protein con.	25.00	30.00	35.00
Mustard Oil Cake	9.00	12.00	15.00
Rich bran (auto)	8.00	14.00	20.00
Starch	50.80	36.80	22.80
Alpha cellulose	5.00	5.00	5.00
Binder (Carboxymethyl cellulose)	2.00	2.00	2.00
Vitamin and Minerals Premix	0.20	0.20	0.20

Table 2. Mean growth performance and feed utilization of *Oreochromis niloticus* fed various protein levels and two feeding regimes for 8 weeks

Diet number (% protein)	**1** (20% CP)		**2** (25% CP)		**3** (30% CP)	
Feeding regime	**Restr.**	**Satia.**	**Restr.**	**Satia.**	**Restr.**	**Satis.**
Initial body wt. (g)	1.53^{a} ± 0.04	1.55^{a} ± 0.07	1.55^{a} ± 0.07	1.53^{a} ± 0.04	1.55^{a} ± 0.07	1.55^{a} ± 0.07
Final body wt. (g)	11.48^{c} ± 1.24	11.50^{c} ± 1.41	14.45^{b} ± 1.48	16.64^{ab} ± 1.22	15.25^{ab} ± 1.20	17.45^{a} ± 1.20
Weight gain (g)	9.95^{c} ± 1.20	9.95^{c} ± 1.41	12.90^{b} ± 1.41	15.12^{ab} ± 1.25	13.70^{ab} ± 0.92	15.90^{a} ± 1.27
Weight gain (%)	651.72^{c} ± 63.71	644.79^{c} ± 125.21	831.04^{b} ± 53.33	992.37^{ab} ± 105.08	886.15^{ab} ± 99.73	1028.75^{a} ± 129.05
Specific growth rate (SGR) (% day)	3.36^{c} ± 0.14	3.34^{c} ± 0.28	3.72^{b} ± 0.09	3.98^{ab} ± 0.16	3.81^{ab} ± 0.17	4.04^{a} ± 0.19
Food conversion ratio (FCR)	1.85^{a} ± 0.05	1.86^{a} ± 0.03	1.34^{b} ± 0.02	1.40^{b} ± 0.04	1.15^{c} ± 0.05	1.22^{c} ± 0.02
Protein efficiency ratio (PER)	2.35^{a} ± 0.18	2.42^{a} ± 0.10	2.55^{a} ± 0.09	2.62^{a} ± 0.17	2.55^{a} ± 0.13	2.30^{a} ± 0.12
Apparent net protéine utilisation (ANPU, %)	36.16^{a} ± 3.18	40.53^{a} ± 5.50	37.65^{a} ± 1.72	43.33^{a} ± 2.64	42.17^{a} ± 2.81	40.07^{a} ± 4.46

Note: Values are ± SD of two replicates. Figures in the same row having different superscript are significantly different ($p < 0.05$).

Evaluation of selected probiotics in the formulated diets for Oreochromis niloticus

The same aged uniform size fingerlings of *Oreochromis niloticus* were randomly distributed into groups of 50 fish (averaging 1.50 ± 0.06 g in weight) per 80-L fiberglass tank and three replicate tanks used for each test diet. Six experimental diets (iso-nitrogenous and iso-energetic) were formulated to contain 30% crude protein and 16.83 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) Mixture (*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. Composition of the experimental diets and their proximate analyses are shown in Table 2.1**.** Each dietary treatment was conducted in duplicate tanks. Feeding rate was adjusted based on weekly sampling weights of fish. The fish were offered the experimental and control diets, 2-3 times daily at the rate of 10-6% of their body weight and sub-divided into 3 equal feeds at 9.00, 13.30 and 18.00 h. Growth and feed response parameters are shown in Table 3. The growth rate in terms of mean final body weight, weight gain, percent weight gain of experimental fish fed diet 2 was significantly ($p<0.05$) highest than the control diet. There was no significant ($p>0.05$) difference among the growth rate of experimental fish fed diets 3, 4 and 5. Fish fed diets 2-5 showed significantly the higher ($p<0.05$) SGR while the diet 1 producing the lowest SGR value. Fish fed diets 2-5 showed significantly ($p<0.05$) superior FCR value than the control diet. The significantly higher ($p<0.05$) PER values were obtained fish fed diets 2, 3, 4 and 5 but no significantly difference among themselves. The ANPU value in diet 2 was significantly highest ($P<0.05$) and ANPU value in diet 1 was the lowest (Table 4). From the results of this feeding trial, it is logical to conclude that feed incorporated with the probiotics (Bactocell, *Bacillu*, Levucell) can be used as a fish feed additives in *Oreochromis niloticus* culture, to enhance fish health, better feed efficiency and growth performance.

Table 3. Formulation and proximate composition of the experimental diets (% dry weight) for *Oreochromis niloticus*

Diet no.	1 (Control)	2 (Bactocell)	3 (Bacillus)	4 (Levucell)	5 (Mixture 3)	6 (Navio plus)
Ingredients						
Fishmeal (Indonesia)	25.00	25.00	25.00	25.00	25.00	25.00
Meat & bone Meal	20.00	20.00	20.00	20.00	20.00	20.00
Mustard Oil Cake	12.00	12.00	12.00	12.00	12.00	12.00
Rich bran (auto)	22.00	22.00	22.00	22.00	22.00	22.00
Starch	15.80	15.75	15.75	15.75	15.75	15.75
Binder (Carboxymethyl cellulose)	2.00	2.00	2.00	2.00	2.00	2.00
Alpha Cellulose	3.00	3.00	3.00	3.00	3.00	3.00
Vitamin and Minerals Premix	0.20	0.20	0.20	0.20	0.20	0.20
Probiotics (Diets 2-6)	-	0.05	0.05	0.05	0.05	0.05
Proximate composition						
Crude Protein	29.90	29.88	29.89	29.90	29.89	29.88
Crude Fat	10.45	10.45	10.40	10.45	10.45	10.40
NFE	37.67	37.67	37.67	37.67	37.67	37.67
GE (kJ g^{-1})	16.83	16.83	16.83	16.83	16.83	16.83

Table 4. Mean growth performance and feed utilization of *Oreochromis niloticus* fed selected probiotics for 8 weeks

Diet no.	1 (Control)	2 (Bactocell)	3 (Bacillus)	4 (Levucell)	5 (Mixture 3)	6 (Navio plus)
Initial body wt. (g)	1.55^{a} ± 0.07	1.58^{a} ± 0.04	1.53^{a} ± 0.04	1.55^{a} ± 0.07	1.58^{a} ± 0.04	1.55^{a} ± 0.07
Final body wt. (g)	10.85^{c} ± 0.49	14.80^{a} ± 0.42	13.60^{a} ± 0.14	12.98^{a} ± 0.25	12.20^{ab} ± 0.42	11.85^{bc} ± 0.48
Weight gain (g)	9.30^{c} ± 0.42	13.23^{a} ± 0.39	12.08^{a} ± 0.11	11.43^{a} ± 0.18	10.63^{ab} ± 0.39	10.30^{bc} ± 0.57
Specific growth rate (SGR) (% day)	3.51^{b} ± 0.05	4.00^{a} ± 0.01	3.91^{a} ± 0.02	3.80^{a} ± 0.05	3.66^{ab} ± 0.02	3.62^{bc} ± 0.15
Food conversion ratio (FCR)	2.51^{a} ± 0.07	1.70^{b} ± 0.08	1.78^{b} ± 0.03	1.81^{b} ± 0.02	1.90^{b} ± 0.05	2.28^{a} ± 0.12
Protein efficiency ratio (PER)	1.10^{b} ± 0.05	1.70^{a} ± 0.08	1.66^{a} ± 0.02	1.59^{a} ± 0.01	1.52^{a} ± 0.04	1.28^{b} ± 0.06
Apparent net protein utilisation (ANPU, %)	20.55^{c} ± 0.21	27.05^{a} ± 1.21	26.81^{a} ± 0.47	26.46^{a} ± 0.28	26.05^{a} ± 1.14	24.07^{b} ± 2.43
Protein digestibility (%)*	87.23	92.89	92.26	91.90	92.05	90.86

Note: Values are ± SD of two replicates. Figures in the same row having different superscript are significantly different ($P < 0.05$).

Development and optimization of feeds with probiotics in Oreochromis niloticus farming

The follow up feeding trail on: development and optimization of feeds with probiotics in *Oreochromis niloticus* (feeding trail-3) is also being conducted in pond conditions. The same aged uniform size (average wt. 4.25 ± 0.06 g) fingerlings of *Oreochromis niloticus* were stocked in the ponds at the rate of 3,000 fish/400 m^2 pond (75,000/ha). Four experimental diets (iso-nitrogenous and iso-energetic) were formulated to contain 28.20% crude protein and 16.83 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. Composition of the experimental diets and their proximate analyses are shown in Table 5. The bite-sized (2.0-3.0 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 10-8% of their body weight. Growth and feed response parameters are shown in Table 3.2. This feeding trail of fish species is still running and it will be completed end of October 2014. After completion of the feeding trial, the technical recommendations will be provided.

Table 5. Formulation and proximate composition of the experimental diets for *Oreochromis niloticus*

Diet no.	**1 (Control)**	**2 (Bactocell)**	**3 (Bacillus)**	**4 (Levucell)**
Ingredients				
Meat & bone Meal	24.00	24.00	24.00	24.00
Soybean Meal	15.00	15.00	15.00	15.00
Mustard Oil Cake	20.00	20.00	20.00	20.00
Rich bran (auto)	28.00	28.00	28.00	28.00
Maize Meal	7.25	7.25	7.25	7.25
Wheat Flour (Atta)	5.05	5.00	5.00	5.00
Salt	0.50	0.50	0.50	0.50
Vitamin and Minerals Premix	0.20	0.20	0.20	0.20
Probiotics (Diets 2-4)	-	0.05	0.05	0.05
Cost (Tk./Kg)	**30.60**	**30.80**	**30.80**	**30.80**
Proximate composition:				
Crude Protein	28.20	28.20	28.20	28.20
Crude Fat	11.00	11.00	11.00	11.00
Ash	12.01	12.01	12.01	12.01
Fibre	6.68	6.68	6.68	6.68
NFE	32.41	32.41	32.41	32.41
GE (kJ g^{-1})	16.83	16.83	16.83	16.83

Table 6. Mean growth increment of *Oreochromis niloticus* fed selected probiotics for 10 weeks in ponds

Diet no.:	**1 (Control)**	**2 (Bactocell)**	**3 (Bacillus)**	**4 (Levucell)**
Initial weight (g)	4.25 ± 0.06	4.20 ± 0.07	4.30 ± 0.06	4.25 ± 0.05
Final body weight (g)	30.60 ± 1.26	36.50 ± 1.90	35.20 ± 1.30	35.90 ± 2.24
Weight gain (g)	26.35 ± 2.30	32.30 ± 2.42	30.90 ± 2.61	31.65 ± 3.28

Development of quality feeds for *Clarias batrachus* farming: an approach to reduce feeding cost

Researchers: Dr. Md. Zulfikar Ali, SSO
Mritunjoy Paul, SO

Objectives

- To optimize dietary protein to energy ratio (P/E ratio) for *Clarias batrachus*
- To investigate the efficiency of non-protein energy sources in locally available feed ingredients
- To optimize dietary non-protein carbohydrate to lipid ratio (CHO/L ratio) for *Clarias batrachus*
- To develop cost-effective quality feeds for *Clarias batrachus* farming

Achievement

In order to investigate the interactions of dietary protein and energy and their utilization, two feeding trials in lab and pond conditions were conducted with a view to develop cost-effective quality feeds for C*larias batrachus* farming. An 8-week feeding trial was conducted in a static indoor rearing system with 18 cylindrical fibre glass tanks (70-L each) to investigate protein to energy ratio (P/E ratio) in *Clarias batrachus* (1.15 ± 0.05 g). Six fishmeal based diets of two protein levels (30 and 35%), each with three lipid levels (5, 10 and 15%) resulted in P/E ratios ranging from 16.33 to 21.89 mg protein kJ^{-1} gross energy (GE) were fed to 50 fish (per 70-L tank) in triplicate. Fish were fed 8-10% of their body weight three times per day adjusted fortnightly. Significantly higher ($P < 0.05$) growth rates in terms of weight gain, % weight gain and specific growth rate (SGR) were evident in fish fed with higher protein diet. The highest growth rate was found by fish fed 35% protein, 17.11 kJ^{-1} GE with a P/E ratio of 20.47 mg protein kJ^{-1} GE. Significantly better ($P < 0.05$) feed conversion ratio (FCR) was also evident in fish fed with higher protein diet and best FCR was found by fish fed 35% protein, 10% lipid, 17.11 kJ^{-1} GE with a P/E ratio of 20.47 mg protein kJ^{-1} GE. The study reveals that walking catfish *C. batrachus* performed best the diet containing 35%, 17.11 kJ g^{-1} and 20.47 mg protein kJ g^{-1} GE protein, gross energy and P/E ratio respectively. The follow up 6-month feeding trial was conducted in pond conditions with *Clarias batrachus* based on results from previous feeding trial (P/E ratio) in lab conditions with a view to devolve cost effective quality feeds in *Clarias batrachus* farming. Eight experimental ponds (400 m^2 area) situated in the pond complex of FS, BFRI, Mymensingh were selected for the feeding trail. The same aged uniform size (average wt. 4.50 ± 0.07 g) fingerlings were stocked in the ponds at the rate of 5,000 fish/400 m^2 (1,25,000/ha). Four experimental isonitrogenous (35% CP) and isoenergatic (17.11 kJg^{-1} GE) diets were formulated with a P/E ratio 20.47 mg protein kJ^{-1} GE based on results from previous studies of optimized P/E ratio of *Clarias batrachus*. The non-protein energy was adjusted by varying the ratios of lipid and carbohydrate in the diets so that the lipid to carbohydrate ratios (L/CHO, g/g) ranged from 0.25 to 0.65. Each dietary treatment were conducted in duplicate ponds. Fortnightly fish sampling is being done to adjust the daily feed ration for the following week. The fish were offered the experimental diets, 2 times daily at the rate of 10-6% of their body weight. Significantly higher ($P < 0.05$) growth rates were attained at higher carbohydrate diet and the highest level growth performances were reduced at 12 weeks feeding trial. The feeding trial with *Clarias batrachus* in ponds is running smoothly and continued up to early November 2014. The result obtained for 12 weeks feeding trial so far is very encouraging. After completion of the feeding trial in pond conditions, the technical recommendations (production, economic analysis, net profit etc.) will be provided.

Investigation and identification of emerging fish diseases and development of their control strategies

Researchers: 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 Shing (*Heteropneustes fossilis*)
- Histological changes in different organs of diseased fish
- Development of control strategies to minimize fish mortality using better management practices

Achievement

Collection of diseased shing: A total number of 120 cultured diseased Shing (*Heteropneustes fossilis*) fish were collected randomly from Gouripur, Tarakanda, Muktagachha, Khashigonj and Fulpur of Mymensingh district. The collected diseased Shing were examined clinically with paying an attention to the behaviors in the ponds, changes in color and respiratory manifestations with a special care to the external lesions.

Clinical and post mortem findings: The clinical examination of diseased fish exhibited: loss of equilibrium, grayish white spot (Figs. 1 & 2), slight lesion on body, body and tail erosion, hemorrhage in base of fin and edge of head, move with whirling & heavy mortalities of fish occur shortly after the advent of lesions. Congestion and enlargement in internal organs were appeared in postmortem examination. In the laboratory, each diseased Shing fish was rinsed with distilled water and the surface of the fish was decontaminated by dipping it in ethyl alcohol and lightly flamed. Swabs from the different organs of each diseased Shing were inoculated on Tryptic Soya Agra then incubated at 30°C for 24 hours for bacterial growth.

Fig. 1 Grayish white spot on body

Fig. 2 Grayish white spot on head region

Biochemical tests for bacterial identification: Pure cultures of the bacterium were isolated from the infected skin, fin, gill, liver and kidney of infected Shing with the clinical signs described. The bacterium was grown on basic agar media such as Tryptic Soya Agar (TSA), brain heart infusion agar, and blood agar. After 3 to 4 days of incubation on TSA the colonies were found round, convex and entire. Biochemical tests such as gram stain, motility, Indole (Fig 3), Voges proskeur, Methyl red, Urase production, H_2S, Nitrate reduction, Oxidase, Catalase, Glucose, TSI (Fig. 4) and NaCl tolerance as well as API 20 E test kits were used for diagnose bacteria those isolated from diseased Shing. Bacteria of the *Aeromonas hydrophila, A. salmonicida, A. sobria, Pseudomonas angulliseptica, P. fluorescens* and *Vibrio anguillarum* were identified from the infected lesion (skin and fin), gill, liver and kidney of infected Shing. Isolated strain of *Aeromonas* spp. from infected Shing showed Oxidative positive, Catalase positive, Urease negative and methyl red negative. While the strain of *Pseudomonas* spp. was gram-negative rod, oxidative, H_2S production negative and Urease positive.

Bacteria isolated from different organs of infected shing: A total of 85 bacterial strains were isolated from 120 samples of infected Shing. The species composition and sources of these strains are presented in Table 3. The isolation frequencies of these 85 strains upon anatomical parts of infected Shing were as follows: infected skin and fin 30 (32.94%), gill 12 (14.11%), liver 10 (11.76%) and kidney 33 (38.82%). *Aeromonas* species were distributed as follows: *A. hydrophila* 34 (40.00%), *A. salmonicida* 14 (16.47%), *A. sobria* 8 (9.41%) as well as 5 (5.88%) unidentified *Aeromons* strains. On the other hand, only two species of *Pseudomonas* and one species of *Vibrio* were found from different organs of infected Shing. *Pseudomonas anguliseptica, P. fluorescens, Vibrio anguillarum* and *Streptococcus* spp were distributed as 12 (14.11%), 4 (4.70%), 3 (3.52%) and 5(5.88%), respectively in infected Shing (Table 1). *Aeromonas hydrophila* appeared to be the main pathogen in infected Shing rather than other species.

Table 1. Bacteria isolated from different organs of infected Shing

Isolated bacteria	Distribution (Number & %) of different bacterial stains (n=85) according to site of isolation				Total
	Infected area (skin & fin)	Gill	Liver	Kidney	
A. hydrophila	15 (17.64)	3 (3.52)	5 (5.88)	11 (12.94)	34 (40.00)
A. salmonicida	5(5.88)	2 (2.35)	2 (2.35)	5 (5.88)	14 (16.47)
A. sobria	3(3.52)	2 (2.35)	1 (1.17)	2 (2.35)	8 (9.41)
Unidentified sp.	2(2.35)	0	1 (1.17)	2 (2.35)	5 (5.88)
P. anguliseptica	2(8)	3 (3.52)	1 (1.17)	6 (7.05)	12 (14.11)
P. fluorescens	1(1.17)	0	0	3 (3.52)	4 (4.70)
V. anguillarum	0	1(1.17)	0	2 (2.35)	3 (3.52)
Streptococcus sp.	2 (2.35)	1(1.17)	0	2 (2.35)	5 (5.88)
Total	30 (32.94)	12 (14.11)	10 (11.76)	33 (38.82)	85

Experimental infection: Experimental infection of healthy Shing with isolated *Aeromonas hydrophila* via intraperitoneal (I/P) route showed nearly more or less same changes recorded in naturally infected fish. In aquarium condition different *A. hydrophila* doses were used for observation of mortality (Fig. 13). The highest (80%) and no mortality was observed at 4.8 $x10^7$ cfu/ml and 3.2$x10^3$ cfu/ml dose, respectively with in 15 days (Table 2).

Table 2. Pathogenicity test using different doses (cfu/ml) of *A. hydrophila*

Number of fish injected	*A. hydrophila* dose (cfu/ml)	% of infected	% of mortality
10	3.2 x 10^3	0	0
10	2.7 x 10^4	20	5
10	3.2 x 10^5	60	35
10	4.2 x 10^6	70	45
10	4.8 x 10^7	80	50

Susceptibility to antimicrobial agents in-vitro condition*:* Antibiotic sensitivity test of each pathogenic species was performed under *in-vitro* condition. Ten different antibiotic dices namely, Ampicillin, Azithromycin, Chlortetracycline, Ciprofloxacine, Gentamicin, Levofloxacine, Novobiocine, Oxytetracycline, Penicillin and Tetracycline were tested against six fish pathogens namely *A. hydrophila, A. salmonicida, A. sobria, P. anguilliseptica, P. fluorescens* and *V. anguillarum*. It was observed that all the isolated bacteria were sensitive to Ciprofloxacine and Levofloxacine, Azithromycin and Gentamicin. Ciprofloxacine and Levofloxacine were highly effective against *A. hydrophila, A. almonicida, A. sobria P. anguilliseptic* and *P. fluorescens* except *V. anguillarum* (Table 3). Novobiocine was highly effective against *V. anguillarum*, while Azithromycin, Gentamicin showed moderate effect against all the isolated bacteria. Ampicillin amd Penicillin did not show any effect against all bacteria (Figs. 1 & 2).

