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Bangladesh Fisheries Research Institute

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BFRI Annual Progress Report 13

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Foreword

Fisheries sector plays an important role in the economy and livelihood of Bangladesh in terms of nutrition, employment and export earnings. Since inception, Bangladesh Fisheries Research Institute (BFRI) has been implementing research programmes reflecting the national developmental needs and policy. BFRI has so far innovated 57 improved aquaculture and management technologies through demand driven research. A good number of such technologies have been disseminated in the field in various degrees. During 1992-2017, fish production has increased by more than three folds from 1.2 million mt to 4.10 million mt due to dissemination of the developed technologies. As a consequence, Bangladesh attained 4th position in the globe in freshwater aquaculture production.

One of the important mandates of BFRI is to carry out and co-ordinate fisheries research in the country. The goal of the research is to develop improved aquaculture and management technologies for sustainable development of the fisheries sector. The Institute prioritizes annual research programmes incorporating suggestions and recommendations of different stakeholders like farmers, entrepreneurs, academicians & policy makers.

The research programmes and the activities implemented by the Institute during 2017-2018 for development of the sector have been presented in this report. A total of 51 research projects were implemented in different stations and sub-stations of the Institute during the reporting period. The BFRI scientists succeeded in developing technology of seed production and culture of endangered fish species, gutum (*Lepidocephalus guntea*) in its Freshwater Sub-station at Saidpur. Other activities included here are technology innovation, training, publication, finance etc. of the Institute.

The main outputs of BFRI in terms of technology generation for increasing fish production and policy guidelines formulation for fisheries development of the country forwarded in line with the Govt. 7th Five Year Plan and Sustaionable Development Goals (SDG). While aquaculture has been progressing very well due to development of various technologies, some of the new and emerging issues have cropped up in the process, which need to be seriously dealt with to maintain the current growth of the aquaculture industry. Besides, new intervention in marine sector is a thurst area of research to be undertaken on priority basis.

We hope this report will be useful to researchers and planners of different national and international organizations for the formulation of project proposal and policy guidelines for fisheries development.

Dr. Yahia Mahmud
Director General

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Bangladesh Fisheries Research Institute: An Overview

The fish and fisheries are integral part of the culture and heritage of Bangladesh. The sector plays a significant role in nutrition, employment generation and foreign exchange earnings. Keeping in view of the immense potentials of the sector in providing better nutrition and job opportunities, particularly to the poorest of the poor, and the urgency for optimum scientific utilization of the aquatic heritage, the President of the People's Republic of Bangladesh was pleased to promulgate an Ordinance entitled "The Fisheries Research Institute Ordinance 1984" on 11 July 1984. In pursuance of this Ordinance, the Fisheries Research Institute (FRI) was established in July 1984. In 1997, the FRI has been renamed as Bangladesh Fisheries Research Institute (BFRI) through the amendment of the 1984 Ordinance.

Though the Institute was established in 1984, it actually started functioning in 1986 with the recruitment of required manpower and creation of initial research facilities. Since then, the institute has been playing a key role in assisting the nation to achieve the goal of fisheries development as set out in successive development plans.

Vision of the Institute

Development of need based technology leading to increasing fisheries production of the country.

Mission of the Institute

To conduct research for the development of need based technology on aquaculture and fisheries resource management of the country.

Mandate of the Institute

- ✓ To carry out basic and adaptive research for development and optimum utilization of all living aquatic resources and coordinate fisheries research activities in Bangladesh;
- ✓ To conduct experiment and standardize techniques for maximizing productions and better management of living aquatic resources;
- ✓ To identify new production opportunities and develop them to usable levels;
- ✓ To develop skilled research manpower through training;
- ✓ To transfer developed technologies to users through training of extension workers, planners, fish farmers and other stakeholders;
- ✓ To advise the Government in all matters relating to research and management of living aquatic resources.

Management of the Institute

The Institute (BFRI) is an autonomous research organization and linked up administratively with the Ministry of Fisheries and Livestock, Government of the Peoples' Republic of Bangladesh. The general direction, administration and supervision of the affairs of the institute is vested in the Board of Governors consisting as follows:

Board of Governors

Chairman	: Hon'ble Minister, Ministry of Fisheries and Livestock
Vice-chairman	: Secretary, Ministry of Fisheries and Livestock
Members	: Executive Chairman, Bangladesh Agricultural Research Council
	: Vice-chancellor, Bangladesh Agricultural University, Mymensingh
	: Member (Agriculture), Planning Commission
	: Director General, Department of Fisheries
	: Two Members of the Parliament to be appointed by the Govt.
	: Two persons to be appointed by the Govt. among the persons having interest in fisheries development
	: Two persons to be appointed by the Govt. engaged in research in BFRI
Member-Secretary	: Director General, BFRI

Board of Governors may exercise all powers and doing all acts and things that may be performed or done by the Institute. The Board may appoint such committees, as it may consider necessary to assist it in the performance of its functions. As the Chief Executive of the Institute, the Director General takes appropriate steps in implementing its programs in the light of the policies and directives formulated by the Board of Governors.

BFRI Organogram

The Headquarters of the Institute is located at Mymensingh. The Institute has five research stations and five sub-stations based on different aquatic ecosystems. The organogram of the institute is shown in next page.

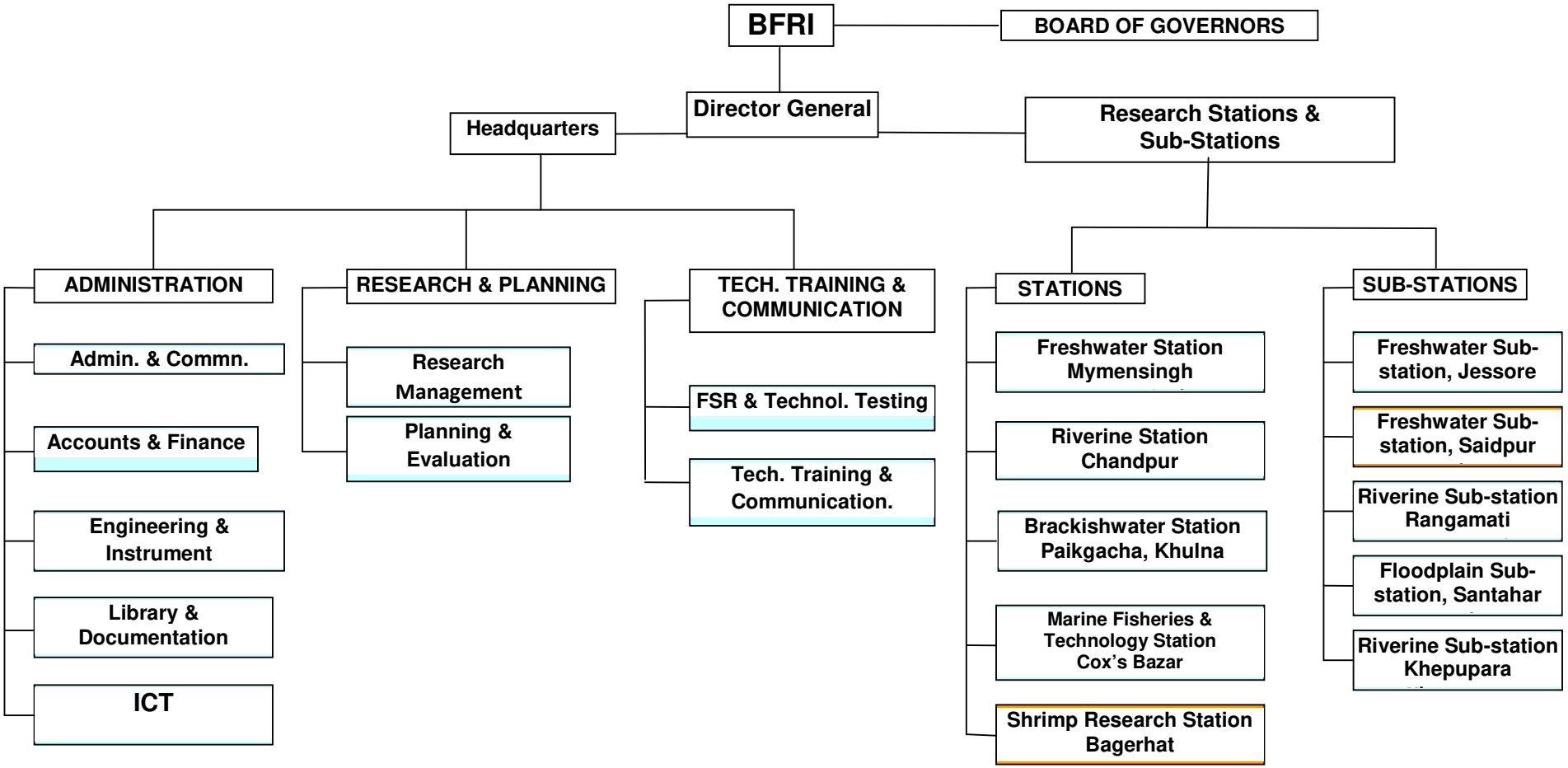
Stations and Sub-stations

Headquarters, Mymensingh

The Headquarters of the Institute is located at the south-west corner of the Bangladesh Agricultural University, Mymensingh, which is about 120 km north of the capital city, Dhaka. The Headquarter functions through its various divisions in respect of administrative development, coordination and operation of its research programs. The divisions are:

- Research Management
- Planning & Evaluation
- Technology Testing, Training & Communication
- Administration & Common Service
- Engineering & Instrument
- Library, Documentation & Public Relations
- ICT and
- Accounts & Finance

ORGANOGRAME
Bangladesh Fisheries Research Institute
Mymensingh 2201



Freshwater Station (FS), Mymensingh

The largest station of the Institute, with an area of 40 ha is located at Mymensingh attaching to the BFRI Headquarters. The station has well established and sophisticated carp and prawn hatcheries. The station has as many as 118 drainable ponds consisting of 20 mini ponds; 52 nursery ponds (0.1 ha each), 47 rearing ponds (0.25 ha each) and 16 grow-out/brood stock ponds (1.6-2.6 ha each). Other physical facilities include a feed store, office buildings, residential quarters, a 35 bed constructed dormitory, a community center and a 5-bed guesthouse. The station is actively involved in conducting research on hatchery management, fish genetics and reproduction, carp polyculture, integrated fish farming, fish feed and nutrition, pearl culture, fish disease, health management and socio-economic aspects. The various research activities of the station are implemented by the following divisions:

- Reproductive Physiology & Genetics,
- Aquaculture & Farming System,
- Nutrition, Food & Feed Technology,
- Fish Disease Diagnosis & Health Management;
- Soil, Water & Productivity Management;
- Fisheries Socio-economics.

Three sub-stations are attached to the Freshwater station. These are:

Floodplain Sub-Station, Santahar: To support the floodplain fisheries development program taken up by the Government, studies on the ecology, limnology and gear selectivity of floodplains are being undertaken at the Santahar Sub-station.

Freshwater Sub-Station, Jessore: To support freshwater aquaculture farmers and hatchery operators of greater Jessore region, the Freshwater Sub-Station has been conducting research on breeding and culture of BFRI super Tilapia, carp disease diagnostic services and also farming system research and development.

Freshwater Sub-Station, Saidpur: To support the fisheries development program in northern region of Bangladesh, a freshwater sub-station is established in Saidpur Upzilla under Nilphamari. The prime objective of the sub-station is to conduct need based research to suit with the ecosystem of northern Bangladesh and to transfer technology to the farmers through effective training and demonstration.

Riverine Station (RS), Chandpur

The station is situated in the riverine port city of Chandpur, with an area of 17.2 ha and has 36 non-drainable ponds ranging in size from 0.12 to 0.37 ha each and with a total of 8.6 ha. water area. In addition, the station has one carp, one catfish and one prawn hatchery, two deep tube-wells, specialized laboratories, library, office buildings, residential quarters and a 8-bed guest house. One research vessel, one mechanized wooden boat equipped with research facilities, and three speed boats are available for undertaking riverine survey and studies relating research and management to hilsa and other riverine fisheries resources. The Riverine Station consists of 6 research divisions, which are as follows:

- Stock Assessment & Resource Dynamics;
- Fisheries Resource Management & Conservation;
- Culture-based Fisheries Management;
- Reproductive Biology of Riverine Species;
- Environment & Aquatic Pollution.

Two Sub-Stations are attached with the Riverine Station, and these are:

Riverine Sub-Station, Rangamati: To devise sustainable management and development strategies for the Kaptai lake fishery, Riverine Sub-Station (RSS) undertakes various adaptive research programs. Priorities are given on continuous monitoring of biological productivity, stock assessment, natural spawning, and population dynamics of various commercially important fishes and major carps, in particular. Recently, RSS has been introducing pen and cage aquaculture programs in the creeks and lagoons of Kaptai lake to culture fingerlings of major carp and thus to support artificial stocking of the lakes by Bangladesh Fisheries Development Corporation (BFDC), Kaptai lake project. Extension works are being carried out through adaptation of pen and cage aquaculture, installation of pens and cages in the creeks/coves in Kaptai lake on participatory basis.

Riverine Sub-Station, Khepupara, Patuakhali: The fish landing and wholesale center of BFDC at Khepupara Upazilla has been handed over to BFRI to develop as a Sub-Station and carry out research mainly on hilsa fishery. The old infrastructure has now been renovated by BFRI. Due to manpower, funds and logistic constraints, research is being conducted on hilsa in a limited scale. In addition to this, technical advice to the fish farmers are being provided and improved fish seeds are distributed to the local farmers time to time.

Brackishwater Station (BS), Paikgacha, Khulna

The station was established in 1987 with a view to undertake research and development activities on various aspects of coastal aquaculture and fisheries management. The station is located at Paikgacha Upazilla under Khulna and has an area of 30.56 ha. The station has got 53 drainable experimental bracksihwater ponds of different sizes ranging from 0.05 to 1.0 ha, an experimental hatchery for the production of prawn and commercially important brackishwater fin-fish seeds and a number of laboratories. The station has 5 research divisions, such as:

- Nutrition & Feed Technology;
- Disease Diagnostic & Health Management;
- Brackishwater Aquaculture;
- Estuarine Ecology & Environment;
- Soil, Water & Productivity Management.

This station is involved in conducting research on increasing productivity of coastal *ghers*, environment friendly shrimp culture development, crab seed production and fattening, seed production and culture of commercial finfishes, diseases management, aquatic environment monitoring etc. The research work undertaken so far by this station includes socio-economic studies on shrimp farming, survey and assessment of shrimp fry resources and its breeding ground, production potential of *gher* fishery (with improved management practices), polyculture of shrimp and mullet, culture and fattening of mud crab *(Scylla* spp.), breeding and nursing of *Macrobrachium rosenbergii*, improved method of shrimp farming etc.

Marine Fisheries & Technology Station (MFTS), Cox's Bazar

This station, with an area of 4 ha, was established at Cox's Bazar in 1991. The station is being equipped with five specialized laboratories, and one outdoor complex with 39 cisterns (200 m^2 each), a two-storied office building including laboratory, eight residential buildings for officers and staff accommodation, one seminar room, one library, one service building and a 8-bed guest house. The laboratories of the station are:

- Water quality;
- Fish technology;
- Biology;
- Marine museum;
- Live Feed Lab.

The mandate of the station includes research on marine fish and shrimp seed production, marine ecology, environmental studies, production systems for marine shrimp, fin-fish and shell-fish, stock assessment and population dynamics of commercially important species, oceanographic studies, diseases diagnosis and control, development of processing and preservation technologies, socio-economic studies of marine and coastal fishers and quality control of marine products.

Shrimp Research Station (SRS), Bagerhat

The station was established on 2010 at Sadar Upazilla under Bagerhat with an area of 8.0 ha. The mandate of the station is to conduct research on enhancing shrimp production, shrimp health management, shrimp feed & nutrition, post harvest handling & quality control of shrimp and shrimp products. The station consist of a 2-storied Office-cum-Laboratory building, 3-storied Staff dormitory, and 4-storied Training dormitory of the station. Moreover, a pond complex composing 9 experimental ponds of different sizes are being used for experimental purposes. The laboratories of the station are:

- Shrimp Health Management;
- Quality Control;
- Shrimp Feed & Nutrition;
- Water & Soil Quality Management.

Manpower

The manpower status of the Institute is highlighted in the following table:

Head	Approved posts			Filled up posts		Vacant posts	
	Officer	Staff	Total	Officer	Staff	Officer	Staff
Revenue	162	295	457	116	228	46	67
Development	27	30	57	22	26	05	04

Development of Technologies

Regular research activities of the institute lead to generate various aquaculture and management technologies for better management of the resources and increase the fish production. Till 2016-17, the Institute has evolved more than 59 aquaculture, biotechnological and fisheries management technologies. Among them, 3 package technologies have been developed during 2016-17 and these are as follows :

- ✓ Breeding and seed production of endangered sp. gutum (*Lepidocephalus guntea*)
- ✓ Sea weed (*Hypnea* spp.) culture in the coast.

Technology transfer: Subsequent to development of technologies or management practices, the generated research results were transferred through various mechanisms. Different government agencies including Dept. of Fisheries, NGOs, farmers and entrepreneurs were offered training on research-evolved technologies. After successful maturation of technologies, printing materials like manuals, booklets, leaflets, posters etc. were published and distributed among the users.

On-Farm trials: Field trials of the on-station research findings were conducted for adaptation of technologies in on-farm conditions through government and non-government extension agencies, private entrepreneurs and NGOs.

Farmer's Advisory Services: The Institute through its different Stations and Sub-Stations provided advisory services to the farmers on improved fish farming technologies, water quality monitoring, feed quality, diseases control etc. Scientists of the institute also provided service on national crises related to fisheries and environmental issues as and when deemed necessary.

Training Programs

Research activities of the Institute tends to develop the fisheries sector by generating suitable and modern aquaculture technologies for better management of aquatic resources and increase fish production. The Institute organizes series of well structured training programs every year to disseminate the research evolved technologies to the end users. Meanwhile for effective transfer and dissemination of the technologies and management procedure the Institute undertakes elaborate programs such as training of extension workers both of Government and NGOs, teachers, journalists setting up demonstration ponds and visual materials. The training programs organized on different aspects are as follows:

- Improved fish culture and management
- Supplementary fish feed preparation and management
- Fry production & culture of GIFT and mono-sex Tilapia
- Fish disease and health management
- Seed production and culture techniques of endangered fish species
- Pearl culture techniques in freshwater ponds
- Shrimp nursery, culture and management
- Crab fattening techniques
- Pen and cage culture techniques
- Fisheries and aquaculture research management
- Mud eel culture technique
- Office management

The Institute also implements training on research methodology, office management, e-filing, foundation training and other research oriented programs for researchers of the Institute to shine up their capability.

Training programs conducted: BFRI organizes series of training programs every year for farmers, entrepreneurs unemployed youth, rural women, university students, extension workers both of government and NGOs, teachers, journalists and LGED fisheries facilitators. The main objective of offering such type of need and opportunity based training is to transfer and disseminate technologies among various stakeholders and end users. During 2016-17 a total of 68 training batches were completed and 1712 nos. of people were trained by the Institute.

Institutional manpower development: The Institute is strengthening the capabilities of scientists, administrative and management personnel through in-country and overseas short-term and long-term training programs, study tour etc. During the reporting period, a total of 12 scientists achieved overseas short-term and long-term training in 8 programs. Besides, 8 different in country training programs have been organized for the scientists and officers. A number of 2 delegated scientists have been awarded with abroad higher studies and 1 scientist have been awarded with in-country PhD studies opportunity.

Workshop/Seminar organized: The Institute organizes and participate to a number of national and international workshops and seminars in different disciplines to identify the problems and sharing and exchanging knowledge generated through research. During 2016-2017, a total of 6 scientists participated to different international seminars and workshops to exchange their knowledge along with the scientists of different countries. The institute and its stations and sub-stations organize regional and national workshops every year to review the research projects and to present the research progress of the institute.

Public Relation & Publications

Bangladesh Fisheries Research Institute (BFRI) Public Relations (PR) department provides information among different stakeholder of fisheries sector and so on. PR department also give information as well as latest research success to the press. The department distributes institute's publications among the related organizations including research organization, university, and NGO's. The department liaising with and answering enquiries from media person and other organizations through telephone, email or interpersonal communication. It also maintains updating information & engaging with its stakeholder on social media. The department writing and distributing press releases to targeted media as well as collecting and analyzing the media coverage. The wing maintains good relation with the community. The department also prepares speech on different occasion and it creates a media plan that contains a detail plan of media coverage.

The Institute publishes research findings, annual reports, newsletters, journals, workshop proceedings, training manuals, extension materials in the form of booklets, leaflets and posters. The publications are available at the Library and Documentation Center as well as at different regional stations and sub-stations of the Institute. The following publications were published during the reporting period:

Institute gives special value to publication and documentation of aquaculture and management technologies for their wider adoption. For this reason, extension manuals, leaflets, posters, handouts etc. were well circulated to govt. and non-govt. extension agencies, farmers, entrepreneurs etc.

Library and Documentation

Bangladesh Fisheries Research Institute Library and Documentation Centre (FRILDOC) act as a repository of literature and technical information and provides latest information on scientific research and experimental development in all branches of fish and fisheries. The most of the FRILDOC collection backup on the subjects: aquaculture, brackish water aquaculture, mari culture, marine science, biology, ecology, environmental science, agriculture, life sciences, sea weeds, plankton, food processing, feeds, zoology, botany, geography, economics, marketing, geology, socioeconomics, rural development etc.

The Library has 7,888 technical and general books 183 titles of scientific periodicals 2,819 miscellaneous publications. In addition to above collection, the library has kinds of reference books, academic dissertations, government and others departmental publications.

The FRILDOC is operating in fully automated environment. The various activities of the centre have been computerized using Library Management Information System (LMIS) software.
The FRILDOC provides the following documentation services:

- Document Delivery Service
- Current Awareness Service
  i) Current Content Service
  ii) Monthly Accession list
  iii) Monthly News paper Articles
- Reference service
- Bibliographical service
- Abstracting service
- SDI (Selective Dissemination Information) Service
- Internet Service
- Photocopy Service
- ASFA (Aquatic Sciences and Fisheries Abstract) DVD Service
- TEEAL (The Essential Electronic Agricultural Library) Service
- Digital Library Service (BFRI in Aquatic Commons digital repository(http://aquaticcommons.org/view/issuing_agency/Bangladesh_Fisheries_Research_Institute.html).

During the reporting period of 2016-2017, a number of books, Journals, periodicals etc. procured for the library. The library has also received a noticeable number of books journals, periodicals, proceedings, research reports, annual report, newsletters and magazines on complimentary and exchange basis. The library maintained exchange programs with more than 75 leading national and International organizations. The category wise list are shown below:

Items	2017-2018
Books	139
Journals	11
Reports/Proceeding of seminars and workshops/papers	15
Newsletters/Bulletins/Reprints/Off prints	77
ASFA (Aquatic Sciences and Fisheries Abstract) DVD	up to 2016
TEEAL (The Essential Electronic Agricultural Library)	up to 2013

During the reporting period about 120 scientists and research support personnel of the institute used the library. Moreover, about 191 users from outside BFRI consulted FRILDOC. The library maintained free mailing of institutional publications to various research organizations. Universities, NGOs, entrepreneurs and farmers to keep the aware with the latest development in fisheries research.

Working Linkage

The overall research, training and management activities of the institute were carried out in close cooperation and linkages with various national and international organizations/agencies. The institute also maintained close contact with public extension organizations, different NGOs working in the country, for dissemination of technologies and obtaining feed-back from them. BFRI collaborated with national universities and maintained close liaison for fisheries research and development (R & D). Among the national collaborators, definitely the main focus implies to the Department of Fisheries (DOF) followed by NARS Institutions and joint research and development programs with different NOGs.

Finance and Accounts

The sources of funds of the institute comprise grants from the government, and grants from different donor agencies. Government grant from the revenue budget is usually provided to meet only salaries and allowances of staff small protein of operational costs. The cost of development, maintenance and research

is also borne by the government from its development budget provided in the form of development project. The budget provided from its revenue head is quite insufficient to meet the recurring expenditures and research as well. Again, processing and flow of fund through development project is not continuous.

Receipts and expenditure: The institute received an amount of Tk. 27,70,20,000 lakh during the year 2016-17 from the government revenue budget and the expenditure incurred was Tk. 26,78,88,000 lakh.

Income: During reporting period, the institute earned Tk. 25.00 lakh from the sale of by-products obtained from various ongoing research projects. These include sale of spawn, fish, short tender schedules, conveyances and other miscellaneous items.

Developments Projects

Project Title	Project Period	Estimated cost (In Lakh Taka)	Objectives of the Project
Development and Dissemination of Pearl Culture Technology	July 2012-June 2019	1845.00	• To carry out research for development of sustainable pearl culture technology • To conduct research for propagation of pearly mussels through development of breeding technology • To provide training to the fishermen, rural women and entrepreneurs to disseminate pearl culture technology.
Culture of *Cuchia* (Mud Eel) and Crab in the Selected Areas of Bangladesh and Research Project (Component-B, BFRI Part)	July 2015-June 2018	1386.35	• To assess existing population and stock of mud crab for the conservation and management of natural stock and to conduct survey on the existing status of *cuchia.* • To develop breeding, seed production and culture technology of mud crab and *cuchia*. • To optimize the developed technologies on mud crab fattening and *cuchia* production through demonstration in the farmers' field. • To provide technology based training on mud crab and *cuchia* seed production and culture to the GO and NGO extension workers, farmers and entrepreneurs. • To establish a laboratory cum hatchery buildings for BS, MFTS and strengthening of the existing laboratory facilities for BS, FS, FSS and MFTS. • To strengthen some necessary infrastructures of FS, Mymensingh BS, Paikgacha, MFTS, Cox's Bazar and FSS, Santahar.
Strengthening of Hilsa Research in Riverine Station, Chandpur	January 2017-June 2021	3353.90	• To establish office cum hilsa laboratory building and other infrastructures for strengthening hilsa research in the Riverine Station. • To carry out demand driven research for development of appropriate technologies for increasing production and conservation of hilsa fisheries resources. • To provide technology based training to different stakeholders on production and conservation of hilsa fisheries.

Research Progress
2017-18

Field Validation of Selected High Valued Fish Culture Technologies for Maximizing Production

Researcher: Dr. Anuradha Bhadra, Principal Scientific Officer
Dr. Mohammad Nurullah, Director (Research & Planning)
Dr. A.H.M. Kohinoor, Principal Scientific Officer
Md. Shahidul Islam, Senior Scientific Officer
Md. Moshiur Rahman, Scientific Officer
Parvez Chowdhury, Scientific Officer

Budget: Tk. 18,00,000.00

Objectives

- To validate the production technologies of koi (*A. testudineus*), shing (*H. fossilis*) and monosex tilapia (*O. niloticus*) and culture of monosex tilapia with shing and gulsha
- To analyze the benefit -cost ratio

Achievements

Expt. 1. Validation trial on culture of tilapia (O. niloticus) with shing (H. fossilis) and gulsha (M. cavasius)

The present trial was performed for validating the growth and production performance of Monosex tilapia (*O. niloticus*) with shing (*H. fossilis*) and gulsha (*M. cavasius*) for the period of five months from February through June 2017 in 02 selected farmer's pond at Palashbari upazilla under Gaibanda district having area of 800 and 1000 m^2 each. Prior to stocking, ponds were dried and cleaned for weed and unwanted aquatic animals. The dried ponds were treated with 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 1.5 meter. All sorts of inputs such as fish fry, fish feed, fertilizer, chemical were supplied to the selected farmers. The fry of monosex GIFT tilapia, shing and gulsha were stocked at the stocking density of 62500/ha, 25,000/ha, and 25000/ha, respectively. After stocking, fish were fed at a rate of 5-12% of body weight with supplementary feed (26% crude protein). Fish sampling were done at monthly interval to know the fish growth status and also to adjust feed ration. After five months, fish were harvested by repeated seine netting and Total weight and number of fish from each pond was recorded. Survival and gross production of fish of each pond were estimated.