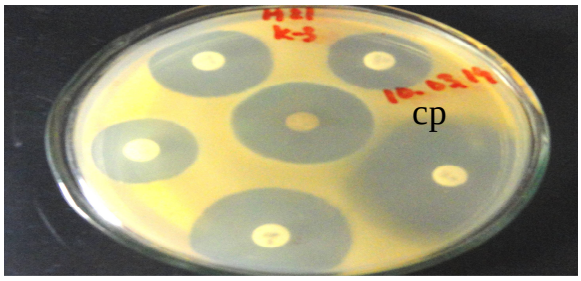

Fig. 1 Ciprofloxacine and Levofloxacine highly sensitive against *A. hydrophila*

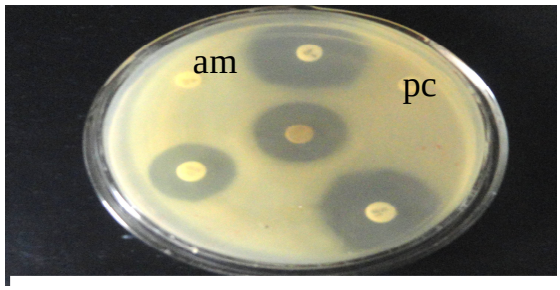

Fig. 2 Ampicillin and Penicillin highly resistant against all isolated bacteria

Table 3. Antibiotics sensitivity test on isolated bacteria from infected Shing

Antibiotic(Cons/Disc)	***Aeromonas hydrophila***	***A. salmonicida***	***A. sobria***	***Psudomonas anguliseptica***	***V. anguillarum***
Ciprofloxacin (5µg)	+++	+++	+++	+++	++
Levofloxacin (5µg)	+++	+++	+++	+++	++
Gentamicin (10µg)	++	++	++	+++	++
Azithromycin (15µg)	++	++	++	++	+
Tetracycline (30µg)	+	+	+	+	+
Oxytetracycline (10µg)	-	+	+	+	+
Chlortetracycline (25µg)	-	-	+	+	+
Novobiocine (5µg)	-	-	-	-	+++
Ampiciline (10µg)	-	-	-	-	-
Penicillin (10µg)	-	-	-	-	-

-: no inhibition, +: inhibitory zone between 5-12mm, ++: inhibitory zone between 13- 20 mm. +++: inhibitory zone between 21-30 mm above

Co-habitation trial

Co-habitation trials have been conducted with infected Shing (tail erosion, pale color in body and hemorrhagic lesions) and healthy Shing in aquarium and mini ponds.

In aquarium: Aquarium size was 0.24 m^2 and 5 fish/aquarium were stocked (Fig. 24). Healthy fish was affected 75% within 12 days and those fish were treated with 3% salt and Ciprofloxacin 1 g/kg feed with water exchange. As a results, infected fish cured 55% after 7 days of treatment.

In mini ponds: Healthy Shing was infected with some infected Shing and density was 1000 Nos/dec. Forty percent affected fish was found within 2 weeks. Affected fish were treated with Ciprofloxacin @ 1g + vit.C 1 tab./kg feed for 5 days with water exchange and Ciprofloxacine mixed in pond water @ 5-7g/dec/3 feet water depth. Again, salt 250 g/dec. and lime 250 g/dec. were also applied at a single dose. Fourty (40) percent fish were cured.

Treatment trial at farmer's pond: Twenty Shing farmer's ponds were selected for Co-habitation trials. Treatment trials were initiated after two days of the disease outbreak. Grayish white spot in infected Shing has been treated with Ciprofloxacine @ 1g + vit.C 1 tab./kg feed for 5 days with water exchange and Ciprofloxacin mixed in pond water @ 5-7g/dec/3 feet water depth. Again, salt 250 g/dec. and lime 250 g/dec. were also applied at a single dose. Thirty (30) percent fish were cured.

Refinement of freshwater pearl culture techniques in Bangladesh

Researchers: Arun Chandra Barman, SO
Md. Harunor Rashid, SSO
Mohammad Ferdous Siddique, SO
Mst. Sonia Sharmin, SO

Objectives

- Determination of suitable culture techniques for maximum pearl production
- Dissemination of technology through on-farm trial and training.
- Refinement of image pearl culture technology

Achievements

The operated mussel having 2-4 number of inserted Nucleus were stocked in different culture techniques such as Net-bag hanging method and Grazing method in 3-4 feet water level of the pond. Organic and inorganic fertilizer was given fortnightly to the pond @3kg cowdung 100g T.S.P. and 100g urea per decimal. Growth of pearl is being monitored once in a month through sacrificing mussels. Water temperature, pH, plankton growth, organic matter, NH_4-N, PO_4-P, DO and Ca^{2+} parameters are being monitored fortnightly. On 23.07.13 pond no. 56 is stocked with 130 mussels with different nuclei such as Fish eyeball, Puti and dal. Result of the nuclei operation is giving below (Table 1).

Table 1. Nuclei insertion and their status

Sl no	Number of nucleus	Nucleus wt. (mg)	Nucleus size (mm)	Comments
P_1-P_{64}	4	15-17	1.5-1.8	Puti were used as nucleus. Four Puti were inserted into the mantle tissue
P_{65}-PP_{74}	4	15-17	1.5-1.8	Puti were used as nucleus. Four Puti were inserted
F_{86}-F_{108}	2	8.4-8.9	1.3-1.5	Two Eyeballs on both sides of mantle tissue
$F+P_{75}$– $F+P_{85}$	2	15-18	1.4-1.8	One Eyeball in one side and one green Puti in opposite side of mantle tissue
F_{109}-F_{115}	4	8.3-8.9	1.3-1.5	Four Eyeball on both sides of mantle tissue
D_1-D_{15}	4	15-18	1.7-1.9	Four dal on both sides of mantle tissue

After15 days of inoculation, first sampling was done and mussel no. P_{56}, F_{96}, P_{46}, D_{12}, P_{14} were sacrificed. Sampling showed that all sacrificed mussel kept nuclei. But 30 days of inoculation sampling showed that (P_{15}, D_5, F_{97}, $F+P_{79}$) mussels began to reject the nuclei and it remain continuing. Then the mussels were inserted with mantle tissue and nucleus together and culture environment was kept same (Table 2).

Table 2. Nuclei with mantle tissue insertion and their status

Sl no	Number of nucleus	Nucleus wt. (mg)	Nucleus size (mm)	Comments
$P+T_{1-50}$	2	15-17	1.5-1.8	Two Puti with mantle tissue slice were inserted into the mantle tissue.
$P+T_{51-140}$	4	15-17	1.5-1.8	Four Puti with mantle tissue slice were inserted into the mantle tissue.

After15 days of inoculation, Sampling was done and mussel no. $P+T_{38}$, $P+T_{45}$, were sacrificed. Sampling showed that all sacrificed mussel kept nuclei. After 30 days of inoculation Sampling showed that ($P+T_3$, $P+T_4$) mussels remain nuclei. Sampling after 60 days showed that ($P+T_{49}$, $P+T_{51}$) mussels remain nuclei and a pearly layer on nucleus is observed.

Demo farm activity: There were three demonstration farms such as: Uzanpara, Darirampur, Trishal, Shaon Fisheries, Boruka , Fulbaria, Bithimoni Breeding and fish farm, Konabari , Ishorgonj. Description of the demonstration farms are giving below (Table 3).

Table 3. Different parameters in Demonstration farm

Parameters	**Trishal**	**Fulbaria**	**Ishorganj**
No of Mussels	1000	500	500
pH	7.50	7.65	7.9
Dissolved Oxygen (mg/l)	5.20	5.5	6.0
Ca^{2+} (mg/l)	26	28.5	17.2
(%) Mussel containing pearl	76	83	48

Development of aquaponic techniques in Bangladesh

Researchers: 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

Achievement

After 80 days of rearing, fishes were harvested by netting. Total weight and number and individual weight and length of fish ware recorded. Indian spinach and green leaf were harvested fortnightly. Indian spinach and green leaf were planted on the tanks holding GIFT in T_1R_1, T_1R_2, and T_1R_3, respectively. Green leaf was planted on the tanks culturing *Anabas sp*. in T_2R_1 and T_2R_2, respectively. Green leaf was harvested 10 times and Indian spinach was harvested three times during the culture period.

Table 1. Growth and production performance of fish and vegetable

Treatment	**T_1R_1**	**T_1R_2**	**T_1R_3**
Stocking density (m^{-3})	60	60	60
Initial wt. (g)	1.3	1.3	1.3
Av. final wt.(g)	65	68	61
Total production (kg)	3.5	3.5	3.1
Yield kg m^{-3}	4.1	4.1	3.7
Wt. gain per day (g)	0.80	0.83	0.74
Survival (%)	99	99	97
Feeding rate (%)	5	5	5
Total fish (No)	53	53	53
Survived fish (No)	52	52	51

Treatment 1. GIFT harvesting (Batch 1**:** Aug – Oct, 80 days)

Treatment	**T_2R_1**	**T_2R_2**
Stocking density (m^{-3})	120	120
Initial wt. (g)	1.5	1.5
Av. final wt.(g)	45	43
Total production (kg)	10.5	8.30
Yield kg m^{-3}	6.2	4.7
Wt.gain per day (g)	0.52	0.50
Survival (%)	98	95
Feeding rate (%)	5	5
Total fish (No)	200	200
Survived fish (No)	196	190

Treatment 2. *Anabas* sp. harvesting

Replication	**Vegetable**	**Total Production /Tray(kg)**	**Yield kg m^{-2}**	**Survival (%)**
T_1R_1	Indian Spinach	1.0	0.66	100
T_1R_2	Indian Spinach	1.0	0.66	98
T_1R_3	Green Leaf	1.7	1.3	100
T_2R_1	Green Leaf	2.1	1.4	100
T_2R_2	Green Leaf	3.35	2.24	100

Vegetable harvesting

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

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

Objectives

- To validate the production technologies of Gulsha (*M. cavasius*), Pabda (*Ompok pabda*) and Rui (*Labeo rohita*) at different stocking densities;
- To validate the production technologies of Shing (*H. fossilis*), Magur (*Clarias batrachus*) and Tilapia (*O.nilotica*)
- To analyze the benefit -cost ratio

Achievements

Expt. 1. Culture of gulsha (M. cavasius), pabda (O. pabda) and rui (Labeo rohita) in farmer's pond

Pond selection and preparation: This technology was validated in 6 farmer's pond at Tangail Sadar, Sirajgonj Sadar and Belkuchi during October 2013 to May 2014. Before conducting this experiment, ponds were dried and cleaned for weed and unwanted aquatic animals. The dried ponds were left exposed to sunlight for several days and 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.

Fish stocking and management: The fry of Gulsha, Pabda and Rui were stocked at the stocking density of 75,000/ha, 25,000/ha and 2500/ha, respectively. After stocking, fish was fed at a rate of 5-20% of body weight with supplementary feed (30% crude protein). Feed adjustment was done through fish sampling.

Water sampling and analysis: Water quality parameters such as water temperature, transparency, pH, dissolved oxygen (DO) and total ammonia were analyzed at 15 days interval between 0900 to 1000 hrs.

Harvesting: After seven months rearing, fish 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.

Results: The physico-chemical parameters of different ponds of the project area viz., temperature, transparency; pH, dissolved oxygen and total ammonia of are presented in Table 1. The values of temperature, transparency, dissolved oxygen; pH and total ammonia were 18.6 – 31.0°C, 1.20-1.40 cm, 4.93-7.2 mg/l, 7.21-8.66 and 0.0-0.03 mg/l, respectively.

Table 1. Water quality parameters during experimental period

Parameter	Value
Water Temperature (°C)	18.6 – 31.0
Transparency (cm)	1.20-1.40
pH	7.32-8.25
DO (mg/l)	4.93-7.2
Total ammonia (mg/l)	0.0-0.03

Details of average growth and production performances are presented in table-2. After successful completion of trial, the mean harvesting weight of Gulsha, Pabda abd Rui were 35.12±3.01, 32.17±2.47

and 856±4.35, respectively. The survival rate of Gulsha, Pabda and Rui were 86, 75 and 98%, respectively. The production of Gulsha, Pabda abd Rui were 2.27, 0.61 and 2.09 MT/ha, respectively.

Table 2. Culture of Gulsha, Pabda and Rui in 2 upazila's and there production is given below:

No. of ponds	Stocking density/ha			Mean initial Wt. (g)			Harvesting wt. (g)			Production (MT/ha)			Total Product (MT/ha)
	Gulsha	Pabda	Rui	Gulsha	Pabda	Rui	Gulsha	Pabda	Rui	Gulsha	Pabda	Rui	
02	75,000	25,000	2,500	1.05± 2.45	2.50± 1.85	24± 2.29	35.12± 3.01	32.17± 2.47	856± 4.35	2.27	0.61	2.09	4.97

The benefit and cost analysis of gulsha, pabda and rui were calculated. 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, net benefit over a period of seven months of Tk. 6,87,900 /ha. The production as well as economic return was very promising and encouraging.

Expt. 2. Culture of shing (H. fossilis), margur (C. batrachus) and tilapia (O. nilotica) in farmer's pond

The physico-chemical parameters of different ponds of these project area viz., temperature, transparency, pH, dissolved oxygen and total ammonia of are presented in Table 4. The values of temperature, transparency, dissolved oxygen, pH and total ammonia were 20.05 – 29.54°C, 1.24-1.36 cm, 5.12-7.89 mg/l, 7.16-8.47 and 0.0-0.01mg/l, respectively.

Table 4. Water quality parameters during experimental period

Parameter	**Value**
Water Temperature (°C)	21.02 – 30.52
Transparency (cm)	1.24-1.40
pH	7.16-8.47
DO (mg/l)	5.12-7.89
Total ammonia (mg/l)	0.0-0.02

The average growth and production of Shing, Magur and Tilapia are shown in Table 5. After termination of seven months culture trial, harvesting mean weight of Shing, Magur and Tilapia were 37.23±3.14, 135.17±4.25 and 272±4.12, respectively where the total production was 8.08 MT/ha/7 months, respectively. The obtained results of production were more or less similar with on-station results.

Table 5. Culture of shing, magur and tilapia in 2 upazila's and there production

Stocking density/ha			Mean initial wt. (g)			Harvesting wt. (g)			Species wise production (MT/ha)			Total Product. (MT/ha)
Shing	Magur	Tilapia	Shing	Magur	GIFT	Shing	Magur	GIFT Tilapia	Shing	Magur	GIFT Tilapia	
75,000	25,000	12,500	1.25 ±2.21	3.5 ±1.89	4.0 ±0.87	37.23± 2.14	135.17 ±4.25	272± 4.12	2.38	2.67	2.96	8.08

The cost of production and return from culture of Shing, Magur and Tilapia were analyzed for evaluating the economic viability. 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, net benefit over a period of seven months of Tk. 9,84,185/ha was observed. In the present trial, higher production as well as higher net benefit was found rather than on station result. Farmers are very happy having such a good production of Shing, Magur and GIFT Tilapia.

Investigation on the access route of toxic drugs and chemicals in fish

Researchers: Mohammad Ashaf-Ud-Doulah, SO
Md. Shirajum Monir, SO

Objectives

- To know the access route of aquadrugs and chemicals in fish
- To know residue level of aquadrugs and chemicals in fish
- To find out the accumulation level of aquadrugs and chemicals in plankton, benthos and fish

Achievements

The fish were divided into four (T_1, T_2, T_3 and T_4) groups of 7 species (Carps, Pangas, Shing and Thai koi). The specimens were rearing in experimental mini ponds. The first (T_1,) second (T_2), third (T_3) and four (T_4) groups were exposed to melatheon 5ml/dec., tetracycline 2g/kg feed, chlortetracycline 2g/kg feed and oxytetracycline 2g/kg feed, respectively 15 days interval for culture in 90 days. Physicochemical condition of water during experimental period were also recorded such as; temperature 29.17 ^{0}C, dissolved oxygen 6.28 ppm, pH 7.27, alkalinity 180.12 ppm and amonnia 0.24 ppm.

Histopathological analysis: The experimental fish were sacrificed at the end of 90 days. Muscle, gill and liver and kidney tissues were removed and put in 10% buffered formalin. After fixation for 24-30 h, tissues were dehydrated through a graded series of ethanol, cleared in xylene, and infiltrated in the paraffin. Sections of 4-6 µm were prepared from paraffin blocks by using a rotary microtome. These sections were then stained with Hematoxylin-Eosin. Histopathological lesions were examined and photographed using Leica photomicroscope.

Gill: The most common changes in gill of catla (*Catla catla*) were hemorrhage (h), loss of secondary lamellae (ls), hyperplasia (hy), lamellar fusion (f), desquamation, and necrosis of epithelial, epithelial lifting, oedema, lamellar fusion, collapsed secondary lamellae and curling of secondary lamellae (cl) after using melatheon 5ml/dec (Figs. 1 & 2).

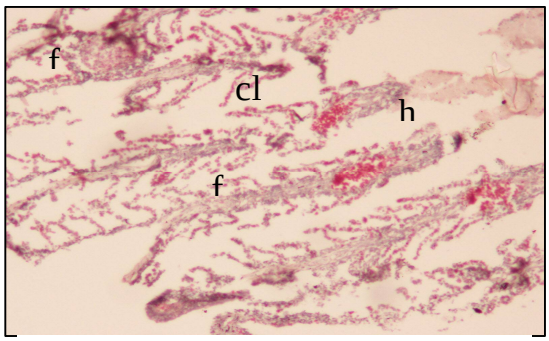

Fig. 1. Gill of catla.

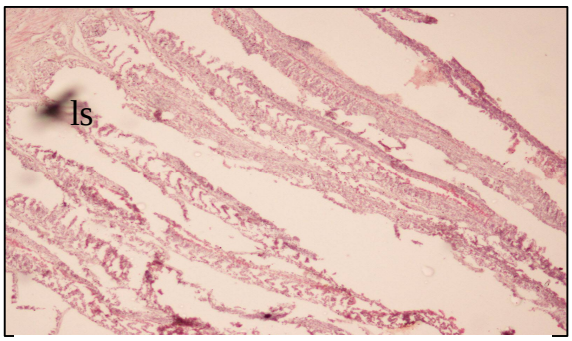

Fig. 2. Gill of catla.

Liver: In the liver tissues of rui (*Labeo rohita*) exposed to melatheon, vacuolated (v), cloudy swelling and disruption of hepatocytes (dh), hemorrhage (h) congestion, vacuolar degeneration, karyolysis, dilation of and nuclear hypertrophy were seen (Figs 3 & 4).

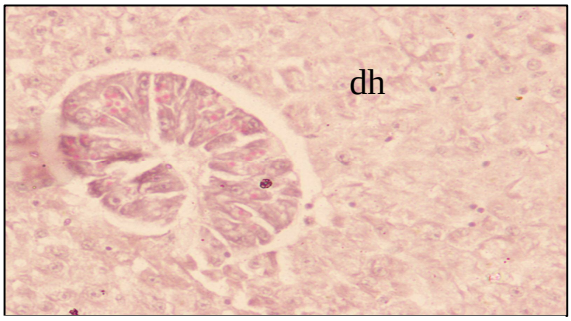

Fig. 3. Liver of rui.

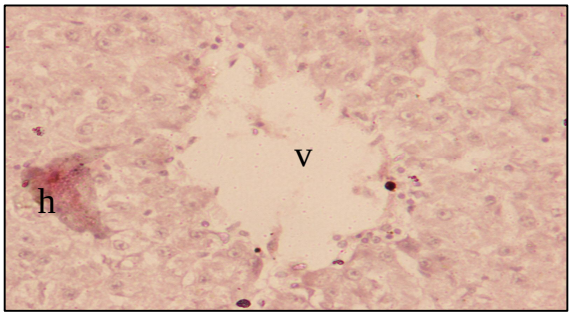

Fig. 4. Liver of rui.

me (h), in tubular cells, vacuolation of kidney tubules, mild damage renal tubules (mdrt), vacuoles mainly in the epithelium of the proximal tubules, hemorrhage and necrosis were seen (Figs 5 & 6).

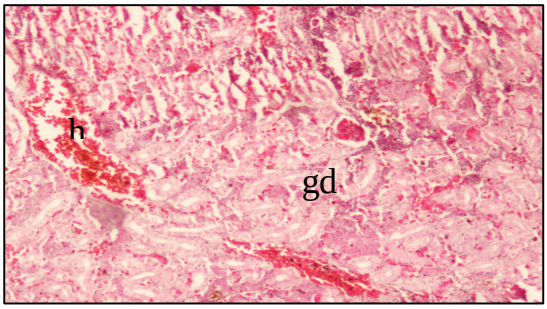

Fig. 5. Kidney of pangus

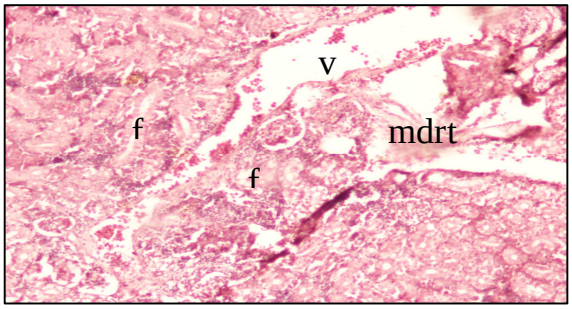

Fig. 6. Kidney of Pangus

Estimation of residue level in the experimental fish: Samples from different experimental fish such as pangas, catla, rui, mrigal were taken for detection of residue level of melathione, tetracycline, chlortetracycline and oxytetracycline. For the detection of melathine residue level, standard level was used 0.02 mg/kg body wt but residue level was not found in the basis of standard in the experimental fish. On the other hand, 100 ppd standard was used for the detection of residual level of different antibiotics but no residue level was found (Tables 1 & 2).

Table 1. Quantity of residue of pesticide and antibiotics estimated from experimental fish

Fish species	No of samples test	Detected residue	Level of residue	MRL set by FAO	Remarks
Pangas	10	Melathione	0	0.02 mg/kg body wt	Not detected
Catla	10	Tetracycline	0	100 ppb	
Rui	10	Chlortetracycline	0	100 ppb	
Mrigal	10	Oxytetracycline	0	100 ppb	

Table 2. Quantity of residue of pesticide estimated from farmers fish ponds

Fish species	No of samples test	Detected residue	Level of residue	MRL set by FAO	Remarks
Plankton	2	Melathione	0	0.01 ppm	Not detected
Catla	2	Fenitrothion	0	0.02 ppm	
Rui	2	Diazinon	0	0.02 ppm	
Mrigal	2	Quinalphos	0	0.01 ppm	
Koi	2	Chlropyriphos	0	0.01 ppm	

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 develop natural and artificial breeding technique *M. cuchia*
- To determine effective hormone and optimum dose for successful induce breeding of *M. cuchia*
- To determine suitable habitat and food on the basis of larval production
- To determine whether artificial breeding of *M. cuchia* is suitable or not
- To study availability, marketing channel, export and future potentiality of *M. cuchia*

Achievements

Expt. 1. Natural breeding in pond

Two mini earthen ponds (each 5 decimal) were prepared by sun drying followed by liming at the rate of 1kg/dec. After drying up the ponds, Urea, TSP and Cowdung were applied at the rate of 0.10kg, 0.075kg and 8kg/decimal, respectively. Water depth was maintained at about 1.0 m. Fencing was done with nylon net, bamboo and rope to prevent entering of different creatures. A total 35 pairs of broods (female average B.W 340g & male average B.W 230g) were stocked during 1st week of March/14 in each pond. The stocked broods were fed with ½ kg moribund fingerlings of Taki, Guchi and Puia weekly and ½ kg spawn of Carpio during experimental period. The feeds were applied at the rate of 2-3% of body weight. Water hyacinth, Helencha and PVC pipes were provided in the pond to create suitable and safe shelter. The pond was fertilized at fortnightly. Water quality parameters such as DO, pH, temperature (°C), and alkalinity (mg/L) were 6.32±1.11, 7.53±0.2, 30.40±1.66 & 179.45±2.63, respectively. During 12 June/2014, an attempt was made to identify the spawning nests/holes and collected naturally spawned juveniles from the pond. During collection of larvae, parents were found in every hole. *Monopterus cuchia* provides parental care and guarded their larvae. Larvae were collected from the holes. About 10% larvae were found with yolk-sac. Yolk-sac was absorbed in the rest. After collection larvae were shifted into cistern and tray. Bottom of cistern and tray were covered by clay mud and length-weight of fry were recorded. First 3 days, boiled egg's yolk was supplied daily in the morning and next two times of the day earthworm's juice was provided. After 3 days earthworm's juice and zooplankton were provided.

Expt. 2. Induced breeding in pond

Broods were reared in a pond with feed and fertilizer following the methods as stated above. In case of induced breeding in pond, a rectangular pond (size 5 deci.) was selected. The best broods were selected during May-June, when the cuchia attained gonadal maturity. A total 15 pairs of brood cuchia were injected and stocked in the pond for breeding. Pregnyl was applied as inducing agent (Table 1). Single dose of Pregnyl was applied to both the female and male. After hormone treatment, the broods were released in the pond for natural spawning and feeding with 500g moribund fingerlings of Taki, Guchi, Puia weekly and 500g fry of Carpio during experimental period. Mean water temperature (°C), DO, pH and alkalinity (mg/L) were 30.58±1.72, 6.55±1.21, 7.47±0.84 and 180.18±1.75, respectively. After 38 days, attempts were made to identify the nests/holes and juveniles were collected from the nests by complete dewatering the pond.

Table 1. Hormone treatment for breeding of *M. cuchia* in pond

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

Expt. 3. Induced breeding in cistern

Cistern having a dimension of 2.74 x 1.82 x 1.00 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 and Checca PG were applied in different cisterns (Table 2) and one cistern was used as control (No hormone applied). Earthworm, dead/moribund Guchi, Taki and Puia were supplied as food for injected *M. cuchia*. During the experimental period, mean water temperature (°C), dissolved oxygen (mg/L), 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. Observations were made on the effect of such hormone treatments. Ovulation was not observed with the female received double doses of 30mg cPGE and 30 mg cPGE/kg BW and the male received 30 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 + 40 mg cPG/kg BW and the male received 20 mg cPGE/kg BW but ovulation was not also observed. Again another female received single doses of 20 mg Checca PG/kg BW and male received 10 mg Checca pg/kg B.W but male and female did not respond to this hormone treatment. Ovulation was not also observed from control in which no hormone applied.

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

Female	Male
Double dose: 30 mg cPG and 30 mg cPG/kg BW	30 mg cPG/kg BW
Double dose: 20 mg cPG and 40mg cPG/kg BW	20 mg cPG/kg BW
Single dose: 20 mg Checca PG/kg BW	10 mg Checca PG/kg BW
Single dose: 40mg cPG/kg BW	20mg cPG/kg BW
Control: No hormone applied	Control: No hormone applied

Expt. 4. Effects of different foods on growth and survival of M. cuchia spawn in tray

The experiment was conducted for 21 days with 10 days old spawn. The area of each tray was 0.75 m^2 and depth of water was from 10-12cm. Experimental trays were made of still sheet. Floor and side walls of tray were covered by soil to create suitable and natural environment for *M. cuchia* like as pond bottom. Stocking density was kept at 2000/m^3 for all treatments with three replications. The experiment was conducted in four treatments with zooplankton (Treatment-1), earthworm pest (Treatment-2), small fish pest (Treatment-3) and nursery feed (Treatment-4). Feeding rate was adjusted at 50% - 20% of body weight/day. Feeding frequency was twice a day. Growth and survival rate were recorded in seven days interval. Water shower provided on each tray that maintained continuous flow of water and helped to clean the tray. Water quality parameters were recorded in seven days interval. Initial mean length (cm) and weight (g) of stocked fry were 4.7 ± 0.277 cm and 0.069 ± 0.007 g in each tray. After 21 days of rearing, it was observed that highest final mean length and weight of juvenile were found from T_2 and lowest final mean length and weight were found from T_3 respectively (Table 3).

Table 3. Growth performance of *M. cuchia* with different feeds

Growth parameters	Zooplankton (Treatment-1)	Earthworm pest (Treatment-2)	Small fish pest (Treatment-3)	Nursery feed (Treatment-4)
Initial length (cm)	4.70 ± 0.28	4.70 ± 0.28	4.70 ± 0.28	4.70 ± 0.28
Initial weight (g)	0.069 ± 0.01	0.069 ± 0.01	0.069 ± 0.01	0.069 ± 0.01
Final length (cm)	5.54±0.24	5.56±0.30	4.87±0.30	5.13±0.27
Final weight (g)	0.122±0.01	0.124±0.01	0.076±0.02	0.102±0.02
Weight gain (g)	0.053	0.055	0.007	0.033
(%) Weight gain	76.6	79.7	10.14	47.8
Survival (%)	91	92	80	82
Specific growth rate	1.18	1.21	0.20	0.81

Survey on availability, marketing channel and export potentiality of Monopterus cuchia in Bangladesh

Eel marketing system and channel: In fish marketing systems, there are a number of people involved in the study areas. The market chain from collector to consumers passes through a number of intermediaries like wholesalers, arotders, exporters and buyers. Collector directly sells their eel to wholesalers or through local agents. In some cases, local beparies collect freshwater eel from the collectors (Fig.1). In the study areas maximum number of collectors, sellers or supplier take small amounts of dadon (credit) from arotders to ensure the supply of eel. Sellers and arotders commonly use mechanical vehicles (trucks, pickup and microbus) to transport eel from local area to Dhaka packing centers which takes 6-7 hours depending on the communication system. Aluminum containers, plastic drums and bamboo baskets with polythene covers are commonly used for keeping freshwater eel alive during the transport. Finally exporter export freshwater eel by cargo plane.

Culture potentials and feasibility: In Bangladesh, freshwater eel is an export fishery that playing an important role in international markets. Though eels have not yet been given any attention, its culture and collection could be considered as an alternative option for poor peoples and an immerging trade for fishery product traders. There are four species of eel, *Monopterus cuchia, Anguilla bengalensis, Pisodonophis boro* and *Pisodonophis cancrivorus* available in Bangladesh, in which *Monopterus cuchia, Anguilla bengalensis* and *Pisodonophis boro*, are presently exported to Japan, Korea, HongKong, Thailand, China and Taiwan. Bangladesh has great opportunity to develop eel farming industry because it has vast water resources such as rivers, haors, baors, beels, canals and floodplain. Every year huge amount of eels are collected from these water bodies. A research has been conducted on eel by BFRI that, freshwater eels can be cultured in pond and breed in pond successfully.

Adoption of mass seed production and development of suitable culture technologies of some commercially important fish species in the North-West Bangladesh

Researchers: Kh. RashidulHasan, SSO
Dr. ShafiqurRahman, SSO
MalihaHossainMou, SO

Objectives

- To develop induced breeding and nursery techniques of tengra (*Mystusvittatus*)
- To develop culture technique of *M. vittatus*
- Adoption of Thai-koi, shing, GIFT and Thai-sarpuntipolyculture techniques at Saidpur

Achievement

Development of brood rearing techniques of M. vittatus

Semi adult tengra (*M. vittatus*) fish have been collected from Teesta Barrage Irrigation canal, floodplains and local markets in greater Rangpur region and stocked in well-prepared ponds at a density of 80-120 decimal^{-1}. The fish are fed with supplementary feed comprising 20% rice bran, 30% fish meal, 20% mustard oil cake, 25% meat bone meal and 1% vitamin and mineral premix at the rate of 6-8% of body weight. To ensure natural feeds, the pond is being fertilized at fortnightly intervals with organic fertilizer (4 kg decimal^{-1}) as well as inorganic fertilizer (200 g decimal^{-1}; urea & TSP). Pond water is being exchanged with underground water regular basis to facilitate gonad development of the fish. After 5 (six) months, the growth performances of *M. vittatus*in captive condition are shown in Table 1.

Table 1. Growth performance of *M. vittatus* under three different stocking in captive condition

Parameters	Treatments		
	T_1	T_2	T_3
Stocking density (nos decimal^{-1})	80	100	120
Stocking size (g)	6.64±2.3	6.64±2.3	6.64±2.3
Culture period (months)	5	5	5
Av. final size (g)	18.0±1.7	16.2±5.1	14.4±2.8
Survival	82	80	78
ADG (g day^{-1})	0.08	0.06	0.05
HC (g cm^{-1})	1.33	1.12	1.09

Studies of reproductive parameters of M. vittatus

The fish collection process is still continuing for the studies of reproductive parameters like; sex ratio,gonadosomatic index (GSI), ova diameter, and fecundity and to know the spawning seasion of *M. vittatus.* A total of 246 tengra fishes have been collected during January 2014 to June 2014. The sex ratio and GSI of collected fishes have been studied monthly; the results are shown in Table 2.

Table 2. Sex ratio and GSI value of collected *M. vittatus*

Month	♂	♀	Sex ratio (♂:♀)	GSI% (♀)
January, 14	33	16	1:0.48	-
February	20	11	1:0.55	0.26±0.17
March	28	15	1:0.54	11.20±1.99
April	25	16	1:0.64	17.00±6.86
May	20	12	1:0.60	22.00±3.83
June	30	20	1:0.67	36.59±7.42
Total/average	156	90	1:0.58	14.51±13.96

Development of breeding techniques of M. vittatus

The broods (2♂:1♀**)** were injected a single doses Ovatide at the rate of 1.0, 1.5 and 2.0 ml kg^{-1} in both the males and females respectively in T_1, T_2 and T_3. Immediately after administering the hormones spawnerswere released into breeding hapa settled in the concrete tanks of the hatchery (capacity: 500 l) containing dechlorinated tap water (temperature: 27-31°C; DO: 5.9-6.5 ppm; CO_2: 3.0–4.0 ppm; pH: 7.8-8.2). Different doses were used to optimize desired hormone doses to detect ovulation, fertilization, spawning, hatching, survival to yolk sac absorption. After 22-30 hrs of injection, ovulation was occurred in all cases. Of them, 1.5 ml kg^{-1} showed the best breeding performances in terms of egg output rate,

fertilization rate, hatching rate and survivability of hatchling. After absorption of yolk sac (2-3 days), the spawn were transferred into metallic trays and fed on Artimea up to 10 days to optimize rearing condition of larvae. The latency period, incubation temperature, spawning remarks is presented in the Table 3. The egg output rate, fertilization rate, hatching rate and survivability of hatchling are given in Table 4.

Table 3. Spawning response of *M. vittatus* (1.5♂:1♀ ratio) using single doses of ovatide

Treats.	Ovupin-super doses (ml kg^{-1})		Latency period (hrs)	Incubation temperature (^{0}C)	Remarks
	♂	♀			
T_1	1.0	1.0	22-23	22-30	Successful ovulation, higher fertilization and hatching were observed
T_2	1.5	1.5	22-24	22-28	Successful ovulation, highest fertilization and hatching rate were observed
T_3	2.0	2.0	22-23	22-28	Successful ovulation, good amount of fertilization and hatching were observed

Table 4. Spawning performances of *M. vittatus*(1.5♂:1♀ ratio) using single doses of ovatide

Treats	Parameters values (Mean±SE)			
	% of egg release	% of fertilization	% of hatching	% survival of 03 days hatchling
T_1	100.0^{a}±0.0	72.3^{c}±1.5	59.0^{c}±0.6	53.0^{c}±1.5
T_2	100.0^{a}±0.0	87.7^{a}±1.5	72.7^{a}±0.7	63.3^{a}±0.9
T_3	100.0^{a}±0.0	79.3^{b}±0.7	69.7^{b}±0.9	58.3^{b}±0.9

Different superscripts in the same column represent significant difference (P<0.05) of mean values

Development nursery rearing techniques of M. vittatus

For the development of fry rearing/nursery rearing technique of tengra,10-12 days old fryhave beenstocked in well-prepared nursery ponds at different stocking densities (8,000, 12000, 16000 fry $decimal^{-1}$) under three treatments having three replications each. Water quality parameters and growth performances of fry for each experimental pond are being monitored at fortnightly intervals. The experimental design is presented in Table 5.

Table 5. Experimental design of nursery rearing of *M. Vittatus*

Treatments	Stocking density (no. $decimal^{-1}$)	Feeding/culture period
T_1	8,000	Commercially catfish feed (containing 35% protein**)**; application**:** 25-10%, twice daily. Culture period:-45 days
T_2	12,000	
T_3	16,000	

Investigation, diagnosis, control and prevention of commonly occurring fish diseases in Jessore region

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

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. List of the data respondents and information are tagged in.

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

Development of mass seed production technique of *Pangasius pangasius*

Researchers: Akhery Nima, SO
Md. Mehedi Hasan Pramanik
B.M. Shahinur Rahman, SO

Objectives

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

Achievements

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 3.0-3.5 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 4 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) & 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	24	26	24	-	-	16	-	20
December	24.5	29	27	-	-	18	-	22
January	25	32	30	-	-	19	-	24
February	30	34	26	-	-	-	-	-

Biomonitoring of the rivers Padma, Meghna and Dakatia

Researchers: Shanur Jahedul Hasan,SO
Akhery Nima, SO
Md. Istiaque Haider, SO
Avijit Basu, 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

Padma, Meghna and their branches and tributaries are intricately associated with the existence of Bangladesh. Fish and fishery resources of these rivers are the main source of livelihood for a number of peoples of the country. The aquatic ecosystem of these rivers is still better than the many rivers of upstream, but situation is gradually declining as the surface runoff coming from the upstream rivers are mixing with this and imposing threats for its longer wellness.

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 13.53±6.40 feet (Hajiganj) to 58.32±36.23 feet (Meghna ghat) . Transperancy also varied among the study sites in a wide range which was highest in Hajiganj 135.33±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.

Occurence of plankton in Padma, Meghna and Dakatia: Abundance of plankton in three river systems showed a wide range of variation (Fig. 1-8). 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.

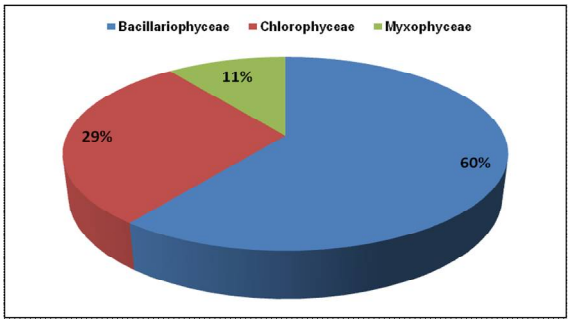

Fig 1. Phytoplankton composition of Padma

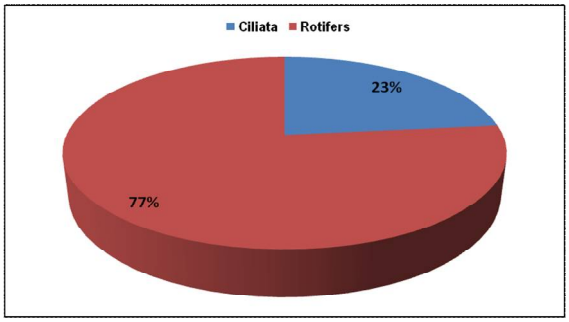

Fig 2. Zooplankton composition of Padma

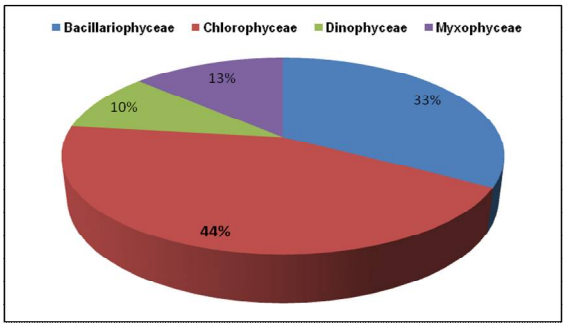

Fig 3. Phytoplankton composition of Meghna

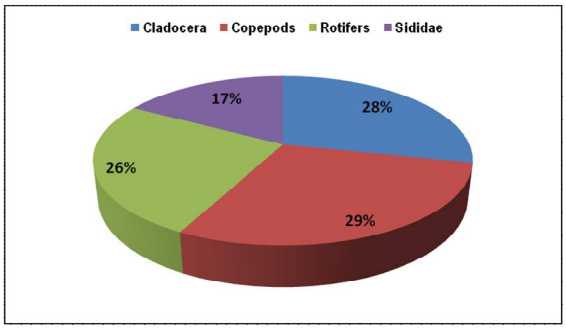

Fig 4. Zooplankton composition of Meghna

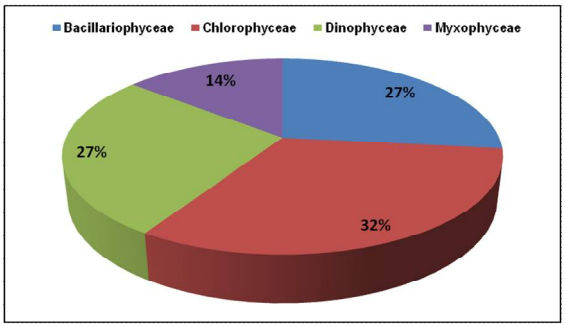

Fig 5. Phytoplankton composition of Dakatia

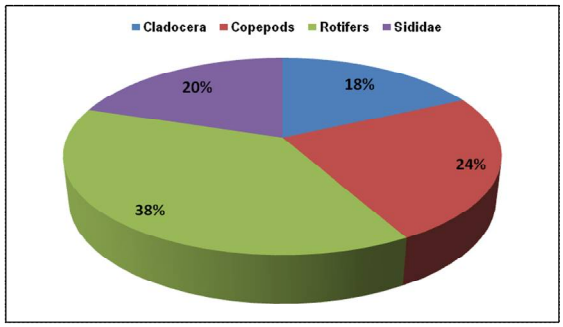

Fig 6. Zooplankton composition of Dakatia

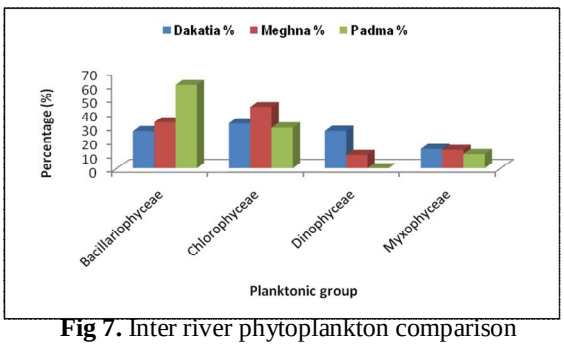

Fig 7. Inter river phytoplankton comparison

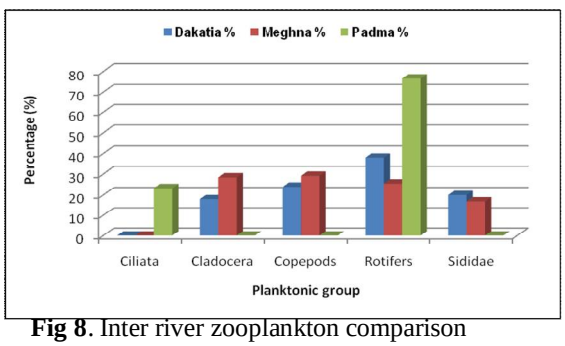

Fig 8. Inter river zooplankton comparison

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, 3, 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
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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

Impact of environmental factors on abundance and distribution of important fishes in the River Meghna

Researchers: Md. Robiul Awal Hossain, SSO
Shanur Jahedul Hasan, SO
Md. Mehedi Hasan Pramanik, SO
Md. Istiaque Haider, SO

Objectives

- To study the environmental factors in different season;
- To study the abundance and distribution of important riverine fishes in different season; and
- To find out the correlation between environmental factors and abundance and distribution of fishes

Achievements

Meghna is a very significant water body, the major nursery grounds of hilsa (*Tenualosa ilisha*) and many other commercially important riverine fishes such as Ayre, Boal, Pangas, Rita, Shillong etc.The availability of the aforesaid fishes are declining day by day and some of them are threatened. The primary productivity of a water body is the manifestation of its biological production which is depend on different environmental factors like temperature, photoperiod, rainfall, pH, DO, free CO2 etc. Factors such as water level, meteorological factors like light intensity, photoperiod, rainfall, wind velocity, etc., and hydrological cycle (inflow and outflow) have great influence on the rate of primary production in lacustrine and flowing waters. Seasonal variation of different environmental factors are necessary to asses for abundance and distribution of important fishes of the Meghna river (Shatnol-Alexander).