Details of stocking, harvesting, growth and production of monosex GIFT tilapia, shing and gulsha in two ponds during the study period are presented in Table 1. The results showed that the GIFT tilapia reached the harvesting weight ranged of 210-242g. While harvesting weight range of shing and gulsha were found to be 35-42g and 30-34g, respectively. Based on the number of fish harvested at the end of the experiment, survival ranged from 67 to 88%. The survival rate of monosex GIFT tilapia, shing and gulsha were ranged from 90-85, 82-84 and 75-78%, respectively. Total production of fish as recorded in trial ponds- 1 and 2 were 13114 and 14370 kg/ha, respectively. The production obtained in the present study was very encouraging and very close to on- station trials. The reasons getting higher production might be due to application of higher protein enriched floating feed and better management. The net benefit obtained from pond-1 and 2 were Tk.52000 and Tk.40000, respectively. It may be concluded that the production and economic return of GIFT tilapia, shing and gulsha polyculture was very encouraging.

Table 1. Harvesting wt., survival and production of fish under two ponds

Name of farmer	Name of species	Stocking density/pond	Harvesting weight (g)	Survival (%)	Species wise production/pond	Total production/ha
Zulfiker Ali (Pond 1)	Tilapia	8750	210	90	1654	13114
	Shing	3500	35	82	100	
	Gulsha	3500	30	78	82	
Ali Mokshu (Pond-2)	Tilapia	6250	242	85	1285	14370
	Shing	2500	42	84	88	
	Gulsha	2500	34	75	64	

Expt. 2. Validation trial on culture of koi (A. testudineus), shing (H. fossilis) and GIFT (O. niloticus) in farmer's pond

The trial was carried out for validation of the technology of Vietnamese koi with shing and monosex GIFT tilapia for the period of 4 months during August to November 2016 in four farmers pond having 1000-7200 m^2 under Nasirnogar upazila under Brhambaria district. Prior to stocking, ponds were dried and cleaned for weeds and unwanted aquatic animals. After drying, ponds were treated with limed at the rate of 250 kg/ha. Five days after liming, ponds were filled-up with deep tube well water up to the depth of 1 meter**.** Fingerlings of Vietnamese Koi (*A. testudineus*) were stocked in all the ponds on 01, August 2016 in all the four ponds at the rate of 125000/ha. Shing and monosex GIFT strain were stocked at the rate of 25000 and 12500/ha, respectively after 15 days of stocking of Vietnamese Koi. During stocking, enough sufficient care was taken to reduce stress. At the beginning of the validation trial fishes were fed with floating crumble feed (30% protein) at the rate of 25% of total biomass. After fifteen days onwards, ball shaped floating feed containing30% protein was supplied to the fishes. The feeding rate was gradually reduced to 5% at the end of culture period. Fishes under all treatments were sampled regularly at fortnightly intervals to determine growth rate as well as feed adjustment. A total of 120 days rearing, fish were harvested by repeated seine netting followed by pond drying. Total fish weight and number of fish from each pond were recorded. After harvesting, survival and gross production of fish of each pond was estimated.

Details of harvesting weight, survival (%) and production of different farmers ponds are shown in Table 2. Average body weights of fry of Vietnamese Koi during stocking were 1.0, 4.0 and 3.0g, respectively in all the ponds. Harvesting weight of Koi attained the body weight ranged from 122-155g with a mean of 137±14.14. Growth of shing widely varied in different ponds, which varied from 40-82g with the mean weight of 57.50 ±18.28g. The highest and lowest harvesting mean weight were observed in pond 1 and 4, respectively. Though the stocking density of shing was same in all the ponds. In spite of that, the mean harvesting weight was varied due to farmers management. After harvesting Monosex GIFT attained an average body weight range from 240 - 256g with the mean value of 246±18.48g. A better production was obtained from such type of culture technique. It was observed that the range of production was 1663 to 20448 kg/ha/4 months. 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 Koi, Shing and GIFT Tilapia. The net benefit of Pond-1, 2, 3 and 4 were Tk. 133650, Tk. 563100, Tk. 107900 and Tk. 95000, respectively. The cost benefit analysis revealed that the highest net benefit was found in pond -2 amounting Tk. 563100 while the lowest was Tk. 90500 in pond-4.

Table 2. Harvesting wt. (g), survival and production of fish under different ponds

Name of farmer	Name of species	Stocking density/pond	Harvesting weight (g)	Survival (%)	Species wise production/pond	Total Production/ha
Narayan Das (Pond-1)	Koi	22000	138	85	2580	19107
	Shing	4400	82	77	277	
	Tilapia	2200	256	90	506	
Subrato Sarker (Pond-2)	Koi	90000	155	86	11997	20448
	Shing	18000	60	76	820	
	Tilapia	9000	238	89	1906	
Yosuf Miah (Pond-3)	Koi	25000	125	88	2750	17385
	Shing	5000	48	74	177	
	Tilapia	2500	250	88	550	
Shariful Islam (Pond-4)	Koi	35000	130	82	3731	16632
	Shing	7000	40	70	196	
	Tilapia	3500	240	87	730	

Development of Nuclei and Post Harvest Technology for Pearl Production

Researchers: Mohammad FerdousSiddique, Senior Scientific Officer
Dr. Mohosena Begum Tanu, Principal Scientific Officer
Arun Chandra Barman, Senior Scientific Officer
Sonia Sku, Scientific Officer
Abu Ryhan, Scientific Officer
Md. NazmulHossen, Scientific Officer
Md. Saiful Islam, Scientific Officer

Budget: Tk. 12,00,000.00

Objectives

- To prepare suitable nuclei for optimizing pearl production in freshwater mussel, *L. marginalisand L. corrianas*
- To improve luster of pearl produced in freshwater mussel.
- To increase shelf life of pearl produced in freshwater mussel.

Achievements

Expt. 1. Evaluation of different nuclei materials and standardization of size of nuclei for producing pearl in freshwater mussel, Lamellidens marginalis.

The powdered shells of *L. marginalis* and *L. corrianas* was collected and grinded.

- The cutting and shaping equipment was designed and installed with two grinders with controlled rotation
- For shell cube cutting and shaping cutting disk and a 8 inch carborabdum was used
- The Nuclei making equipment was designed and installed with controlled rotation of 1500 rpm
- Two pairs of carborundum wheels with grooves was used for round nuclei preparation.
- The polishing machined was designed and installed with controlled rotation of 100-800 rpm

Treatment	Nuclei Type	Used Shell/ particulars
Treatment-1	Stelon nuclei	*Lamellidens marginalis and L. corrianus*
Treatment-2	Shell bead nuclei	*Xancu spyrum*
Treatment-3	Justification of suitability (*Roundness, Dimensional Accuracy, Hardness, Brittleness, Thermal Expansion Characteristic, Effect of drilling, Specific gravities)*	Stelon nuclei, Shell bead nuclei and standard nuclei

Steps of shell bead nuclei preparation

Cerastoderma edule ***Xancus phyrum***

Expt. 2. Enhancement of pearl luster and shelf life by pearl treatment

Treatment -1 (Bleaching)	Treatment-2 (Maeshori)	Treatment-2 (Heating)
Collection of Pearl ↓ Dipping to remove impurities ↓ Drilling ↓ Soaking in H_2O_2 ↓ Cooling ↓ Temperature and light control	Collection of Pearl ↓ Measuring Pearl ↓ Dipping to remove impurities ↓ Drilling ↓ Soaking in H_2O_2 ↓ Heating and enlightening ↓ Temperature and light control	Collection of Pearl ↓ Measuring Pearl ↓ Dipping to remove impurities ↓ Drilling ↓ Soaking in Distilled water ↓ Heating at 80^oC ↓ Soaking in H_2O_2eating at 80^oC ↓ Temperature and light control

Progress in Treatment-1

- Image pearls of BFRI were cleaned with concentrated brine
- Pearls were placed in hydrogen peroxide (10%, 15%, 20%, 25%, 30%, 35%, 40%
- Pearls are kept under intense fluorescent light (1,700-11,900 lumens) and 20-40^{0}C where for as long as six months

Progress in Treatment-2

- Image pearls of BFRI were dipped in methyl alcohol and cleaned
- cleaned pearls were dipped in hydrogen peroxide and methyl alcohol (10-40%)
- Intense florescent light (3400-15,300 lumens) for 30 days.
- Temperature kept at 60^{0}C.

Progress in Treatment-3

- Image and rice pearls of BFRI were cleaned with concentrated brine solution
- Cleaned pearls were soaked in distilled water
- Pearls kept at 80^{0}C at heating cabinet
- Pearls kept in hydrogen peroxide and methyl alcohol (10%, 15%, 20%, 25%, 30%, 35%, 40%
- Intense florescent light(3400-15,300 lumens) for 4 months.
- Temperature kept at 33^{0}C -40^{0}C.

Development of Breeding and Culture Technology of Triangle Sail Mussel, *Hyriopsis cumingii*

Researchers: Mohammad FerdousSiddique, Senior Scientific Officer
Dr. Mohosena Begum Tanu, Principal Scientific Officer
Arun Chandra Barman, Senior Scientific Officer
Sonia Sku, Scientific Officer
Abu Ryhan, Scientific Officer
Md. NazmulHossen, Scientific Officer

Budget: Tk. 15,00,000.00

Objectives

- To adopt *Hyriopsis cumingii* in the environment of Bangladesh
- To identify the survival and growth performance of *H. cumingii* in Bangladesh
- To identify the suitable culture techniques of of *H. cumingii* in Bangladesh
- To identify the controlled breeding of *H. cumingii* in the pond ecology of Bangldesh

Achievements

Expt. 1. Experiment was conducted in ponds of Freshwater Station, BFRI, Mymensingh. Ponds were dried and cleaned for weed and unwanted aquatic animals. Salting was done to remove earth worms @ 1.25 kg/ decimal for 24 hours. The dried ponds was treated with lime at the rate of 1 kg/dec. Five days after liming; water was supplied from shallow tube-well to the ponds and filled up to the depth of 1.5 meter. Bamboo banas (height 3.5 m) covered with nets of 1.27 cm mesh size was used to keep the *H. cumingii* stock isolated. The prepared ponds were then stocked with collected *H. cumingii* @ 80/decimal were cultured in grazing method with *grass carp, mrigal, taki, shing* @ 40/decimal.

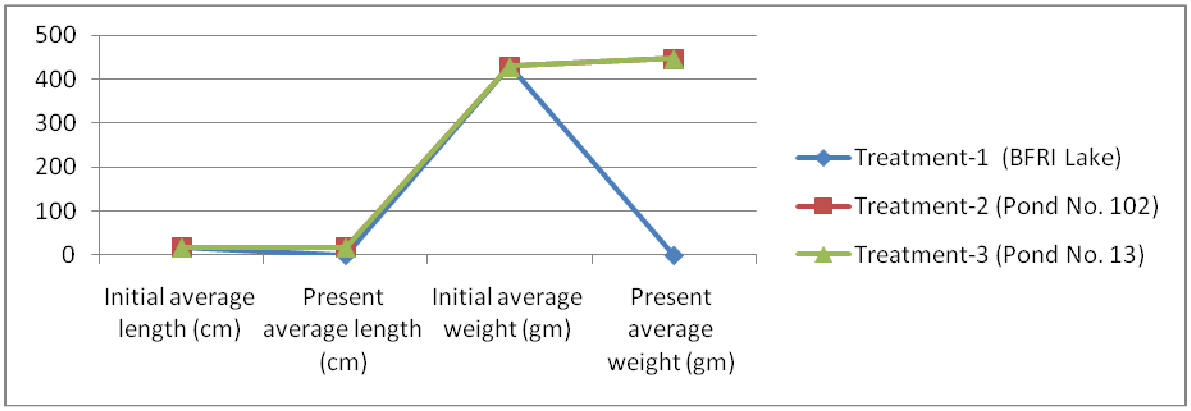


Fig. 1. Growth performance of *H. cumingii*

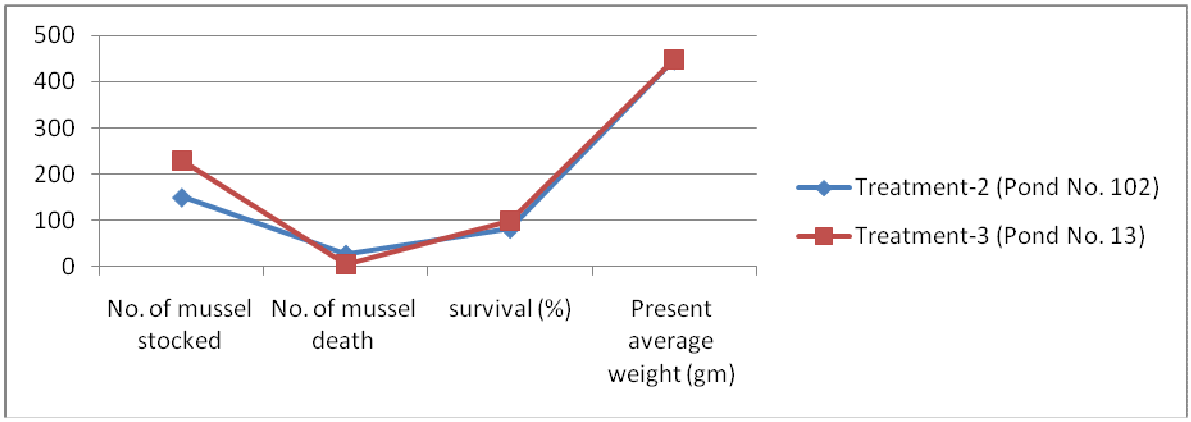


Fig. 2. Survival status of *H. cumingii.*

Expt. 2. Experiment was conducted in two ponds of Freshwater Station, BFRI, Mymensingh. Ponds were dried and cleaned for weed and unwanted aquatic animals. Salting was done to remove earth worms @ 1.25 kg/ decimal for 24 hours. The dried ponds was treated with lime at the rate of 1 kg/dec. Five days after liming; water was supplied from shallow tube-well to the ponds and filled up to the depth of 1.5 meter. The prepared ponds was then stocked with collected *H. cumingii* @ 80/decimal while the other was stocked with *L. marginalis* @ 80 no/decimal and cultured in grazing method.

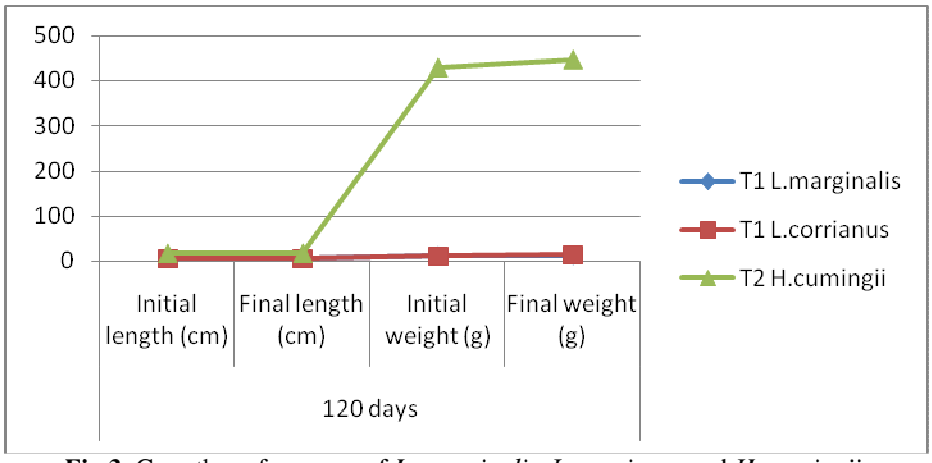


Fig 3. Growth performance of *L. marginalis*, *L. corrianus* and *H. cumingii.*

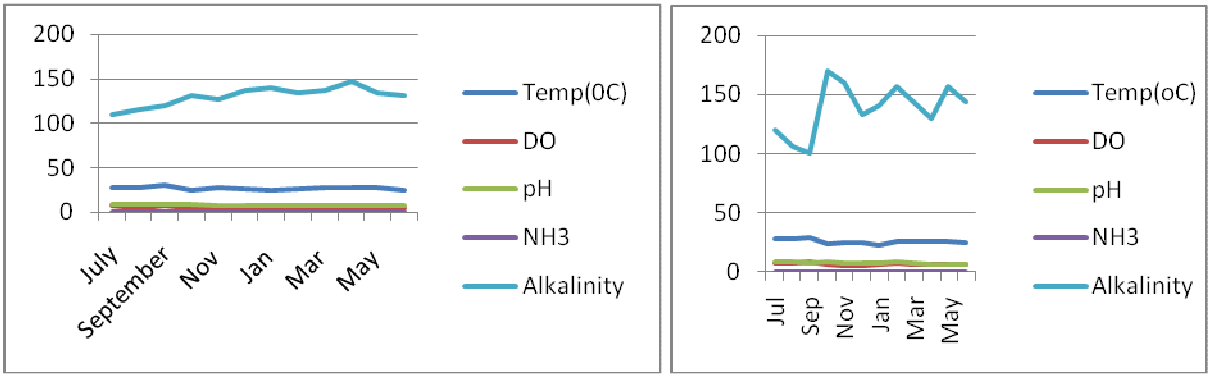


Fig. 4. Water quality parameters in pond-13 and pond-102 (July 2016- June 2017).

Development of Controlled Breeding and Culture Technique of Cuchia, *Monopterus cuchia*

Researcher: Dr. Durin Akhter Jahan, Senior Scientific Officer

Budget: Tk. 10,00,000.00

Objectives

- To develop control breeding technique formass seed production of *M. cuchia*in pond ecology
- To develop control breeding technique of *M. cuchia*in cistern ecology
- To evaluate the growth performance of cuchia fingerlings
- Refinement of low cost feed technology for cuchia culture

Achievements

Expt. 1. Development of control breeding technique forM. cuchiain cistern ecology

The experiment was conducted in cistern ecology with 3 treatments during July to June. From July to February cistern was prepared. After preparation of cistern, brood cuchia was stocked in the month of March and experiment was continued up to June. To conduct the experiment in cistern ecology, at least 1 feet soil layer and composed was used. Then water hyacinth wasused as shade and shelter.Three replications for each treatment wasmaintained for this environment. Stocking density was 10/m^2.Mature male and female eels wasstocked at the rate of 1:2 ratio. In Treatment-1, supplementary feed, fish paste, Treatment-2, fish paste, atta and Treatment-3, fish paste, fish meal,atta was supplied at the rate of 3-5%estimated body weight. At the same time fish, snail, earth warm was a lso used as live supplementary feed.Baby eel were produced in Treatment-1 where fish paste was used as supplementary feed. After rearing cuchia in cistern ecology baby eel were produced only in Treatment-1 and Treatment-2. Details production performances are shown in the following Table.

Table 1. Production performance of baby eel in cistern ecology

Treatments	Replication	Production of baby eel (Nos.)	Av. production of baby eel (No.)
T-1	R-1	93	70.33± 26.63
	R-2	77	
	R-3	41	
T-2	R-1	12	20.67±7.77
	R-2	23	
	R-3	27	
T-3	R-1	0	0
	R-2	0	
	R-3	0	

Expt. 2. Develop control breeding technique formass seed production of M. cuchiain pond ecology

During July to Junean experiment was conducted in the pond complex of Freshwater Station of Bangladesh Fisheries Research Institute, Mymensingh. In this experiment 3 treatment were maintained. Brood collection was completed within February. For the pond preparation filter net was placed in the bottom of the pond and then 1.0-2.0 feet soil and composed layer (10 cm) wasused on the filter net. After pond preparation, brood cuchiawas stocked in the month of March and the experiment was continued up to June.In Treatment-1, 2 & 3, brood cuchiawas stocked 15, 30 & 45/decimal, respectively. Similar water depth was maintained in all treatments. Mature male and female cuchiawas maintained at 1:2 ratio. Supplementary feed, fish paste, fish meal and atta was used at the rate of 3-5% of estimated body weight and live small indigenous species (SIS) and live snail was supplied in all ponds.During breeding season May to June brood cuchia was bred. In Treatment-1, 2 and 3, baby cuchia were collected 1722, 2446 and 1343, respectively. Replication wise baby eel production are shown in the following Table.

Table 2. Details production performance of M. cuchia in pond ecology

Treatments	Replication	Production of baby eel (Nos.)	Av. production of baby eel (No.)
T-1	R-1	569	1722± 6.25
	R-2	581	
	R-3	572	
T-2	R-1	812	2446±20.21
	R-2	797	
	R-3	837	
T-3	R-1	427	1343±19.22
	R-2	451	
	R-3	465	

Expt. 3. Refine rearing technique of cuchia fingerlings

This experiment was conducted in cistern ecology for a period of 90 days (March to May). Three stocking densities such as T_1: 100; T_2: 200 and T_3: 300m^2wasmaintained. In all the treatments the cuchiawas fed

with live tubifex. For this experiment tubifex bed was developed for continuous feed supply. Continuous water flow was alsoprovided for sufficient oxygen of tubifex. After 15 days interval weight of cuchiafingerlings wererecorded to observe their growth performance. Details growth performances are shown in the following Table.

Table 3. Average growth performance of cuchia fingerlings

Treatments	Initial weight (g)	Av. final weight (g)	Survival rate (%)
T-1	0.22±0.19	20.11^{a}±1.13	61.33^{a}± 5.12
T-2		14.16^{b}±1.77	46.33^{b}±6.11
T-3		10.09^{c}±1.92	38.67^{c}±6.18

Expt. 4. Refine low cost feed technology for cuchia culture

This experiment was conducted in pond ecology for a period of 120 days. From July to February pond preparation was done. Filter net was placed in the bottom of the pond and then 1.0-2.0 feet soil and composed layer (10 cm) wasused on the filter net. After pond preparation, cuchia fingerling was stocked in the last week of February and the experiment was continued up to June. Two treatments with 3 replications weremaintained for the experiment. In treatment 1, cuchiawasfed with the diet comprised fish paste (50%)+fish meal (40%)+atta (05%)+rice bran (05%). In treatment 2 cuchiawas fed with the diet comprised fish meal (90%)+atta (10%). Stocking densities of cuchiawas maintained 10/m^2. Helencha/water hyacinthwas used in all Treatments as the shelter of eels.

Table 4. Growth performance of cuchia using low cost feed

Treatments	Replications	Initial weight (g)	Final weight (g)	Av. final weight (g)
T-1	R1	62.23±8.63	148	167.33±19.50
	R2		167	
	R3		187	
T-2	R1		151	149.33 ±11.59
	R2		137	
	R3		160	

Reproductive Biology of Captive and Wild Populations of Endangered Mud Eel *Monopterus cuchia*

Researchers: Prof. Dr. S. M. Rahmatullah
Prof. Dr. Harunur Rashid
Prof. Dr. Mst Kaniz Fatema

Budget: Tk. 6,00,000.00

Objectives

- To perform histological observation of gonads (ovary and testes) of wild and captive populations of *M. cuchia* for identifying breeding and peak breeding season in the nature and captivity;

- To study the GSI of wild and captive mud eel and to compare with the histological observations of gonads; and
- To check probable occurrence of protogynous in *M. cuchia* through observation and manipulation of group breeding behavior and gonad histology.

Achievements

Investigating different aspects of reproductive physiology

Observation : Careful observation on external sexual characters of cuchia like. Coloration- brown, grey brown and black brown, ventral part was observed reddish brown in the month of April and May. Shape- female abdomen is swollen. Genital papilla – tubular and elongated in male, round in female. Behavior- males are more active during March, April, May. Fecundity of fish during the breeding season is being calculated by direct count. Highest observed fecundity in the month of March to May

Month	**Fecundity Range**
March	182-1234
April	218 -778
May	147 - 745
June	122 - 685

Gonado-somatic index (GSI)

Month	**Female GSI**
July	0.264
August	1.17
September	0.77
October	0.45
November	0.42
December	0.73
January	1.25
February	3.31
March	6.28
April	7. 15
May	7.03
June	6.18

Gonad histology of female cuchia

Year round observation on female gonad

- Female cuchia occupies from March to July
- The breeding season is Mid March to Mid July.
- September is the dry period and
- Ovary starts to develop from October and testis starts to develop again from the month of January.

Observation of inter-sexuality during early stage of gonad development

Two types of gonadal tissues were found in Squash method (Microscopic observation) - testicular and ovotesticular gonadal tissue.

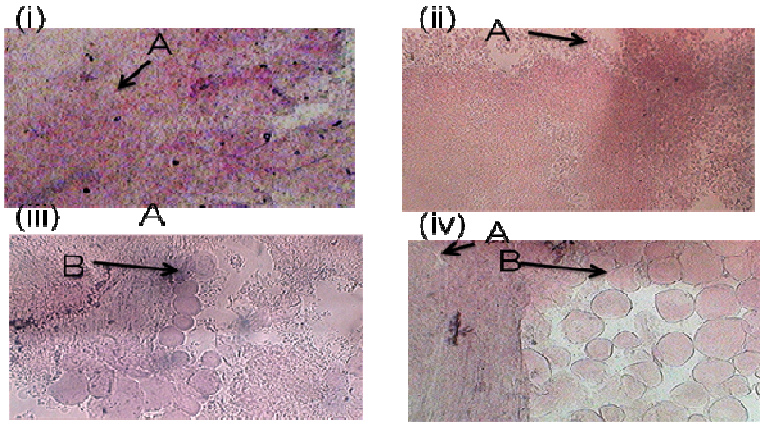


Fig. 1. Squash method showing testicular gonad (i & ii) where A is granular like structure of Spermatogonia, and Ovotesticular gonad (iii & iv) where B is Circular structured oogonia along with granular spermatogonia

Microscopic observation – Histology method

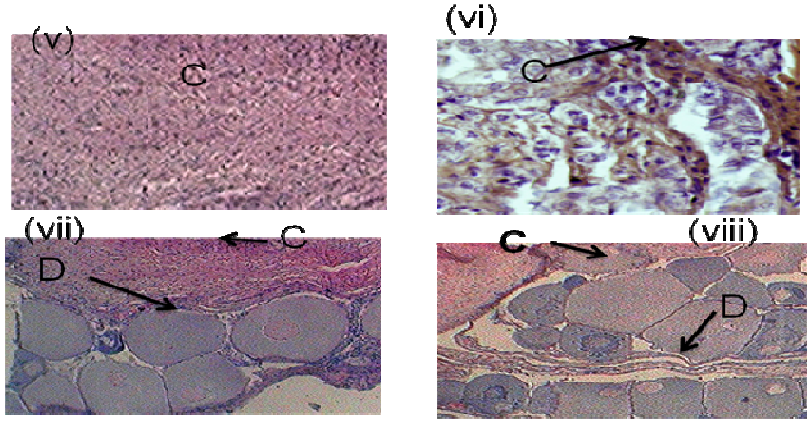


Fig. 2. Histology method indicating testicular gonad (v & vi) where C is Spermatogonia, and Ovotesticular gonad (vii & viii) where D is Circular structured oogonia along with granular spermatogonia

The investigation was carried out for the period of 6 months, July to December 2016. Gonad samples were collected from 150 mud eel of 7.0-22.0 cm length-size juvenile mud eel. Gonads were fixed with Bouin's fluid and preserved in 70% ethanol for histological study. Before fixation of gonad tissue, a 0.3-.0 cm piece of fresh gonad was cut and squashed by Aceto-carmine and observed under microscope. Two types of gonadal tissues were found - testicular and ovotesticular gonadal tissue.