A comprehensive survey was conducted before initiating the main project work and now one year research work has been completed. This study comprises thirteen sampling points of Meghna. The purpose of this survey was findings of the project will be assessed to what extent the environmental factors are affecting the abundance of the important fishes; and relation between environmental factors in different season and distribution of important fishes of the Meghna river

Physico-chemical parameters: Temperature (Air and water), transparency, dissolved oxygen (DO), free carbon dioxide (CO_2), hardness, total alkalinity were determined following APHA (1995). Ammonia and nitrite were estimated using a HACH water test kit (model-FF-2). Conductivity and pH meter were used to determined water pH and specific conductance respectively. Three physical and seven chemical parameters were studied for river spots of Meghna (Table 1).

Table 2. Values of water quality parameters (Range)

Parameters	Air Temp. °C	Water Temp. (0c)	SD Tran. (cm)	DO (mg/l)	Free CO_2 (mg/l)	pH	Hardness (mg/l)	T. Alkalinity (mg/l)	Conductivity (µS/cm)	Ammonia (NH3 mg/l)
MG	15.6-37	17.8-30	25-59	5.5-6.5	8.4-10	7.75-8.25	60-68	29-50	148-280	00-0.03
AB	21-37	21.1-30	26-50	6.15-6.35	10.4-16.5	7.75-8.5	46-88	48-62	163-281	0.0
Ep	22-26	20-29	16-66	5.0-6.0	8.0-13.4	7.25-7.5	35-67	27-48	141-263	0.0
Sn	18.9-25	21.11-29	38.3-62	4.0 -6.35	5.6-13.8	7.25-7.5	36-69	30-50	137-268	0.0
HG	22.2-26	19-24	45-75	7.2-7.3	5-5.2	8.25	88-90	41-45	272-290	0.02-0.03
HC	21-32	18.9-29	35-50	5.3-5.7	9.5-12	8.0	120-185	130-132	223-277	0.0
CV	16.7-32	16.1-29.5	33-56	5.7-7.3	12-17	8-8.25	102-124	58-132	211-275	0.0
Ib	20	18.9	41	7.2	15	8.25	121	79	282	0.0
CJ	21.1	19.4	40	7.12	15.1	8.25	120	80	288	0.0
Hz	22.2-30	21.1-28	21-39	5.2-7.1	9.2-14	8.0-9.0	48-97	29-71	176-199	0.0
Kg	22.2-30	20.0-30	19-30.0	3.5-7.21	15-17	7.75-8.25	85-103	38-71	174-279	0.0
Axr	18.9-30	19-30	5-14.0	3.7-6.5	13.0-14	8.0	417-802	100-145	370->1000	0.0

Air temperature and water temperature range was limited from 15.6-30.00°**C** and 16.1-29°**C** respectively. Transperancy also varied among the study sites in a wide range which was highest in Eklashpur 16-66cm and lowest in Alexanzar 5-14cm. Some of the parameters range were indicating the gradual fading of the freshness of rivers.

Plankton sample collection: Replicate plankton samples, each of 50 L were collected from various spots around each sampling station by means of a bucket and filtered through bolting silk plankton net of 50µ. The filtrate were transferred to another bottle and preserved immediately in 1:100 Lugol's solution. Qualitative and quantitative analysis of planktons were done following drop count method (APHA 1995). Identification of plankton were made following Ward and Whipple (1959) and Presecot (1962).

Table 2. Dominating genera of plankton in different sampling point

Place	Phyto. (No./L)	Domi. P. (No/L)	Zoo. (No./L)	Domi. Z. (No/L)
MG	158×10^2	Ulothrix (100×10^2)	39×10^2	Brachionus (32×10^2)
AB	55×10^2	Ulothrix (23×10^2)	14×10^2	Brachionus (11×10^2)
Ep	283×10^2	Melosera (139×10^2)	3×10^2	Nauplius (2×10^2)
Sn	48×10^2	Ulothrix (21×10^2)	10×10^2	Brachionus (6×10^2)
HG	330×10^2	Ulothrix (285×10^2)	20×10^2	Brachionus (17×10^2)
HC	326×10^2	Ulothrix (288×10^2)	12×10^2	Brachionus (12×10^2)
CV	376×10^2	Ulothrix (312×10^2)	11×10^2	Brachionus (7×10^2)
Ib	386×10^2	Ulothrix (325×10^2)	30×10^2	Brachionus (22×10^2)
CJ	375×10^2	Ulothrix (325×10^2)	35×10^2	Brachionus (20×10^2)
Hz	529×10^2	Ulothrix (459×10^2)	27×10^2	Brachionus (27×10^2)
Kg	571×10^2	Ulothrix (488×10^2)	26×10^2	Brachionus (15×10^2)
Axr	234×10^2	Ulothrix (216×10^2)	8×10^2	Nauplius (4×10^2)
CL	258×10^2	Ulothrix (213×10^2)	9×10^2	Brachionus (7×10^2)

The dominating phytoplankton is ulothrix in Hazigang (459×10^2) and kaligang (488×10^2), consequently zooplankton in Hazigang (27×10^2) representing the abundance of fish.

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

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

Objectives

- To find out the seed quality and 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 to find out the probable remedial measures in cage culture
- To monitor the water quality during the culture period

Achievements

Growth performance of probiotics treated nursery reared Monosex tilapia 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 12 May 2013 to 10 November 2013. The stocking density was 50/m^3 for all treatments. Average weight of 33.66±6.23gm no probiotics treated monosex tilapia fingerlings were stocked in T_1 (control). Average weight of 33.66±6.23gm probiotics treated nursery reared fingerlings with 2gm probiotics/kg feed and 3gm probiotics/kg feed were stocked in T_2 & T_3 respectively. A commercial probiotic named "Biotics" manufactured by Anova Pharma Joint Stock Company, long An Province, Vietnam was used for the experiment and its composition is given in Table 1. Feeding has been done with pelleted semi-buoyant feed at 5-3% body weight concurrently twice daily. Average weight (gm) of final harvest (120 days), SGR (% day), FCR, Survival rate and production of all treatments are shown in Table 2.

Table 1. Composition of per kg "Biotics"

Ingredients	**Quantity**
Sacchromyces cerevisiae(Min)	1.75×10^{11} CFU
Lactobacillus acidophilus	1.5×10^{9} CFU
Bacillus subtilis	2.1×10^{9} CFU
Aspergillus oryzae	1.5×10^{9} CFU
amylase	3042 IU
Protease	11950 IU
Cellulase	500 IU
Lipase	870 IU
Beta-glucanase	1957 IU
Xylanare	739 IU
SiO_2	25%
Al_2O_3	4%
CaO	1%
Na_2O	0.025%
MgO	0.5%
Fe_2O_3	0.5%

In this study, there were no significant differences ($p<0.05$) in initial mean weight 33.66±6.23gm among treatments. Final weight in probiotic treated cages (cages belong to T_2 and T_3) was significantly ($p<0.05$) higher than control (T_1). Average weight was recorded higher in fish fed with probiotic supplement. Weight gain was found to be highest (Table 2) in T_2 which was significantly different from both T_1 and T_3. In case of ADG the result was as same as weight gain. SGR was significantly higher in T_2 than that of T_1 and T_3. FCR was the best in T_2 and significantly different from T_1 but not from T_3 (Table 2). Survival rate and production per cage was also highest in T_2 and in case of production per cage it was significantly different from both T_1 and T_3.

Table 2. Growth parameters of monosex tilapia observed in different treatments

Growth parameters	Treatments		
	T-1	T-2	T-3
Mean initial weight(gm)	33.66±6.23	33.66±6.23	33.66±6.23
Mean final weight(gm)	207.90±7.01[a]	271.48±13.69[b]	240.07±6.35[c]
Weight gain(gm)	174.24±7.01[a]	237.82±13.69[b]	206.41±6.35[c]
Average daily gain (gm)	1.45±0.058[a]	1.98±0.11[b]	1.72±0.05[c]
SGR (% per day)	1.52±0.028[a]	1.74±0.042[b]	1.64±0.021[a]
FCR	1.41±0.057[a]	1.11±0.047[b]	1.29±0.12[a b]
Survival rate (%)	95.76±0.86[a]	97.54±0.65[b]	96.94±0.40[a b]
Production (kg/cage)	357.62±14.01[a]	476.79±27.41[b]	418.94±12.65[c]

The water quality parameters were monitored fortnightly in the adjacent area of experimental cages in Dakatia river, Chandpur by HACH water test kit (model-FF2). The levels of all the water quality parameters did not show any deviation from acceptable limit throughout the culture period (shown in Table 3).

Table 3. Water quality parameters of the area adjacent to the experimental cages

Dissolve O_2 (mg/l)	**Free CO_2 (mg/l)**	**pH**	**NH_3 (mg/l)**	**Total alkalinity**	**Total hardness**	**BOD (B) (mg/l)**	**BOD (N) (mg/l)**
7.29±1.04	3.18±0.79	8.25±0.35	0.10±0.14	132.98±16.23	164.16±21.51	5.85±2.50	7.69±1.62

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

Achievement

During the experimental period 50 cages were installed near the Riverine Sub-Station, Ranganmati and Kaptai SadarUpazila. The sizes of the each cage were 3mX3mX2m. For the making of the cages the

material used are-knotlessplastic net (mesh size 1.1 cm), plasticdrum, bamboo, covering net etc. The fish fingerlings (average initial weight 15g) were stocked @ 30 fish/m^3, 50 fish/m^3,70fish/m^3, 90 fish/m^3as T_1, T_2, T_3 and T_4 respectively. Feeding was done regularly usingpelleted 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. The growth and production performance of Thai Koi (*Anabas testudineus*) in four different treatments are presented in Table 1.

Table 1. Growth and Survival rate of Thai Koi (*Anabas testudineus*) 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	5.74±0.21	4.13±0.50	11.71±0.790	37.90±6.30	71	1.84	2.65
T_2	50	5.82±0.21	4.31±0.60	12.10±0.66	40.47±5.15	68	1.87	2.72
T_3	70	5.66±0.27	3.86±0.63	11.98±0.81	39.94±7.09	63	1.95	2.84
T_4	90	5.98±0.26	4.50±0.58	11.18±0.77	31.37±6.72	59	1.63	2.93

The average production in each treatment was 1.48 kg/ m^3, 1.41 kg/ m^3, 1.37 kg/ m^3 and 1.29 kg/ m^3 in T_1, T_2, T_3 and T_4 respectively. The average production and the survival rate of T_1 (30fish/m^3) were higher than other treatment. So the lower stocking density of Thai Koi (*Anabas testudineus*) can be recommended for the cage culture.

Water quality parameters: A summary of values (Mean ± SD) of water quality parameters measured in the cages during the experimental period are presented in Table 2.Water quality parameters were within suitable range for fish production throughout the experimental period.

Table 2. Water quality parameters of cage culture area

Parameters	Values (Mean ± SD)
Water Temp(°C)	78.17±1.32
DO(mg/L)	6.18±0.67
CO2(mg/L)	9.14±1.36
pH	7.52±0.67
Total Hardness(mg/L)	58.13±5.62
Total Alkalinity(mg/L)	57.37±6.34
Ammonia(NH3)	Nill

Impact of brush shelter on the production potentiality of Kaptai lake

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

Objectives

- To know the species composition and abundance in the brush shelter
- To evaluate the impact of brush shelter on the breeding success of different fish species

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 in this year two brush shelter were harvested from every upazilla. Brush shelter was preparedby two typesof 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 wereused 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 likeMethi, akangi, fish call powder were used to attract fish before harvesting.

Expert fishing team was hired for fishing in brush shelter. Seine net (Jukjal) 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.

Water quality parameters: Water quality parameters were analyzed to observe any appreciable changes that might have occurred in response to different areas of Kaptai Lake. The result of the water quality analysis indicated the suitable ranges of quality parameters for fishes in different study areas of Kaptai Lake (Table 1). The growth of fish and other aquatic organisms strongly depends on the water quality. In the present study we investigated all physical and chemical factors of water quality parameters of different study areas of Kaptai Lake.

Table 1. Mean values of water quality parameters from different four areas during the study period

Parameters	Different areas of Kaptai Lake			
	Rangamati Sadar	**Kaptai**	**Langadu**	**Barkol**
Air temperature (^{0}C)	26.25±3.54 (20-30)	26.75±2.82 (23-31)	26.5±2.45 (23-30)	28±2.14 (25-31)
Water temperature (^{0}C)	25.75±3.24 (21-29)	26.5±2.27 (22-29)	25.5±2.62 (22-29)	27.13±1.96 (24-30)
Dissolved Oxygen (mg/l)	6.13±0.26 (5.83-6.44)	6.06±0.46 (5.52-6.92)	5.98±0.26 (5.61-6.34)	6.58±0.54 (5.68-7.34)
CO_2 (mg/l)	2.64±0.57 (1.87-3.46)	3±0.78 (1.95-4.03)	2.99±0.6 (2.13-3.96)	3.09±0.56 (2.36-3.99)
pH	7.94±0.45 (7.37-8.62)	7.62±0.14 (7.5-7.85)	7.62±0.14 (7.42-7.80)	7.22±0.4 (6.75-7.85)
Total alkalinity (mg/l)	63.05±4.77 (53.50-68.75)	61.90±6.57 (52.56-70.50)	62.17±6.53 (54.24-70)	58.57±3.74 (53.56-65.6)
Transparency (m)	1.97±0.24 (1.65-2.22)	1.90±0.39 (0.99-2.19)	2.08±0.08 (1.95-2.18)	2.02±0.53 (0.95-2.85)
Water depth (m)	9.79±3.88 (4.8-15.4)	10.78±4.41 (5.4-17.5)	12.8±3.82 (7.2-18.4)	11.39±3.89 (7.1-18.1)

Species composition: Species composition was recorded according to the group and order of fish and prawn during the period of harvesting. The result of percentage composition and species composition and abundance of fishes from the harvested brush shelter has been presented in Tables 2 & 3 respectively.

Table 2. Species composition from the brush shelter in Kaptai Lake

Group	Order	Local Name	Scientific Name	Contribution in Total Production (%)
FISH	Siluriformes	Kajuli	*Ailiacoila*	4.82
		Gulsa	*Mystuscavasius*	8.54
		Tengra	*Mystusvittatus*	6.35
		Pabda	*Ompokpabda*	5.09
		Boal	*Wallagoattu*	12.48
	Cypriniformes	Air	*Sperataaor*	6.68
		Calibaush	*Labeocalbasu*	16.86
		Bata	*Labeobata*	4.87
	Perciformes	Tilapia	*Oreochromisniloticus*	9.64
	Channiformes	Shol	*Channastriatus*	5.80
		Gajar	*Channamarulius*	4.82
	Osteoglossiformes	Foli	*Notopterusnotopterus*	4.97
	Synbranchiformes	Baim	*Mastacembelusarmatus*	2.68
	Others (Fish and Small prawn)			6.39

Table 3. Abundance of Fishes in brush shelter in different areas of Kaptai Lake

RangamatiSadar	Kaptai	Barkol	Langadu	Abundance
Calibaush	Calibaush	Kajuli	Tilapia	High
Boal	Gojar	Calibaush	Calibaush	High
Kajuli	Shol	GulsaTengra	Boal	High
GulsaTengra	GulsaTengra	Boal	GulsaTengra	Medium
Pabda	Tilapia	Pabda	Baim	Medium
Air	Boal	Baim	BujuriTengra	Medium
Shol	Foli	Air	Shol	Low
Foli	BujuriTengra	Foli	Foli	Low
BujuriTengra	Baim	BujuriTengra	Pabda	Low
Gojar	Air	Bata	Air	Very Low
Tilapia	Pabda	Chingri	Kajuli	Very low
		Shol	Bata	Very low

Production: In this study, average fish production from brush shelter was 12.18 kg/decimal. The average natural fish production of Kaptai Lake was 0.50kg (DoF, 2013). The fish production of brush shelter was 24 to 32 times more than the natural fish production of Kaptai Lake. Juvenile of different fishes take shelter in the brush shelter and they were harvested before mature. Among the harvested fishes, Calibaush about 28% were less than legal size (23cm) and 16% Air were juvenile.

Table 4. List of juveniles harvested from the brush shelter in different areas of Kaptai Lake

Rangamati Sadar Calibaush	**Kaptai** Calibaush	**Barkol** Calibaush	**Langadu** Calibaush
Air	Air	Bata	Bata
Shol	Shol	Air	Air
Gojar	Gojar	Baim	Shol
	Baim	Shol	

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.
- To assess the pattern and extent of changes of the parameters.
- To find out the seasonal succession and relationship between phytoplankton and zooplankton in Kaptai lake

Achievements

The study was conducted from July 2012 to June 2013. Five sampling stations (Rangamati Sadar Kaptai, Barkal, Langadhu and Naniarchar upazilla) were selected taking into consideration i) the following streams and drainage arms, ii) their catchment area, and iii) shallow, medium and deep water level of the lake. Water samples for physico-chemical and biological parameters were collected fortnightly from each sampling station with water sampler bottle during morning hours in between 8.30 to 10.30 a.m. The bottle was allowed to sink up to the desired depth and its mouth was opened and filled up and the cap locked underwater before taken out of water. Caution was taken to avoid any air bubble inside the bottle. Immediately after collection the water samples were analyzed. Some of the results were recorded at the sampling sites whereas the others were recorded in the laboratory. Temperature of water and air were recorded by a centigrade thermometer. Water transparency was measured through secchi disc reading. Dissolved Oxygen, P^H, free CO_2, total alkalinity, total hardness of water were measured by using HACH water testing kit (Model: FF-3, USA). Statistical analysis were applied to find out the standard deviation of different parameters in different months and to determine the extent of correlation amongst different parameters.

Monthly fluctuations, range, mean values (x) and standard deviation (±SD) of different physcio-chemical factors and relationships among the factors are presented in Tables 1, 2 and 3.

Table 1. Monthly fluctuation of different physico-chemical parameters with range and Mean values (±SD)

Parameters	2013						2014				
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Air temp.^{0}C	29.01	30.70	31.52	30.54	22.33	23.35	21.04	23.79	27.12	27.49	30.19
Water temp.^{0}C	27.90	29.88	30.38	29.59	21.54	23.10	20.42	23.08	26.04	26.55	29.21
P^H	7.17	7.17	7.08	7.22	7.36	7.50	8.20	7.68	7.55	7.69	7.60
CO_2(mg/l)	4.45	4.25	3.86	3.89	3.88	3.32	5.33	7.81	7.15	5.99	5.56
Total alkalinity (mg/l)	64.91	67.36	71.97	70.96	82.21	90.68	90.32	81.32	68.93	68.31	70.77
Total hardness (mg/l)	55.17	60.60	60.99	65.47	65.24	79.88	81.34	87.49	75.63	77.09	82.73
Secchi disc Transparency (m)	1.20	1.70	1.65	1.90	2.04	2.13	2.39	2.46	2.07	2.61	2.36
DO (mg/l)	6.38	6.33	6.14	6.13	5.35	5.50	5.33	3.90	5.55	6.02	5.91
Water depth (m)	11.76	9.14	7.20	7.33	6.90	6.43	7.89	5.68	6.78	4.39	11.04
Rainfall (mm)	19.25	6.58	24.58	17.33	0.00	0.00	0.00	1.67	7.33	8.42	13.00

Monthly variation of air temperature ranged from 21.04^{0}C to 31.52^{0}C (x ± SD: 27.30 ±1.70^{0}C). Highest air temperature (31.52^{0}C) was recorded in September, 2013 and the lowest (21.04^{0}C) in January, 2014. The fluctuation of water temperature varied from 20.42 to 30.38^0 C (x ± SD: 26.47 ± 1.64^0 C).The maximum water temperature (30.38°C) was recorded in September, 2013 and minimum (20.42^{0}C) in January, 2014.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= 0.998, p<0.01) (Table 2). The pH of water always found to be alkaline in nature and it varied between 7.08 and 8.20 (x ± SD: 7.49 ± 0.37).

Free CO_2 ranged between 3.32 to 7.81 mg/l (x ± SD: 5.14 ± 1.48 mg/l). The maximum (7.81 mg/l) value was recorded in February, 2014 and minimum (3.32mg/l) in December, 2013. In the present investigation free CO_2 showed inverse correlation with dissolved oxygen (r = -0.504, < 0.05) (Table 2).

Table 2. Correlation among physico-chemical parameters of Kaptai Lake
(Values are shown as r=coefficient correlation)

	Air temp.°C	Water temp.°C	Dissolved oxygen (mg/l)	Free CO2 (mg/l)	Total hardness (mg/l)	Total alkalinity (mg/l)	P^H	Secchi disc Transparency (m)	Water depth (m)	Rainfall (mm)
Air temp.°C	1	.998**	.716**	-0.11	-0.487	-.842**	-.610*	-0.521	0.459	.816**
Water temp.°C	.998**	1	.719**	-0.122	-0.471	-.818**	-.601*	-0.52	0.465	.794**
Dissolved oxygen (mg/l)	.716**	.719**	1	-0.504	-.660*	-.610*	-0.457	-.599*	0.518	.607*
Free CO_2 (mg/l)	-0.11	-0.122	-0.504	1	.615*	-0.128	0.537	0.459	-0.136	-0.243
Tatal hardness (mg/l)	-0.487	-0.471	-.660*	.615*	1	0.52	.803**	.854**	-0.337	-.586*
Total alkalinity (mg/l)	-.842**	-.818**	-.610*	-0.128	0.52	1	0.543	0.449	-0.359	-.697*
PH	-.610*	-.601*	-0.457	0.537	.803**	0.543	1	.714**	-0.179	-.624*
Transparency (m)	-0.521	-0.52	-.599*	0.459	.854**	0.449	.714**	1	-.619*	-0.574
Water depth (m)	0.459	0.465	0.518	-0.136	-0.337	-0.359	-0.179	-.619*	1	0.361
Rainfall (mm)	.816**	.794**	.607*	-0.243	-.586*	-.697*	-.624*	-0.574	0.361	1

The value of total alkalinity was found to fluctuate from the minimum of 64.91 mg/l to the maximum of 90.68 mg/l (x ± SD: 74.97 ± 9.69 mg/l). The highest value was recorded in December (90.68 mg/l) 2013 and the lowest in July (64.91 mg/l) 2013. In the present study total alkalinity showed a positive correlation with total hardness (r=-0.52) (Table 2). Total hardness varied from 55.17 to 87.49 mg/l with mean value of (x ± SD: 72.16± 12.24mg/l). The highest amount of hardness was recorded in February, 2014 and the lowest in July, 2013. In the present investigation, total hardness showed positive correlation with p^H (r = 0.803, p< 0.01). Rainfall varied from 24.58 mm to 00.00 mm with mean value of (x ± SD: 8.90± 9.71mm). The highest amount of rainfall was recorded in September, 2013 and the lowest in December, 2013. In the present investigation, total hardness showed inverse correlation with Rainfall (r = - 0.586, p< 0.05) and total alkalinity showed inverse correlation with Rainfall (r = - 0.697, p< 0.05) (Table 2).

Table 3. Relationships among the physico-chemical parameters of Kaptai Lake (2013-2014)

Parameters	**Correlation (*r*)**
Air temp.℃ with Water.temp℃	.998**
Water temp.℃ with Dissolved oxygen (mg/l)	.719**
Total hardness (mg/l) with P^H	.803**

Total hardness (mg/l) with Secchi disc transparency	.854**
Total hardness (mg/l) with rainfall	-.586*
Total alkalinity (mg/l) with rainfall	-.697*
Dissolved oxygen(mg/l) with free CO_2 (mg/l)	-.504
Secchi disc transparency with free CO_2 (mg/l)	.459

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

In the study, highest mean abundance of Euglenophyceae, Cyanophyceae, Bacillariophyceae and Chlorophyceae (Table 4 & Fig 1) were found in January 2014 (1.84±0.337 x 10^3 cells/l), August 2013 (11.76±0.023 x 10^3 cells/l), June 2014 (16.23±3.638 x 10^3 cells/l) and June 2014 (16.82±0.235 x 10^3 cells/l). Highest mean abundance of Copepoda, Rotifera, Cladocera and Crustacea (Table 5 & Fig 2) were found in January 2014 (0.37±0.068 x 10^3 cells/l), August 2013 (2.35±0.236 x 10^3 cells/l), June 2014 (3.17±0.135 x 10^3 cells/l) and June 2014 (3.98±0.153 x 10^3 cells/l).

The present study is baseline study on monthly variation of physico-chemical variables and plankton abundance of the Kaptai lake which will prove effective in case of lake ecosystem management and conservation. The findings of the present study will be helpful for the future researcher to work on these aspects and replace the discrete data about water quality parameter and plankton abundance of Kaptai lake and establish a faithful document explaining variation and inter-relation among different physical and chemical parameters of lake Kaptai.

Refinement of creek's aquaculture technology of Katai lake

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

Objectives

- To refine culture technology for sustainable fish production in creeks
- To identify problems regarding fish culture in creeks with their solution
- Dimonstration of this technology

Achievements

Study area: Nine suitable creeks (average 1acre) of Langadhu, Sadar, Nanarchar Upazilla of Rangamati Hill Tracts considered for the whole study of the experiment.

Selection of the creeks: Creeks were considered by the soil type, water retention capacity, pollution free and water depth (3m to 9m). Preparation of the creeks was done by repairing mouth of the creeks (making dam or construction of pen or both). After two weeks, dirty materials were removed from the creeks. After preparing the creeks lime ($CaCO_3$) were applied at the rate of 250 kg ha^{-1}. Then all concerned creeks were fertilized with compost (mixture of chopped and sun dried green plants-88%, cow dung-10%, urea-1% and lime-1%) 1,250.0 kg $ha^{-1,}$ urea 37.5 kg ha^{-1} and TSP 25.0 kg ha^{-1}. All creeks were left 10 days to promote algal development.

Stocking rate of fingerling: For gaining good production healthy and disease free fingerling were stocked. Fingerlings were stocked at the rate of 60/65/70 decimal. Fingerling size was 7-10 cm.

Name of species	T_1	T_2	T_3
Catla	25	20	20
Rohu	25	20	20
Mrigal	20	25	20
Total	70	65	60

Food and feeding management: All creeks were fertilized at fortnightly intervals throughout the study period. Formulated feed (20-25% protein) were supplied twice daily (at dawn and before dusk) at the rate of (10 to 5%) body weight. The feed were adjusted periodically in accordance with the growth performance of each species.

Growth and survival of fishes: In order to observe the growth performance sampling were done once in every month. Fishes were collected randomly at least 10% of each species. The fish weights were taken.

Final harvest and estimate the survival of fishes: All the fishes were harvested after completion of the experiment. Fishes were counted and measured individually to assess the survival rate and growth.

Water quality parameters monitoring: Water quality parameters such as p^H, temperature, transparency, dissolved oxygen (DO) and toxic ammonia were measured fortnightly throughout the study period in the late morning (9:00 to 10:00 A. M). Primary production of surface water was measured.

In the study, we found that weight of Catla in T_3R_1 (393.5±31.62gm) was the highest in the experiment. On the other hand, weight of Rui in T_1R_2 (312.2±28.03gm) and weight of Mrigal in T_3R_2 (284±15.42 gm) were the highest in 210 days experiment. Highest specific growth rate (SGR) of Catla, Rohu and Mrigal were found in T_1R_2 (1.14), T_1R_2 (1.65) and T_3R_2 (1.39) respectively. Survival rate of Rohu in T_2R_2 was higher than T_2R_2 and T_3R_2. In general growth performance of Catla was comparatively higher than Rohu and Mrigal. Among the three treatments, T_3R_1 was the best stocking density considering the highest growth of the Catla in the creeks and T_1R_2 was the best stocking density considering the highest growth of the Rohu in the creeks.

Participatory approach at different stages of technology development: A group of entrepreneurs living within the immediate vicinity of the creek, which were property right (beneficiaries), were assigned for overall management of the project. At least ten to fifteen beneficiaries were considered for a group selection including a team leader. Entrepreneurs were responsible for guarding, cleaning shoreline of creeks, administering feed as per requirement, taking part of fish harvesting, etc. By attending in all stages of technology development, they were capable to undertake such type of aquaculture system individually at the end of project period.

Carp brood development and growth performance evaluation of BFRI produced fingerling and local fingerlings

Researcher: Syed Lutfor Rahman, SSO

Objectives

- To produce quality carp seed at RSS, Khepupara hatchery from BFRI reared brood.
- To compare the growth performance of carp by using BFRI produced fingerlings and local fingerlings at farmer's level
- Adoption of backyard prawn hatchery.

Achievements

Collection and rearing of fingerlings for raising brood fish: Improved species of Catla (*Catla catla*), Rohu (*Labeo rohita*), Rajputi (*Barbonymus gonionotus*) and Carpio (*Cyprinus carpio*) were collected from Freshwater station of BFRI, Mymensingh. The collected species were reared in ponds of RSS and produced brood fish.

Comparison the growth performance between improved and local brood fingerling: To compare the growth performance between BFRI improved and local fingerlings of *Labeo rohita,* stocked in two ponds of RSS with same size, equal density and equal feeding management. Fingerlings were stocked at the rate of 5000/ha. Local fingerlings were collected from the farmer's nursery pond. Culture period was four months. The results are shown in Table 1-2. The final average length and weight was found for BFRI improved species of *Labeo rohita* 16.4 cm and 113.2g and locals one were 15.6cm and 112.4g respectively. BFRI improved fingerlings of *Labeo rohita* showed 12.6% and 8.2% more growth than that of local fingerlings in respect to length and weight respectively. During culture period some important water quality parameters (dissolved oxygen, alkalinity, hardness, pH and ammonia) of the pond water were monitored monthly. More or less similar results were found in two ponds of BFRI and local fingerlings (Table 3).

Table 1. Growth evaluation of improved BFRI Rohu, *Labeo rohita with* local private hatchery fingerlings

Sources of seeds	Initial average length (cm)	Final average length (cm)	Growth (cm)	Growth (%)	Difference (%)
BFRI improved fingerlings	10.8	16.4	5.6	51.9	**12.6**
Local nursery's fingerlings	11.2	15.6	4.4	39.3	

Table 2. Growth evaluation of improved BFRI Rohu, *Labeo rohita with* local private hatchery fingerlings

Sources of seeds	Initial average weight (g)	Final average weight (g)	Growth (g)	Growth (%)	Difference (%)
BFRI improved fingerlings	28.8	113.2	84.4	293.1	**8.2**
Local nursery's fingerlings	29.2	112.4	83.2	284.9	

Table 3. Water quality parameters of two different pond water

Parameters	BFRI improved fingerlings pond	Local nursery's fingerlings ponds
Dissolved oxygen (mg/l)	6.25±1.24	5.94±1.41
Alkalinity (mg/l)	82.4±9.2	79.8±8.4
Hardness (mg/l)	55.7±6.4	52.6±5.7
pH	7.43±0.24	7.56±0.15
Ammonia (mg/l)	0.02±0.01	0.02±0.02

Distribution and dissemination of improved carp breeds to fish farmers: Collected improved species of carps were reared in RSS ponds and produced brood fish. Improved spawn of Rohu, Silver carp, Rajputi and Gift tilapia were produced in RSS hatchery. Maximum spawn was disseminated to local nursery farmers. Due to shortage of nursery and rearing ponds, small scale improved fingerlings were produced in RSS ponds. In this year total 15.5 kg spawn and 1,17,000 fingerlings were produced inn RSS, Khepupara. Improved spawn, fingerlings were disseminated to the local farmers in this region.

Brackishwater Station

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

Achievements

The following interventions have been applied in the culture system traditionally followed by the farmers:

Soil and water liming: Soil of the *ghers* were treated with CaO @ 250 kg/ha and water was treated with dolomite @ 15 ppm.

In-pond nursing of post larvae: An in-pond nursery has been constructed at one corner of each *gher* by encircling 50- 60 m^2 areas by encircling nylon net fastened in bamboo frame. During each stocking, post larvae (PL) of shrimp were stocked in the nursery and reared for ten days before releasing into the *ghers*. In the nursery, PLs were fed with CP nursery feed twice daily. Six stockings of PL were as done as done by the farmer in the previous year.

Pond management: Growth of aquatic weeds was controlled by eradicating manually. Water of the *ghers* was exchanged as done by the farmer in the previous year. No feed was applied for rearing of shrimp.

Physicochemical characteristics of water: The water quality characteristics *viz*., temperature, transparency, pH, salinity, alkalinity and dissolved oxygen of three selected *ghers* are being determined monthly following standard methods and will be continued up to final harvest. The collected physicochemical parameters up to 140 days of rearing are presented in Table 1.

Table 1. Water quality characteristics of the selected *ghers* up to 140 days of culture

Parameters	***Gher* 1**	***Gher* 2**	***Gher* 3**
Temperature (^oC)	32-34	29-32	30-33
Salinity (ppt)	10-17	09-18	09-18
Depth (cm)	45-60	50-65	48-56
Transparency (cm)	30-35	35-42	32-43
pH	8.5-9.6	8.2-9.0	8.4-8.9
Alkalinity (mg/l)	140-160	180-240	180-240
Dissolved oxygen (mg/l)	8-10	8-11	9-12

Biological characteristics of water: The quality and quantity of phytoplankton and zooplankton of the selected *ghers* are being estimated monthly following standard methods (Cupp, 1943; Newell and Newell, 1973; Santhanam and Srinivasan, 1994) and presented in Table 2.

Table 2. Biological characteristics of the selected *ghers* up to 140 days of culture

Plankton	***Gher* 1**	***Gher* 2**	***Gher* 3**
Phytoplankton (Cell/l)	17.2 10^2-22.5 x 10^2	15.3 x 10^2-19.8 x 10^2	19.9 x 10^2-21.4 x 10^2
Zooplankton (No./l)	0.84 x 10^2-1.5 x 10^2	0.73 x 10^2-1.0 x 10^2	0.62 x 10^2-0.85 x 10^2

Most common phytoplanktons are *Scenedesmus*, *Cyclotella*, *Coscinodiscus*, *Spirulina* and *Synedra and* that of zooplanktons are rotifers, nauplius larvae, clodocerans and copepods.

Harvest of Shrimp: After 70 days of 1st stocking, selected harvesting of shrimps are being done in every new and full moon period by trap method. Amount of shrimp harvested till 30 August has been shown in Table 3. Sale proceeds and income will be assessed after final harvest at the end of the year.

Table 3. Harvest of shrimp from different *ghers* up to 15 July 2014

Particulars	***Gher* 1**	***Gher* 2**	***Gher* 3**
ABW (g) at harvest	20-22	21-22	20-22
Harvest (kg/pond)	35+40+38+32=145	36+40+34+10=120	30+32+35+50=147
Harvest (kg/ha)	290.00	303.00	242.97

Diversification of culture practice for optimizing production of the shrimp (*Penaeus monodon*) culture system in the coastal *ghers*

Researchers: Dr. S.B. Saha, CSO
Shamsun Nahar, DD
Azhar Ali, SO

Objectives

- To study the ecology and production feasibility of different cropping patterns in *Penaeus monodon* culture system in the coastal ghers.
- To study the impact of introduction of different fin fishes for increasing production in ghers.

Achievements

Experimental design : The experiment is conducted in twelve on-station ponds of 0.1 ha each following the design as given in Table 1.

Table 1. Design of the experiment

Treatments	**Stocking (No/m^2)**	**Culture period**	**Crop(s)**	**Replication (No/m^2)**
T_1	3	Short cycle (60 days)	Double	2
T_2		Long cycle (120 days)	Single	2
T_3	5	Short cycle (60 days)	Double	2
T_4		Long cycle (120 days)	Single	2
T_5	7	Short cycle (60 days)	Double	2
T_6		Long cycle (120 days)	Single	2

The ponds were prepared by drying, liming (Quick lime : dolomite 1:1) @ 250 kg/ha of soil and then filled with the tidal water up to a depth of 1m. Water was treated with chlorine @ 20 ppm to disinfect water and kill all animalcules. Fermented molasses were applied to the pond water to develop colour of water to prevent penetration of sunlight and then fertilized with urea and TSP @ 25 and 30 kg/ha, respectively for quick development of colour of water and production of plankton. After production of sufficient plankton required quantity of PCR tested PL was acclimatized with the pond water and stocked to the in-pond nursery made of nylon net fastened in bamboo frame on 09 April 2014. In the nursery the stocked PL were fed with CP nursery feed. After 3rd week of nursery rearing, the juveniles were released to the whole pond by up-folding the nylon net of the nursery enclosure. In the grow-out ponds, the shrimp were fed with CP feed depending on the biomass of shrimp.

Growth of fishes was monitored at weekly interval and feeds were adjusted accordingly. The water of the ponds was treated with dolomite @ 15 ppm on monthly basis and fertilized with inorganic fertilizer whenver necessary. Aeration has been provided to the ponds whenever necessary through agitating water by paddle wheel/airjet. Zeolite @ 4 ppm was applied to the ponds in 3rd and 4th month of culture. Feeding behaviour and well being of shrimp was checked twice daily by setting check tray. After 60 days of culture, shrimps of all short cycle ponds were harvested by complete dewatering and the ponds were prepared again for 2nd cycle as already mentioned. But due to unavailability of quality seed, stocking of ponds was delayed by about 20 days. By this period, phytoplankton production was reduced and some unwanted aquatic weeds grew in the ponds. Feeding management of the ponds was also hampered after 30 days of culture due to unavailability of CP feed in the market.

The water quality variables *viz*., temperature, depth, transparency, salinity, pH and total alkalinity were monitored at seven days interval following standard methods. Dissolved oxygen (DO) was monitored almost daily after 50 days of culture (DOC). The recorded average water quality variables are shown in table 2. All water quality variables except dissolved (DO) were congenial for culture of shrimp in all stocking ponds in both short cycles and long cycle culture systems. As shown from Figs. 1-2, dissolved oxygen (DO) in ponds with 7 Nos./m^2 in both short cycle crops decreased to near about 3.0 mg/l in the late night after 56 DOC. At this DO level, though movement of shrimps was normal but this DO level is not sufficient enough for their normal growth. DO level of ponds with 5 Nos./m^2 and 7Nos./m^2 in long cycle culture also decreased to uncongenial level in the late night after 91 DOC and 57 DOC, respectively. In this situation, supplementary oxygen was supplied to the ponds at 1 h/late night in short cycle ponds and 1-2 h/late night in long cycle ponds. DO at 3 Nos/m^2 and 5 Nos/m^2 in both short cycles and 3 Nos/m^2 in long cycle culture was always congenial for shrimp and there was no need of supply of additional oxygen in these ponds. Supplementary oxygen was also supplied occasionally in some ponds with 3 Nos/m^2 density in long cycle culture. To ascertain the changes in soil quality due to different culture practices, soil samples from both short and long cycle ponds were collected, air dried and processed for analysis of texture, EC, pH, organic carbon, total nitrogen and phosphorus in the laboratory.

Table 2. Water quality variables of the experimental shrimp (*Penaeus monodon*) culture ponds

Variables	1st short cycle crop (60 days)			2nd short cycle crop (60 days)			Long cycle crop (120 days)		
	3/m^2	5/m^2	7/m^2	3/m^2	5/m^2	7/m^2	3/m^2	5/m^2	7m^2
Temperature (^{o}C)	29.7-34.0	29.5-34.2	29.5-35.0	29.5-31.0	30.0-31.5	29.5-31	29.5-35.2	30.2-35.0	30.0-35.2
Depth	108-117	85-111	95.125	118-129	104-127	106-136	92-110	93-115	114-129
Transparency (cm)	30-40	25-45	25-35	30-48	27-40	22-37	32-47	28-42	25-45
Salinity (ppt)	10-17	11-17	11-17	9-11	9-11	9-11	10-17	11-17	10-17
pH	8.2-8.9	8.2-8.8	8.1-8.8	8.3-9.4	8.3-9.4	8.2-8.7	7.0-9.2	7.4-9.1	7.5-9.0
Morning DO (mg/l)	4.0-6.3	3.8-6.6	2.3-6.0	4.2-6.1	4.3-6.2	3.0-5.0	3.4-6.1	2.9-6.3	2.5.6.5
Alkalinity (mg/l)	134-156	126-163	134-160	88-108	101-118	120-140	106-155	112-150	125-163

The production performance of shrimp in both short and long culture ponds are summarized in Table 2. In the 1st crop of short cycle (60 days) culture, average growth of shrimp was 17.39g, 16.51g and 15.87g and production of shrimp was 406.92 kg/ha, 747.80 kg/ha and 1007.92 kg/ha at 3, 5 and 7 Nos/ha density, respectively. In the 2nd crop of short cycle (60 days) culture, average growth of shrimp was 20.42g, 16.03g and 14.79g at 3, 5 and 7 Nos/m^2 density, respectively. In the long cycle (120 days) culture, average growth of shrimp was 39.36g, 32.51g and 30.51g and average production of shrimp was 913.57 kg/ha, 1429.38 kg/ha and 1857.31kg/ha at 3, 5 and 7 Nos/ha density, respectively. Total production of both 1st and 2nd crop of short cycle culture was higher than that of long cycle culture at 7 Nos/m^2 densities and production was reverse at 3 Nos/m^2 and 5 Nos/m^2. But the differences in production between short cycle (two cycles) and long cycle culture at all three densities were insignificant.

Table 2. Growth and production performance of shrimp in different culture systems

Treatments	Stocking densities (No/m^2)	Culture period	Crop(s)	ABW (g)	Survival (%)	Production (kg/ha)	FCR
T_1	3	Short cycle (60 days each) culture	1st crop	17.39	78.00	406.92	1.19
			2nd crop	20.42	65.07	397.50	1.16
			Total			**804.42**	
T_2		Long cycle (120 days) culture	**Single crop**	**39.36**	**77.23**	**913.57**	**1.57**
T_3	5	Short cycle (60 days each) culture	1st crop	16.51	90.56	747.80	1.16
			2nd crop	16.03	68.81	549.07	1.20
			Total			**1296.87**	
T_4		Long cycle (120 days) culture	**Single crop**	**32.79**	**86.92**	**1429.38**	**1.54**
T_5	7	Short cycle (60 days each) culture	1st crop	15.87	90.80	1007.86	1.13
			2nd crop	14.79	86.11	891.52	1.12
			Total			**1899.39**	
T_6		Long cycle (120 days) culture	**Single crop**	**30.51**	**85.64**	**1857.31**	**1.63**

Expenditure and income from production of different culture systems are shown in Table 3. Both gross income and benefit cost ratio (BCR) were significantly higher in long cycle crop than that of aggregate of two short cycle crops. Cost of production of was higher in ponds with higher stocking densities. This was due to consumption of higher quantity of feed by higher shrimp biomass in higher stocking ponds.