Size	No. of fry	Testicular gonad (Nos.)	Ovotesticular gonad		Female gonad
			Nos	Character of female (%)	
7.0-12	60	40	20	10-30%	Nil
12.1-17	60	44	16	30-50%	Nil
17.1- 22	30	12	18	45-70%	Nil

However, in the juvenile stage, no fully developed ovary were observedin the all examined fishes. The female characters in ovotesticular gonad was increased with the increase of length. Histological study of the sampled gonads also confirmed the result that obtained in squash method. It could be concluded that the primordial gonad of mud eel passes through a male phase with an initial appearance of male sex cells

followed by intersex and then the occurrence of female sex cells. This result concludes that mud eel poses hermaphroditic character and development of female mud eel starts from an ovotesticular gonad tissue. It is the first hand information on the type of gonadal development and differentiation of early stage of mud eel.

Observation of protogynous sex change in cuchia

Fishes were stocked between the sizes of 220 - 495g. Data analysis is going on. No evidence of protogynous sex changing was found.

Development of Feed for Gonadal Maturation and Better Breeding Performance of *Monopterus cuchia* and the Nursery Management

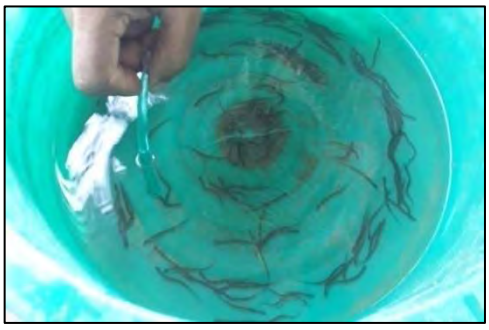
Researchers: Prof. Dr. Md. Fazlul Awal Mollah
Prof. Dr. Mohammad Matiur Rahman

Budget: Tk. 6,50,000.00

Objectives

- Studying the effects of different combination of feeds on gonadal maturation of *M. cuchia* broods.
- Determining the maturity of gonads of *M. cuchia* broods treated with different feeds through gonadosomatic index (GSI), fecundity and through measurement of serum Ca^{2+} level.
- Observing the quality and quantity of seeds produced by broods reared with different feeds.
- Studying of appropriate feed for culture of *M. cuchia* larvae in laboratory condition.

Acheivement



A total of 220 cuchia with the average length of 54 cm and 63 cm and weight of 207 g and 386 g for male and female, respectively were collected from different *beels* of Mymensingh district and were maintained in the cisterns in the "Mini Hatchery & Breeding Complex" of the Faculty of Fisheries, BAU, Mymensingh for conditioning for 3 days. No mortality was found during conditioning. Newly excavated six ponds were used as two sets (3 in each set) of experimental ponds. A total of 60 cuchia was stocked in each set of 3 experimental ponds, i.e., 20 cuchia in each pond. The fish were fed with 2 different combinations of supplementary feeds, *i.e.* Squid paste+fish paste (Treatment-I) and compost worm+fish paste (Treatment-II) at the rate of 2 to 5% of their body weight. Growth in terms of average initial weight, average final weight, percentage weight loss, and survival rate (%) of both male and female *M. cuchia* cultured in ponds were determined. In both the treatments weight loss was found of the stocked cuchia in the ponds. The final weight loss after 6 months rearing periods were 8.03% and 5.31% for T-I and 7.71% and 6.20% for T-II for male and female, respectively. Survival rate for male was also found more of less similar in both the cases but comparatively higher mortality was found for females in both the treatments. Through proximate composition analysis it was found that both the feeds contained similar amount of protein and fat.

For the determination of GSI, two female fish from each treatment group was sacrificed during the experimental period and subsequently, the gonadosomatic index (GSI) and fecundity was determined. The Gonadosomatic indexes of male and female *M. cuchia* showed single peaks. Significant rise in Gonadosomatic index was observed for male in the month of April in both T-I and T-II and declined in April which indicated the onset of spawning. In case of female highest Gonadosomatic index was also similar in both the treated groups and highest peak was found in April indicated the maturation of maximum ovaries. It was found that fish in T-I where squid was feed as PUFA enriched diet with small fish showed comparatively higher fecundity (724±21) than those of fish in T-II (668±17) where compost worm was feed with small fish. The blood serum Ca^{2+} concentration of females was determined using the method of Blood Safety and Clinical Technology, World Health Organization (2006) with slight modification. The effects of PUFAs on serum Ca^{2+} concentration (mg/dL) during February to June were measured. In May the highest serum Ca^{2+} concentrations for T-I and T-II were measured as 17.3 mg/dL and 16.7 mg/dL, respectively. From the end of May the level of Ca^{2+} concentrations of both the treatments were gradually decreasing; however, now significant difference was found among the treatments.

From all the experimental ponds variable numbers of baby eels were collected. In T-I, where squid and fish paste were supplied showed better performance compared to T-II where compost worm and fish paste was supplied. A total of 403 and 311 baby eels were collected from the ponds under T-I and T-II, respectively.

The collected *M. cuchia* larvae from the experimental ponds were raised in plastic bowls for a further period of 8 weeks. Nine bowls were divided into 3 groups and each group was considered as a treatment with 3 replications for each. Each bowl was stocked with 20 larvae of cuchia to see the suitability of various feeds like chopped tubificid worm+zooplankton (Treatment-I), finely chopped compost worm+zooplankton (Treatment-II), and squid paste+zooplankton (Treatment-III) keeping other variables constant. The growth in terms of length and weight was found different among the three treatments. The highest growth in terms of length and weight was observed in T-I (11.62±3.05 cm and 1.39±0.21 g) where fry were fed with tubificid worms collected from natural sources and zooplankton followed by T-II (10.62±0.18 cm and 1.04±0.11 g) and T-III (10.00±0.29 cm and 1.02±0.08 g) where, compost worm and zooplankton, and squid paste and zooplankton were applied, respectively. It was observed that the length gain (4.72±0.23) and weight gain (1.12±0.12) obtained in T-I was significantly higher than those of T-II and T-III. The survival rate (%) was also found higher in T-I (100%) where fry were fed with chopped tubificid worms and zooplankton, than in T-II (90%) and T-III (90%). From the above data as it was observed that T-I showed comparatively better yield in consideration of both the number and size of baby eels. It is therefore, suggested that PUFA enriched squid meal had a positive effect on the gonadal maturation, gonad quality and breeding performance of *M. cuchia*.

Table 1. Growth performance of *M. cuchia* larvae fed with different kinds of feed during 45 days experiment

Parameters	**Treatment-I (T-I)**	**Treatment-II (T-II)**	**Treatment-III (T-III)**
Feed applied	Tubificid worm+ Zooplankton	Compost worm+ Zooplankton	Squid paste+ Zooplankton
Initial average length (cm)±SD	6.90±0.10	6.90±0.10	6.90±0.10
Initial average weight (g)±SD	0.28±0.09	0.28±0.09	0.28±0.09
Final average length (cm)±SD	11.62±0.33	10.62±0.18	10.00±0.29
Final average weight (g)±SD	1.39±0.21	1.04±0.11	1.02±0.08
Gain in length (cm)±SD	4.72±0.23	3.72±0.08	3.10±0.19
Gain in weight (g)±SD	1.12±0.12	0.77±0.02	0.74±0.01
Survival rate (%)	100	90	90

Improvement of Culture Practices of the Soft-shell Mud Crab (*Scylla* sp.) in Bangladesh

Researchers: Prof. Dr. NurulAbsar Khan
Dr. Sk. Ahmad Al Nahid
Dr. Md. Assasuzzaman

Budget: Tk. 7,50,000.00

Objectives

- To study the existing culture practice of soft shelled mud crab
- To improve the existing culture practice of soft shelled mud crab

Achievements

Expt. 1. Effects of different types of feed on molting behavior, growth and survival and body composition of mud crab in soft shell farming system

The adult crabs which average weight 45-55gm were collected from the Cox's Bazar landing center and brought to the laboratory. Crabs were cleaned with chlorine water and then sea water to remove dust and algal particle and kept separately 1crab/chamber for conditioning for 7days with salinity at 15ppt. Continuous aeration was also provided. Crabs were then fed with five different types of feed namely Trash fish (T1), Commercial feed (T2), Formulated feed (T3), Trash fish + Formulated feed (T4) and Trash Fish + Commercial feed (T5). Each treatment had three (03) replication and minimum eight (08) crabs were stocked for each treatments. A simple recirculatory system was established to conduct the experiment.

Individuals crabs fed with trash fish performed better than any other treatments in this experiment. Crabs fed with trash fish in combination with formulated feed also perform similar results. Crabs feed with commercial feed and formulated feed has significant differences with Treatment 1 and Treatment 4. Variation was observed in different treatments is due to seeds collected from the wild sources and crabs were habituated to feed trash fishes as because % average weight gain is high at T1. T3 performance is high as because feed were prepared with a aim to commercialize the crab feed and for maintaining better protein and lipid level in the feed. The following graph represents the % weight gain of the individuals' crabs with different feed.

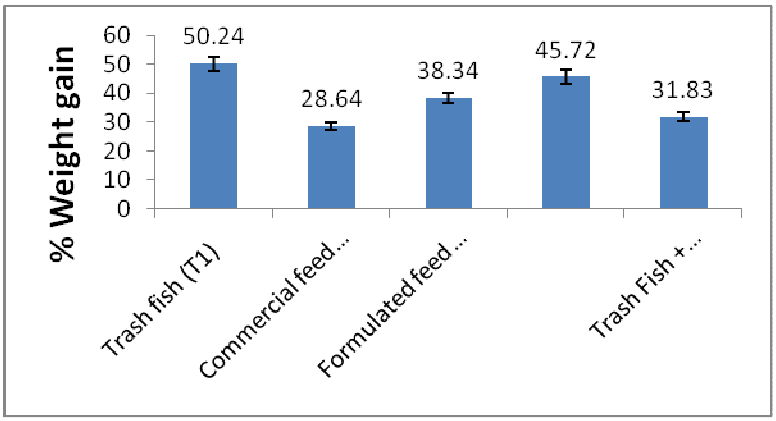


Fig. 1. Data showing the % average weight gain at different feeding level of crabs

Number of molted crabs: Number of molted crabs was also related the feed supplemented to the crabs. Molting was observed from 54.37% to 80.12%. Highest number of molting (80.12%) was observed at T1 and lowest at commercial feed (54.37%). There is no significant differences were observed at T4 with T1. Formulated feed was performed more or less similar to trash fish. But significant differences were observed at T2 and T5. Following figure shows the number of molted crab's at different treatments.

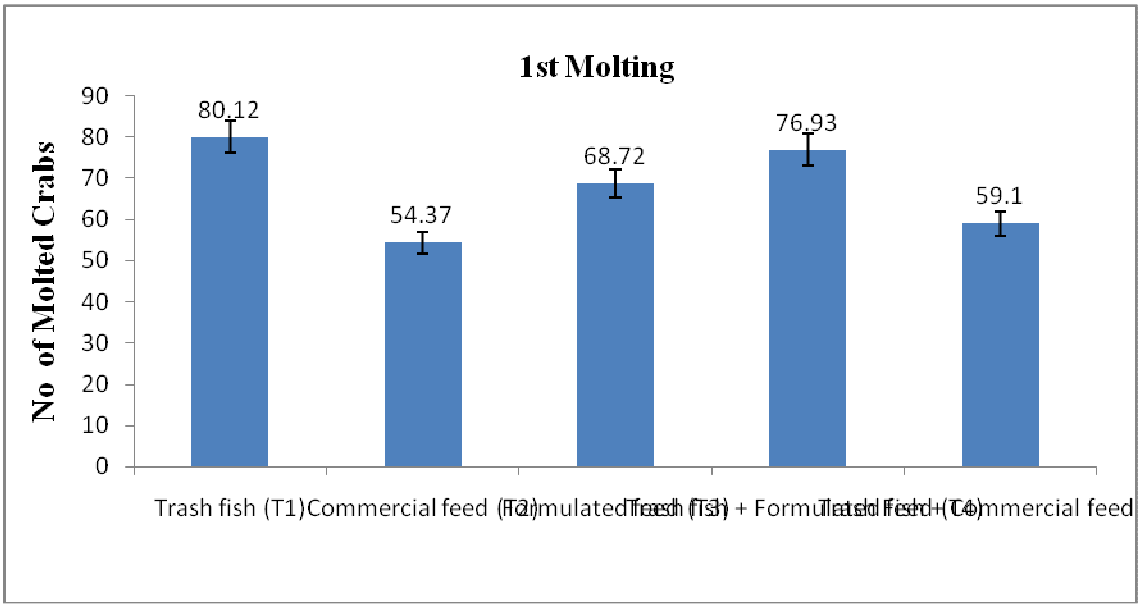


Fig. 2. Number of molted crabs at different treatments.

In 2nd molting rate of survival was also varies according to the treatments. Highest survival and molting was observed at T1 (38.12%) and lowest at T2 (6.21%). While in T3 molting was 20.24%, in T4 molting was 32.63% and in T5 was 8.78%.

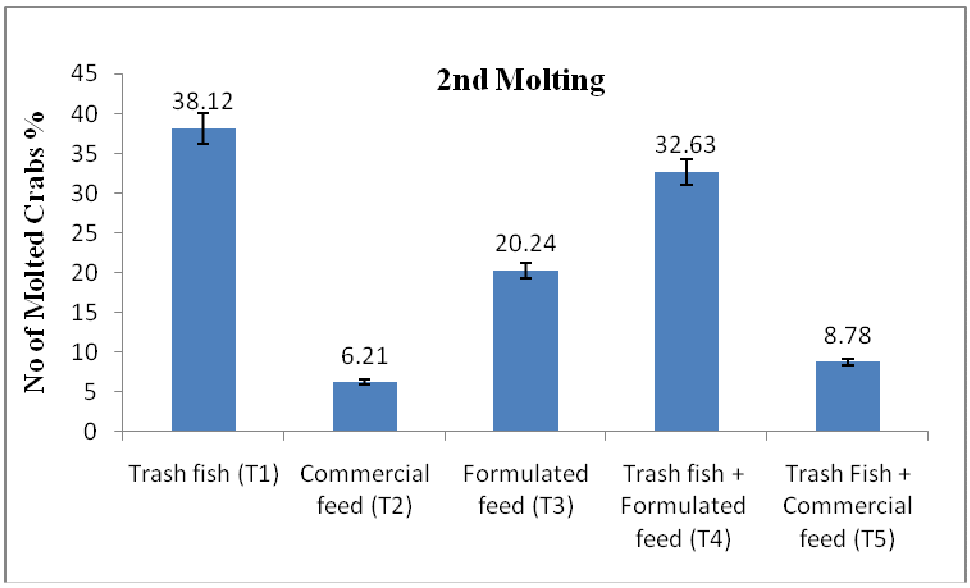


Fig. 3. Number of molted crabs (%) at 2nd molting duration.

Mortality: Mortality was also recorded during the experimental periods. Highest mortality was recorded in T2 (34.82 and 28.24%) in both 1st and 2nd molting periods while lowest mortality was recorded from T1 (22.64 and 22.24% respectively). In T3, T4 and T5 Mortality was 28.17, 24.47, 31.95 at 1st molting and 23.56, 24.11 and 27.93 respectively).

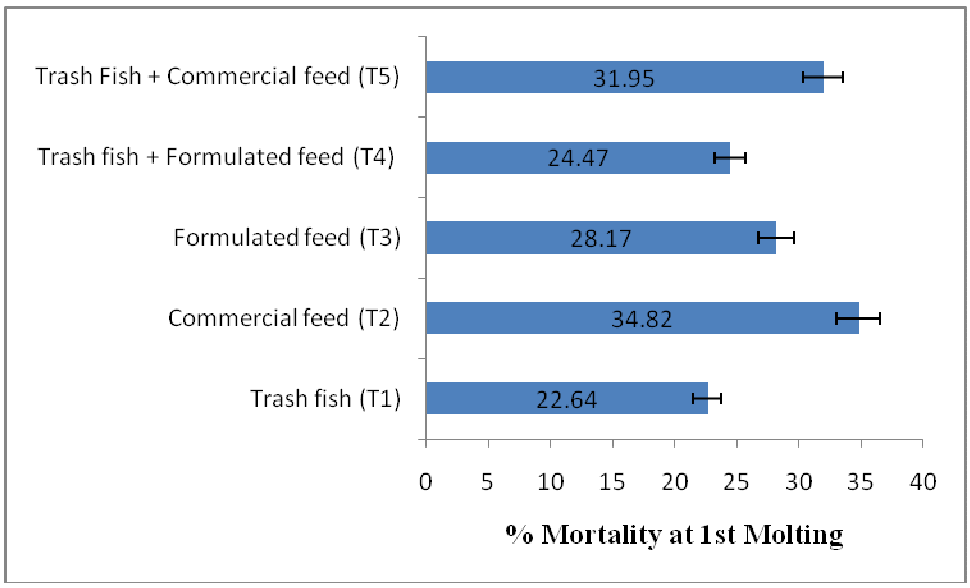


Fig. 4. Mortality at 1st Molting

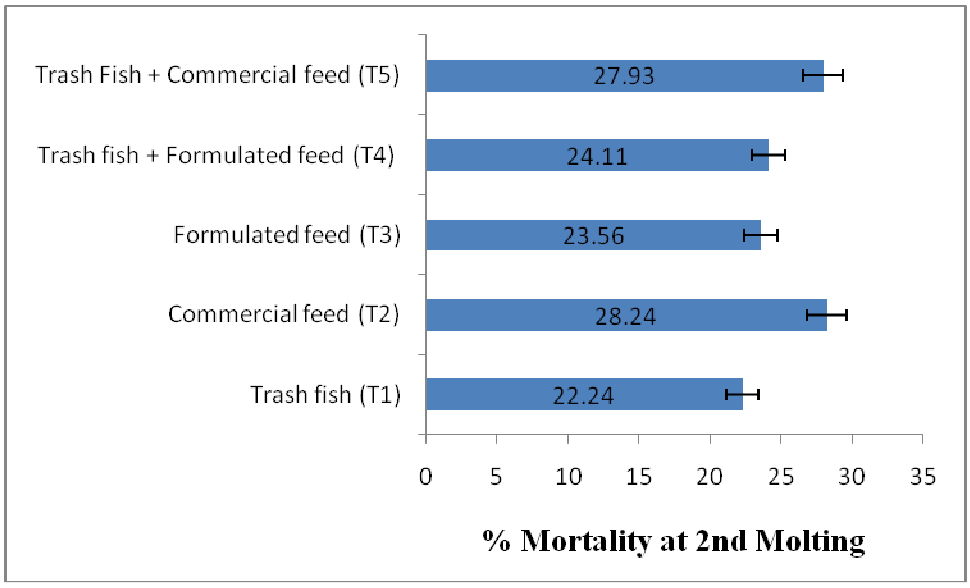


Fig. 5. Mortality at 2nd Molting supplemented with different types of feed

Body composition of crabs: Body composition of mud crab at different feeding rations is presented in the following Table:

Treatments / Parameters	Trash Fish T1	Commercial Feed- T2	Formulated Feed- T3	Trash Fish+ Formulated Feed- T4	Trash Fish+ commercial Feed- T5
Protein	14.18 ± 1.42	11.39 ± 4.58	**15.25±2.31**	14.48 ± 3.47	13.88 ± 1.97
Carbohydrate	**0.88 ± 1.47**	0.81 ± 1.69	0.84±1.23	0.86 ± 2.10	0.82 ± 2.89
Lipid	0.60 ± 1.07	0.58 ± 3.78	**0.63±1.78**	0.59 ± 1.29	0.58 ± 3.18
Moisture	**65.75 ± 9.32**	64.43 ± 5.49	63.35±8.97	62.10 ± 4.3	64.43 ± 5.49
Ash	0.73 ± 5.89	0.67 ± 10.89	0.75±9.25	0.74 ± 7.19	0.70 ± 7.72

Data values shows that, crabs feed with formulated feed performs better than any other feed. This is might due to preparation of balanced feed for crab in culture system. From the above discussion it might be concluded that crabs performance in the soft-shell farming system is still dependent of trash fish. Performance by feeding trash fish is better than any other feeding ingredients. This is might due to seed which actually harvested from the wild and still not habituated in the culture condition. However, crabs cultured with formulated feed perform more or less similar with trash fish. This might be a good options in future to adopt crabs culture in soft-shell farming system.

Expt. 2. Effects of physical attributes of formulated feeds on feed utilization and growth performances of mud crab in soft shell farming system

For this experiment formulated feed were categorized into five different classes on the basis of their shapes and sizes namely, 5gm, 8gm and 10gm which were treated as T1 to T3 and observed for a periods of 90 days. Besides, crabs were fed at daily, one day interval and two days interval basis and data were recorded.

Among the three different treatments crabs fed with 8gm feed at 2 days interval performs better growth and response in terms of weight gain, molting and mortality in both farm and laboratory condition. There were no significant differences observed in crabs fed with 8 and 10 gm feed at two days interval. But significant differences were observed in daily feeding of 5gm feed and 1 day interval feeding of 5 and 10gm of feed. This is might due to their nocturnal behavior and feeding mechanisms of crabs.

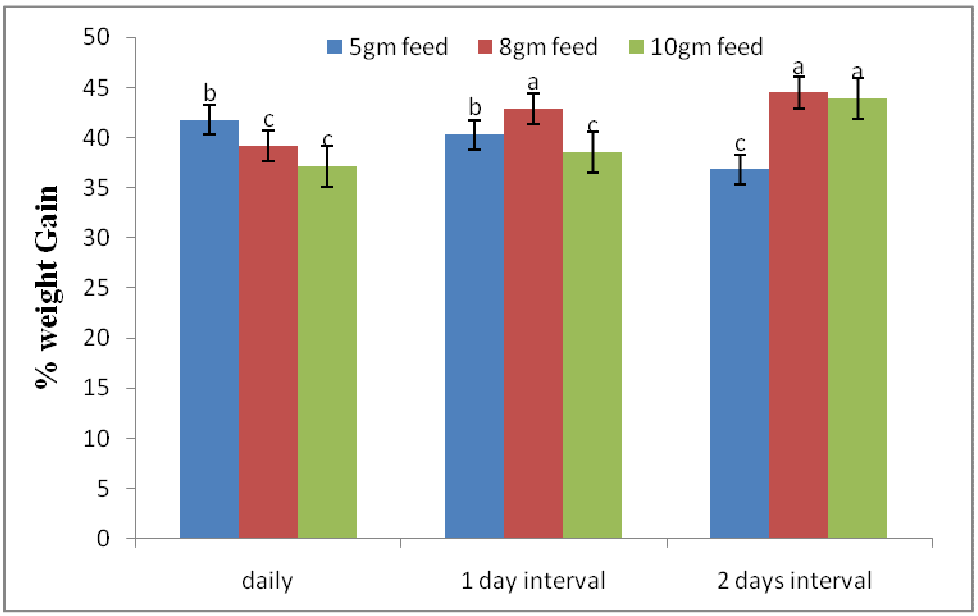


Fig. 1. Weight gain of crabs at 90 days interval at different feeding level and duration

Number of molted crabs: Molting of crabs also shows similar results as per weight gain of crabs. Crabs feed with 8 gm feed at 1 day or two days interval performs better in both 1st and 2nd molting duration. Crabs also show better performance at 2 days interval. This is might because exact amount of feed needed for crabs for their growth and development.

	1st molting			2nd molting		
	Daily	1 day interval	2 days interval	daily	1 day interval	2 days interval
5gm feed	69.79±1.2	68.78±2.1	65.14±1.9	21.75±1.7	18.67±2.1	19.74±2.9
8gm feed	67.87±2.9	**72.56±1.3**	**74.23±2.7**	17.37±1.9	**24.87±1.6**	**26.42±3.2**
10gm feed	65.32±1.9	68.23±2.8	**73.16±2.1**	18.98±2.2	19.14±3.1	**25.76±1.7**

Expt. 3. Bio-economic evaluation of soft shell crab farming subjected to the removal of a single and double chilepeds of mud crabs

Chelipeds are the major organ responsible for cannibalistic behavior of crabs. This cannibalistic behavior limits soft shell crabs farming in mixed conditions which require individual chamber for culture. Handling of crabs is also very difficult during soft-shell culture due to their chelipeds. There is a believing that aggressive behavior responsible for energy expenditure and delay in molting.Therefore, this experiment was taken to evaluate the chelipeds ablation on the molting behavior and growth performance of crab during soft-shell farming.

To set up this experiments we choose four different ways to evaluate the effects of claw ablation. These four treatments are T1: No chelipeds ablation, T2: Single cheliped ablation, T3: Both chelipeds ablation and T4: Both chelipeds ablations + two crabs in one chambers and kept in bucket in the laboratory and crab box in the farm. Individuals crabs were regularly fed at 2 days interval with trash fish. Continuous aeration, water quality monitoring and health status of crabs were also recorded time to time basis.

Cheliped removal of crabs shows better growth in soft-shell farming system. Removal of single chelipeds shows around 8% increased body weight than no removal of crabs, while removal of double cheliped of crabs shows 10% increased growth than control. Most interestingly, when removing double chelipeds and put two crabs in one cellular chamber it increases around 17% total better growth than control one. This is might due to prevention of energy loss by chelipeds and limits them in aggressiveness.

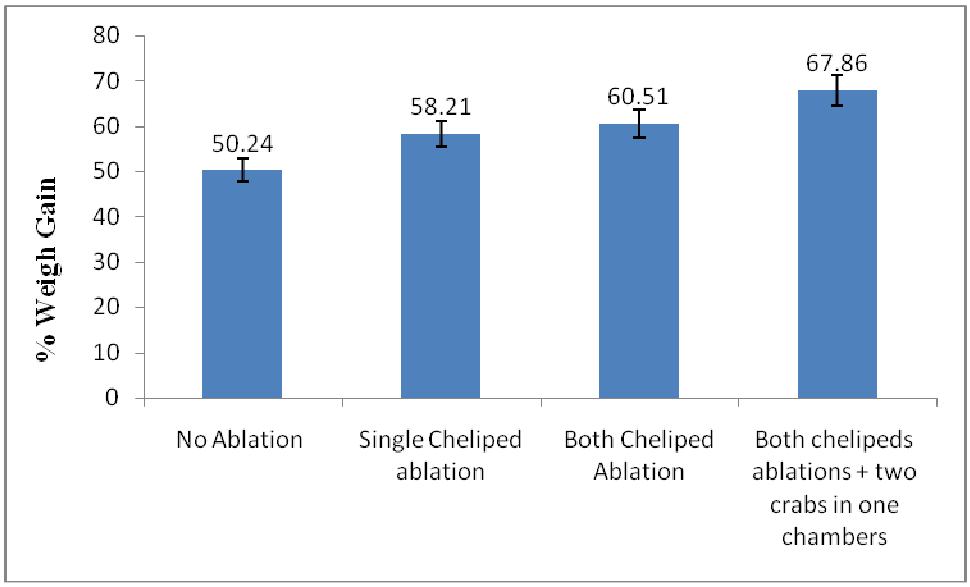


Fig. 2. Weight gain of crabs at different treatments

Molting of crabs: Molting of crabs varies according to different treatments. Highest molting duration was observed at control experiment, while cheliped removal accelerates molting of crabs. Lowest duration requires when removing double cheliped of crabs. Removal of double chelipeds also increases rate of molting during 2nd molting time. Though keeping two crabs in one chamber after claw ablation reduces time for molting but it declines 2nd molting because two crabs usually not molt at the same time and after molting crabs were very much weak and susceptible for attack by others. Thus mortality of crabs was observed.