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 both dietary supplementation and spreading 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 as well as spreading into the soil	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. Required amount of monosex tilapia fries (ABW, 0.2 g) were stocked in the in-pond nurseries made of nylon net fastened in bamboo frame on 13th April 2013. Fishes were fed with commercial floating tilapia feed (Mega feed containing 30% protein). 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 @ 5g or 5ml probiotics per kg feed and probiotics was also spread into the soil @ 1kg per pond monthly. 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 determined at weekly interval and dissolved oxygen were determined frequently in the morning following standard methods (APHA, 1992 and Strickland and Parsons, 1975). The population of total heterotrophic bacteria (THB) and *Vibrio sp*.of water and soil of the ponds were monitored fortnightly by plate count method as mentioned by Barrow and Feltham, 1993. For testing of protein digestibility, feces of fishes from different treatments was collected and dried for further analysis.

Throughout 105 days of culture, temperature of water was 29-34°C and almost same in all ponds. Depth of water is maintained at a level of one meter in all ponds. As shown in Fig. 1a, salinity of water is also almost same in all ponds. Salinity of water was 12 ppt during stocking and increased to highest level 16.5

ppt at 55-65 days of culture and again gradually decreased to 10 ppt at the later part of the 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 is congenial for culture and varied from 7.7-9.0 (Fig. 1c). Alkalinity is almost same (116-155 mg/l) in all ponds (Fig. 1d). Initial level of morning dissolved oxygen (DO) was 5.0-6.70 mg/l which decreased to 1.2 at the later part of the culture period. At this level of low DO, no mortality of tilapia was observed.

Total heterotrophic 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). *Vibrio* count was higher in control ponds than those of probiotics treated ponds.

Table 2. Total heterotrophic bacteria (THB) and *Vibrio sp* in different treatments.

Treatments	Probiotics	Water		Soil	
		THB (CFU/ml)	*Vibrio sp.* (CFU/ml)	THB (CFU/g)	*Vibrio sp.* (CFU/g)
T1	Safegut	13.00-19.75 x 10^3	13.00-21.00	45.5-60.00 x 10^4	30.00-32.75
T2	Zymetin	11.00-14.50 x 10^3	15.50-19.00	44.00-55.75 x 10^4	42.50-45.00
T3	Probio-Aqua	11.00-18.50 x 10^3	12.50-16.75	50.50-66.00 x 10^4	37.50-45.50
T4	No probiotics	10.50-13.00 x 10^3	17.00-22.00	42.50-51.75x 10^4	48.75-56.50

As shown in Table 3, average production of tilapia was highest of 8799.34kg/ha in T3, where tilapia was supplied with Probio-aqua treated feed followed by 8235.69kg/ha in T2 where tilapia was fed with zymetin treated feed, 8002.50kg/ha in T1 where tilapia was fed with safegut treated feed and 6953.52kg/ha in T4 where no probiotics was used. Though average production of tilapia was highest in ponds where tilapia was fed with probio-aqua but growth of tilapia was highest in ponds where tilapia was fed with safegut. After 40 days of culture, mortality of some tilapia was observed due to lesions in the body. After 2-3 days of application of potassium permanganate @ 0.5 ppm in pond water, no lesion or mortality was observed.

Table 3. Production performance of tilapia in different treatments after 106 days of culture.

Treatments	ABW(g)	Survival %	Production (kg/ha)	FCR
T1 Safegut	242.50	60.0	8002.50	1.57
T2 Zymetin	183.73	81.5	8235.69	1.31
T3 Probio-Aqua	188.00	85.1	8799.34	1.14
T4 No probiotics	203.26	62.2	6953.52	1.56

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

Researchers: Dr. S.B. Saha
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*).

Achievement

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

To validate the findings of the previous years, the study was carried out in six 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 zooplankton 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 20 April, 2014. From the second day of stocking, fish, fries were fed twice daily with a mixture of finely powdered mustard oil cake, rice bran and fish meal at the ratio of 2:3:5. Feed was given @ 6 kg/million of hatchlings which was raised to 10 kg from the 6th 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 was 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 28-30^{o}C and 14-15 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 21.5-84.5cm was recorded in ponds fertilized with inorganic fertilizers only (T2). Transparency was 23.5-84.5 cm and 24-59.5 cm in ponds fertilized with organic fertilizers (T1) and mixture of organic and inorganic fertilizers (T3). pH of water of all the ponds was congenial for nursery rearing and varied from 8.44-9.89 (Fig. 1b). Alkalinity was almost same (131-299 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 173-219 mg/l, 162-218 mg/l and 155-229 mg/l in T1, T2 and T3, respectively (Fig. 3c). Dissolved oxygen was always congenial for normal survival of fish fry in all ponds. As shown in Fig. 1d, concentration of dissolved oxygen was 3.34-7.2 mg/l, 4.9-8.15 mg/l and 2.63-7.3 mg/l in T1, T2 and T3, respectively.

Concentration of both phytoplankton was higher in inorganic fertilizer treated ponds, whereas zooplankton production was higher in organic fertilizer treated pond. After four weeks of nursing, the growth of fries was highest of 5.20-5.30cm in T1 followed by 4.05-4.68cm in T2 and 4.16-4.36 cm in T3 (Table 1). Survival of the stocked fries was highest of 83.03-86.96% T1 where ponds fertilized with only organic fertilizer followed by 80.84-82.72% in T3 where ponds were fertilized with mixture of organic

and inorganic fertilizer and 74.39-78.90 in T2 where ponds were fertilized with only inorganic fertilizer. This result corroborates the findings of the previous years.

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	5.30	0.68	83.03
	R2	5.20	0.76	86.96
T2 (Urea @ 50 kg/ha &TSP @ 60 kg/ha)	R1	4.68	0.60	74.39
	R2	4.05	0.48	78.90
T3 (Cattle dung @ 2.5 t/ha, urea @ 25 kg/ha and TSP @ 30 kg/ha)	R1	4.16	0.76	80.84
	R2	4.36	0.68	82.72

Study 2. Evaluation of efficacy of different feeds for production of brackishwater catfish

The study were conducted in earthen ponds (1000 m^2 each) with three different feeds *viz*., (i) Mega pangus sinking feed (30% protein), (ii) Quality pangus sinking feed (30% protein) and (iii) farm made feed (30% protein, containing fish meal-15%, soybean meal-32.22%, rice bran- 22.39%, mustard oil cake-22.39%, binder-7% and vitamin premix-1%) each with two replicates. The prepared feed was formulated following Pearson's square method. 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 three days of liming, water of the ponds were fertilized with 2.5 ppm urea, 3.0 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 were stocked in all ponds on 22 May'14 at a density 16 Nos/m^2. The stocked fishes are being fed with different feeds @ 4-6% of estimated fish biomass. Growth of fishes is being checked fortnightly for the adjustment of feed. Physico-chemical parameters of water *viz*., temperature, transparency, salinity, pH, dissolved oxygen and alkalinity are being determined weekly following standard methods. After 102 days of rearing, growth of fishes was recorded as 11.64-11.76g, 14.84-15.36g and 12.32-12.36g in ponds supplied with Mega feed, Quality feed & farm made feed, respectively. After five months of rearing, all fishes will be harvested and production will be estimated and compared.

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

Determination of the feeding frequency for the fattening of mud crab (Scylla serrata)

Two successive trials were conducted following the design as given in Table 1.

Table 1. Design of the experiment

Treatments	Feeding frequency	Replications	Stocking density
T1	Feeding daily	3	2 indiv./m^2
T2	Feeding at alternate day		
T3	Feeding at two days interval		
T4	Two days feeding at one day interval		

For the experiment feed was formulated by Pearson's square method containing 30% protein for the fattening of mud crab using different feed ingredients as shown in the table 2.

Table 2. Formulation of different feeds

Feed ingredients	% of ingredients used	% Protein
Fish meal	20.0	10.8
Rice bran	31.0	3.72
Meat and bone meal	9.0	4.32
Soyabean meal	31.0	11.16
Atta	7.0	--
Vitamin and minerals	1.00	--
Binder (artificial)	1.0	--

For the study, two ponds of 1000 m^2 each 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 ponds were 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 in each compartment at a density of 2/m^2. Feed in each treatment was applied at the rate of 6% body weight of the stocked crabs twice daily following the design of the experiment. Fattening performance of the crabs were initially checked after 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. After 21 days of rearing, all crabs were harvested by dewatering the ponds and development of gonad was checked and recorded.

In the 1st trial, procured crabs were collected from the Sundarbans. Temperature, salinity, pH, morning dissolved oxygen and alkalinity of water of the pond were 32.8-34.5^oC, 16-18‰, 8.1-8.5, 3.3-6.2 mg/l and 145.46-130.50 mg/l, respectively. All these parameters were congenial for crab fattening. Gonad

development performance of crabs has been shown in Table 3. After six days of rearing (DOR), gonad of 40% crab was developed in T1 where crabs were fed daily, 30% in T2 where crabs were fed at alternate day, 15% in T3 where crabs were fed at two days interval and 20% in T4 where crabs were fed two days feeding at one day interval. After 21DOR, 100% gonad in all crabs was fully developed in T1, 100% gonad developed in 70% crabs in T2, 100% gonad developed in 65% crabs in T3 and 100% gonad developed in 75% crabs in T4. But gonad of 30%, 35% and 25% crabs did not develop fully in T2, T3 and T4, respectively. Survival of crabs was 28.75% 25.00%, 34.58% and 22.08% in T1, T2, T3, and T4, respectively.

Table 3. Fattening performance of crabs (*Scylla sp*)

Treatments	Replications	Gonad development (%)						Survival (%)
		6 DOR*	9 DOR	12 DOR	15 DOR	18 DOR	21 DOR	
T1 (Feeding daily)	R1	45	65	70	75	90	100	31.25
	R2	40	55	65	65	80	100	33.75
	R3	35	60	60	70	85	100	21.25
	Average	50	60	65	70	85	100	28.75
T2 (Feeding at alternate day)	R1	25	55	55	60	65	80	27.50
	R2	30	50	50	55	65	70	31.25
	R3	35	60	60	65	65	65	16.25
	Average	30	55	55	60	65	70	25.00
T3 (Feeding at two days interval)	R1	15	50	50	55	65	65	41.25
	R2	10	55	55	60	60	60	32.50
	R3	20	45	45	65	70	70	30.00
	Average	15	50	50	60	65	65	34.58
T4 (Two days feeding at one day interval)	R1	25	55	55	60	75	80	22.50
	R2	20	45	45	60	70	75	23.75
	R3	15	50	50	60	65	70	20.00
	Average	20	50	50	60	70	75	22.08

In the 2nd trial, procured crabs were collected from waterbodies in and around Paikgacha Water quality parameters *viz*., temperature, salinity, pH, morning dissolved oxygen and alkalinity of water of the pond were 31.8-34.5^{o}C, 10-13‰, 8.0-8.5, 4.3-6.2 mg/l and 120.46-134.50 mg/l, respectively. Gonad development performance of crabs has been shown in Table 4. After six DOR, 50% gonad of the stocked crabs was developed in T1 where crabs were fed daily, 40% in T2 where crabs were fed at alternate day, 20% in T3 where crabs were fed at two days interval and 30% in T4 where crabs were fed two days feeding at one day interval. After 21DOR, 100% gonad in all crabs was fully developed in T1, 100% gonad developed in 80% crabs in T2, 100% gonad developed in 70% crabs in T3 and 100% gonad developed in 75% crabs in T4. But gonad of 20%, 30% and 25% crabs did not develop fully in T2, T3 and T4, respectively. Survival of crabs was 76.25% 68.75%, 66.66% and 73.33% in T1, T2, T3, and T4, respectively.

Table 4. Fattening performance of crabs (*Scylla serrata*)

Treatments	Replications	Gonad development (%)						Survival (%)
		6 DOR*	9 DOR	12 DOR	15 DOR	18 DOR	21 DOR	
T1 (Feeding daily)	R1	55	65	70	75	90	100	81.25
	R2	50	55	65	65	80	100	75.00
	R3	45	60	60	70	85	100	7250
	Average	**50**	**60**	**65**	**70**	**85**	**100**	**76.25**
T2 (Feeding at alternate day)	R1	40	55	55	65	70	80	65.00
	R2	30	50	50	60	65	70	67.50
	R3	50	60	60	70	75	90	73.75
	Average	**40**	**55**	**55**	**65**	**70**	**80**	**68.75**

T3 (Feeding at two days interval)	R1	10	50	50	55	65	65	72.50
	R2	20	55	55	60	60	65	58.75
	R3	30	45	45	65	70	80	68.75
	Average	**20**	**50**	**50**	**60**	**65**	**70**	**66.66**
T4 (Two days feeding at one day interval)	R1	40	55	55	60	75	80	80.00
	R2	40	45	45	60	65	75	70.00
	R3	40	50	50	60	70	70	70.00
	Average	**40**	**50**	**50**	**60**	**70**	**75**	**73.33**

Pattern of gonad development was almost same in both trials. But survival of crabs was much higher in 2nd trial than that of 1st trial. In the 1st trial, due to unavailability of required number non-gravid crabs in Paikgacha, there were no alternate of stocking crabs collected from the Sundarbans. Generally transportation of crabs from the Sundarbans takes long period. As a result, these crabs become weaker and vulnerable. This might be the reason of lower survival in the 1st trial.

The finding of the above trial on the fattening of mud crabs using artificial feeds in earthen pond corroborates the findings of the previous years' study which confirms possibility of fattening of mud crab using artificial feed. The study reveals that daily feeding is very much needed for early development of gonad.

Shrimp Research Station

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

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

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

Achievement

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.

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 (°C)	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.

Bioaccumulation of hazardous chemicals in shrimp farming system of Bangladesh

Researchers: Md.Nahid Hasan, SO
H.M. Rakibul Islam, SO
Rubia Akter, SO

Objectives

- To identify available antibiotics and their metabolites in shrimp farming system in south-western region of Bangladesh.
- To identify the source of hazardous antibiotics in different shrimp culture pattern.
- To assess their residues in water and shrimp.
- To assess the pesticides residues using in fish drying system in various parts of Bangladesh.

Achievements

The experiment was conducted for identification and quantification of banned antibiotic as well as Nitrofuran metabolites in shrimp and Organochlorine pesticides residues which are used by the processor

during drying of fishes. For source identification of nitrofuran metabolites sampling of freshwater shrimp was done every 10 days interval by applying three different feed. Feed samples were analyzed by LCMS/MS but found no metabolites.

Table 1. Nitrofuran metabolites in freshwater shrimp under three different feeding trial

Feed	Days	AMOZ (ppb)	AOZ (ppb)	AHD (ppb)	SCA (ppb)	MRL (ppb)
F1 (Modern Feed)	1	0.237	0.3325	ND	5.36	AHD, AMOZ, AOZ, SEM=1 ppb
	10	0.03	0.266	ND	3.02	
	20	0.22	ND	ND	2.145	
	30	ND	0.61	ND	ND	
F2 (Quality Feed)	1	0.033	0.67	ND	4.46	
	10	0.484	0.68	ND	4.96	
	20	ND	1.38	ND	3.67	
	30	ND	0.775	ND	0.695	
F3 (Home made)	1	ND	ND	ND	4.29	
	10	ND	0.57	1.04	ND	
	20	ND	1.37	3.82	3.32	
	30	ND	ND	ND	3.34	

For detection and quantification of Nitrofuran metabolites in shrimp total 54 samples were analyzed which were collected from Mongla, Kachua and Bagerhat sadar upazilla of Bagerhat district. Among the analyzed samples only one from Mongla detected above the MRL at 2.78ppb.

Table 2. Detected pesticides concentration and risk based consumption for contaminated fish

Species	Pesticides	ARL	BW (Kg)	CSF	Pesticides Concentration Cm (ppm)	CRlim (Kg/day)	CRlim (g/day
Shrimp	Heptachlor	0.00001	70	2	10.24	0.0000341	0.0341
Churi		0.00001	70	2	4.08	0.000857	0.0857
Loittya		0.00001	70	2	8.26	0.000423	0.423
Rupchanda		0.00001	70	2	3.06	0.0001	0.114
Ayar		0.00001	70	2	0.11	0.003	3.18
Baim		0.00001	70	2	0.025	0.014	14.00
Chapila		0.00001	70	2	0.030	0.011	11.67
Gulsa		0.00001	70	2	0.036	0.010	10
Tengra		0.00001	70	2	0.005	0.07	70
Gulsa	Dieldrin	0.00001	70	2	0.007	0.05	
Ayar	DDT	0.00001	70	0.34	0.098	0.021	
Tengra	DDT	0.00001	70	0.34	0.028	0.071	

Impact of probiotics on shrimp (*Penaeus monodon*) production

Researchers: Dr. Khan Kamal Uddin Ahmed, CSO
Rubia Akter, SO

B.M. Shahinur Rahaman, SO
Md. Motiur Rahaman, SO

Objectives

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

Acheivement

The experimental design is based on using a single probiotics with different doses and manners at same stocking densities for all cases are shown in Table 1.

Table 1. Experimental design

Treatments	Stocking density (No./ha)	Application of Probiotics	
		Probiont type	Dose
T_1	30,000	Probiotics mixed with feed	2.0-1.0 g/kg of feed
T_2	do	Probiotics broadcast on the pond	Every 10 days Intervals (15 liter/ha)
T_3	do	Feed without probiotics	--

A selected probiotics such as super biotic is applied at a different doses of 2-1 g/kg of feed and super PS is used at 15 liter/ha in the ponds under treatment 1 and 2. The artificially manufactured probiotics (beneficial bacteria), *Bacillus* spp. Comprising strength of ±CFU/g (recommended by manufacturer) is administered in the ponds. The experiment is carried out in 9 on-station ponds having an area of 0.052—0.064 ha.

The research ponds were dried and re-excavated. The soil of ponds were treated with lime (CaO) at the rate of 250 kg/ha. After liming, tidal water was taken into the ponds up to a depth of 50-60 cm. All unwanted animals of water were removed using rotenone (40gm/decimal). Lime was again applied @ 25 kg/ha after 3 days of introducing rotenone. Pond's water then fertilized with TSP and urea (2:1) @ 37.5 kg/ha. After production of plankton, juvenile of Shrimp were stocked according to the experimental design (Table 1). The juvenile (ABW, 2.0 g) were stocked in all the ponds on April/20 2014. Juveniles of Shrimp were fed with Quality feed (gold plus-grower) @ 5-3 % of total biomass twice daily.

Fortnightly water quality parameters *viz* water depth, dissolved oxygen, temperature, pH, salinity, ammonia, nitrate, total alkalinity and transparency were recorded. Remarkable variations were not found among the different treatments. Growth of shrimp was measured and feed was adjusted after every fortnight. On 11th July/2014, the average weight of shrimp in T_1, T_2 and T_3 was 22.065 ±5.52, 19.87 ±4.98 and 10.71 ±2.42g, respectively. Higher growth was obtained from T_1 followed by T_2 and T_3. Day after 90 of husbandry, all shrimp were harvested. The survivality rate of shrimp production was reckoned 80%. The production of shrimp was found 475 kg/ha in T_1, 327.57 kg/ha in T_2 and 136.79 kg/ha. in T_3. So the highest production was found using super PS (T_1)

Bacterial load: The population of total heterotrophic bacteria (THB) of pond waters and sediments is estimated on monthly intervals as depicted in Table 2. Bacterial floras present in ponds are analyzed and it is found that bacterial load in water and sediment ranged from 4.8 x 10^3— 155 x 10^3 CFU/ml and 6.3 x 10^3—364.0 x 10^3 CFU/mg in T_1, 5.2 x 10^3—170 x 10^3 CFU/ml and 7.0 x 10^3—483 x 10^3 CFU/mg in T_2 and 2.3 x 10^3—50 x 10^3 CFU/ml and 3.0 x 10^3—251 x 10^3 CFU/mg in T_3, respectively.

Table 2. Quantitative profile of THB in waters and sediments of ponds

Treatments		Bacterial load (CFU/ml and CFU/mg)
T_1	Water	4.8×10^3— 155×10^3
	Soil	6.3×10^3—364.0×10^3
T_2	Water	5.2×10^3—170×10^3
	Soil	7.0×10^3—483×10^3
T_3	Water	2.3×10^3—50×10^3
	Soil	3.0×10^3—251×10^3

Water quality monitoring: Different water quality parameters (temperature, water depth, dissolved oxygen, pH, salinity, ammonia, nitrate, total alkalinity and transparency) are measured at weekly intervals. Remarkable variations in parameters were not found among the different treatments. Values of different water parameters are shown in Table 3.

Table 3. Water quality parameters (mean ± SD) of the ponds

Parameters	T_1	T_2	C
Temperature (^oC)	29.63±1.36	29.7±1.57	29.7±1.41
Salinity (ppt)	2.5±0.41	2.5±0.41	2.5±0.41
DO (mg/L)	4.78±0.52	4.98±0.39	5.08±0.22
pH	8.2±0.28	8.15±0.26	8.15±0.26
NO_2-N (mg/L)	0.002±0.0009	0.001±0.0005	0.001±0.0005
NH_4-N (mg/L)	0.17±0.005	0.16±0.005	0.16±0.005
Total alkalinity (mg/L)	94.00±12.14	97.5±11.00	100.00±18.26
Transparency (cm)	34.00±4.69	36.5±5.80	36.3±4.27

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

Particulars	Treatments		
	T_1	T_2	T_3
Stocking density (no./m^2)	2.30	2.30	2.30
Stocking size (g)	2	2	2
Harvesting size (g)	22.065 ±5.52	19.87 ±4.98	10.71 ±2.42
Survival (%)	83.33%	80%	77.77%
FCR	1.83	2.01	2.48
Production (kg/ha)	475.00	327.57	136.79

Development of grow-out feed using locally available feed ingredients for black tiger shrimp (*Penaeus monodon*)

Researcher: Dr. Khan Kamal Uddin Ahmed, CSO
B.M. Shahinur Rahman, SO
Rubia Akter, SO

Objectives

- Formulation of artificial diets for bagda grow-out using locally available ingredients
- Determine the efficacy of formulated feed on growth, survival and production of shrimp in earthen ponds/ghers

Achievements

Feed formulation: Different types of collected local feed ingredients for the experiments such as dhyancha seeds, mustard oilcake, soya bean meal, meat and bone meal were selected for the formulation of grow-out feeds (Table 1). Three diets with a protein level of 35% was formulated using Pearson`s square method and was adjusted this level by trial and error method. Essential Amino Acid (EEA) and Essential Fatty Acid (EFA) profiles of the selected ingredients were included in test diets. The protein content and amino acid readjusted until the fulfillment of protein and amino acid level in the diets. Locally available feed ingredients like rice bran, wheat bran, wheat flour, broken maize as well as vitamin & minerals were used as common ingredients for the formulation of three diets. Formulated diets were analyzed for proximate composition to check the accuracy of formulation. Diets was palletized and dried at room for 2-3 days. The feed is kept in airtight polythene bags and stored at room temperature.

Table 1. Feed formulation (Quantity as %)

Ingredients	**Feed-1 (T_1)**	**Feed-2 (T_2)**	**Feed-3 (T_3)**	**Feed-4 (Control)**
Fish meal	24.00	24.00	24.00	Quality feed (Gold Grower)
Meat &Bone meal	12.00	12.00	12.00	
Soyabean Meal	**0.00**	**8.00**	**8.00**	
Mustard Oil Cake	15.00	13.00	10.00	
Dhyancha seed	**24.00**	**14.00**	**10.00**	
Sola	0.00	0.00	**10.00**	
Rice bran (Auto)	18.55	18.55	19.55	
Wheat flour (Atta)	5.00	**9.00**	5.00	
Lime Stone	1.00	1.00	1.00	
Vit. & Minerals premix	0.15	0.15	0.15	
Pellet binder	0.30	0.30	0.30	
Total	100	100	100	

Table 2. Proximate analyses of feed

Parameters	**Feed-1**	**Feed-2**	**Feed-3**	**Feed-4**
Crude protein	35.05	35.02	35.09	37.5 **(28.53)**
Crude Fat	8.50	8.40	8.10	7.00
Ash	11.89	12.53	12.07	3
Fibre	6.40	5.98	6.80	-
NFE	27.90	28.02	27.56	-
GE (kjg^{-1})	16.14	16.20	16.06	-
Cost (Tk./Kg)	**43.10**	**43.80**	**44.40**	**55**

Growth trial: Twelve ponds were selected for experiments. These ponds were dried, renovated and prepared using lime (CaO, $CaCO_3$) followed by inorganic/ organic fertilizers. Black tiger shrimp *(P. monodon)* post larvae was collected from the local markets of Bagerhat district. Post larvae of shrimp reared in nursery pond for 21-25 days. Thereafter, ponds will be stocked with nursed PL.

Table 3. Water quality parameters as recorded from pond condition under different treatments

Parameters	Treatments			
	T_1	T_2	T_3	T_4 (Control)
Temperature (^{0}C)	28-30 ^{0}C	28-30 ^{0}C	28-30 ^{0}C	28-30 ^{0}C
pH	8.0-8.5	7.8-8.4	7.9-8.5	7.9-8.5
Salinity (ppt)	2.5-3.0	2.5-3.0	2.4-3.0	2.4-3.0
DO (mg/l)	4.6-5.34	4.6-5.4	4.7-5.35	4.6-5.4
Ammonia (mg/l)	0.032	0.035	0.034	0.035

Feeding: Feed was supplied twice daily @ 10% of body weight for the first month, 8% for the second month and 5-3% for the rest period. 10% of stocked shrimp is sampled by cast net. Weight of the shrimp was taken using portable balance for growth monitoring, feed adjustment and disease checking. Water quality was also monitored and recorded at weekly intervals.

Growth and survival rate: The nursed shrimp PL of average body weight of 2.0 g stocked at rate of 120/dec. and reared for a period of 90 days. After 90 days culture, the growth performance of 14.1g, 14.3g, 20.5g and 12.3g 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 20.5g obtained from Feed-3 (fish meal 24%, Meat &Bone meal 12%, soya-bean meal 8%, mustard oil cake 10%, Dhyancha seed 10%, Sola 10%, rice bran 19.55%, wheat flour 5%, lime stone 1%, vitamin & minerals 0.15% and 1%) and the lowest of 11.44g was recorded in grower shrimp supplied with commercial feed. Different growth parameters and Survival of shrimp with different feeds are shown in Table 4.

Table 4. Growth performance and Survival of Shrimp using different feeds in pond

Treatments	Initial wt. (g)	Final wt. (g)	SGR* (% days)	Survival rate (%)
T_1 (feed-1)	2.0	14.1	13.44	72.3
T_2 (feed-2)	2.0	14.3	13.66	73.5
T_3 (feed-3)	**2.0**	**20.5**	**20.55**	**76.0**
T_4 (Control) (commercial feed)	2.0	12.3	11.44	70.2

**SGR=Specific Growth Rate

Investigation into shrimp/prawn diseases and their control strategies in South-Western region

Researchers: H.M. Rakibul Islam, SO
Md. Ariful Islam, SO
Rubia Akhtar, SO

Objectives

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

Achievement

Investigation of immerging diseases is one of the most important mandates of Shrimp Health Management Laboratory. Therefore, under the project 12 ghers were investigated randomly in context to aqua ecology and pathogens. Another 12 ghers were also sampled under case study. Most of the ghers (70%) found to be in trouble due to poor pond preparation, inadequate feeding and lower water depth. Due to lower water depth and sudden rainfall, 80% of the ghers having P. monodon attacked by WSSV in the month of March to May. However, the water depth tend to rises from late May towards June and onward, stocked golda (*M. rosenbergii*) of the previous year badly infected by the complex form of infection by different group of bacteria (Table 1)

Table 1. Bacterial infection in to *Macrobrachium rosenbergii*

Selective Media	Pathogen	Intensity				
		Gill	Rotten Zone	Wound	Soil	Water
Mannitol salt agar (MSA)	Staphylococci, Micrococci	++	+	+	-	-
Eosin methylene blue agar (EMB)	Gram-negative enteric bacilli	+++	++	++	-	-
TCBS agar	Vibrio sp.	+	+++	++	+	-

The initial treatment, therefore, replied with reducing the mortality to 5% (Figs. 1 and 2) and successful molting of over 37% of larvae to PL (Fig. 3). PCR test for the presence of MrNV was also performed but found negative (Fig. 4). With this success, hatchery activity of SRS started experimentally to figure out the probable cause of non molting issue and mass larval mortality. Each and every stage monitored and standard operating procedure maintained strictly. Further modification in LRT management (complete wash out of LRT after 3 days and larvae stored into a fresh tank with new water) and additional 5 ppm bleaching to the used water prior to bring into the main reserve. Along with the SRS prawn hatchery, three more hatcheries in Morelgonj, Fakirhat and Gopalgonj overcome the molting issue and successfully produce PL of M. rosenbergii. Besides, four hatcheries were survayed within the project period. The hatcheries, failed completely found to be under poor management in terms of inappropriate dose of disinfectants and contact time to disinfectants. Improper management, therefore, result in poor water quality and facilitated the growth of excessive protozoans (Zoothamnium sp. & Dinoflagellates) in the LRT. Bloom of Zoothamnium and excessive presence of Dinoflagellates (9×106 nos/ton water) cause poor feeding affinity to the larvae, thereby, causes shrinkage and incapable to molt and resulted in complete drain out (Table 2).

Hence, initially, proper management of the hatchery and a bit modification in LRT operation found to withstand the current constrains in the hatchery operation. Further investigation along the line therefore, required to figure out the actual cause of the constrains.

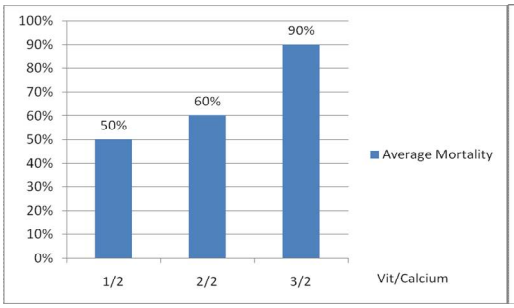


Fig. 1.

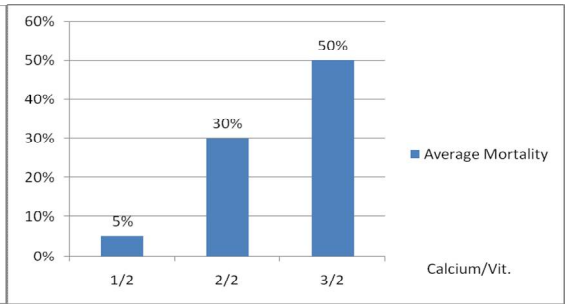


Fig. 2.

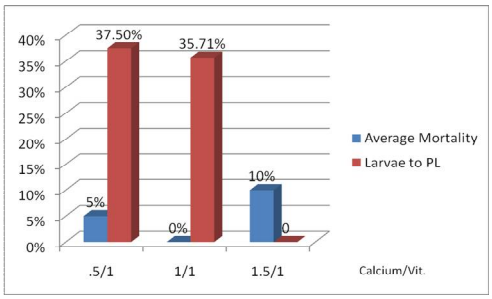


Fig. 3.

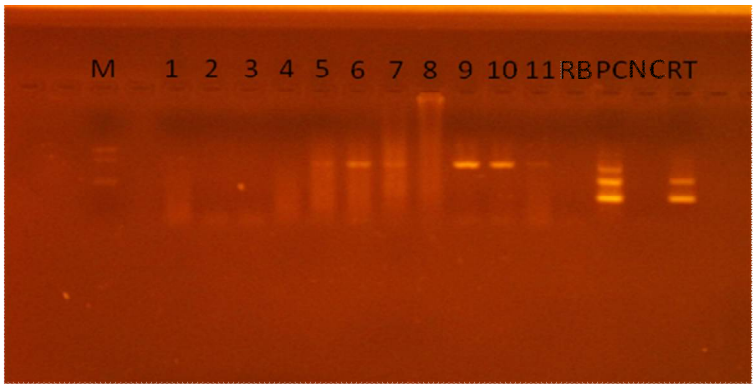


Fig. 4. M- Marker; 1-Brack ;2-Gollamari; 3-Khulna; 4-Jalalabad; 5-Sundarban; 6-Rupsha; 7- River(J); 8- Gher(J); 9-Male (A), 10- Female(A); RB- Reagent Blank;PC- Possitive Controll; NC-Negative Controll; RT-Reseverse Transcriptage.

Table 2. Hatcheries surveyed under the project and measures taken

Name of Hatchery	Type of Hazard	Cause	Measures Taken	Comments
Aqua Gold Hatchery	Larval mortality @ Stage iv	Excessive protozoans	-	Drained out
Rupa Golda Hatchery	Larval mortality @ Stage vi	Excessive ammonia due to uneaten custard	Reduce Feeding Rate and Water Change	Stable
Baruipara Golda Hatchery	Larval mortality @ Stage x	Excessive ammonia due to uneaten custard	Reduce Feeding Rate and Water Change	Stable
Gollamari Govt. Hatchery	Mortality @ Stage xi	Excessive protozoans	-	Drained out

Marine Fisheries & Technology Station

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

Researchers: 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.

Achievements

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 others available literatures consulted and the data were compiled and analyzed both manually and with the help of MS Excel program.

Table 1. Total landings & Groupwise percentage (July, 2013-June, 2014)

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

The collected data which was starting from July, 2013 to June, 2014, 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. Highest landing of sharks found in Cox'sBazar area (35%) followed by Chittagong, Dubla Island, Kuakata and Barisal area.

Crafts and gearss: 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 (32%) followed by

Shark net (26%) and SBN. But in Barisal region maximum sharks 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 was found maximum in the January-March quarter and it was above 35% of the total catch.

Estimation of stock: In the year of 2013-14, 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 2013-14.

Table 2. Estimation of total stock and standing crop of sharks, skates and rays (2013-14)

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

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.

Achievements

New seaweed bed: Seaweed research team of Marine Fisheries & Technology Station, Cox's Bazar discovered a new natural seaweed bed from Nuniarchara to Nazirartek areas of Backkhali river and Moheshkhali Channel estuary of Cox's Bazar. *Hypnea musciformis and Enteromorpha intestinalis etc.* are the main seaweed species of this seaweed bed. Some chemical parameters of water and soil seaweed beds were analyzed. The results are shown in Table 1.

Table 1. Some water chemical parameters of seaweed beds of Cox's Bazar

Water Parameters	Bakkhali estuary Seaweed bed	Saint Martin Island Seaweed bed
Nitrate (NO3)	0.673 mg/l	0.731 mg/l
Nitrite (NO2)	0.452 mg/l	N.D.
Sulphate	16,236.28 mg/l	10775.25 mg/l
Total Phosphate	N.D.	N.D.
Calcium (Ca)	411.23 ppm	439.30 ppm

Table 2. Some soil chemical parameters of seaweed beds

Soil Parameters	Bakkhali estuary Seaweed bed	Saint Martin Island Seaweed bed
Calcium (Ca)	2,660.52 ppm	1,83,878.32 ppm

Seaweed culture: Seaweeds are generally cultivated in lagoons or sheltered intertidal zones. Culture experiment site was Coast Guard point, Saint Martin Island, Teknaf, Cox's Bazar. Date of culture experiment set up was 13 January, 2014 and closed at first week of April, 2014. Net 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. Micronutrients enriched seaweed species *Hypnea sp., Caularpa racemosa* and *Sargassum* sp. were selected for culture experiment in Saint martin island. Seaweed seeds (small cutting of live seaweed) were attached to the nets with short length of string at a density of seaweed seed were 25-28 seed/m^2.

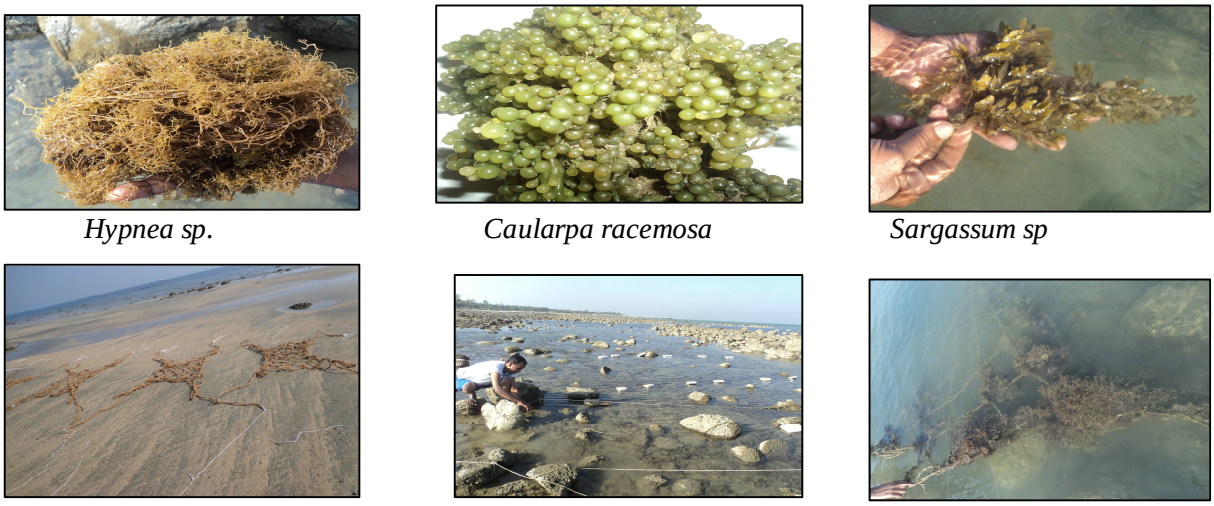


Fig. 1. Seaweed culture net, set-up & production

Production of seaweed: After 30 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 *Sargassum sp*. grew to 15–52 cm from an initial 5–10 cm length within 30 days. Seaweed biomass was evaluated for each species separately. The highest weight specific growth rate was found in *Sargassum sp*. from 5.2% to 5.5% per day, followed *Caularpa racemosa* from 4.5% to 5.0% per day and the lowest weight specific growth rate in *Hypnea sp* from 0.8% to 1.0% respectively.

Proximate/Nutritional analysis study: To assess the proximate compositions of seaweeds eg. Protein%, Lipid%, Moisture% and Ash% of some selected seaweed species were analyzed. The results are shown in Table 3.

Table 3. Proximate composition of some selected seaweed of Bangladesh

	Enteromorpha intestinalis	*Hypnea musciformis*	*Padina tetrastromatica*	*Porphyra sp.*	*Sargassum oligocystum*	*Hydroclathrus clathratus*
Moisture	60.40	12.23	15.27	18.56	18.39	10.23
Ash	58.55	39.03	62.77	48.45	49.56	77.55
Protein	14.25	25.51	6.98	10.34	6.46	5.48
Fat	7.49	6.35	4.88	8.52	7.70	4.20

Micronutrients like Calcium (Ca), Iron (Fe), Potassium (K), Sodium (Na) and Zinc (Zn) contents of *Enteromorpha intestinalis***,** *Hypnea musciformis***,** *Sargassum oligocystum*, *Padina tetrastromatica***,** *Hydroclathrus clathratus* and *Porphyra sp***.** were analyzed. The results are shown in Table 4.

Table 4. Micronutrients contents in selected seaweeds of Bangladesh

Seaweed	Type	Ca (ppm)	Fe (ppm)	K (ppm)	Na (ppm)	Zn (ppm)
Enteromorpha intestinalis	Green	5935.84	5570.34	16234.27	65824.82	14.91
Hypnea musciformis	Red	3329.61	3690.61	60679.44	27807.15	20.05
Sargassum oligocystum	Brown	14761.52	3795.04	88846.89	30798.54	13.42
Padina tetrastromatica	Brown	183155.46	14160.95	23839.61	21058.95	15.66
Hydroclathrus clathratus	Brown	21196.92	24334.55	5404.13	34267.38	439.16
Porphyra sp	Red	9140.44	2465.21	22175.86	45948.35	67.89

The another attempt was made for micronutrient analysis of powder form of some selected seaweed species. The results were shown in Table 5.

Table 5. Micronutrients contents in selected seaweeds in powder form

Seaweed	Sample	Ca (ppm)	Fe (ppm)	K (ppm)	Na (ppm)	Zn (ppm)
Hypnea sp.	Powder	14057.14	1382.72	1112.44	1011.15	50.29
Hypnea musciformis	Powder	1601.27	1479.58	23424.37	1870.06	8.13
Sargassum oligocystum	Powder	4699.21	1465.02	35696.43	9794.65	1.98

Seaweed product development study: Seaweed processing is small-scale and done manually. It was air dry or sundry to allow some natural bleaching. Seaweed was washed with water to remove soluble impurities such as salt as well as to assist in the separation of foreign matter such as other weeds, debris, sand, stone, shell and pieces of coral. Then they soaked in freshwater. The soaking and sorting foreign matters was repeated till the seaweeds were bleached. It was washed as many as four or five times either briefly or given more thorough soaking overnight. Dried one took more times between washing. Washing was carried out in open cement tanks with or without some form of mechanical agitation and accompanied by hand, sorting to remove the foreign matters.

Micronutrients enrichment test case study: To know the impact of seaweed addition in food items, for a test case normal salad and salad with seaweed (Other salad items remain constant) were prepared and micronutrients analysis were done. The results were shown in Table 6.

Table 6. Micronutrients determined within normal salad and salad with seaweed.

Treatment Type	Ca (ppm)	Fe (ppm)	K (ppm)	Na (ppm)	Zn (ppm)
Normal Salad	833.05	16.29	6507.82	17,663.24	4.93
Salad with seaweed	1,565.14	154.17	6031.64	15,636.07	8.85

Development of broods for mass seed production of striped mullet, *Mugil cephalus* & seabass, *Lates calcarifer*

Researchers: Ehsanul Karim, SO
Md. Shahzad Kuli Khan, SO

Objectives

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

Achievements

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 stocking and rearing in two saline water ponds of Marine Fisheries & Technology Station, Cox's Bazar. This rearing was a continuation of the brood rearing started in October 2011 with the adjusted salinity by using brine up to 10-15ppt. The average weight of these fishes was found 1270g after rearing of two years and hopefully all the fish will grow up to mature adult by the end of this year.

The salinity was maintained by using brine/crude salt upto 10-15ppt, before the availability of seawater which was brought by truck from the nearby sea shore. 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. At present, the fish looks very healthy and hopefully it will show all of the external features of sexual maturity in the coming December, 2014 to February, 2015. On the other hand, collection of wild live broods of Mullets for stocking purpose and gonadal study of Mullets were done after collecting live/dead mullets from pond reared as well as wild.

Gonadal development of Mullets

In case of gonadal development study, Mullets of body weight 1050-2200g 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 2 & half years rearing some significant gonadal development was noticed (Table 2).