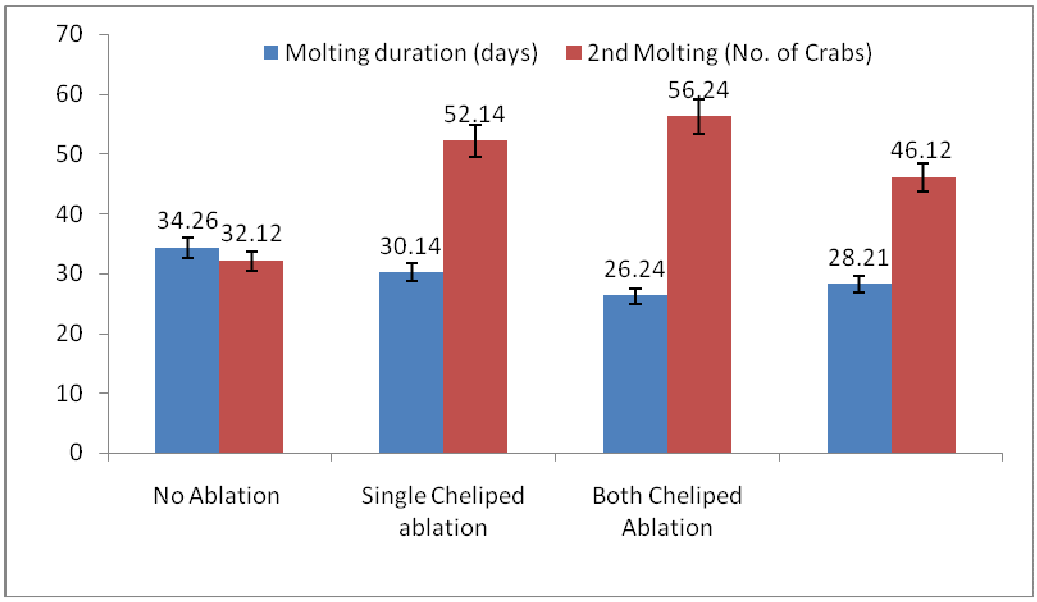


Fig. 3. Schematic representation of molting duration at 1st molting periods and number of molted crabs at 2nd molting duration

Impact of Fish Sanctuary and Beel Nursery on Openwater Fisheries: Biodiversity, Production, Socioeconomics and Livelihood

Researchers: Prof. Dr. Mostafa AR Hossain, Dept. of Fish. Biol. & Genetics, BAU, Mymensingh

Budget: Tk. 6,50,000.00

Objectives

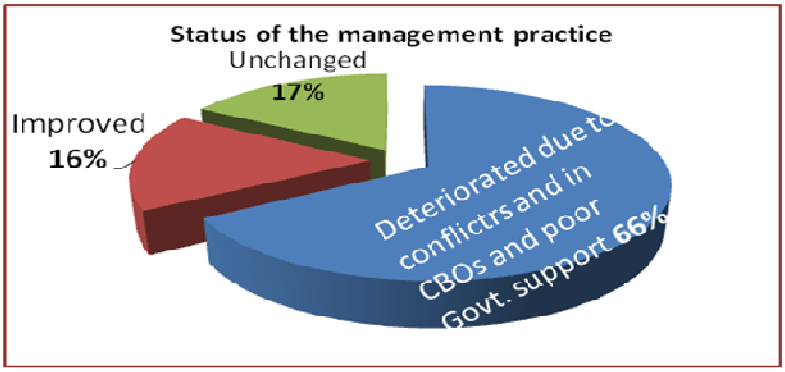
- To assess the impact of fish sanctuaries and beel nurseries established under different development projects of Govt. (DOF) on fish production and biodiversity focusing on biological and environmental parameters
- To study the impact on social, economic and livelihood issues of fishers and other stakeholders living in and around the fish sanctuaries and beel nurseries, and
- To review the performance/management status of sanctuaries and nurseries with the identifications of problems and constraints and to recommend measures for improvement and sustainability

Achievements

CBFM approaches ensures sustainable resource management that considers ecology, secure rights of poor fisher folks and promote the equitable distribution. CBFM models in Bangladesh are very much context specific in terms of underlying factors - biological, ecological, technical , institutional and socio-political conditions. Though there might be limitations in some of the CBFM approaches, overall it has a great potential to supply fish to whole nation by -

- Utilizing the under-utilized or un-utilized water bodies including rivers, beels
- Increasing fish production and annual income of producers
- Creating employment opportunities and income generating potentials in terms of forward and backward linkages

Fish sanctuary (refuges where fish are protected during dry season) help to restore fish habitat and fish diversity. Beel (Large surface water body that accumulates surface runoff water through internal drainage channel). More than 500 sanctuaries covering an area of 1745.6 ha in parts of 291 jalhohals have been established. In last two years 284 sanctuaries including 46 in 2015-16 have been established under different projects. The sanctuaries covers about 0.14% of total dry season inland water area of Bangladesh and 1.7% of the total area of the 291 Jalmohals. Management has deteriorated in about 66% of the sanctuaries after the completion of projects due to conflict and poor organization of CBOs, lack of Govt. support etc.



Average fish production from beel is few hundred Kg ha^{-1} that can be substantially increased by using beel nursery technique. DoF started "Beel Nursery" program from 2009-10 in different dead rivers, beels, haor and government and non government water bodies. So far 986 beel nurseries have been established that generated about 15,000 kg of additional fish production. For proper functioning of " fish sanctuaries" and " beel nurseries" scientific monitoring and data collection are essential particularly on – No. of species, Size of fish, Comparison of fish production, Abundance of fish species, Biodiversity index, Type of substrate, Substrate preference of fish, Fisherman's benefit and Market chain. Thus effectiveness of sanctuaries and beel nurseries need to be evaluated based on biological and socioeconomic data and also needed to be compared with similar control waterbodies.

Field visit and assessment done

Sl. No.	District Name	Upazilla Name	Beel Name
1	Naogaon	Sapahar	Joboi Beel
2	Jessor	Ovaynogor	Dumurtala Beel
3	Khulna	Dumuria	Mirzapur Beel
4	Begherhat	Fakir hat	Chakuli Beel
5	Rajshahi	Puthia	Kanta Beel
6	Natore	Noldanga	Haliti Beel
7	Pabna	Atgharia	Chatra Beel
8	Sylhet	Gopalgonj	Bagha Beel

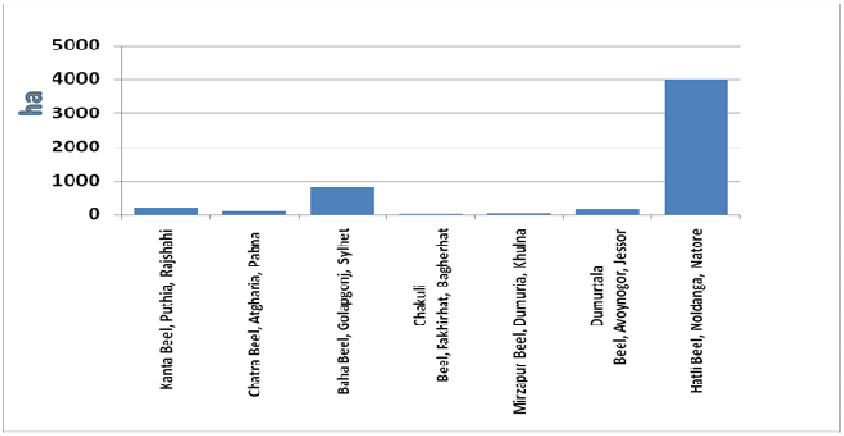
In addition to eight selected by DoF, Purbo Chor Korimchi Beel nursery, Duyani Para, Guzardiya, Karimganj, Kishoreganj, Baikka Beel Wetland Sanctuary and a Beel Nursery in Mirzapur, Tangail were also servyed.

Sl No.	Beel	Lesaing Amount (BDT)	CBO Name	CBO Members	Registration
1	Kanta Beel, Puthia, Rajshahi	No	Kanta Beel Samaj-bhittik Sangothon	130	No
2	Chatra Beel, Atgharia, Pabna	2,75,000	Chatra Beel Samaj-bhittik Sangothon	191	Registered
3	Baha Beel, Golapgonj,	7,97,669	Bhai Bhai Matshyajibi Samity	26	Registered

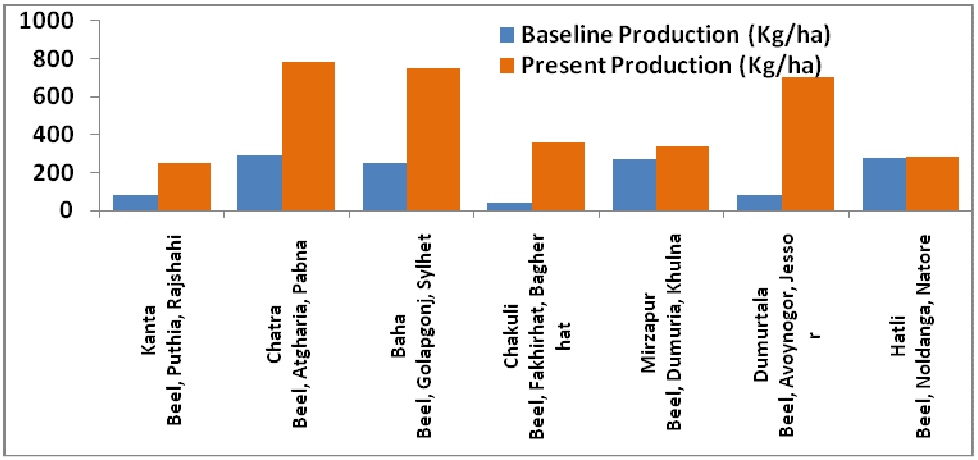
	Sylhet				
4	Chakuli Beel, Fakhirhat, Bagherhat	No	Chakuli Matshyajibi Samabai Samity	150	No
5	Mirzapur Beel, Dumuria, Khulna	No	Mirzapur Avyashryam Sangrakkhan Comitee	200	No
6	Dumurtala Beel, Avoynogor, Jessor	No	Betorbhita Dumurtala Beel Matshyachashi Community Group	243	No
7	Hatli Beel, Noldanga, Natore	No	Halti Beel Tanki (BhushanChhara) Samaj-bhittik Sangothon	420	No

Beel nursery technique: Open water bodies are leased out through the open call from DC office for 3-4 years on written agreement. Mot cases, powerful people and local influentials get the tender and then sell out the right to others. Management was done by community co-management group. Different training programs are arranged by DoF for awareness building. Main culture species are rui, catla, carpio, silver carp, grass carp, Thai sarputi, tilapia. Spawn are nursed in part of the waterbody for about two months before stocking in the beel . After stocking in the beel when beel is full of water, all kind of fishing is banned for three months. Fry/fingerlings are usually stocked in March- April and harvest in November – January.

Beel area



Comparison of Baseline Production and present Production

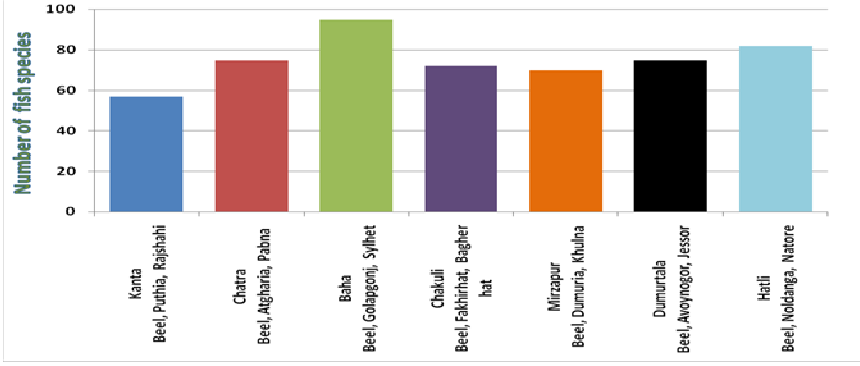


Environmental impacts

Beel nursery: Water quality is good due to extensive culture practice along with no use of pesticides, feed etc. Wild species diversity is in good condition. These are strongly under-stocked with very poor culture management.

Sanctuary: Good water is depth. Availability of fish habitat increased/improved. Fish production is satisfactory. Availability of aquatic vegetation, shellfish and migratory and local birds increased.

Fish biodiversity: The beels were found enriched with many indigenous fish species and according to the CBO members, many species are now more abundant that the pre-beel nursery period. In addition to stocked fish, many species like punti, kholisa, darkina, dehla, mola, tengra, gulsa, baim, bacha, bela, chikra, air, air, boal, shol, taki, potka, kuchia, bheda, foli, chital, pabda, batashi, chela and different species of prawn were abundant due to establishment of beel nursery.



Major problems

Major problems in sanctuaries and beel nurseries were identified as illegal fishing, local muscle man, increase of lease value, many times lease go to wrong people – not fishers but influential, there are substantial speed money involved, financial assistance from government is insufficient, local poor and marginal are deprived in most cases, particularly when lease go to wrong people, biodiversity suffer.

Issues need to be considered

The major issues that need to be ressolved are - lack of knowledge of farmers on stocking density, feeding and overall pond management, inaccessibility and low availability of quality fish seed and feed, true fishers and hardcore poor are deprived from catching fish, problems with leasing like leasing value increases, not providing to the true fishers, etc. , limited participation and allocation from DoF, ongoing conflict - the true stakeholders (the landowners and fishers) vs the influential rich outsiders and negative impact on sis and large indigenous species

Coupled with other factors (biophysical and ecological), problems of group formation, access, rights and profit sharing are some of the problems that limit the sustainable management and expansion of fish sanctuary and beel nursery approach in the country. Policy gap assessment identified that, policy reform is needed in beel nursery and sanctuary approach for sustainable and pro-poor management of different water bodies in Bangladesh. The management tools need to be used include monitoring, control and surveillance as well as more assistance from service providers.

Recommendations for technical improvement

Every year, lease value for khas land and inundated land increases to some extent. As the product price is not increasing, so how much the increased lease value is justified – need to be answered. Dredging is needed in some beels to maintain proper depth for fish and to avoid inundation, embankment for some beels also necessary. More active involvement of DoF and other technology providers is needed. There are scopes to improve management and increase production and profitability from stocking, feeding and other management aspects. Fish farmers are facing discrimination in terms of electricity bill. For irrigating crop land, farmers are paying the bill Tk. 2.5 per unit, but fish farmers are paying Tk. 8. Group members should be trained properly with modern fish farming tools and techniques by BFRI, DoF, University, and NGOs.

Recommendations for biodiversity improvement

Biodiversity conservation of both SIS and indigenous large fish should be ensured. Instead of stocking exotic fish like silver, grass, bighead carp, Thai sarpuntui etc., local fish should be given priority . Non-fisher, non professional people should not get the lease, because at the end of the leasing period (3^{rd} /4^{th} year), they try to catch everything including eggs, spawns, fry fingerling first using fine meshed net and then by dewatering which is extremely harmful for biodiversity

Nutrition and Gender Issues

Fish consumption by the family members of the stakeholders is not ensured. Therefore, fish (SIS) should be harvested for family consumption (twice a week -may be) at small quantity and distributed among the shareholders and poor and marginal of the community (400-500 g / household) with informal agreement that no one can sell this fish and household nutritional security is ensured. Gender balance is not ensured in any of the system; almost no women are involved in the process. Involvement of the women particularly from poor and marginal community must be ensured

Complexities of group formation or partnership

Skill and experience of fish farming are not equal for all partners. Lack of trust to each other and lack of equal investments and participation are also major problems. Everybody is attracted by the profit but no one wants to work hard. When fish is stolen, partners blame each other

Long term strategy

Government should establish an integrated and coordinated legal, policy and institutional frameworks for sustainable aquatic resource management. Government agencies and DoF should ensure that true fishers get the lease. More beels should be brought under fishery and nursery with proper training.

Modernization of fish sanctuary and beel nursery technologies and improvement of overall management at all level could reduce risk and improve biodiversity, production and profitability. Beel nursery along with setting up of permanent sanctuary in the beel would be a very effective method to conserve biodiversity and ensure sustainable fish production. Stocking brood fishes (SIS) in the nursery pond during the starting of beel nursery would be another effective technique. Above all, scientific research initiatives have to be undertaken in order to identify better solutions of technical, social, environmental and nutritional issues induced by these community based production system.

Studies on the Human Health Benefit of Fish Peptides Producedfrom Low Valued Marine fish species of Bangladesh

Researchers: Dr. Md. Kamal, Professor, Dept. of Fish. Technology, BAU, Mymensingh

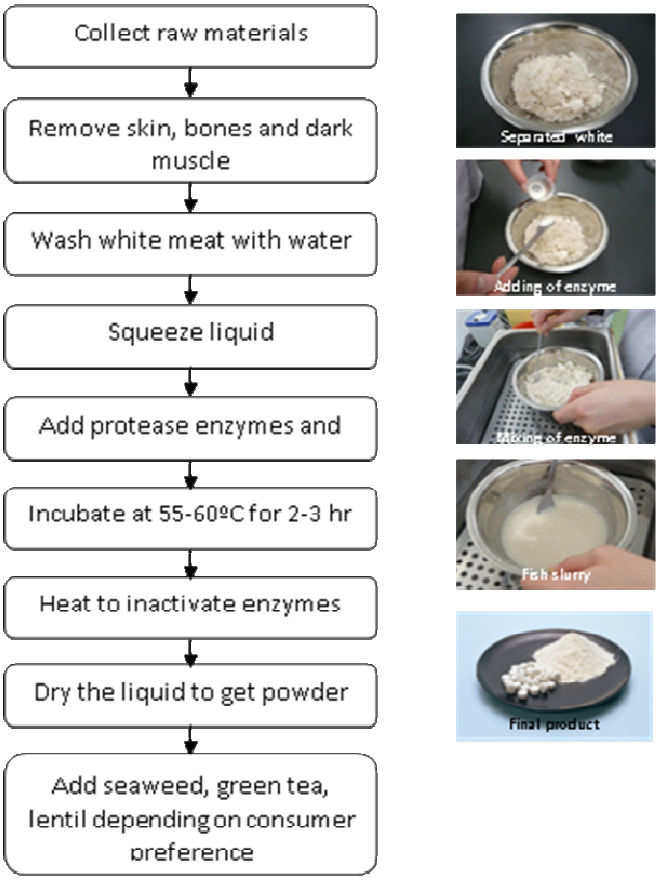
Budget: Tk. 6,50,000.00

Objectives

- Identification of suitable low cost marine fish species for production of fish peptides;
- Production of fish peptides from suitable species;
- Test of the products against various health activities in lowering blood pressure, diabetes and body fitness.
- Train up of marginal processors, particularly women on production technology;
- Organize the national and multinational pharmaceutical companies in production of fish peptides.

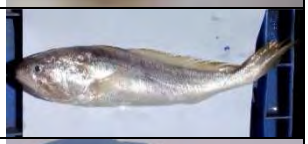
Achievements

This study was conducted in Cox's Bazar region. The area was selected for this study considering the following reasons: (i) large number of artisanal marine fishing activities;(ii) large quantities of artisanal small marinefishes are available round the year; (iii) low price of raw material for production of fish peptides and (iv) good link among the different stakeholders in supplying raw materials for production fish peptide products.



Identification of suitable samples: A detailed survey was conducted in the major markets in Cox,s Bazar and its nearest area, and Teknaf area to identify the suitable species for the production of fish peptides. The fishes having large quantities of white ordinary muscles are suitable for fish peptides and therefore, these types of fishes were chosen for production of peptides. The major markets visited and surveyed were Baharchara Bazar, BaroaBagar, KalorDukanBagar, BFDC fish landing center, katoli Bazar, Sonar para bazar, Link road bazar, Upazilla bazar, Kharuilla Bazar, RmuBzar, Nazirtek landing, Samitipara bazar, PT school bazar, Ali Zaharbaza and Moheshkhali Bazar. In Teknaf major markets are Teknaf fish market, Teknaf station fish market, Sabrung bazar, Noyapara bazar, Subrung, Shaparirdip fish market and Teknaf Beach landing. The fish available in these markets are mainly harvested by seine net, gillnets, bottom fixed gillnets, estuarine set bag net, marine set bagnet, long lines and trammel nets. There following species of fishes, their local and scientific names, sizes and prices are shown in the Table.

Table 1. Identification of suitable species for production of fish peptides

Local name and species	**Muscle type and seasonal distribution**	**Size**		**Price (Tk/Kg)**	**Picture**
		Length (cm)	**Weight (g)**		
Guijja/ Ghora *Arius gagora*	Dominants with white muscle and mainly available in October to January.	30-70	400-4500	130-250	
Dhommach *Gerres filamentosus*	Dominants with white muscle and the fishes are mainly available in*October to January.*	15-20	50-200	130-150	
Rangga koi/ ranggachoikka *Lutjanusjohnii*	Dominants with white muscle and mainly available in *December. to April.*	20-50	200-3000	150-250	
Rupalipoa/Kettipoa *Johnius belangerii*	Dominants with white muscle and mainly available Round the year.	15-30	50-200	120-200	
Kala poa/ *Protonibea diacanthus*	Dominants with white muscle and mainly available in December to April.	15-40	50-450	120-250	
Loijjapoa *Panna microdon*	Dominants with white muscle and mainly available inJuly to November	15-30	50-350	130-300	
Dattapoa *Pennahia pawak*	Dominants with white muscle and mainly available Round the year.	15-30	50-200	100-250	

Lalpansa/ Ranggachowkka *Lutjanus malabaricus*	Dominants with white muscle and mainly available in April to July.	20-50	200-2500	130-250	
Ranggachowkka *Lutjanuss anguineus*	Dominants with white muscle and mainly available in Dec. to April.	20-50	200-3500	130-150	
Rupban *Nemipterus japonicus*	Dominants with white muscle available in some seasons.	10-20	100-200	120-150	
Sadadatina *Pomadasys argenteus*	Dominants with white muscle and mainly available inSept. to October.	20-30	300-700	250-350	

Muscle yield of different species of jew fish: In case of marine fish, generally, demersal fishes which feed on mid water or bottom and move gently or periodically, have higher content of white muscles, with very little dark muscle. White muscles have lower level of lipids, haemoglobin, glycogen and vitamins compared to dark muscles. In function, white muscle is sprinting muscle used for sudden, quick movements needed for escaping from a predator or for catching prey. In addition to white muscles, many pelagic or meso-pelagic fast swimming species have also certain amount of dark tissue of a brown or reddish color. Dark muscle is characterized with higher levels of lipids, haemoglobin, glycogen and most vitamins. Dark muscle usually contains more trimethylamine oxide and amino acids. From technological point of view, the high lipid content of dark muscle is important because of problems with rancidity. Dark muscle also inhibits gel forming ability of muscle tissue which is an important characteristic of fish for heat treated textured foods. For the fish peptide production, it is important to identify the fish based on fish muscle types. Usually fish having white muscle fish are suitable for fish peptide production. It is also important to see muscle yield which greatly influence the peptide production since myofibrillar proteins present in the muscle in the largest amounts(actin, myosin, tropomyosin and troponin) structural proteins, which constitute 65-70 % of the total protein (compared with 40% in mammals). It is well known that peptide producer is interested mainly in the edible part of the fish, that is the flesh or muscle

Muscle yield of different jew fish species were determined. Muscle yields and other parts of the body were determined based on total weight. The muscle yields varied from 20.67 to 35.19%. The highest yield was obtained in Dattiyapoa (*Pennahiapawak*) and the lowest muscle yield was obtained in Kettipoa /Sadapoa (*Pennahiamacrophtalmus*). Kettipoa are nomally small in sizes therefore muscle yield is poor.

Fish species	**Length (cm)**	**Weight (gm)**	**Carcass (gm)**	**Muscle (gm)**	**Skin (gm)**	**Egg (gm)**	**Muscle yield (%)**
Dattiyapoa *(Pennahia pawak)*	111	686.13	212.34	241.51	118.41	16.40	35.19
Kettipoa/Rupalipoa *(Johnius belangerii)*	65	175.34	76.63	36.26	40.64	-	20.67
(Lalpoa *Panna microdon)*	99	397.43	146.45	116.69	55.75	13.51	29.36
Kala poa *(Protonibea diacanthus)*	106	757.84	261.96	179.54	101.12	45.56	23.69

Chemical composition: The main chemical components of the fish are water, crude protein and lipid. Together they make up about 98% of the total mass of the flesh. These components have the largest impact on the nutritive value, the functional properties, the sensory quality, and the stability of the meats. The contents of the main component in the fish body depend primarily on the species, feed intake, migratory swimming and sexual changes in connection with spawning. The chemical composition of fish muscles of the different species of jew fish were determined. The analysis was carried out in the Fish Nutrition laboratory of the Faculty of Fisheries, BAU. The moisture content varied from 78.36 to 80.42%, lipid content varied from 0.53 to 1.87%, crude protein 18.18 to 18.43% and ash content varied from 0.12 to 0.97% in wet weight basis. In dry weight basis, lipid content varied from 2.54 to 8.66%, crude protein 84.44 to 92.87% and ash content varied 2.76 to 6.40%. The fish species analyzed in the present study were in the group of high protein and low.

Species	**Dry matter (%)**	**Moisture (%)**	**Lipid (%)**	**Crude protein (%)**	**Ash (%)**	**Carbohydrate (%)**
Pennahia pawak	20.94	79.06	0.53 (2.54)	18.43 (88.02)	1.01 (4.84)	0.97 (4.63)
Johniusbelangerii)	21.64	78.36	1.87 (8.66)	18.27 (84.44)	1.38 (6.40)	0.12 (0.55)
Panna microdon	20.32	79.68	0.53 (2.60)	18.27 (89.90)	1.30 (6.39)	0.22 (1.08)
Protonibea diacanthus	19.58	80.42	0.57 (2.89)	18.18 (92.87)	0.54 (2.76)	0.29 (1.48)

Figure within the parenthesis are shown on moisture free basis.

Fish peptide production: Fish peptide was prepared from DattaPoa (*Pennahiapawak*) using 0.020% papin at pH. 6.5 in two conditions, washing (1:1) or without washing the mince. The fish was chosen for peptide production because of its high muscle yield and high protein content. The most important thing is that this fish species is abundantly available round the year in the costal area of Cox's Bazar and Teknaf. The price of the is low compared to the other commercially important fish species. There is a well defined supply chain and one can buy the fish easily at low cost from any stages of the supply chain.

After adding papain enzyme and heating at 55-60^{o}C for 2-3 hours, white hydrolyzed peptide suspension were produced. It was dried in oven at 80^{o}C for 6 hours to produce dry peptide powder. During drying the colour of the peptides gradually turned from white to brown. The brownness of the peptide powder is less in mince produced after washing. Protein contents of the peptide powder produced in two conditions were measured. The concentration of protein was in the range of 95-96% (D/W) in peptides produced in both conditions. The observation was that there was a little bitterness in peptide powder produced without washing whereas bitterness was not felled in peptide powder produced after washing. But peptide produced in both conditions smells like dry fish.

Genetic Improvement of BFRI Rohu and Rajpunti through Selective Breeding Techniques

Researchers: Dr. Selina Yeasmine, Senior Scientific Officer

Objectives

- Genetic improvement of BFRI Rohu, *Labeo rohita* through selection
- Genetic management of BFRI Rajpunti, *Puntius gonionotus*
- Distribution of improved germplasms

Budget: Tk. 8,50,000.00

Achievements

Expt. 1. Communal grow-out trials of BFRI F_3 improved Rohu

Following protocols are followed for the production of F_4 generation. BFRI F_3 improved stock of rohu are used as the experimental fish. A 30 advanced fingerlings to a total of 900 of F_3 rohu from each of the selected 30 families are stocked for communal rearing in grow out experimental pond. Before stocking the pond was filled up with water from a deep tube well. Urea and TSP were applied at the rate of 100 and 50 g/dec. Then, the pond was left for 7 days for the production of plankton. Then, 900 fingerlings of F_3 rohu were stocked. Fish are being fed with locally available commercial feed containing about 35% protein at the rate of 3-5% body weight daily. Thus, an average of 900 fish (#30 from 30 families) have been rearing communally in rearing pond to raise brood fishes following all scientific management measures. In the F_3 generation, evaluation of growth and other performances are being carried out through communal rearing in controlled conditions. After communal rearing, the fish will be sampled for growth and sex along with configuration, color, maturity-age etc. and the number of the fish. Growth performances of F3 rohu during communal rearing are shown in table 1. The results of the present study on growth performances in terms of mean length and mean weight gain of F_3 rohu are 42.94±3.83 (cm) and 1847.74±88.82 (g) respectively. From this result of growth performances it is observed that the fishes are not yet ready for selective breeding. So, the breeding program will be conducted for selective breeding on mass selection using best selected individuals to produce next generation in next year (2018). So, research progress is going.

Table 1. Growth performance of BFRI F_3 improved generation of Rohu in communal grow out pond

Parameters	Initial status (April '16)	Present status (September '17)
Length (cm)	16.74±1.71	42.94±3.83
Weight (g)	54.02±15.20	1847.74±88.82

Selection protocol for breeding of F_3 rohu will be performed following protocols given in Fig. 1.

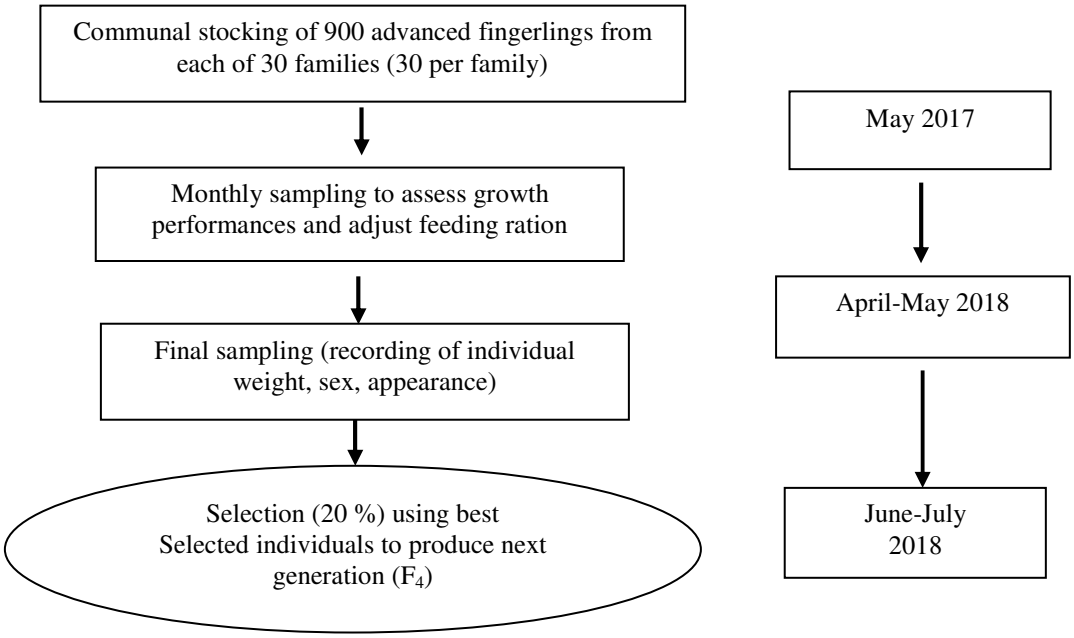


Fig. 1. Selection protocol for breeding of F_3 rohu.

Expt. 2. Evaluation of growth performances between BFRI improved Rohu and local Rohu

Growth performances are the most important parameters for the evaluation of fish culture and its productivity. To compare the growth performances between local rohu and BFRI Improved F3 rohu an experiment was conducted an on-station trial for a period of six months. Local rohu were collected during March'17 from a local hatchery of Muktagacha, Mymensingh. After collection 140 no. of rohu fingerlings (70 BFRI Improved F3 rohu & 70 from local hatchery) were tagged with PIT tag. Then, tagged fish were stocked & reared in the same pond (20 decimal; depth-1m). Tagged fish were stocked in the month of August'17. Supplementary feed (35% proteins) was supplied to the fingerlings @ 5% of BW. After 6 months of rearing, the fish were harvested. The length (cm) and weight (g) of the BFRI Improved F3 rohu and local rohu were recorded and the growth data were analyzed using ANOVA. The results of the growth performances are presented in Table 2. After six months rearing the mean weight of BFRI Improved rohu and local rohu is 421.96±105.19 and 360.45±78.79 (g) respectively. Form this study it is showed that BFRI Improved rohu are performed higher growth achievement at 17% compared to local Rohu (Table 2).

Table 2. Growth performances between BFRI Improved Rohu & local Rohu

Parameters	**Initial (April 2016)**		**Present Status (September 2016)**		**Remarks**
	Length (cm)	Weight (g)	Length (cm)	Weight (g)	BFRI Rohu 17% higher growth compare to local
BFRI improved	11.52±1.70	16.22±7.48	30.35±5.3	421.96±105.19	
Local hatchery	11.50±1.70	16.21±10.76	29.8±1.38	360.45±78.79	

Expt. 3. Stock improvement of BFRI Rajpunti through family/mass selection and rotation breeding program

The improved F_4 generation of rajpunti broodstock (4 groups as A B C D) were used for the production of next generation (F_5 progeny). At the beginning of the experiment, four groups were reared in separate ponds following all scientific management measures, i.e. fertilization, liming, supplementary feeding and water management. For the production of next generation, 40 pairs best broods (male:female= 1:1) were used for single pair mating to produce 40 progeny families (10 family in each group) through rotation of selected males of A B C D to selected females of B C D A and again form four groups as A B C D. For this purpose, the selected best 40 males were crossed with 40 females to produce of F5 generation. After injection the broods in the each pair were kept in 40 breeding hapas which were set up in cistern in the hatchery. After spawning the broods were transferred in the ponds and the produced families were nursed in hapa in cistern for 7 days. After nursing 7 days in cistern the progeny of each family were transferred in another hapa which were set up in the pond (group-wise) for nursing. After one month of rearing in nursery hapa, from each progeny groups, 150 fry were transferred in rearing hapa (2.0 m^3). Nursery feed were supplied in all the hapas at the rate of 15% of estimated biomass. The equal numbers of fingerlings (#40) from each family of the four groups (10 family per group) were stocked in four ponds in the name of A B C D groups for grown up and are being reared for further selection. The genetic development further will be continued generation after generation following the same protocol.

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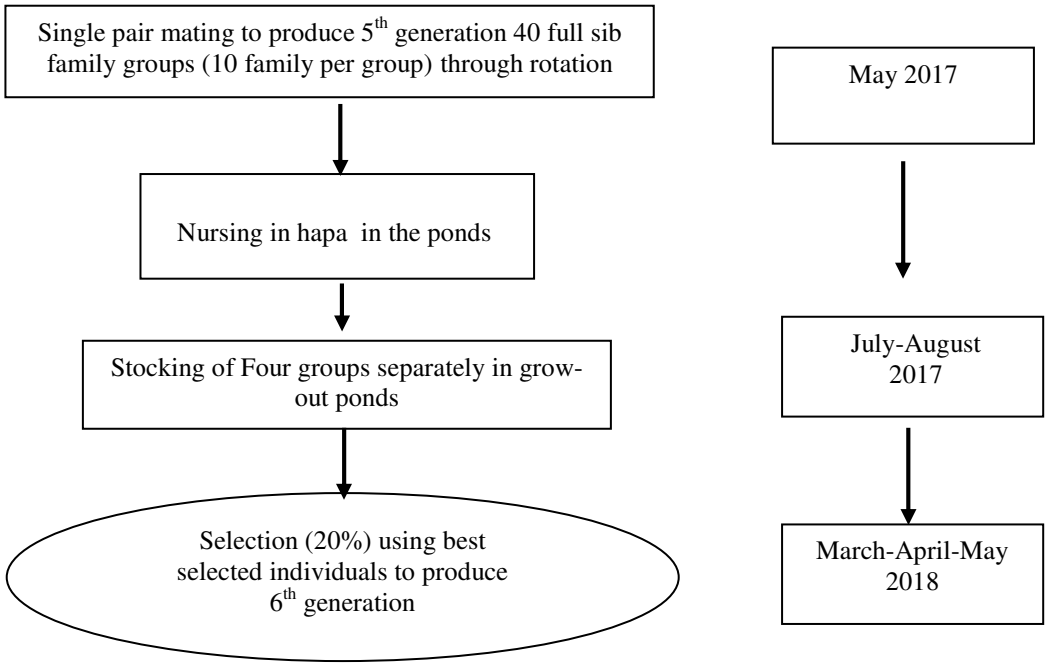


Fig. 2. Design for genetic improvement of Rajpunti

Quality Mass Seed Production of Carp, Catfish and Prawn

Researchers: Dr. Md. Shaha Ali, Principal Scientific Officer
A.K.M Saiful Islam, Senior Scientific Officer
Rumana Yasmin, Scientific Officer
Md. Abdur Rab Mondal, Scientific Officer

Budget: Tk. 12,50,000.00

Objectives

- To upgrade & produce quality carps & catfishes spawn/fry & disseminate to the farmers, hatchery & nursery owners
- To develop live gene bank with quality brood stocks through implementation of effective breeding plan
- To assess the requirement of water in the hatchery for the production of carps and pangas spawns
- To produce quality seed & improved nursery techniques of PL of freshwater prawn.

Achievements

Expt. 1. Grow-out management and brood development for best performed breeds of wild stock

With a view to producing wild carp broods, grow-out ponds were stocked with 20% best selected fingerlings from secondary nursery and stocked under polyculture system. The grow-out management and broods development is in progress and the present status of wild stocks are shown in Table 1 and the protocols followed are shown below:

1. Pond Selection:
Pond Are : 40-50 decimal
No. of Ponds : 2 ponds for each stock
Culture Period : 12 months

2. Management protocol

a) Pond preparation: Cleaning of weeds, drying and dyke repairing, liming @ 250 kg/ha & maturing (Cow dung) @ 3000 kg/ha, Urea @ 25 kg/ha, TSP @ 25 kg/ha

c) Feed: Commercial pelleted feeds (25-30%) 5-3% body weight/day

e) Water management: Water quality parameters will be monitored monthly

b) Stocking rates and ratio
Rate **:** 5,000 fingerlings/ha
Breeds **:** Wild breeds
Size **:**10-15cm
Ratio **:** Catla 25%, Rohu 35%, Mrigal 35% (depends upon on the availability of wild breeds)

d) Fertilization: Cow dung @ 2000 kg/ha/month and Inorganic fertilizers 50 kg/ha/month. Both fertilizers will be used in every alternate week.

g) Brood management: After 6 months rearing in grow-out pond, selected 10% fish will be reared in separate pond (@ 2500/ha) up to brood development.
In brood pond 25% protein feed with vit. E-premix will be given at 3-4% bw/day for proper development of gonad

Table 1. Present status of wild breeds of river Halda and Jamuna in brood ponds

Wild sources of breeds	Halda	Jamuna
	Individual wt. range (g)	Individual wt. range (g)
Catla	3000-4500	3000-4500
Rohu	2000-3000	2000-3500
Mrigal	2000-3500	2000-2500

These broods are being used for mass seed production in the year 2017.

Quality seed production of carp, catfish and prawn

Quality mass seed production of carp, pangas and prawn started from mid of May 2017 as the repairing works of hatcheries were in progress. Following the established methods of breeding management, every year BFRI has been produced quality seeds of carps/catfishes/prawn and distributed to the fish farmers, hatchery owners and nursery owners in different parts of Bangladesh. On the other hand, the wild sources carps brood developed under this project are being used for mass seed production and distribution to the fish farmers/ and nursery operators and also to the hatchery owners for further mass seed production in their own hatcheries. Quality mass seed of carps, pangas and prawn production target and results so far achieved during the year 2016-17 is shown in Table 2.

Table 2. Production target and achievement of quality seed of carps, catfishes & prawn

Species	Production Target (2016-17)		Target so far achieved (2016-17)		Breeding period
	Spawn (kg)	Fry/ Fingerling	Spawn (kg)	Fry/ Fingerling	
Catla (Halda)	60	10,000	35.88	5,000	April-June
BFRI Rohu	100	50,000	140.48	70,000	April-July
Mrigal (Halda)	50	20,000	72.95	20,000	April-July
Pure line Silver carp	20	10,000	1.5	-	March-July
Pure line Bighead carp	20	10,000	28.88	20,000	March-July
BFRI-GISB (Silver Barb)	50	1,00,000	31.25	50,000	March-July
Pure Kalibasu	-	-	5.58	5,000	April-June
Thai Pangas (Red meat)	20	50,000	-	-	May-August
Vietnamese Pangas (White meat)	10	50,000	10.00	1,50,000	May-August
Prawn (Wild source)	-	50,000 Pls	Hatchery under repair	-	May-August
Total=	340	3,50,000	326.52	3,20,000	

Expt. 2. Assessment of the requirement of water in different hatchery systems for the production of carp and pangas spawn

The total amount of water required for the unit production of carp and pangas spawns using two different hatching systems were estimated considering following criteria as:

a. Circular tank hatchery system

- Total amount of water needed up to ovulation (Included conditioning)
- A standard amount of fish were kept in cistern for ovulation (about 300 kg female brood were kept in 10,000 litre capacity tank)
- About 350 kg male brood were also kept in another 10,000 litre capacity tank
- Total amount of water required in incubation tank (about 25 kg fertilized eggs were kept in 10,000 litre capacity circular incubation tank)
- Water losses (if any) of water were estimated for the whole operation.

b. Bottle hatchery system

- Total amount of water required up to ovulation (Included conditioning)
- A standard amount of fish were kept in cistern for ovulation (about 300 kg female brood and 350 kg male were kept in 10,000 litre capacity tank separately)
- Total amount of water required in incubation bottle for hatching (about 02 kg fertilized eggs were kept in 225 litre capacity incubation bottle)
- After hatching the spawn were transferred to the square tank (about 12 kg spawn were kept in 10,000 litre capacity cistern)
- Any losses of water were estimated for the whole operation

As per designed of the above mentioned system water needed in all operations were measured and presented in Table 3.

Expt. 3. Effects of stocking densities on survival and growth of M. rosenbergii post larvae in indoor system

The experiment is fully dependent of the availability of the PLs in the prawn hatchery. Due to the unavailable research facilities as well as faulty PL production system in the FS prawn this year the production PLs was not initiated. Under these circumstances, prawn hatchery is being re-designed and repaired the production system. The repairing works is now in progress and hopefully finished after 2 months. So it would not be possible to produce prawn PLs as well as to conduct experiment during the year 2017-18.

Table 3. Requirements of water for the unit production of carp and pangasius spawn under different hatchery systems

Hatchery system	Conditioning (up to 1st inj.) 2 cisterns (5 hrs) (L)	Conditioning (1st to 2nd inj.) 2 cisterns (6 hrs) (L)	Control spawning up to fertilization in spawning arena (7 hrs) (L)	Stripping methods up to fertilization in 2 cisterns (6 hrs) (L)	Circular incubation for hatching in 4 tanks (18 hrs) (L)	Circular incubation up to yolk-sac absorption in 4 tanks (74 hrs) (L)	Bottle incubation for hatching in 50 bottles (24 hrs) (L)	Square incubation tank up to yolk- sac absorption in 4 tanks (68 hrs) (L)	Total amount of water needed for 100 kg spawn (L)	Total amount of water needed for 1 kg spawn (L)	Total amount of water needed for 1 g spawn (L)
Circular hatchery	72710± 375	65927± 681	127515 ± 1270	-	679377 ± 3114	2720566 ± 6024	-	-	3666095 ± 8393	36660 ± 83.93	36.66 ± 0.08
Do	73010± 432	65342± 1209	-	56426± 1232	680584 ± 2420	2718603 ± 2231	-	-	3593965 ± 7013	35939 ± 70	35.93 ± 0.07
Bottle hatchery	72043± 858	65104± 1180	-	55026± 1051	-	-	963433 ± 3564	477116 ± 3564	1632722 ± 6182	16327 ± 62	16.32 ± 0.06

Development of Induced Breeding and Culture Techniques for Mekong Giant Catfish, *Pangasianodon gigas*

Researchers: Dr. Md. Khalilur Rahman, Chief Scientific Officer

Budget: Tk. 8,50,000.00

Objectives

- To develop induced breeding technique for *Pangasianodon gigas*
- To develop rearing technique for *Pangasianodon gigas*

Achievements

Introduction in BFRI, Mymensingh: The BFRI has long experience on artificial breeding of *Pangasius* species and developing artificial breeding and culture technologies of *Pangasius sutchi* and *Pangasius pangasius* in 1993 and 2004, respectively. After receiving the information of introduction of *Pangasianodon gigas* in Bangladesh, BFRI showed their interest to work on this species. Accordingly, communication has been made to collect the species from the local Ramy Fish Farm Ltd, Boilor, Trishal, Mymensingh. A verbal gentleman agreement has been made between Ramy Fish Farm Ltd. and BFRI regarding the sharing of spawn of first production and giving training to the workers of Ramy Fish Farm Ltd. on artificial breeding techniques, spawn rearing and culture. After verbal agreement, authority of the Ramy Fish Farm Ltd. agreed to supply 50 individuals of *P. gigas* to the BFRI authority for conducting research on artificial breeding, spawn rearing and culture. Accordingly, 15 fishes of *P. gigas* were collected from the Ramy Fish farm Ltd. to BFRI on 18 March 2015, then 12 fish on 28 March 2015, again 12 fish on 17 April 2015 and finally 12 fish on 06 June 2015. However, one fish was died due to head injury during transportation by an open truck of 5 tons capacity.

Description of *P. gigas*: The Mekong Giant Catfish is the world's largest freshwater fish. It has a whitish underside and the back and fins are grey. The eyes are located low on the head and point downwards. Whilst juveniles have barbels, adults can be distinguished from other large catfish by their reduced barbells and lack of teeth.

Meristic Characteristics of *P. gigas*: Meristic characters of *P. gigas* were recorded. It is a huge fish having no teeth in jaws. Following characters are recorded.

Lateral Lines: Single
Not interrupted
Barbells: 02
Gill rakers: Total: 15-17
Vertebrae: Total: 48-48
No. Dorsal Fin: 01
Spines Total: 2-2
Soft-rays total: 7 – 8
Adipose Fin: Present
Caudal Fin: Forked; more or less normal
Anal fin: No.: 01, Soft-rays total: 35
Pectoral fin: more or less normal
Spines: 01
Soft-rays: 10 – 11
Pelvic: more or less normal
Position: Abdominal: behind origin of D1
Soft-rays: 6-9.

Stocking in pond: A total of 15 fish collected on 18 March 2015, was stocked in a pond having an area of 40 decimal. One fish was died due to head injury during transportation. Rest fishes were stocked in another pond having an area of 150 decimal.

Table 1. Sampling weight of *Pangasianodon gigas* on 18 March 2016

Sl	Sex	Length (m)	Weight (kg)	Comments
1	♀	1.64	75	A, S & S
2	♂	1.75	90	A, S & S
3	♀	1.66	85	A, S & S
4	♀	1.62	72	A, S & S
5	♀	1.64	80	A, S & S
6	♀	1.60	70	A, S & S
7	♀	1.58	65	A, S & S
8	♀	1.58	65	A, S & S
9	♂	1.52	58	A, S & S
10	♀	1.50	54	A, S & S
11	♀	1.64	78	A, S & S
12	♀	1.62	70	A, S & S
13	♂	1.54	58	A, S & S
14	♂	1.58	64	A, S & S
15	♀	1.54	56	A, S & S

Growth of fishes was found satisfactory in both the pond. A total of 15 fishes were measured and weight range was found as 54 and 90 kg in the month of March 2016 (Table 5). A total of 12 fish was sampled on 06 June 2016 and sampling weight range of fishes was found as 42 and 95 kg (Table 6).

Table 2. Sampling weight of *Pangasianodon gigas* on 06 June 2016

Sl	Sex	Length (m)	Weight (kg)	Comments
1	♂	1.50	58	A, S & S
2	♂	1.65	88	A, S & S
3	♀	1.56	65	A, S & S
4	♀	1.52	58	A, S & S
5	♀	1.46	50	A, S & S
6	♀	1.36	42	A, S & S
7	♂	1.44	48	A, S & S
8	♂	1.50	54	A, S & S
9	♂	1.52	56	A, S & S
10	♂	1.72	85	A, S & S
11	♂	1.75	95	A, S & S
12	♂	1.65	85	A, S & S

Feeding and Water management: The ponds was filled up with fresh water from a deep tube well and treated with dry cow-dung at the rate of 5 kg/dec. After manuring, the pond was left for 7 days for growth of zooplankton. After growing plankton, *P. gigas* was stocked at a stocking rate of 10 kg/dec. Fish was fed with locally available commercial feed containing about 28% protein at the rate of 3% body weight daily (Table 7). Water shower was provided daily in each pond for 2-3 hours. Moreover, freshwater from a deep tube well was provided once a week. Water quality parameters were recorded biweekly. Health and gonadal development were checked from April 2015. Female *P. gigas* was 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.

Inducing Experiment by cPGE: Trials on induced breeding of *P. gigas* were conducted on 17 June 2016. Both the ponds were netted at 09:00 hours and 05 gravid females and 02 males were selected primarily selected. Selected fishes were housed in a net hapa in the pond having a dimension of 8 m x 4 m. Water shower was provided by a submersible pump. At 20:00 hours in the evening, primarily selected fishes were checked again and finally 01 female and 01 male were selected for induced breeding trial. The female, having comparatively soft and bulging belly was selected as brood while the male counterpart was identified by observing elongated protrude genital papilla. Carp Pituitary Gland Extract (cPGE) was administered at the rate of 9 mg/kg BWt and 3 mg/kg BWt of female and male, respectively. Dose of the female was split into 2 portions. First dose was 3 mg/kg BWt and administered at 20:00 hours on 17/06/2016. After 12 hours interval 2nd dose was applied at 6 mg/kg BWt at 08:00 hours on the following day (18/06/2016). The male received a single dose at a rate of 3 mg/kg BWt at the time of 2nd dose of the female (Table 8).

Table 3.. Details of induced breeding trials on *P. gigas* on 17 June 2016

Item	**Criteria**
Examination	Gonadal development Secondary sexual characters
Male ♂	01 Wt: 75 kg Single Dose
Female ♀	01 Wt: 90 kg, Double Dose
Dose 1st ♀	3 mg/kg BWt
Interval	12 hours
Dose 2nd ♀	6 mg/ kg BWt
Dose 1st ♂	3 mg/kg BWt

At 16:00 hours on the following day, the injected fish was checked for stripping. However, no sign of ovulation was observed although the belly became more soft and bulging than the uninjected conditions. In case of male no milt was found when gentle pressure was applied on the abdomen. Both the brood was kept in the hapa and water shower was provided again. At 22:00 hours the injected fishes were checked again and no sign of ovulation was observed. Next day (19/06/2016), at 08:00 hours, the injected fishes were checked again and found no change. Then the fishes were treated with $KMnO_4$ to prevent fungal infection on skin, lip of mouth and fins. Finally, the injected fishes were released in the pond.

Mass Seed Production and Conservation of Endangered Important Fish Species in Bangladesh

Researchers: Md. Moshiur Rahman, Scientific Officer
Laxmi Majumdar, Scientific Officer

Objectives

- To optimize the hormone doses of Foli, *Notopterus notopterus*
- To develop appropriate seed production technique of Shal Baim, *Mastacembelus armatus* through artificial propagation
- To know the production performance of Mohashol, *Tor putitora* with carps at on farm condition.

Budget: Tk. 12,00,000.00

Achievements

Expt. 1. Standardization of hormone doses for N. notopterus

Fish in the pond were found to be fully mature and ready to spawn after proper brood management practice. All of the fish did not mature at a time and first growing fishes were found to mature in early breeding season followed by others. During the experimental period water quality parameters such as temperature (°C), pH, DO (mg/l) and total ammonia (mg/l) were recorded at monthly interval. The values of temperature, transparency, dissolved oxygen; pH and total ammonia were 20.31–30.69°C, 50-60 cm, 5.16-7.55 mg/l, 7.20-8.53 and 0.01-0.04 mg/l, respectively. Regular exchanges of underground water were made to facilitate sexual maturity. Corresponding data representing the effects of PG doses on ovulation rate, fertilization rate, hatching rate and survival rate are shown in Table 1.

Table 1. Performances of different doses of PG on induced breeding of *N. notopterus*

Treatments	PG Dose		Ovulation rate (%)	Fertilization rate (%)	Hatching rate (%)	Survival rate (%)
	Male	Female				
T_1	2.5	5	62.33 ± 6.52	61.96 ± 9.54	53.36 ± 7.56	58.69 ± 6.89
T_2	3	6	73.36 ± 8.41	75.39 ± 6.92	76.26 ± 2.86	67.23 ± 6.32
T_3	3.5	7	69.93 ± 4.32	62.36 ± 8.29	68.59 ± 4.36	65.58 ± 3.74

Ovulation rate: The highest average ovulation rate (73.36%) was recorded in T_2 whereas the lowest value (62.33%) was found in T_1 (Table-1). In a lower dose 73.36 % ovulation rate indicated that the brood fishes were highly mature which was the impacts of brood management practice with special diet. Among three doses of PG in the viewpoint of ovulation rate T_2 showed highest result followed by T_3 and T_1.

Fertilization rate: Average fertilization rate were recorded as 61.96, 75.39 and 62.36 in treatments T_1, T_2 and T_3, respectively. The highest fertilization rate (75.39%) was recorded in T_2 while the lowest fertilization rate (61.96%) was found in T_1.

Hatching rate: Average hatching rate of *N. notopterus* were found 53.36, 76.26 and 68.59% in treatments T_1, T_2 and T_3 respectively. The highest hatching rate was recorded as 76.26% in T_2 and the lowest hatching rate was recorded as 53.36% in treatment T_1.

Survival rate: After 30 days of experimental period, the survival rate of *N. notopterus* larvae those were produced by three different hormone dose treatments were 58.69, 67.23 and 65.58% in T_1, T_2, and T_3, respectively.