Table 1. Observation of dissected Mullets of three years old for gonadal development

Weight range of Mullets (g)	**Pond-1** 987-1295	**Pond-2** 1085-1380
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,14	exists and absorbed in March,14
Semen	slightly exists and absorbed in March,14	slightly exists and absorbed in March,14

Length-Weight Data & Gonadal Study (Histological Test) observation of Wild & Pond Cultured Striped Mullets (*Mugil cephalus*) for brood development were recorded (Table 2).

Table 2. GSI value of MFTS-Pond Cultured Mullets

Month	Total Wt	Total L	Gonad Wt	GSI Value	Maturity (%) & Stages
Dec,13	1.63 Kg	60 cm	64 gm	3.92	Developing
Jan,14	1.75 Kg	64 cm	85 gm	4.86	Yolk granule stage
Feb,14	2.2 Kg	70 cm	181 gm	8.30	Close to mature yolk stage (80%)

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

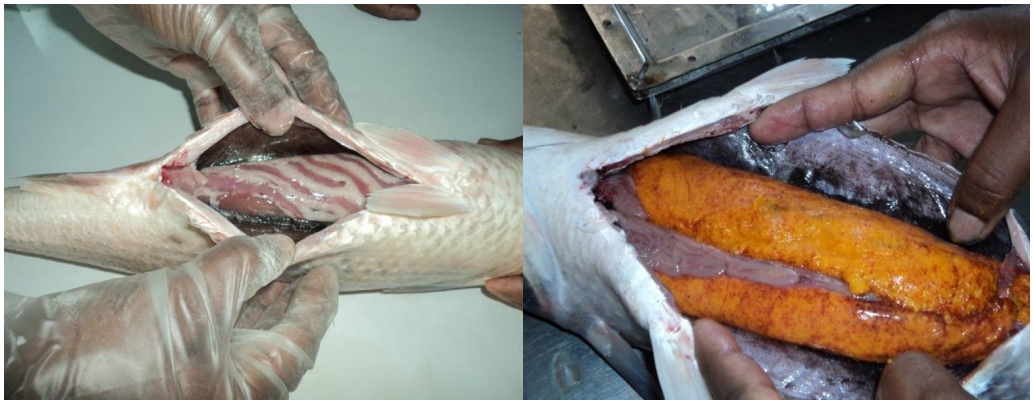


Fig. 1. Gonadal development of Mullets in the month of January, 2014.

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. No response was found when an attempt was made for induced breeding of pond reared brood because of not fully maturation of mullets.

Seabass: Domestication experiment was conducted with different sizes (fingerlings, 1kg & 1kg+ weighted) of wild seabass stocked@ 1200kg/ha (24kg/pond) in on-campus pond (cistern tank) having 10-15 ppt salinity and fed with live tilapia. Growth performance of 1kg size fishes was highest and decreased with the increase of sizes. No gonadal development has been observed.

Table 3. Present status of the growth of seabass

Factors	Seabass
Initial Weight (g)	460
Av. Weight (g) upto last sampling	1650
Ovary	No Development exists
Testis	do
Eggs	do
Semen	do

Feed trial: A feed trial was conducted with live tilapia as prey, 50% tilapia + 50% pellet feed, trash fish 50% + pellet 50%, only trash fish and only pellet feed.. It was observed that seabass prefer live tilapia to pellet feed which might be the cause of least growth increment with 100% pellet feed. This year Sea bass showed gradual interest on trash fish as feed which is encouraging for gonadal development.

Rreproductive biology study: Reproductive biology was observed in this domestication experiment from Nov, 13 to Feb, 14. In case of captive condition no symptoms of gonadal development has been found as yet. No gonadal development has been observed in female reared in pond and also no semen was observed in male of >1 kg sizes. Some other important findings are as follows:

Body depth: It is also essential for brood development. In case of MFTS pond rearing Seabass (20 specimens examined)

Table 4. Difference between existing & ideal body depth.

Body compartment	Body depth (%)	Body depth (ideal %)
Fat mass	20-25	10-15
Fat-free mass	75-80	85-90

Body Mass Index (BMI) = Formula: BMI = weight / $(height)^2$
Weight 1.65 kg and height 42cm/ 0.42m
BMI= 9.35 $kg/m^{2,}$ According to literature, Effective range BMI for brood = 7.0 – 9.0 kg/m^2

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

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

Objectives

- To look into the factors affecting the emerging shrimp disease in Cox's Bazar.
- Assessment of the present status and seasonal variation of WSSV infection in wild brood, hatchery produced PL and farm rearing shrimp using Nested PCR technique.
- Diagnosis of bacterial diseases of shrimps causes severe damages in PL production and farming system.

Achievements

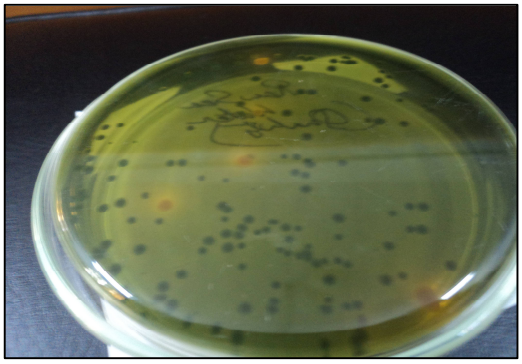
Factors causing emergent fish/shrimp diseases

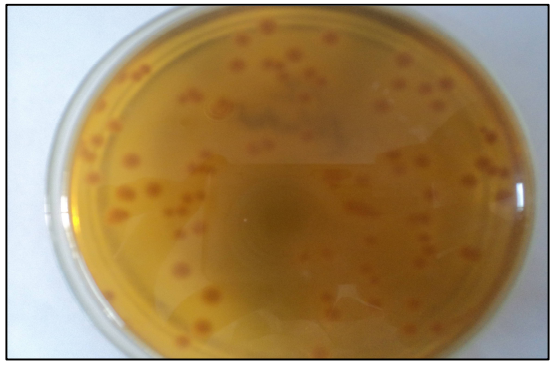
The physico-chemical parameters were observed in shrimp ghers fortnightly for four months from March 2013 to June 2013 and data were recorded. It was observed that shrimp in ghers become susceptible to disease with fluctuation of temperature, sudden fall of salinity due to freshwater runoff and malnutrition etc. Acidic soil $p^{H/}$acid sulphate soil is also a factor causing emerging shrimp disease in ghers of hilly area. 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.

An experiment was carried out in four on-station ponds of Marine Fisheries & Technology Station, Cox's Bazar having area of 200 m^2 from March 2014 to June 2014. There was no severe disease outbreak was observed in on-station trial. PCR test for detecting WSSV were done regularly and was not found any WSSV infection. Different physico-chemical and farming parameters is given in following table.

Parameters	Pond with PCR tested PL	Pond with non-PCR tested PL
Water depth	1.3 m	1.3 m
Salinity	2-10 ppt	2-10 ppt
pH	7.5-8.5	7.5-8.6
Temperature	27^0 -31^0 c	27^0 -31^0 c
Dissolved Oxygen	5-6 mg/l	5-6 mg/l
Culture period	120 days	120 days
Stocking density	5 PL/ m^2	5 PL/ m^2
PL size	PL 16	PL 16
Initial body wt	0.03 mg	0.03 mg
Final wt	15 gm	10 gm
Survival	50%	38%

Bacterial study: Samples of tiger shrimps 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 3.0 x 10^2 to 1.2 x 10^3 cfu/ml. The average count of green colonies (produced by luminous bacteria) was ranged between 5.0 x 10^1 to 5.5 x 10^2 cfu/ml. *Vibrio* is one of the most important pathogen for tiger shrimp post larvae, produced shrimp hatcheries of Cox's Bazar. The study revealed that the concentration of Vibrio colonies is close to fatal range which may hamper of tiger shrimp larval development in shrimp hatcheries and may cause higher mortality.





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 of Hatchery zone of Cox's Bazar during March to June 2014. 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.

- For brood, 30% WSSV positive and 70 % WSSV negative were detected.
- For nauplii, 27% positive in terms of WSSV was detected.
- For nauplii, 3% WSSV positive was detected.
- For juvenile (field sample) 50% WSSV positive was detected.

Status of the existing marine fisheries products and investigation on the use of chemicals or pesticides in the products

Researchers: Dr. Md. Shafiqur Rahman, SSO
Md. Shahzad Kuli Khan, SO

Objectives

- To know the status of the existing marine fisheries products of Bangladesh
- To evaluate the quality, nutritive value and shelf life of the commercially important marine fisheries products
- Investigation of the preparation methods of the products
- Detection and determination of pesticides/insecticides (DDT, heptachlor and dichlorovos) in marine fisheries products (dry fish) at winter and rainy season

Achievement

Dried fish production

About 15% of fishes are cured for mass people consumption at the scarcity of fresh fishes in Bangladesh. The coastal regions and isolated islands are famous for producing dry fish during the period of mid October to mid April. During this period the coastal crisscrossed channels and other depressions remain calm and quiet and therefore, huge amount of fishes are harvested. Such huge catch of fish during the winter season can not be sold on a daily basis at proper prices. To overcome the above circumstances, drying of fish is an alternative option for long term preservation. Various pesticides are used in dried fish to control blowfly and beetle infestations. In field situation, during processing of dried fish, Nogos, Ripcord, Endrin, Malathion, Dimacron, Shobricorn etc. are known to be used, while in storage of the product, DDT, Basudin and Malathion are preferred ones. During present investigation it was observed that Shobricorn (a pesticide prescribe for vegetable and crops by Syngenta and containing profhanophos and cypermethen) was widely used by the dried fish producer in Cox's Bazar area.

Proximate composition of five marine fish samples from three different locations (Cox's Bazar, Kuakata, Patuakhali and Dubla, Khulna) were analysed to assess the overall quality of dried fishes (Table 1). The moisture content of dried fishes varied from species to species and also among localities. Considering the sampling location, the highest moisture content was found in all the samples collected from Cox's Bazar. In contrast, the lowest moisture content was found in the samples of Dubla, Khulna. However, the corresponding values were in intermediate position for all samples collected from Kuakata. Among fish species, the highest moisture content was measured in silver pomfret samples (38.94%) obtained from

Cox's Bazar, which is not excepted. Protein content varied from 51.33% to 77.68% among the six different dried products. The highest protein content was found in Ribbon fish collected from Dubla while the lowest value was found in Olua fish sample collected from Cox's Bazar. The protein content was relatively higher in the fish samples of Dubla as compared to other two locations (Kuakata and Cox's Bazar).

Table 1. Proximate composition of marine dried fishes

	Proximate composition (%)	Cox's Bazar	Kuakata (Patuakhali)	Dubla (Khulna)
Rup chanda (Silver pomfret)	Moisture	38.94	32.59	14.69
Pampus chinensis	Ash	26.01	26.76	6.18
	Lipid	27.74	22.85	17.35
	Protein	55.90	54.26	52.82
Churi (Ribbon fish)	Moisture	27.13	20.76	12.53
Lepturacanthus savala	Ash	21.52	6.37	8.02
	Lipid	7.74	5.54	3.59
	Protein	65.42	63.39	77.68
Lotia (Bombay duck)	Moisture	26.01	23.09	20.01
Harpodon nehereus	Ash	27.60	25.38	15.41
	Lipid	10.04	10.04	10.60
	Protein	69.42	65.47	69.54
Olua (Anchovy)	Moisture	18.04	13.76	14.16
Coilia spp.	Ash	31.37	25.61	20.88
	Lipid	4.74	12.88	9.27
	Protein	51.33	67.80	69.47

The mean concentration (mg/kg) of heavy metals (As, Cd, Cu, Fe, Pb and Zn) in three dried marine species are presented in Table 2. Arsenic concentration was found higher only in ribbon fish than the permissible level (7.5 mg/kg) in the samples of Cox's Bazar (22.27 mg/kg) and Dubla (8.41 mg/kg). The iron content was found relatively higher in Bombay duck in all samples of three locations which varied between 116.85 to 160.18 mg/kg. Further, it was also found above the recommended level in silver pomfret (146.83 mg/kg) sample obtained from Dubla. The Zn concentration also crossed the permissible limit (30 mg/kg) in all three species only for one location in each species and the value varied from 31.08 to 364.74 mg/kg. However, three other analyzed metals cadmium, copper and lead were found within the recommended level in all three species for all considered locations.

Table 2. Heavy metal concentration in marine dried fishes

Dried fish	Heavy metals (mg/kg)	Cox's Bazar	Kuakata (Patuakhali)	Dubla (Khulna)	Permissible level
Rup chanda (Silver pomfret)	Arsenic (As)	1.63	1.47	3.21	7.5
	Cadmium (Cd)	ND	ND	ND	0.50
	Copper (Cu)	0.23	0.30	0.84	30
	Iron (Fe)	37.31	66.67	146.83	100
	Lead (Pb)	0.009	0.32	0.29	0.30
	Zinc (Zn)	20.49	16.95	46.42	30
Churi (Ribbon fish)	(As)	22.27	0.95	8.41	7.5
	(Cd)	ND	ND	ND	0.50
	(Cu)	0.99	0.57	0.84	30
	(Fe)	36.04	48.03	61.34	100
	(Pb)	0.05	0.013	ND	0.30

	(Zn)	364.74	24.91	27.57	30
Lotia (Bombay duck)	(As)	1.46	2.31	1.67	7.5
	(Cd)	ND	ND	0.001	0.50
	(Cu)	0.57	0.68	0.51	30
	(Fe)	116.85	153.08	160.18	100
	(Pb)	0.03	0.12	0.23	0.30
	(Zn)	28.02	31.08	28.60	30

Fermented fish products

The term "fermented fish products" is used here to describe the products of marine finfish, shellfish and crustaceans that are processed with salt to cause fermentation, and thereby to prevent putrefaction. Nappi is an indigenous fermented fish product made from fish and/or shrimp paste obtained by natural fermentation in the presence of high salt concentration. Nappi in general is prepared as follows: The shrimp or fish are mixed with salt at the 10% on the fishing boats, and then spread out on the floor. Further salt is added at 5%, and the product is dried in the sun for about 1 to 3 days, and occasionally turned over, to decrease the moisture content from about 80% to 50% and also to minimize off flavor. The resulting mass is minced, pressed tightly into wooden tubs to exclude all air and allowed to ferment for 1-4 weeks, then again sun dried and packed for sale.

Fermented pastes generally contain amino acids and polypeptides equivalent to about 10% to 40% protein. They are good sources of calcium, iron and some B group vitamins. However, nutritional importance of these products is limited due to its high salt content which restricts its bulk consumption. Moreover, these traditional products are used as a condiment rather than to derive nutrition.

Table 4. Proximate composition of different stages of Nappi

(g/100g) DM	Nappi-stage1	Nappi- stage 2	Nappi- stage 3
Moisture	54.51	43.98	48.18
Ash	23.10	28.62	35.07
Lipid	16.05	15.12	15.04
Protein	51.91	49.46	48.10

Nappi samples were collected from different localities of Cox's Bazar to investigate the proximate composition. The average protein content was recorded to be 26.27%, 33.46% and 22.62% in Teknaf, Moheskhali and Chowpholondi, respectively. The highest protein content was found to be 33.46% from the sample of Moheskhali and the lowest protein content was found to be 22.62% in Chowpholondi the sample collected from Chowpholondi.

Other marine products

Besides dried, smoked and fermented fish products, some other products from marine catch are also available in the coast. They are fish bladder, shark liver oil, oily phasa, fish scale etc.

Table 5. Nutritional composition of various products from marine fishes

Products	Protein (%)	Oil (%)	Ca (ppm)	K (ppm)	Fe (ppm)
Fish bladder	68.06	1.65	823.72	1627.5	33.63
Shark liver oil	2.81	94.99	41.03	445.89	37.88
Oily phasa	27.13	15.15	13113.57	2101.88	54.38
Nappi	29.88	4.17	56709.71	3779.13	328.70

Improvement of dried fish production system suitable for small entrepreneurs and marginal producers

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

Objectives

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

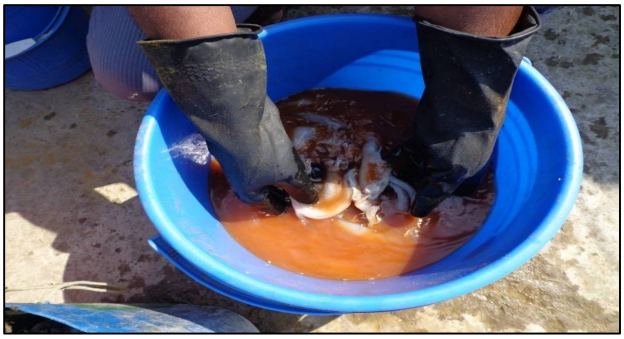
Achievements

Development of fish drying technology for marginal producers: To produce hygienic dry fish in large scale, a model of improved traditional fish drying was developed in BFRI, Marine Fisheries & Technology Station, Cox's Bazar. The experiment was done in Nazirertek Fish drying yard, Cox's Bazar.



Total dry fish processing unit was covered with fine mesh nets to protect infestation. The size and capacity of fish drying is variable. Dryer structure was box type. Dryer size was medium. Fish dryer construction materials was bamboo pole, Bamboo stick, Nylon net (mesh size- 0.8 cm), Fine mesh net, rope and Ladder. Length was 15 meter and width was 7 meter. Height of Dryer was 4 meter (2 meter pole + 2 meter fish drying facilities). Fish drying space was 210 m^3. Bamboo pole was 2 meter interval. Dryer roof and peripheral fence covered with Nylon net (mesh size- 0.8 cm) and dryer bottom covered with fine meshed net. Fish drying facilities- On bottom surface was 105 m^2. Bottom surface area is better for Pomfret and small fishes. Bamboo Colum height was 2 meter, Colum length- Peripheral (15+15+7+7) = 44 meter. Internal Colum was 3 of which height -2 meter & length- 12 meter. Colum interval was 2 meter. Rows in Colum was 5 for Bombey Duck and 3 rows for Ribbon fish (Colum height 2 meter). Fish drying capacity was 225 kg hygienic dry fish can be produced per lot. Fish drying period was 3 days for one lot & one day breaking for cleaning. Fish drying capacity per month was (225 kg × 7 lot) = 1575 kg hygienic dry fish per month. Fish drying activities are operating in Nazirartek is about 8 months per year. Fish drying capacity per year of a medium size improved fish dryer = (1,575 kg × 8 month) = 12,600 kg = 12.6 metric ton hygienic dry fish.

Effect of spice treatment on the quality of dried fish: An experiment was conducted to determine the efficiency of chilli and turmeric spice mixtures at 1%, 1.5% and 2% and 25 kg fish dipped in spice solution for 10 minutes. Bombay Duck (*Harpodon nehereus*), Silver Pomfret (*Stromateus argenteus*), Ribbon fish (*Lepturacanthus savala*) and miscellaneous small fish were dried in this experiment. The cleaned and spiced fish samples were arranged on the dry racks within the box dryer. They were then divided into four batches S0 S1, S2, and S3 (replicated three times) representing un-spiced, 1% spiced, 1.5% spiced, and 2% spiced respectively, then dried for 3 days, stored at room temperature and used for proximate analysis.



Samples were subjected to visual observation, chemical, microbiological analysis and sensory evaluations. Protein, lipid, ash and moisture content of dried products were determined. The results of the proximate analysis of the improved dried spiced fish samples are contained on table 1.

Table 1. Proximate composition of dried fish with spice-salt treatment

(g/100g) DM	Turmeric solution		Chili solution		Sodium Chloride solution	
	Lotia	Chori	Lotia	Chori	Lotia	Chori
Moisture	16.37	26.39	17.18	17.43	15.53	17.89
Ash	13.86	26.88	13.45	12.22	14.08	12.32
Lipid	9.13	6.17	11.47	7.22	12.30	7.74
Protein	80.10	68.26	73.05	77.57	73.13	81.40

There was no significant difference in the proximate components of the samples in all the treatments. The higher protein content of 80.10% was recorded in sample with Turmeric over the 73.05% of chilli

and73.13% of salt in Bombay Duck (Lotia) and 81.40% was recorded in sample with Sodium chloride over the 77.57% of chilli and 68.26% of Turmeric in Ribbon fish (Churi). Moisture loss rate in improved traditional method of fish drying, developed by BFRI, MFTS, Cox's Bazar was recorded and was shown in Table 2.

Table 2. Moisture loss rate in improved traditional method of fish drying

Species	Weight of fish	Moisture loss within 0-24 hours	Moisture loss within 25-48 hours	Moisture loss within 49-72 hours	Dry fish gain (gm)
Bombay Duck	1000 gm	758 gm	71 gm	2 gm	169
Ribbon Fish	1000 gm	559 gm	78 gm	32 gm	331
Silver pomfret	1000 gm	550 gm	80 gm	38	332

Market channel development: Dried samples were packaged in sealed polythene bags with printed labeling. Before packing, headless of Ribbon fish and Bombay Duck were done for higher shelf-life of dried fish. The results of headless are shown in Table 3.

Table 3. The weight loss due to headless of dried fish.

Species	Weight of fish	Wt. of cutting head	Wt. of headless dry fish
Bombey Duck	1000 gm	180 gm	820 gm
Ribbon Fish	1000 gm	210 gm	790 gm

About 200 gm, 500 gm and 1000 gm dried fish were packed for marketing in case of Bombay Duck and Ribbon fish. Single dried pomfret were packed in Celluloid in respect of cost minimize. For market channel development of BFRI dry fish products, supplied to modern chain shops in Dhaka and Chittagong through local selected dry fish trader of Cox's Bazar.