Expt. 2. Development of induce breeding technique of Shal Baim, Mastacembelus armatus

Mature *Mastacembelus armatus*, (average 200-300g weight) were collected from natural habitat during February, 2017 to optimize seed production technique of this fish. Brood fishes of both sexes were stocked in cemented tanks (15m^2 areas). Tanks were provided with all facilities including continuous water supply through porous plastic pipes for aeration. The fishes were fed with pellet feed and trash fish (3-5% body wt). As the fish has hiding tendency, pieces of PVC pipe were used as shelter in each tank. Water quality parameters (DO, pH, temperature and Total ammonia etc) of the tanks were monitored at fortnightly intervals. The values of temperature, dissolved oxygen; pH and total ammonia were 20.5–29.61°C, 3.63-6.31 mg/l, 7.6-8.90 and 0.0-0.03 mg/l, respectively. A regular exchange of underground water was facilitated to attain sexual maturity. Breeding trials were carried out during June–July. Corresponding data representing the effects of PG doses on ovulation rate, fertilization rate, hatching rate

and survival rate are shown in Table 2. Fish did not show any response in 1st two doses but in the 3rd dose precipitated ovulation and successful striping of ovulated eggs observed.

Table 2. Observation of induced breeding trials of *M. armatus*

Treatment	Mean Body weight (g)		Dose of 1st Injection (mg/kg^{-1})		Interval of 2nd injection (hr)	Dose of 2nd Injection (mg/kg^{-1})		Ovulation period (hr)	Fertilization rate (%)	Remarks
	Male	Female	Male	Female		Male	Female			
T_1	268.3 ±15.3	276.6 ±12.6	-	10	06	10	20	-	-	No ovulation
T_2	233.3 ±17.9	195.9 ±9.89	-	15	06	10	25	-	-	Partial ovulation took place
T_3	241.6 ±11.2	231.8 ±7.38	-	20	06	10	30	-	-	Complete ovulation. Successful fertilization and hatching did not occur.

Expt. 3. Study on production performance of mohashol (Tor putitora) with carps at on farm condition

The experiment was carried out for a period of 10 months from November 2016 to August 2017. Experiment was conducted at different famer's pond and each pond was 20 decimal with an average water depth of 1.5 meter at Tarakanda and Fulpur Upazila under Mymensingh district in nine rectangular earthen ponds of identical size. Corresponding data representing the stocking density/ha, initial weight and final weight are shown in Table 3.

Table 3. Species combination used in different treatments

Treatment	Species	Species ratio (%)	Stocking density/ha	Initial weight (g)	Final weight (g)
T_1 (Control)	Mohashol (*Tor putitora*)	100	6000	15.32±3.52	655±10.62
T_2	Catla (*Catla catla*)	35	2100	20.46±5.66	881±15.87
	Ruhu (*Labeo rohita*)	25	1500	16.91±5.62	790±13.52
	Mohashol (*Tor putitora*)	40	2400	15.32±3.52	678±9.85
T_3	Catla (*Catla catla*)	35	2100	20.46±5.66	799±17.56
	Ruhu (*Labeo rohita*)	25	1500	16.91±5.62	690±14.87
	Mrigal (*C. mrigala)*	20	1200	14.89±3.39	585±18.32
	Mohashol (*Tor putitora*)	20	1200	15.32±3.52	530±8.96

In case of mohashol, the average initial weight of 15.32 ± 3.52 g reached to a final weight of 655 ± 10.62g, 678 ± 9.85g and 530 ± 8.96 g in treatments 1, 2 and 3 respectively. In case of catla, the average initial weight of 20.46 ± 5.66 g reached to a final weight of 881 ± 15.87 g and 799 ± 17.56 g in treatments 2 and 3 respectively. In case of rohu, the average final weight of 790 ± 13.52 g and 690 ± 14.87 g treatments 2 and 3 respectively. In case of mrigal, the average initial weight of 14.89 ± 3.39 g reached to a final weight of 585 ± 18.32 g under treatment 3.

Stock Improvement and Dissemination of Commercially Important Tilapia and Climbing Perch Koi through Genetic Selection

Researchers: Dr. A.H.M. Kohinoor, Principal Scientific Officer
Md. Moshiur Rahman, Scientific Officer

Budget: Tk. 25,00,000

Objectives

- To improve the stock of BFRI-GIFT strain using family selection protocol
- To improve the stock of Vietnamese Koi through brood stock replacement technique
- To evaluate of production performance of BFRI GIFT with Magur (*C. batrachus*) and Shing (*H. fossilis*) at different stocking densities.

Achievements

Expt. 1. Stock improvement of the GIFT strain by Family Selection in Bangladesh

Nile tilapia (*Oreochromis niloticus*) is one of the leading aquaculture species in Bangladesh, which shows very good adaptation to local culture conditions, response to fast growth, efficient to food conversion and good tolerance to the changes in water quality as well as disease compared to other cultured species. Over the last five years, more than 300 tilapia hatcheries have been established that are producing >4.0 billion tilapia fry to support commercial farming in >6000 tilapia farms all over the country. Due to rapid expansion of tilapia hatcheries, quantity of seed production has been increased dramatically but genetic quality of those seeds has been deteriorated for poor brood stock management. On the other hand, most of these hatcheries function in genetic and reproductive isolation (i.e. no introductions or replacement by new stocks) and repeatedly use of the same stock every year just to maximize the fixed target of seed production. As a result, tilapia grow out farmers are not in the position of maximizing the target of production and profit due to using of such poor quality seeds. In view of overcoming this situation and mitigating the growing demand for genetically improved tilapia brood stock for quality seed production in the country, Bangladesh Fisheries Research Institute (BFRI) has undertaken a family selection program since 1995 to continue improving genetic quality of the GIFT (Genetically Improved Farmed Tilapia) strain. Since then, this work has been conducted in collaboration with the WorldFish, Penang, Malaysia. The aim of the present study was to evaluate growth performance of the GIFT strain after six generations of genetic selection for increased body weight at BFRI). The founder stock comprised of 30 families having 300 individuals of the GIFT strain was introduced from Malaysia through WorldFish in March 2005. The stock was reared in 100 m^2 hapa for three months, and then individually tagged using Passive Integrated Transponder (PIT) tags at the mean weight between 30 and 40g. After tagging, all the fish were communally grown out in pond until harvest. Breeding value for body weight was estimated using SAS and ASREML statistical packages. The best (highest) breeding values of brooders (40 females and 40 males) from the founder stock were then selected to produce progeny of the first generation (F_1) in 2007. From each family 20 female and 20 male fingerlings were randomly sampled and PIT tagged. A total of 2,000 tagged fish from 40 families were stocked in a pond (1000 m^2) for continuation of the selection program. The same protocol was followed in subsequent generations in 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015 and 2016. In addition, surplus fish after tagging were also reared together with progeny of the founder stock in cisterns and in earthen ponds for growth evaluation (F_1 to F_6 during 2008 to 2012). General linear model analysis indicated that the selected fish had 7.17, 13.60, 23.21, 30.30, 35.38, 39.25, 43.19, 49.03, 52.82 and 56.25% greater harvest weight than that of the founder population in F1, F2, F3, F4, F5, F6, F7, F8, F9 & F10 generations, respectively. The continued stock improvement of GIFT strain

by family selection in every generation at BFRI, enable the institute to supply improved germplasm every year to over 200 tilapia hatcheries for high quality seed production in the country. This attempt was greatly contributing to sustainable increase of tilapia production in Bangladesh.

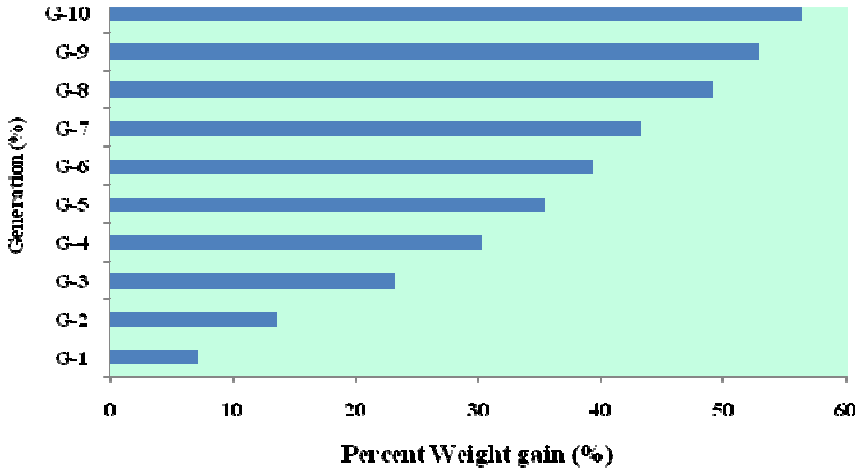


Fig. 1: Generation wise percent weight gain of BFRI GIFT

Expt. 2. Grow-out trial of improved GIFT with shing and magur in semi-intensive culture management

Production performance of GIFT with shing (*M. cavasius*) and magur (*C. batrachus*) were evaluated for five months during February to June 2017 in six farmers pond at Dohakhola, under Gouripur upazila, Mymensingh. All ponds were treated with lime at the rate of 250 kg/ha. After 5 days of liming, ponds were fertilized with cow manure at the rate of 2,000 kg/ha. Three stocking densities of shing and magur were tested keeping the monosex GIFT stocking density similar. Each stocking density of shing and magur was considered as treatment and replicated thrice. Fingerlings of shing and magur were stocked at the rate of 50000 & 25000; 57500 & 17500 and 65000 & 10000 in T-1, T-2 and T-3, respectively. In all the treatments mono sex GIFT tilapia were stocked at the rate of 50,000/ha. The same regime of pelleted feed (28% crude protein) was applied in all the treatments. At the end of the culture period (five months), all fishes were harvested by repeated netting followed by dewatering the ponds. Data were analyzed using the statistical package, Stat-graphics Version 7. The results showed that monosex GIFT reached an average sampling weight of 230.53±13.21g in T-1, 242.85 ±11.4g in T-2 and 224.75 ±9.76g in T-3, respectively. When compared, the harvesting weight of monosex GIFT was not significant among the treatments. The average final weights of magur were 137 ±8.72, 157 ±9.17and 167±9.62g, in T-1, T-2 and T-3, respectively. The poor harvesting weight was observed in T-1 whereas, comparatively higher harvesting mean weight was observed in T-3. The weight of shing showed significant difference ($P<0.05$) among the treatments. However, it was 42 ±3.11, 37 ±3.29 and 31 ±3.09g in T-1, T-2 and T-3, respectively. After five months rearing, the production obtained were 14952 kg/ha, 14235 kg/ha and 13977 kg/ha months from T-1, T-2 and T-3, respectively. The highest production was obtained from T-1, where monosex were stocked with magur and shing at the stocking density 50000 & 25000/ha. The lowest production was obtained in T-3 where magur and shing were stocked at 65000 & 10000 /ha. The production of T-1 showed significant difference ($p>0.05$) with T-2 and T-3, respectively.

Table 1. Harvesting weight and production of fish under different treatments

Treat.	Fish sp.	Stocking /dec.	Harvesting wt. (g)	Survival (%)	Sp. wise prod./dec.	Total Prod.
T-1	GIFT	200	238±13.21	93	44.27	59.81[a] (14952 kg/ha)
	Magur	100	137 ±8.72	68	9.32	
	Shing	200	42 ±3.11	74	6.22	
T-2	GIFT	200	242 ±11.4	89	43.07	56.94[b] (14235 kg/ha)
	Magur	70	157 ±9.17	72	7.91	
	Shing	230	37 ±3.29	70	5.96	
T-3	GIFT	200	250 ±9.76	91	45.50	55.91[b] (13977 kg/ha)
	Magur	40	167±9.62	75	5.01	
	Shing	260	31 ±3.09	67	5.40	

*Figures in the same row having the same superscripts are not significantly different (P>0.05)

Expt. 2. Stock improvement of Vietnamese koi through brood stock replacement technique

The breeding program was initiated involving 1000 brood stock obtained from Vietnam to produce the F-1 generation. A total of 300 male and 300 female were selected and reared in two ponds separately. Induced breeding program were accomplished in April 2017 through brood stock replacement technique for the production of F_1 generation. The fishes were mated in 5 pair cross in a single hapa to ensure equal numbers of male and female fish. After induced breeding, about 20g of hatchlings from each hapa were mixed together and reared in a single nursery pond for 4 weeks. As such four nursery ponds 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. For evaluating the growth performance of non selected group of Vietnamese Koi and improved F-1 generation of Vietnamese Koi, an experiment was conducted for a period of three months with three replications during April to June. The fry of koi were stocked in March 2017 at the stocking density of 75,000/ha at on-station, Mymensingh. There were two treatments with two replicates. Treatment-I was designed with F-1 generation of Vietnamese Koi, while treatment-II with non selected group of Vietnamese 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 88±4.56 and 92.22±5.60g, respectively and results were statistically significant (P>0.05). The F-1 generation of Vietnamese Koi showed 4.79% higher growth than non selected group.

Stock Improvement and Dissemination of Vietnamese White Pangas (*Pangasianodon hypophthalmus*)

Researchers: Dr. Md. Shaha Ali, Principal Scientific Officer
A.K.M. Saiful Islam, Senior Scientific Officer
RumanaYasmin, Scientific Officer
Md. Abdur Rab Mondal, Scientific Officer

Budget: Tk. 15,00,000

Objectives

- To improve the stock of pure Vietnamese white flesh pangas through rotational group breeding techniques
- To compare the growth of improved Vietnamese white flesh & existing stocks of Thai pangas
- To produce Quality seed of Vietnamese white flesh pangas and distribute to the fish farmer/hatchery owners.

Achievements

Expt. 1. Production of F_1 base generation of Vietnamese white flesh pangas through group breeding techniques

Founder stock: A wild stock of Vietnamese (Tra) white flesh pagasius is available for group breeding programs in the BFRI, FS hatchery. This stock was imported from Vietnam during the year 2012 and the present size of the fish is above 3.0 kg which were used to produce F_1 base generation under this project. The special feature of this Vietnamese pangas is that of their flesh is white which has high consumer preferences for the international as well as local market. Stock details and the present status of Vietnamese white flesh pangasius are shown in Fig. 1 and Table 1.

Fig. 1. Vietnamese white flesh Pangas *(Pangasianodon hypophthalmus)*

Table 1. Stock details of collected Vietnamese white flesh Pangas

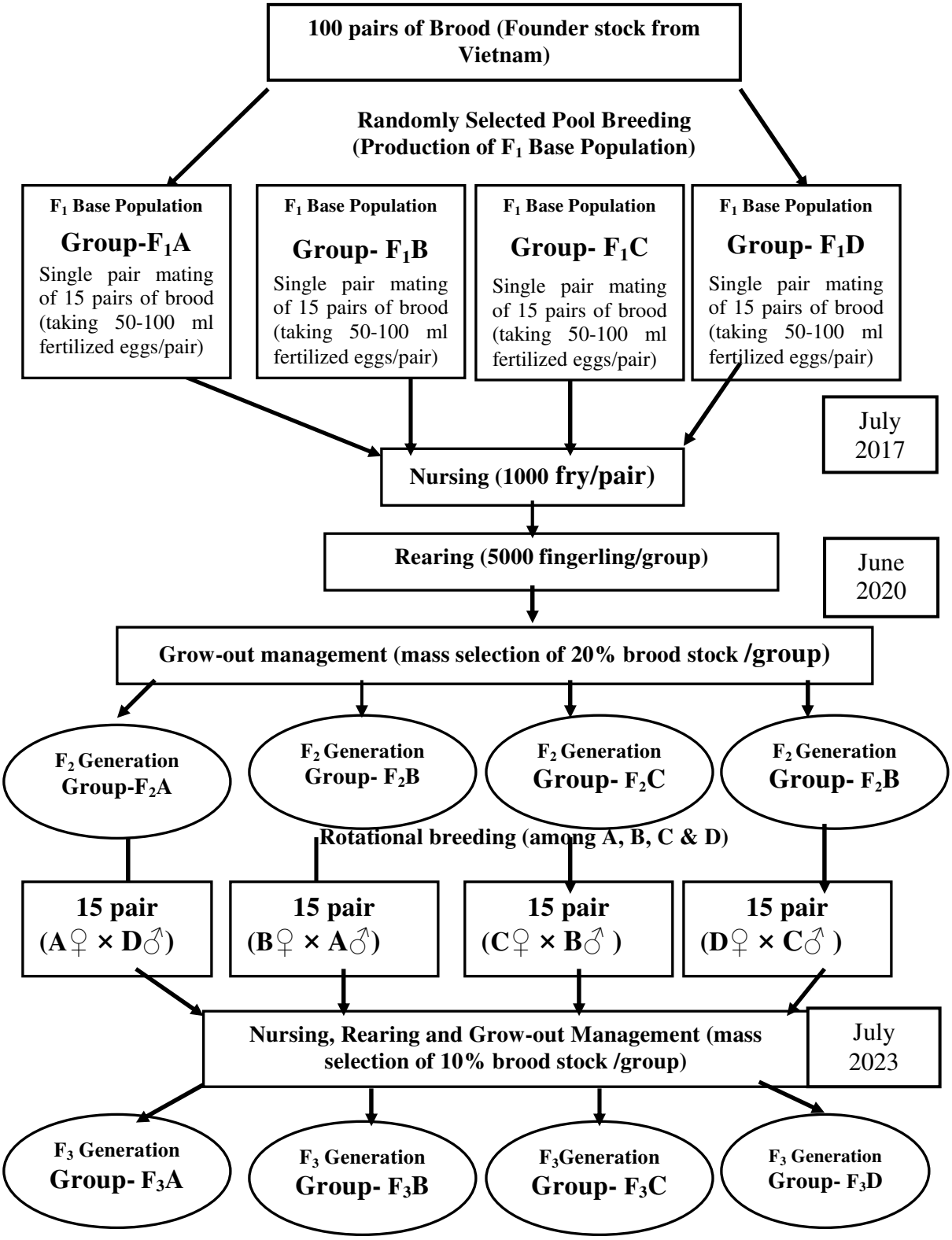
Origin	Year of collection	Special feature	Widely known	Present status Av. wt. (g)	Consumer preferences
Vietnam	Oct' 2012	Wild stock from Mekong River (White flesh)	Vietnamese Tra	3535 ±290	High demand and price in international market

Following the procedures as per PP, breeding of Vietnamese white flesh pangas were initiated in August 2016. During the month of March 2016 best selected 100 pairs out of 250 pairs of immature brood (above 3.0 kg) were stocked in BFRI, FS pond complex to mature them. The fish were fed 28% protein enriched feed to mature them for breeding in June-August. For production of F_1 base generation, 60 pairs of brood were randomly selected (from 100 pairs) for breeding program and separated them into 4 groups (Group-F_1A, F_1B, F_1C and F_1D). Within the randomly selected group, 15 pairs (sex ratio of female and male 1:1) of brood were mated separately to produce 15 families. All mating of the same group were performed in the same day. From each family, a sub sample of fertilized eggs (50-100 ml fertilized eggs/pair) were taken and incubated in funnel/jars or units and spawn from each group were stocked in separate nursery ponds. Details of the breeding protocols and production of F_1 base population data of white pangas are shown in Table 2 and Flow-Chart 1. The breeding activities for the production of F_1 base generation of Vietnamese white pangas are also shown in the Fig. 2.

Table 2. Breeding details of F_1 base generation of Vietnamese white pangas

Breeding date	**Breeding protocol**	**Family in each group**	**Group designation (F_1 base generation)**	**Primary nursery rearing**	**Secondary nursery rearing**
7th August 2016	Single pair matting (60 families were produced)	15 (taking 50-100 ml fertilized eggs/family)	4 (F_1A, F_1B, F_1C & F_1D)	group-wise (40 days)	group-wise (90 days)

Fig. 2. Breeding activities for the production of F_1 base generation of Vietnamese white pangas.



Flow-Chart 1. Schematic flow-chart of group & rotational breeding protocol of pangas

From each group, 5000 fry from primary nursing were reared for the secondary nursing and assuming

40% mortality. From the secondary nursing about 3000 fingerlings are available for stocking in grow-out ponds. The results of the primary nursing and the present status of the F_1 base generation of Vietnamese white pangas in secondary nursing shown in Table 3 and 4.

Table 3. Stocking and growth details of F_1 base generation of Vietnamese white pangas in primary nursery ponds

Species	Stocking density/ decimal	Trial period (days)	Final length (cm)	Final wt. (g)	Survival (%)	Feeding
White pangas (F_1 base generation)	100 g spawn/d (40,000/d)	45	8.41 ± 0.97	5.10 ± 1.37	27	Commercial pelleted feed (30-35% protein)

Table 4. Stocking and growth details of F_1 base generation of Vietnamese white pangas in secondary nursery ponds

Species	Stocking density/ decimal	Trial period (days)	Initial		Final wt. (g)		Survival (%)	Feeding
			length (cm)	wt. (g)	length (cm)	wt. (g)		
White pangas (F_1 base generation)	3000/d	90	8.41 ± 0.97	5.10 ± 1.37	15.24 ± 1.25	25.92 ± 6.04	60	Pelleted feed (28-30% protein)

Expt. 2. Comparative growth study of improved Vietnamese white flesh pangas with local stocks of Thai pangas

A comparative growth performance trial were conducted using fingerlings from best selected group of Vietnamese white pangas (F_1A, F_1B, F_1C and F_1D) with existing/local stocks of Thai pangas in two rearing ponds for four months in Freshwater Station pond complex. The stocking density was maintained 80 fingerlings/ decimal and the fish were fed commercially available pelleted feed (28-30% protein). The fish were stocked on 25th March 2017. The fish were sampled at monthly interval to assess growth performance and adjust the feed ration. After 4 months culture period, the fish were harvested and data were compiled. The present status of the comparative growth experiments of F_1 base generation of Vietnamese white flesh pangas with local red flesh Thai pangas is shown in Table 5.

Table 5. Comparative growth study of Vietnamese white pangas with existing local stocks of Thai Pangas

Stock	SD (dec.)	Initial 25.03.17		Final 25.07.17		Trial period (day)	SGR (%/d)	Comment
		length (cm)	Weight (g)	length (cm)	Weight (g)			
White Pangas	80	15.15 ± 1.17	25.50 ± 5.39	35.42 ± 1.60	408.70 ± 58.72	120	2.31	White pangas showed 4.67% higher growth rate
Thai Pangas	80	15.10 ±0.69	25.25 ± 3.60	34.64 ± 1.31	390.45 ± 65.77	120	2.28	

Effect of Different Types of Feed Ingredients in Formulated Diets on Muscle Color and Growth Performance of *Pangasianodon hypophthalmus*

Researchers: Dr. Momtaz Begum, Principal Scientific Officer
Mritunjoy Paul, Scientific Officer

Budget: Tk. 830,000.00

Objectives

- To evaluate the effect of various sources of feed ingredients and additives on growth of *Pangasianodon hypophthalmus*
- To evaluate the muscle color of *Pangasianodon hypophthalmus*
- To optimize the inclusion level of feed ingredients and additives in the formulated diets.

Achievements

Study 1. Development of quality feeds without meat & bone meal on growth and color in Pangasianodon hypophthalmus

Water quality parameters recorded in all dietary treatments during the experimental period such as temperature (25.00-31.00^{0}C), pH (6.60-7.40), dissolved oxygen (4.90-7.60 mg/L) and total ammonia (0.11-0.25) were (Table 1) within tolerable limits for the fish. Neither mortality nor external clinical symptoms occurred in any treatment during the period of this study.

Growth and feed response parameters are shown in Table 2. Growth performances in terms of weight gain, % weight gain and SGR of fish fed diet 4 was significantly higher ($p<0.05$) than fish fed diets 1, 2 and 3. Food conversion ratio (FCR) values were showed a trend towards lower i.e. better for diet 4. Fish fed diets 1-3 showed significantly ($p< 0.05$) superior FCR value than the diets 4 (Table 2). Protein efficiency ratio (PER) value ranged was 1.76 ± 0.01 with diet 4 producing significantly ($p<0.05$) the higher PER values. The apparent net protein utilization (ANPU %) values was 26.80 ± 0.28 for diet 4 which was significantly higher ($p<0.05$) than diet 1-3.

Table 1. Ranges of water quality parameters observed in the experimental tanks of static indoor rearing system during the experimental period

Parameters	Ranges
Water temperature (^{o}C)	25.00 – 31.00
Dissolved oxygen (mg/L)	4.90 - 7.60
pH	6.60 - 7.40
Total ammonia (mg/L)	0.11 - 0.25

Table 2. Mean growth performance of *Pangasianodon hypophthalmus* fed in different formulated diets for 8 weeks

Diet no.	1	2	3	4
Initial body wt. (g)	1.50 ^{a} ± 0.05	1.50 ^{a} ± 0.05	1.50 ^{a} ± 0.05	1.50 ^{b} ± 0.05
Final body wt. (g)	12.23 ^{a} ± 0.11	12.49 ^{a} ± 0.16	12.40 ^{a} ± 0.28	12.63 ^{b} ± 0.25
Weight gain (g)	10.70 ^{a} ± 0.14	10.99 ^{a} ± 0.16	10.90 ^{a} ± 0.28	11.13 ^{b} ± 0.25

Specific growth rate (SGR) (% day)	3.50 ^{a} ± 0.01	3.54 ^{a} ± 0.02	3.52 ^{a} ± 0.04	3.55 ^{b} ± 0.03
Food conversion ratio (FCR)	1.70 ^{a} ± 0.02	1.67 ^{a} ± 0.01	1.69 ^{a} ± 0.05	1.66 ^{b} ± 0.05
Protein efficiency ratio (PER)	1.70 ^{a} ± 0.05	1.74 ^{a} ± 0.08	1.72 ^{a} ± 0.02	1.76 ^{b} ± 0.01
Apparent net protein utilisation (ANPU, %)	25.85 ^{a} ± 0.21	26.20 ^{a} ± 1.21	25.90 ^{a} ± 0.47	26.80 ^{b} ± 0.28

Note: Values are ± SD of two replicates. Figures in the same row having different superscript are significantly different ($P < 0.05$). * No statistical analysis was possible as determinations were performed on pooled samples.

In conclusion, the results of the feeding trial (diet 4) of *Pangasianodon hypopthalmus* without meat and bone meal and maize showed higher growth performance, feed and protein utilization than in fish fed with these two ingredients. From the results of this feeding trial, it is logical to conclude that feed incorporated without meat and bone meal and maize can be used as a fish feed in *Pangasianodon hypopthalmus* culture, to enhance fish health, better feed efficiency and growth performance.

Study 2. Development of quality feeds through optimization of feed ingredients and additives usages on growth and color in Pangasianodon hypophthalmus

The water quality parameters recorded during the feeding trail, such as temperature (27.0-33.2^{0}C), pH (6.1-8.1) and dissolve oxygen (4.5-7.4 mg/L) were within tolerance limits for Thai pangas. There was no major variation in water quality parameters, which could be attributed to observed growth differences.

Growth and feed response parameters are shown in Table 3. Growth performances in terms of weight gain, % weight gain and SGR of fish fed diet 4 was significantly higher ($p<0.05$) than fish fed diets 1, 2 and 3. Food conversion ratio (FCR) values were showed a trend towards lower i.e. better for diet 4. Fish fed diets 1-3 showed significantly ($p < 0.05$) superior FCR value than the diets 4 (Table 3). Survival and production for feeding trial 4 (Diet 4) exhibited significantly ($p< 0.05$) superior value.

Table 3. Mean growth increment of *Pangasianodon hypopthalmus* fed in different formulated diet for 18 weeks in ponds

	Diets number			
Diet no.	**1**	**2**	**3**	**4**
Initial body wt. (g)	5.05 ^{a} ± 0.07	5.10 ^{a} ± 0.14	5.05 ^{a} ± 0.07	5.05 ^{b} ± 0.07
Final body wt. (Kg)	0.70 ^{a} ± 4.88	0.70 ^{a} ± 5.09	0.60 ^{a} ± 3.96	0.74 ^{b} ± 2.83
Weight gain (g)	694.95 ^{a} ± 4.81	694.95 ^{a} ± 5.23	594.95 ^{a} ± 4.03	734.95 ^{b} ± 2.76
Specific growth rate (SGR) (% day)	4.40 ^{a} ± 0.01	4.40 ^{a} ± 0.06	4.27 ^{a} ± 0.04	4.45 ^{b} ± 0.01
Food conversion ratio (FCR)	1.80 ^{a} ± 0.02	1.67 ^{a} ± 0.01	1.79 ^{a} ± 0.05	1.86 ^{b} ± 0.05
Protein efficiency ratio (PER)	2.05^{a} ± 0.15	2.10^{a} ± 0.12	2.01^{a} ± 0.19	2.30^{b} ± 0.19
Survival (%)	90 ^{a} ±5.0	90 ^{a} ±7.0	87 ^{a} ±4.0	93 ^{b} ±3.0
Production (kg/ha)	20748.00 ^{a} ±300.50	20748.00 ^{a} ±253.80	17784.00 ^{a} ±315.45	21933.60 ^{b} ±337.20

Note: Values are ± SD of two replicates. Figures in the same row having different superscript are significantly different ($p < 0.05$). * No statistical analysis was possible as determinations were performed on pooled samples.

Color profile: Color profile of this study showed that lightness factor was highest for Diet 4 indicating the degree of lightness or darkness of fish fillets and red (+) /green (-) and yellow (+) /blue (-) colour

attributes and redness index were lowest for Diet 4 indicating less redness of fish fillets (Table 4) due to the absence of meat and bone meal and maize as feed ingredients and possible reason behind this is absence of myoglobin of meat and bone meal which is responsible for red colour and absence of carrotinoids of maize which is responsible for yellow colour in fish fillets.

Table 4. Color profile of *Pangasianodon hypopthalmus* fish fillets.

Parameters	Diet 1	Diet 2 (Without MBM)	Diet 3 (without maize)	Diet 4 (without MBM and maize)
L (Lightness)	42.79	54.49	48.20	56.12
a (Red/Green)	1.69	-0.59	0.68	-0.98
b (Yellow/blue)	5.98	4.49	5.36	4.02
Redness Index	0.282609	-0.1314	0.126866	-0.24378

In conclusion, the results of the feeding trial (diet 4) of *Pangasianodon hypopthalmus* without meat and bone meal and maize showed higher growth performance, feed and protein utilization, survival and production, more lightness and less redness than in fish fed with these two ingredients. From the results of this feeding trial, it is logical to conclude that feed incorporated without meat and bone meal and maize can be used as a fish feed in *Pangasianodon hypopthalmus* culture, to enhance fish health, better feed efficiency and growth performance and to produce whitish fish fillets.

Investigation and Identification of Emerging Fish Diseases and Development of their Control Strategies

Researchers: Dr. Nazneen Bagum, Senior Scientific Officer
Md. Shirajum Monir, Senior Scientific Officer

Budget: Tk. 11,00,000.00

Objectives

- To isolate and adapt Shing virus using different cell lines
- To isolate and identify the causal agents of existing and emerging diseases of fish
- To observe histological changes in different organs of diseased fish
- To develop control strategies through laboratory and field trials.

Achievements

Isolation and identify shing viruses from recent outbreaks

Apparently juvenile healthy shing (*Heteropneustes fossilis*) were collected from different areas of Mymensingh district and those juvenile shing were kept in aquariums for preliminary observation of pathogens (virus and bacteria) free. Before dissecting out the tissues for primary culture, the healthy shing were starved for four days and maintained overnight in sterile, aerated water containing 1000 IU ml^{-1} penicillin and 1000 µg ml^{-1} streptomycin. Prior to sacrifice, the fishes were tranquilized by plunging in iced water for 5 min, then disinfected in sodium hypochlorite (500 ppm available chlorine) for 5 min, washed in sterile water and swabbed with 70 % ethyl alcohol. The liver, heart and brain tissues were aseptically excised from the fishes and collected in sterile vials containing phosphate buffered saline

(PBS, pH 7.2) having 500 IU ml^{-1} penicillin, 500 µg ml^{-1} streptomycin and 1.25 µg ml^{-1} amphotericin B. Subsequently, the tissues were washed thrice in the same medium prior to trypsinisation and observed the pathological changes.

Virus identified from different organs of diseased shing (H. fossilis)

A total of 54 samples were collected from different infected fish farms of different upazillas of Mymensingh. Different individual organs of the infected shing were subjected to RT-PCR for identifying tropism of nodavirus and rhabdovirus in shing fish (Fig. 1). The highest nodavirus positive (69%) samples was found in brain of shing fish that collected from Gouripur upazilla but the highest rhabdovirus positive (40%) samples was in spleen of shing fish sampled from Muktagacha upazilla of Mymensingh district. However, within the two viruses nodavirus was in the highest number of infection than rhabdoviruses in all samples.

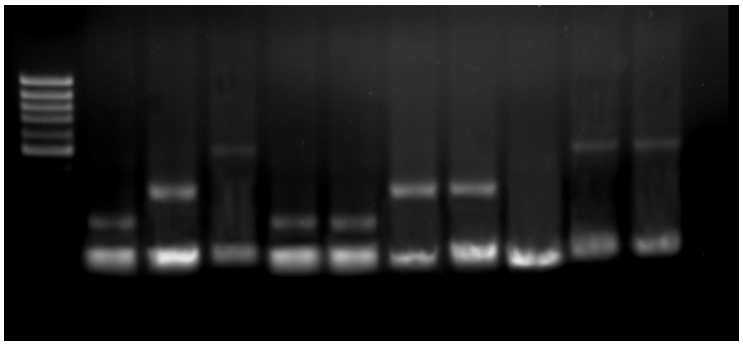


Fig. 1 Agarose gel electrophoresis of PCR amplification products of shing viruses. Lanes: (M) 100 bp DNA marker; (1, 2 & 3) positive control; (8) negative control, (4, 6 & 9 and 5, 7& 10) Noda & Rhabdovirus identified from different infected organs of shing.

Isolation and adaptation of Shing virus using different cell lines

Apparently juvenile healthy shing (*Heteropneustes fossilis*) were collected from different areas of Mymensingh district and those juvenile shing were kept in aquariums for preliminary observation of pathogens (virus and bacteria) free. Before dissecting out the tissues for primary culture, the healthy shing were starved for four days and maintained overnight in sterile, aerated water containing 1000 IU ml^{-1} penicillin and 1000 µg ml^{-1} streptomycin. Prior to sacrifice, the fishes were tranquilized by plunging in iced water for 5 min, then disinfected in sodium hypochlorite (500 ppm available chlorine) for 5 min, washed in sterile water and swabbed with 70 % ethyl alcohol. The liver, heart and brain tissues were aseptically excised from the fishes and collected in sterile vials containing phosphate buffered saline (PBS, pH 7.2) having 500 IU ml^{-1} penicillin, 500 µg ml^{-1} streptomycin and 1.25 µg ml^{-1} amphotericin B. Subsequently, the tissues were washed thrice in the same medium prior to trypsinisation.

Isolation and identification the causal agents of emerging diseases of fish collection of diseased Vietnamese koi

About 150 diseased Vietnamese koi (*Anabas testudineus*) were collected from different upazillas such as Sadar, Muktagacha, Phulbaria, Fulpur, Gouripur under Mymensingh district for investigating the disease causative agents.

Clinical signs and post mortem findings: Naturally infected Vietnamese koi showed loss of appetite, sluggish movement, swimming close to the surface of the water, lethargic, no escape reflex, erratic

swimming which was either spiralling or spinning just below the surface of water, haemorrhages on the skin especially in the base of fins and tail (Fig. 2), ulcer on body, haemorrhage of the eye (Fig. 3), uni- or bilateral exophthalmia, in some cases cloudy change as well as destruction of eye (pop-eye) was observed and severalty infected fish ultimately died 50-60% within 3-15 days in the cultured ponds.

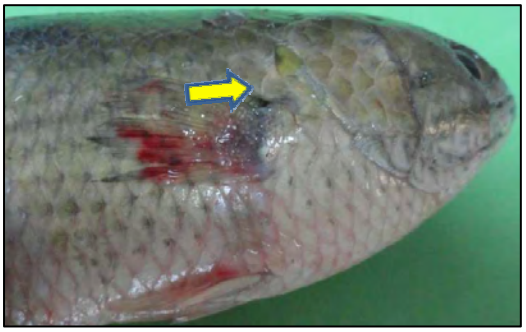


Fig. 2. Haemorrhage on body

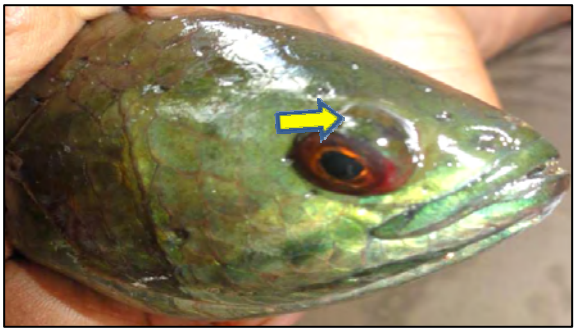


Fig. 3. Haemorrhage in the eye

Isolation and Identification of bacteria: Fish sampling and primary isolation of bacteria were done under complete aseptic condition from the kidney, liver, spleen and ascitic fluid and inoculated on Tryptone Soya Broth (TSB) that incubated at 28-37 ^{o}C for 24-48 h. For molecular detection of the isolated bacteria, seven representative isolates SA-1, SA-2, SA-3, SA-4, SA-5, SA-6, SA-7 and SA-8 were chosen to run PCR assay. The *Streptococcus agalactiae* isolates tested product gave 220 bp clear bands (Fig.4). The gene was amplified with using of the universal primers of 16s rRNA. The primers with the following sequence: F1 (Forward), 5'-GAG-TTT-GAT-CAT-GGC-TCA-G-3' and R1 (Reverse), 5'-AAC-AAC-ACG-TGT-TAA-TTA-CTC-3' were designed which gave an amplicon of 220 bp. The molecular technique was used for *S. agalactiae* identification due to PCR technique is certainly more reliable than the traditional bio-chemicals methods.

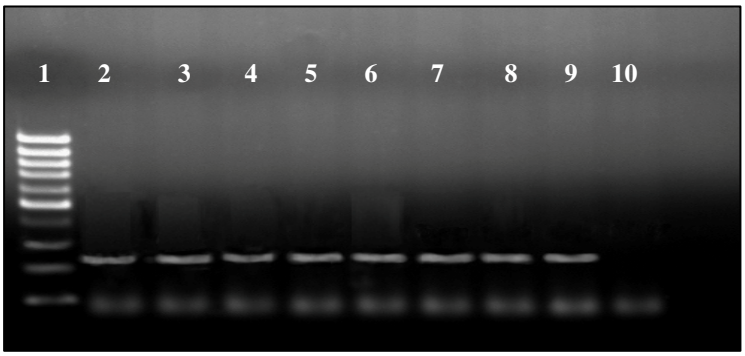


Fig. 4. PCR amplification generated by *S. agalactiae* species specific primer. Lane- 1, 100 bp ladder; Lane 2-9, SA-1; SA-2, SA-3, SA-4, SA-5, SA-6, SA-7, SA-8 isolates, Lane-9, positive control; Lane-10, negative control.

Development of vaccine against *Streptococcus agalactiae*: The isolated *Streptococcus agalactiae* was cultured in Tryptone Soya Broth (TSB) at 28-37°C for 18-24 h (Fig. 5). After confirmed the bacterial culture in broth, the broth were centrifuged at 5000 rpm for 30 min in 50 ml falcon tube. The bacterial palates were separated by pouring the broth liquid (Fig. 6). The isolated bacterial pellets were inactivated by using at a final concentration of 0.05% formalin.

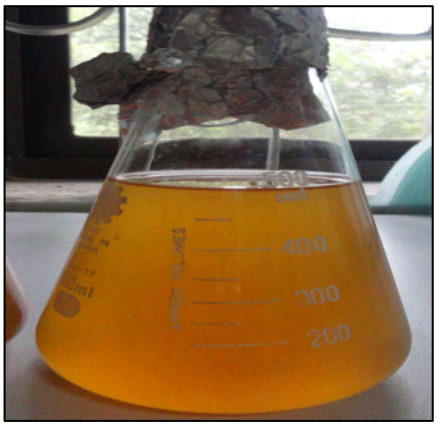


Fig. 5. *S. agalactiae* cultured in Tryptone Soya Broth (TSB)

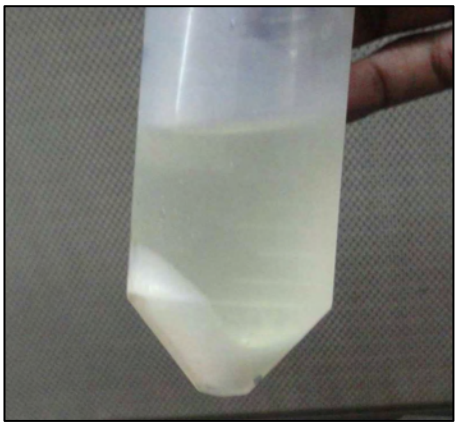


Fig. 6. Pellets of *S. agalactiae* after centrifuged at 5000 rpm for 30 min

The bacterial pellets that were washed 3 times with sterile phosphate buffered saline (PBS) and adjusted to stander density at $2x10^{8-9}$ CFU/ml. The bacteria and formalin were mixed properly and kept at 4^{o}C for 24 h in a sterile falcon tube, with slow stirring. The formaldehyde (37%) was neutralized using 10ml per 1000ml (1/100 dilution) of 15% sodium metabisulphite stock solution added 96 hours after inactivation. Again, the solution was washed properly and the killed bacterial pellets were diluted in PBS. Inactivation of the bacteria was confirmed by inoculating on to TSA and incubating at 30 ^{0}C for 48 h.

Efficacy of an experimentally inactivated Streptococcus agalactiae vaccine against Vietnamese Koi (Anabas testudineus)

Healthy Vietnamese koi: A total of 100 Vietnamese koi were used in this experiment. Fish used in this experiment had an average weight of 100 g and were kept in aquarium with a water volume of 25 L. Collected Vietnamese koi were placed in the aquarium 15 days before the starting of the experiment. After 15 days, tissues of the spleen and brain from the collected Vietnamese koi were taken for bacteriological examination, due to verify whether the fish were free from *S. agalactiae*.

Water quality control: During the experiment, the average concentration of oxygen dissolved in the water was maintained at 4 to 4.5 ppm, temperature at 26 to 28 ^{0}C and ammonia at 0.01 ppm.

Efficacy test of the inactivated *Streptococcus agalactiae* vaccine: Intramuscular injection method was used to know the efficacy of the inactivated *Streptococcus agalactiae* vaccine. In treatment-1, 2, and 3, about 90 Vietnamese koi were intraperitoneally (i.p.) vaccinated with 0.1 and 0.2 and 0.3 ml of inactivated vaccine (2.5×10^{8} cfu/ml), respectively and i.p. challenged after 20 days with 3.0×10^{6} cfu/ml in each treatment. In the control group, 10 Vietnamese koi were i.p. injected with 0.1ml sterile TSB and i.p. challenged 20 days later with 3.0×10^{6} cfu/ml. The challenges were performed using the homologous isolate of *S. agalactiae.* After 3 days of challenged, 2 severely infected fish were died in control group whereas no fish was died in other treatments. At the end of the experiment (after 14 days), the cumulative mortality rate was recorded highest (100%) in control group and lowest (13%) in treatment-2. However, it was found that no mortality was observed in treatment-3 where 0.3 ml of inactivated vaccine used.

Development of Cage Culture Technology of High Valued fishes in the River Ecosystem

Researchers: Dr. AHM Kohinoor, Principal Scientific Officer
Md. Moshiur Rahman, Scientific Officer

Budget: Tk. 10,00,000.00

Objectives

- To utilize the open water ecosystem for fish production through cage culture
- To evaluate the production performance of high valued fish in net cages in the river ecosystem

Achievements

Evaluation of growth and production performance of Magur, C. batrachus in net cages at different stocking densities

Preparation of cages: The cages were made by locally available cages 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 cages were 3.0 m^3.

Installation of cages in the river: Once the frame is anchored at the culture site, the next step is to tie the cages, eight to a battery. Along the top, nylon ropes was used to tie the nets to the bamboo frame firmly to prevent sagging. Sinkers were tied to the bottom corners and the sides of the cages to hold them vertical. The hanging net cages were remaining at least 1-2 meters above the bottom to avoid damage caused by crabs and other bottom dwellers. Cages were installed in the river in late October 2016.

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

Species	Treatments	Replications	Stocking density/m^3
Magur	T_1	3	100
	T_2	3	150
	T_3	3	200
	T_4	3	250

Stocking: Fingerlings of magur were stocked in net cages according to the design of experiment during November 2016 for the period of 7 months. Prior to release, fry were subjected to some prophylactic measures to protect them from diseases and ecoto-parasites. They were dipped in a 5-6% salt solution as well as potassium permanganate (5-8%) for 1 to 2 minutes and then released into the cage water.

Feeding: Feeding was done with pelleted floating feed containing 30% crude protein @ 6-20 % of body weight twice daily.

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

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

maintains water parameters suitable for rearing and in cages though very rarely an algal bloom may push some parameters to the point of threatening fish survival.

Monitoring of growth rate: Fish sampling was done at a regular interval to assess fry length and weight to monitor growth. This information is important for maintaining fish health and optimal feeding, as well as for scheduling the harvest.

Harvesting: Fishes were harvested after 7 months of culture period. Then total number and weight of fishes were recorded and survival, production and cost return analysis were calculated.

The water quality values of temperature, transparency, pH, dissolved oxygen, and total ammonia were 19.9-26.60°C, 54 - 90 cm, 7.12 - 8.36, 7.16- 8.80 mg/l, and 0.01-0.03 mg/l, respectively. The water quality parameters studied during the experimental period were found suitable for fish farming.

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 Magur were 148±4.21, 136±3.95, 125±4.68 and 106±3.96g, in treatments-1, 2, 3 and 4, respectively (Table 1). The harvesting weight of treatment-1 was significantly higher ($P<0.05$) than treatment-2, 3 and 4, respectively. In higher stocking densities, the harvesting weight of Magur was occurred linearly. The survival rate of fish varied between 55 to 74%. In treatment-1, the highest survival rate was observed. The productions obtained in cages were 10.95, 13.26, 15.50 and 14.58 kg/m^3 from treatments-1, 2, 3 and 4, respectively. The highest and lowest production was obtained from treatment-3 and 1, respectively.

Table 1. Harvesting wt., survival and production of magur under different treatments

Treatment	Harvesting Wt. (g)	Survival (%)	Production/m^3 (kg)
Treatment-1	148 ± 5.21	74	10.95[b]
Treatment-2	136± 6.95	65	13.26[a]
Treatment-3	125 ± 4.68	62	15.50[a]
Treatment-4	106± 5.96	55	14.58[a]

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

The economic returns of magur in net cages under four treatments were calculated. Variable costs towards cage preparation, fingerlings, feed and operational costs were taken into consideration during calculating cost of production. Economic returns analysis showed that T_3 generated the highest return over a period of seven months of Tk. 9620/cage (3.0 m^3). After all, the growth performances as well as economic return of magur culture in cages are very encouraging.

Development of Aquaponic Techniques in Bangladesh

Researchers: Dr. Jubaida Nasreen Akhter, Principal Scientific Officer
Md. Rayhan Hossain, Scientific Officer

Budget: Tk. 6,50,000.00

Objectives

- To optimize stocking density of fish and plant in aquaponic system.
- To estimate nutrient level and electrical conductivity in hydroponics system.
- To identify of nitrifying bacteria in bio-filter of aquaponic system.

Achievements

Optimization of stocking density for production of Tilapia, Shing and Magur with vegetable

Experiments were conducted to optimize stocking densities of GIFT, Magur and Shing with vegetable in aquaponic system. Fishes were harvested by repeated netting. Vegetable were harvested within culture period. Harvesting intervals of Tomato, Water Spinach and Lettuce were 15, 7 and 21 days respectively. Growth and production of GIFT, Magur and Shing are shown in Tables 1-3 for 1st batch. Water quality parameters such as NH_3, O_2, and pH were recorded fortnightly (Table 4).

Table 1. Growth and production performance of GIFT

Treatment	**T_1**	**T_2**	**T_3**
Stocking density (m^{-3})	60	80	100
Initial wt. (g)	60 ±1.2	60±1.2	60±1.1
Av. Final wt.(g)	190±10	156 ±13	145 ±9
ADG (g/day)	0.85 ±0.1	0.64±0.1	0.57 ±0.2
Yield kg m^{-3}	10.3	10.2	9.0
Survival (%)	90	83	63

Table 2. Growth and production performance of Magur

Treatment	**T_1**	**T_2**	**T_3**
Stocking density (m^{-3})	60	80	100
Initial wt. (g)	0.26 ±1.1	0.26±1.1	0.26±1.1
Av. Final wt.(g)	31±2.3	29 ±2.4	27.5 ±2.3
ADG (g/day)	0.21 ±0.1	0.19±0.1	0.18 ±0.2
Yield kg m^{-3}	1.15	1.38	1.53
Survival (%)	62	58	55

Table 3. Growth and production performance of Shing

Treatment	**T_1**	**T_2**	**T_3**
Stocking density (m^{-3})	60	90	120
Initial wt. (g)	0.32 ±1.1	0.32±1.1	0.32±1.1
Av. Final wt.(g)	28.3±2.3	26.3 ±2.3	24.5 ±1.2
ADG (g/day)	0.19 ±0.1	0.17±0.1	0.16 ±0.2
Yield kg m^{-3}	1.00	1.59	1.85
Survival (%)	21	67	62

Table 4. Water Quality in Fish Tankis in aquaponic system

Treatment	**GIFT**			**Shing**			**Magur**		
	T_1	**T_2**	**T_3**	**T_1**	**T_2**	**T_3**	**T_1**	**T_2**	**T_3**
DO (ppm)	5.5	5.17	5.0	5.0	5.50	5.78	5.50	5.50	5.30
pH	7.2	7.00	7.10	7.13	7.20	7.18	7.28	7.23	7.20
NO_2-N (ppm)	0.33	0.98	0.98	0.31	0.37	0.70	0.31	0.37	0.45
NH_3-N (ppm)	0.03	0.03	0.06	0.02	0.02	0.03	0.03	0.03	0.05

Variations in the mean values of growth parameters of fishes (weight gain and ADG) under different treatments are shown in Tables 1-3. In case of GIFT average weight gain (g/day) varied from 0.57 g (T_3) to 0.86g (T_1). In case of Shing (*H. fossilis*) average weight gain (g/day) varied from 0.16 g (T_3) to 0.19 g (T_1). In case of Magur (*C. batracus*) average weight gain (g/day) varied from 0.18 g (T_3) to 0.21 g (T_1). The final weight of GIFT, *H. fossilis* and *C. batracus* varied from 145±9 g (T_3) to 190±10 g (T_1), 25±1.2 g (T_3) to 28.5±2.3 g (T_1) and 28±2.3 g (T_3) to 31±2.3 g (T_1), respectively. The survival rate of GIFT, *H. fossilis* and *C. batracus* varied from 63% (T_3) to 90% (T_1), 62% (T_3) to 71% (T_1) and 55% (T_3) to 62% (T_1), respectively. The yield of GIFT, *H. fossilis* and *C. batracus* varied from 7.3 kg/m^{-3} (T_3) to 10.3 kg/m^{-3} (T_1), 1.57 kg/m^{-3}(T_1) to 1.80 kg/m^{-3} (T_3) and 1.15 kg/m^{-3} (T_1) to 1.52 kg/m^{-3} (T_3), respectively. Among the three fishes GIFT showed better performance followed by *H. fossilis* and *C. batracus*. Growth performances of *C. batracus* and *H. fossilis* were not satisfactory probably due to smaller size fingerlings and low water temperature. The survival rate of Lettuces, Water Spinach and Tomato was varied from 86% (T_1, Shing) to 94% (T_3, GIFT), 87% (T_1, Shing) to 97% (T_3, GIFT) and 81% (T_1, Shing) to 93% (T_3, GIFT), respectively. The yield of Lettuce, Water Spinach and Tomato varied from 0.73 kg/m^{-2} (T_1, Shing) to 1.10 kg/m^{-2} (T_3, GIFT), 0.8 kg/m^{-2} (T_1, Shing) to 1.6 kg/m^{-2} (T_3, GIFT) and 0.55 kg/m^{-2} (T_1, Shing) to 1.0 kg/m^{-2} (T_3, GIFT) respectively.

Nutrient released from faucal matter and leftover food of fishes is important for production of vegetable in hydroponic system as growth of vegetable depend on availability of nutrient in the system. Nutrient is released through bacterial break-down of faucal matter and leftover food. Vegetable takes nutrient from the circulated water of the fish tanks. Low density of nutrient in fish tanks/trays usually results poor growth and production of vegetable. Results of nutrient level in water are presented in Tables 5-7.

Table 5. Nutrient Level of Water and Plant in Hydroponic Tray (GIFT)

Replication	Na (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Cl (ppm)
T_1	35.39	10.43	34.27	16.06	8.00
T_2	26.01	9.33	32.47	14.09	7.20
T_3	25.14	8.50	25.60	9.20	6.50

Table 6. Nutrient Level of Water and Plant in Hydroponic Tray (Shing)

Replication	Na (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Cl (ppm)
T_1	24.76	08.63	28.47	09.61	5.00
T_2	28.59	09.64	29.45	10.26	6.00
T_3	29.61	10.84	31.46	12.30	8.00

Table 7. Nutrient Level of Water and Plant in Hydroponic Tray (Shing)

Replication	Na (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Cl (ppm)
T_1	25.76	09.63	26.47	10.61	6.00
T_2	29.59	09.64	29.45	12.26	6.00
T_3	31.61	11.84	32.46	12.30	8.00

The highest EC levels was found in T_3 (0.41 mS/cm) and the lowest EC level was found in T_1 (0.38 mS/cm) with GIFT, Lettuce, Water Spinach and Tomato. On the other hand, EC level varied from T_1 (0.34 mS/cm) to T_3 (0.36 mS/cm) and T_1 (0.34 mS/cm) to T_3 (0.36 mS/cm) with Shing and Magur respectively. In an aquaponic system, considerably lower level of electrical conductivity (EC, 0.3-0.6 mS/cm) is recommended.

Identification of nitrifying bacteria was done in Microbiology Department of Bangladesh Agricultural University following the standard procedures. Total Viable Count was done (Table 8). In bio-filter of

GIFT culture system, the highest number of total bacterial colony in water was recorded in T_3 while the lowest amount of total bacterial colony was found in T_1 with Shing. In qualitative test of bacteria, *Staphylococcus, Bacillus subtilis, Nitrosomonas* and *Nitrobacter* were found in bio–filter which is good for nutrient production.

Table 8. Total Viable Count (TVC) of Bacteria in Bio-filter

Treatments	TVC (cfu/ml)		
	Bio-filter		
	Tilapia	Shing	Magur
T_1	3.5×10^7	1.4×10^7	1.5×10^7
T_2	4.5×10^7	2.5×10^7	2.3×10^7
T_3	5.2×10^7	3.8×10^7	3.7×10^7

Natural Propagation of Freshwater Mussel in Bangladesh

Researchers: Sonia Sku, Scientific Officer
Dr. Mohosena Begum Tanu, Principal Scientific Officer
Arun Chandra Barman, Senior Scientific Officer
Mohammad Ferdous Siddique, Senior Scientific Officer
Md. Moniruzzaman, Scientific Officer
Abu Rayhan, Scientific Officer
Md. Nazmul Hossen, Scientific Officer
SaymunaTarin Lopa, Scientific Officer

Budget: Tk. 7,50,000.00

Objectives

- To know the gonadal histology of freshwater mussels of *Lamellidens marginalis* and *L. corrianus*
- To know the Condition Factor (CF) of freshwater mussels of *L. marginalis* and *L. corrianus*
- To know the reproductive behavior of freshwater mussels of *L. marginalis* and *L. corrianus*
- To environment control breeding of freshwater mussels of *L. marginalis* and *L. corrianus*

Achievements

Identification of breeding season of freshwater mussel Lamellidens marginalis and L. corrianus through gonadal histology

Experiment was conducted in the ponds of Freshwater Station, BFRI, Mymensingh. Physicochemical parameters viz. temperature, dissolved oxygen and free carbon dioxide were estimated during the study period. Freshwater Uninoids species *L. marginalis* and *L corrianas* collected from different ponds of Bangladesh Fisheries Research Institute (BFRI) were stocked in selected ponds. Shell size of collected specimens was measured by vernier caliper. Monthly sample of the mussels shell size was collected during the experiment. Collected individuals were brought to the laboratory and gonad and foot of mussel were separated within 24 for histological study. Mussels dissected for gonadal tissue was fixed in Davidson's fixative for 48 hrs. Targeted tissues then subjected further for block preparation by routine micro technique. Slices having 5-7µm were cut for mounting on glass slide to detect gametogenic stages

among the species. Gonadal sections were stained with Haematoxylene-Eosin staining technique to differentiate the spawning period and gonadal maturity. Stained sections wereestimated under microscope. Developmental stages of male and female gametic cells were differentiated, as described by Peredo and Parada (1984). Development stages of ova and spermatozoa were estimated as mentioned by Haggerty *et.al* (1995) and ova per follicle were recorded.

Twenty samples were collected monthly for gonadal development stage. Spawning period and gonad maturity were observed by histological examination. Five gametogenic stages of the mussels were estimated during the study period from July and June. The results are as follows:

Early development stage: In the female, oocytes remained in attached condition inside the follicles.In the male, spermatozoa was observed in attached condition inside the follicles

Late development stage: In this stage, most oocytes and spermatozoa were ready to release within the follicles.

Ripe stage: In the female, most oocytes were free within the follicles, but some oocytes were attached to the follicle wall. In the male, follicles filled by spermatozoa arranged in characteristic bands.

Spawning: In the female, large spaces inside the follicles and between free oocytes were present. Some follicles were completely devoid of oocytes. In the male, a marked decrease in the quantity of spermatozoa was observed. Large spaces inside the follicles occurred. In some follicles, only a few residual spermatozoa were present.

Spent: At this stage, some unspawned oocytes and spermatozoa were observed within follicles.

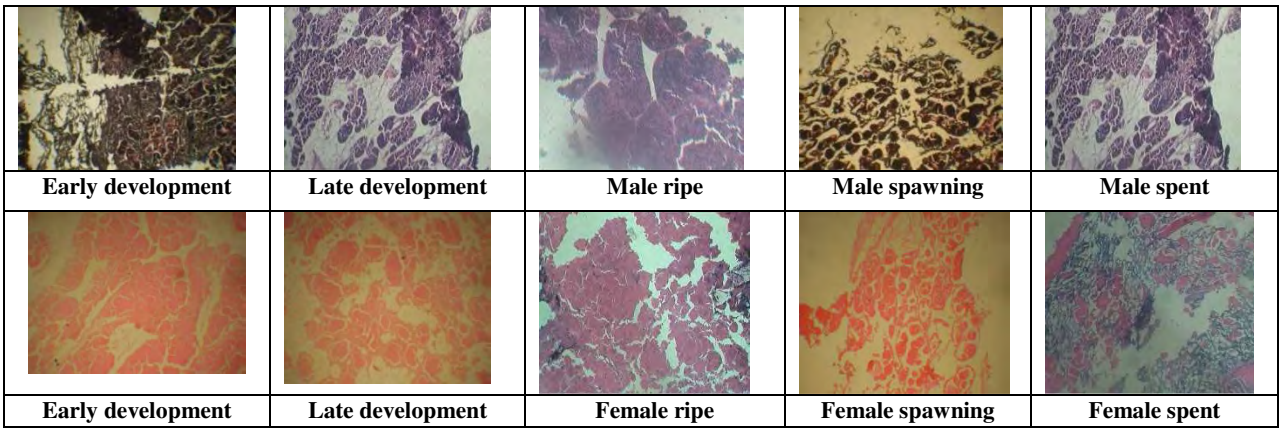


Table 1. Percentage wise different gametogenic stages

Month	Early Dev. (%)	Late Dev.(%)	Ripe (%)	Spawning (%)	Spent (%)	Undifferentiated (%)
July	15	20	50	5	5	5
August	0	15	50	25	5	5
September	0	5	35	30	20	10
October	5	0	10	55	30	0

November	5	0	20	45	30	0
December	5	5	25	0	65	0
January	60	20	0	0	20	0
February	75	25	0	0	0	0
March	35	60	5	0	0	0
April	15	40	30	0	15	0
May	15	50	35	0	0	0
June	10	55	20	0	15	0

Within the study period July to June highest ripe ova was found in July and August followed by September, April and May while high spawning ova was found in October followed by November and September. The high percentages of spent mussels were found in December followed by October and November. (Table 1)

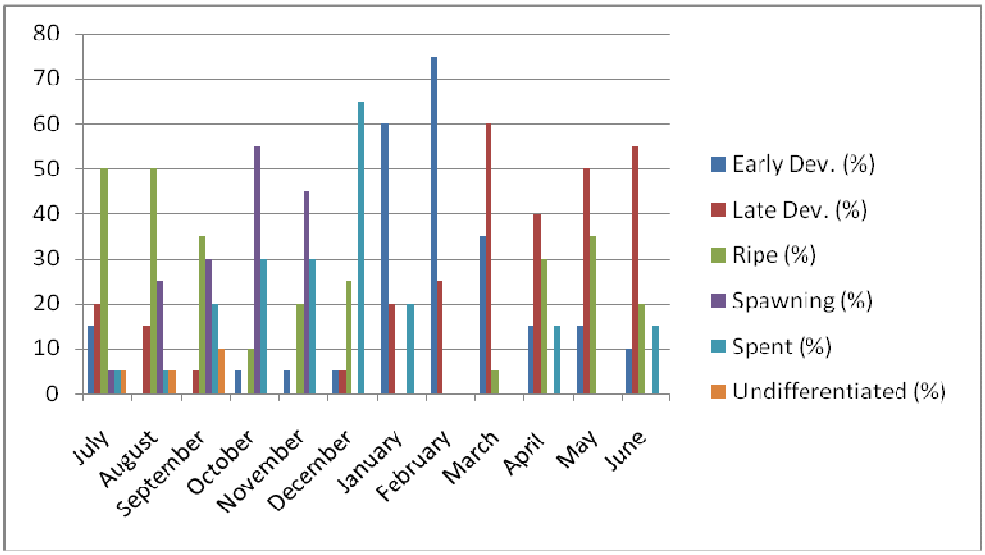


Fig. 1. Percentage of different reproductive stage from July to June.

From the graph 1 it is anticipated that spawning season lies between October and December.

Identification of breeding cycle of freshwater mussels Lamellidens marginalis and L. corrianus through estimation of Condition Factor (CF)

Twenty specimens per month of an adult population of mussel were collected and dissected. Before dissection, shell length and height were measured. Total weight without shell was taken with a balance after blotting the shell and tissue. The condition factor was estimated by the using Fulton's equation (Hile 1936)

$$CF = \frac{W}{H^3}$$

Where CF is condition factor, W is the soft body weight (in g), and H is shell height (inmm).

Table 2. Condition factor of *Lamellidens marginalis*

Months	Condition Factor (CF)
July	0.000282025
August	0.000172981
September	0.000189422
October	0.000481987
November	0.000204036
December	0.000246895
January	0.000269378
February	0.000190690
March	0.000187103
April	0.000187032
May	0.000187102
June	0.000171032

During the study period the estimated CF washigher from October to January where CF was higher in July also (Table 2).

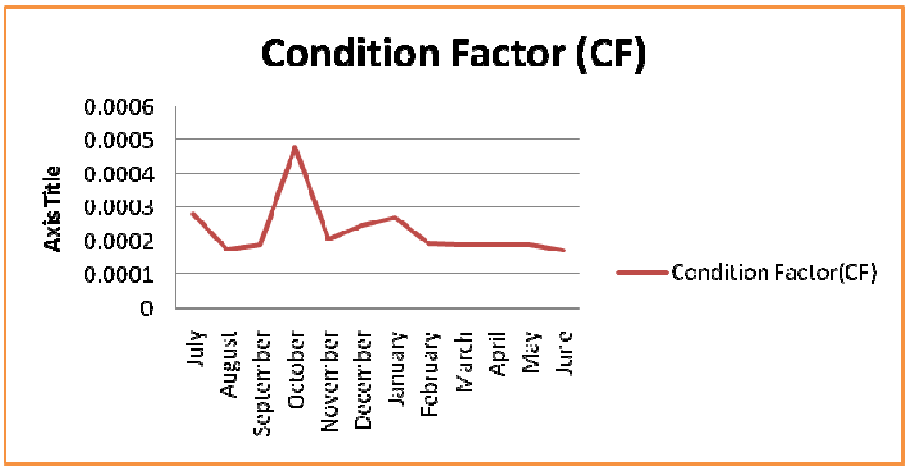


Fig. 2. Condition factor in relation to months.

From the graph 2 it is anticipated that CF is higher between October to December.

Observation of breeding behavior of freshwater mussels Lamellidens marginalis and L.corrianus

Prenuptial behavior of the freshwater mussel was observed in aquarium. Four transparent aquarium and four colored plastic containers were used to observe breeding behavior of mussels. White aquarium was used to observe the pre marital activities of mussels from the outer side of the aquarium; whereas colored container were used to observe the white glochidian behavior. Mussels from the BFRI's ponds were kept in the aquarium and colored plastic containers at a density of 80 mussel/ m^2. *Labeorohita, L. calbasu* and *Oreochromis niloticus* also kept at a density of 10 fish/ m^2. Pond water was used for the experiment. Two aquariums and two containers were arranged with 0.08 meter mud in the bottom, rest of them were kept without mud. *Lamellidens marginalis* and *L .corrianus*were used for the study.

During pick breeding season in October to December fishes gill, fin and slime were observed to find out the presence of glochidia. However, there was no glochidium found at that time in the aquarium.

Control breeding of freshwater mussels Lamellidens marginalis and L. corrianusin natural condition

Four ponds were selected at BFRI pond complex for Control breeding of freshwater mussels. After preparation of the pond mussels were released. Water level was maintained 1-1.5 meter. The stocking density of mussels in pond was250, 200, 150 and 100 mussel/decimal. Stocking density of fish was50fish/decimal (*Catla catla* 6, *Labeo rohita*10, *Cirrhinus cirrhosus* 7, *Heteropneustes fossilis* 10, *Channa punctatus* 10, and *Cyprinus carpio*7). Fish was fed with commercial feed @ 5% of the body weight daily. Research pond was splitted into bana. Organic and inorganic fertilizer wasapplied fortnightly to the pond@3kg cowdung 100gT.S.P and 100g urea per decimal. Lime was applied fortnightly @ 500 g/decimal. Survival of the mussel was monitored once in a month. Water temperature, pH, and plankton growth, NH_4-N, DO and Ca^{2+} was recorded fortnightly

After breeding season it was observed that juvenile mussels found in control breeding pond. Around 200 mussel/decimal were kept in pond with controlled condition. Mussels were kept with natural food to facilitate control breeding.

Table 3. Monthly variations of water quality factors in the experimental pond

Months	Temp. (℃)	(DO) mg/L	pH	Ammonia (mg/l)	Alkalinity
July	24.10 ± 0.7	5.5 ± 1.30	7.20 ± 0.21	0.16±0.06	120±17.32
August	25.30 ± 0.6	5.9 ± 0.04	8.30 ± 0.21	0.10±0.03	150±15.28
September	23.50 ± 0.4	6.0 ± 0.42	7.80 ± 0.49	0.12±0.02	110±26.46
October	25.10 ± 0.6	6.5 ± 0.84	7.80 ± 0.64	0.06±0.04	147.77±26.46
November	24.50 ± 0.7	5.7 ± 0.78	8.02 ± 0.37	0.007±0.07	138.75±10.00
December	22.10 ± 0.6	5.1 ± 0.26	7.98 ± 0.52	0.034±0.03	144.06±10.00
January	18.20 ± 0.5	6.7 ± 0.12	8.24 ± 0.31	0.03±0.02	210.34±15.28
February	25.80 ± 0.4	6.8 ± 0.42	7.98 ± 0.55	0.01±0.03	150±10.00
March	27.05 ± 0.6	4.6 ± 0.57	8.09 ± 0.42	0.06±0.02	100±15.3
April	26.05 ± 0.4	5.5 ± 0.51	8.02 ± 0.22	0.006±0.007	120±15.3
May	25.03 ± 0.5	6.0 ± 0.42	7.88 ± 0.49	0.007±0.006	150±11.5
June	24.10 ± 0.6	5.1 ± 0.27	8.25 ± 0.40	0.03±0.02	210±10.0

Water quality of experimental pond was monitored at 15 days interval. Water temperature, Dissolved oxygen, pH, Ammonia and Alkalinity were ranged from 24.10^{o}C-27.05^{o}C, 4.6mg/L-6.5mg/L, 7.20-8.30, 0.0 mg/L-0.16mg/L and 110-210 respectively (Table 3).

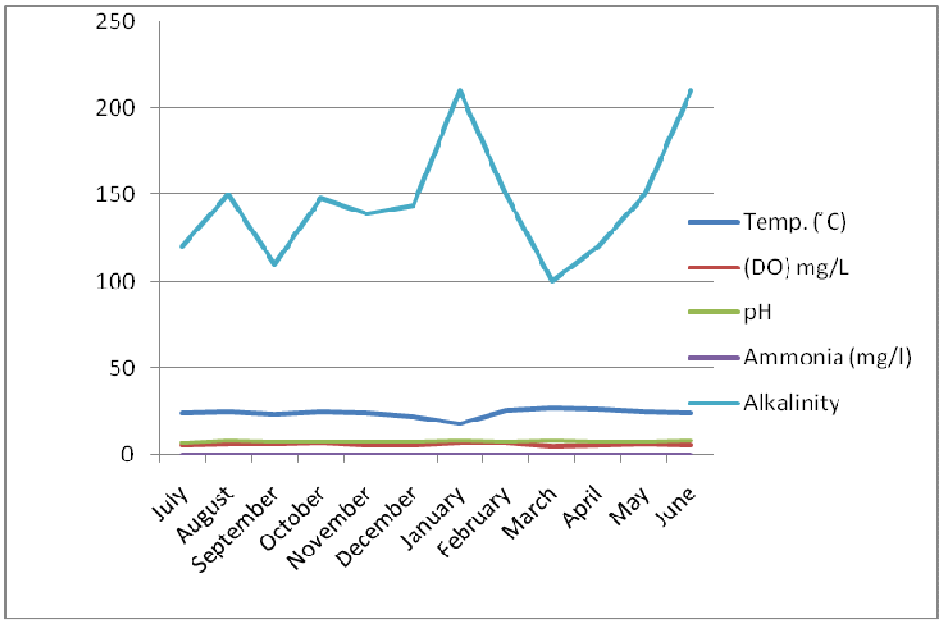


Fig. 3. Monthly variations of water quality factors in the experimental pond

From the graph 3 water quality factors of experimental pond are shows that all the factors was in optimum range.

Refinement of Freshwater Pearl Culture Techniques in Bangladesh

Researchers: Dr. Mohosena Begum Tanu, Principal Scientific Officer
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Budget: Tk. 14,00,000.00

Objectives

- To determine suitable nucleus size for nuclei pearl production in freshwater indigenous mussel
- To determine suitable techniques for maximum non nuclei pearl production in freshwater mussel
- To refine image pearl culture technology
- To disseminate the pearl culture technology through training

Achievements

Determination of suitable nucleus size for nuclei pearl production in freshwater mussel (Lamellidens marginalis, Lamellidens corrianus)

Two ponds had been selected for stocking and rearing of collected mussels. Each pond having 8 decimal areas were prepared by following standard procedure. Ponds were totally drained and the pond bottoms

dried. For stimulating and maintaining the growth of natural plankton, organic and inorganic fertilizer was applied fortnightly to the pond at the rate of 5 kg cow dung, 0.125kg T. S. P. and 0.1kg urea per decimal respectively. Lime was applied at 0.5kg/decimal fortnightly to maintain water pH. Selected ponds were contained sandy soil, clean water and pollution free pond bottom and water depth was 1-1.5 meter. Research ponds were separated by bamboo fence (bana). Water temperature, pH, plankton growth, NH4-N, DO and Ca^{2+} parameters were monitored fortnightly.

After pond preparation young mussel(X) of 1.5-2 year age were collected from different freshwater habitats of the country. Collected mussels were reared separately in stocking pond and rearing pond. Then the reared mussels were kept in cistern without food for one week pre-operative procedure. Mussels were operated by following operation procedure. After operation mussels were kept in cistern without food for one week post-operative procedure. Then the operated mussel were transferred to the another cistern for three weeks post-operative care. After one month post-operative procedure the operated mussels were reared in ponds. Stocking density of mussels were 80/decimal and fish 30/decimal (Catla 6, Rohu 10, Mrigal 10, Kalibaush 4).These fishes were stocked with mussels to ensure the maximum use of pond and control the plankton blooms. For nuclei pearl production different sizes of nuclei (3mm& 4mm) were inserted into the mussel and pearl formation was investigated. After one year culture, survival rate and pearl production rate of the mussels were recorded.

Table 1. Design of the experiment

Culture method	Different size nuclei (mm)	Sp. of mussel to be used for transplantation
Hanging and grazing in cistern and pond	3	*Lamellidens marginalis, Lamelliden corrianus*
Hanging and grazing in cistern and pond	4	*Lamellidens marginalis, Lamelliden corrianus*

In this experiment different size (3 & 4mm) of nuclei was inserted into the mussel by following same culture method. A total of 1800 mussels were operated. Among them 900 were operated in mantle and another 900 operated in gonad with different size of nuclei. By maintaining established procedure different size of nuclei (3, 4) mm were inserted into the mussel.

Table 2. Nuclei pearl production

Size of nuclei(mm)	No of operated mussel	Survival of mussel	Nuclei containing mussel	Nuclei keeping rate	Comments
3	900	654	180	20%	Experiment ongoing
4	900	440	40	10%	

In hanging and grazing in cistern and pond method, a total of 900 mussels were operated with 3 mm size nuclei and cultured in the pond. Survival was 654 and nuclei containing mussel was 180 and nuclei keeping rate was 20 %. By following similar culture method 900 mussels were operated with 4 mm size nuclei and cultured where survival was 440, nuclei containing mussel was 40 and nuclei keeping rate was 10 %. The experiment is still going on.

Determination of suitable techniques for maximum non- nuclei pearl production in freshwater mussel (Lamellidens marginalis, L. corrianus)

The operated mussel having 6 pieces of inserted mantle tissue slice were cultured for 2-3 years in different culture techniques such as Hanging and Grazing, Grazing culture method in pond. Operation procedure was as same as discussed in experiment-1 but here mantle tissue without nuclei were

transplanted. In hanging and grazing method six mussels were hanged from a rope in a net bag. After three months those hanged mussels were released in the pond bottom for free movement. In Grazing method the operated mussel were released directly in the pond bottom. Stocking density of operated mussels were 80/ decimal and fish 30/decimal (Catla 10, Rohu 6, Mrigal8, Kalibaush6). These fishes were stocked with mussels to ensure the maximum use of pond and control the algal or plankton blooms. Two ponds having 30 decimal areas were prepared by following standard procedure before operation. Research ponds were divided by bamboo fence (bana). Organic and inorganic fertilizers were applied fortnightly to the pond at 5kg cow dung, 0.125kg T.S.P and 0.1kg urea per decimal respectively. Lime was applied fortnightly at the rate of 0.5kg /decimal. Survival of the operated mussel was monitored and recorded once in a month. Water quality parameters, temperature, pH, and plankton growth, NH_4-N, DO and Ca^{2+} were monitored fortnightly. After one year culture, survival rate and pearl production rate of the mussel were observed. The design of the experiment and result are given in the Table 3 and 4 respectively.

Table 3. Design of the experiment

Culture method	No. of tissue slice	Sp. of mussel to be used for transplantation
Hanging and Grazing	6	*Lamellidens marginalis, L. corrianus*
Grazing	6	*Lamellidens marginalis, L. corrianus*

In this experiment same number of tissue slice was inserted into the mussel by following different culture method. A total of 600 mussels were operated where a single mussel received 6 mantle tissues. Among them 300 mussels were cultured in Hanging and Grazing and another 300 mussels were cultured in grazing method(Table 4).

Table 4. Pearl production against culture technique

Culture method	Inserted mantle tissue	No of mussel operated	Survival rate of mussel (%)	Pearl producing rate (%)	Comments
Hanging and grazing	6	300	66	60	Experiment ongoing
Grazing	6	300	55	52	Experiment ongoing

In grazing and hanging method a total of 300 mussels were operated and cultured in the pond. Survival rate of operated mussels were 66% and pearl producing rate was60%. Similarly in grazing method 300 mussels were operated and cultured in pond where survival rate 55% and pearl producing rate 52%.

Fine tuning of image pearl technology in freshwater mussel (Lamellidens marginalis, L. corrianus)

Mussels of 3-4 year age were collected from different freshwater habitats of the country. Collected mussels were stocked and reared separately in stocking pond and rearing pond. Ponds were prepared through the standard pond preparation procedure. Ponds were fertilized with organic and inorganic fertilizers like cow dung at the rate of 5kg/decimal, T.S.P at 0.125kg/decimal and 0.1kg/decimal Urea at 15 days interval. Lime was applied at 0.5kg/decimal.Water depth was kept at 1-1.5 meter. Area of pond was 30 decimal. Before operation mussels were kept in cistern without food for conditioning in cemented tanks (2.42m ×1.88m ×1m) with water exchange facility. After operation these mussels were conditioned for one month and then reared into ponds. Research ponds were separated by bamboo fence (bana).Stocking density of mussels were 80 / decimal and fish 30/decimal (Catla8, Rohu8, Mrigal7,

Kalibaush7).These fishes were stocked with mussels to ensure the maximum use of pond and control the algal or plankton blooms.

Different size and shape of images were inserted into the mussel and cultured by hanging and grazing technique in pond and hanging and grazing technique in cistern and pond.

Culture method: In this experiment two culture methods were used

Hanging and grazing in pond: Operated mussels were cultured in net bag for three months. Then mussels were cultured by Grazing method for four months. Before harvesting of mussels were cultured in net bag for one month.

Hanging and grazing in cistern and pond: Operated mussels were kept in cistern for one week without food and then kept in another cistern for three weeks with food. Operated mussels kept in pond for two months by using net bag hanging method. Then the operated mussels cultured in pond for four months in grazing condition. After six months mussels were cultured for one month in net bag hanging method.

Finally, after 7 month culture, the image pearls were harvested. The survival rate and mussel having image were recorded. The design of the experiment and result are given in the table 5 and 6 respectively.

Table 5. Design of the experiment

Name of culture technique	Length of mussel (cm)	Size of Image (cm^2)	Sp. of mussel to be used for transplantation
Hanging and grazing in pond	9-12	3.0 × 1.5 2.5 × 1.5 2.0 × 1.5	*Lamellidens marginalis, L. corrianus*
Hanging and grazing in cistern and pond	9-12	3.0 × 1.5 2.5 × 1.5 2.0 × 1.5	*Lamellidens marginalis, L. corrianus*

Four hundred mussels were operated and cultured by hanging and grazing technique in pond and hanging and grazing technique in cistern and pond.

Table 6. Image pearl production

Culture Techniques	Operated mussel	Length of mussel (cm)	Width of mussel (cm)	Length of image (cm)	Width of image (cm)	Culture duration (month)	Survival rate (%)	Mussel containing image (%)	Nacre	Luster
Hanging and grazing in Pond	200	9-10	4-5	2-3	1.5	7	21	100	0.3	low
Hanging and grazing in Pond and cistern	200	9-10	4-5	2-3	1.5	7	43	100	0.3	low, medium, high

A total of 200 mussels were cultured by Hanging and Grazing in pond where survival rate was 21%. Image containing mussels were 100% and nacre released over image around 0.3mm and another 200 mussels were operated in hanging and grazing in pond and cistern method where survival rate was 43%,

image containing mussels were 100% and nacre released 0.3mm and quality of image pearl were low, medium, high.

Water temperature, pH, plankton growth, NH4-N, DO and Ca^{2+} parameters were monitored regularly. Result is given in the table 7

Table 7. Water quality parameters (average value) of the research pond 44, 45 and 58 during the experimental period

Parameters	Pond no. 44	Pond no. 45	Pond no. 58
Temperature (^oC)	23.57±0.91 – 27.17±0.30	24.37±1.09-26.77±0.29	24.16±0.88-27.33±0.31
DO(mg/ l)	4.50±0.18- 5.90±0.06	4.54±0.20-5.86±0.04	5.09±0.42-5.54±0.04
Alkalinity (mg/ l)	130±5.77-190±5.77	140±10-190±5.77	123.33±8.81-146.66±6.66
pH	6.49±0.98-7.77±0.10	7.16±0.21-7.40±0.25	7.15±0.02-7.53±0.06
NH_{4-}-N (mg/ l)	0-0.08±0.06	0-0.09±0.04	0.002±0.0009-0.03±0.006
Ca^{2+} (mg/ l)	21±2.9-25±3.1	23±3-28±3.5	27±2.5-29±3.7
Phytoplankton ($x10^3$cells/L)	50.25±1.8-52.17±1.2	48.18±1.5-50.29±1.3	50.29±1.2-52.18±1.8

Water qualities of experimental ponds were recorded at 15 days interval. In Pond no.44 water temperature, Dissolved oxygen, Alkalinity, NH_{4-}-N (mg/ l), pH, Ca^{2+} (mg/ l) and Phytoplankton ($x10^3$cells/L) were ranged from 23.57±0.91 – 27.17±0.30, 4.50±0.18- 5.90±0.06, 130±5.77-190±5.77, 6.49±0.98-7.77±0.10, 0-0.08±0.06, 21±2.9-25±3.1 and 50.25±1.852.17±1.2respectively. In Pond no.45 water temperature, Dissolved oxygen, Alkalinity, NH_{4-}-N (mg/ l), pH, Ca^{2+} (mg/ l) and Phytoplankton were ranged from 24.37±1.09-26.77±0.29, 4.54±0.20-5.86±0.04, 140±10-190±5.77, 7.16±0.21-7.40±0.25, 0-0.09±0.04, 23±3-28±3.5 and 48.18±1.5-50.29±1.3respectively. In Pond no.58 water temperature, Dissolved oxygen, Alkalinity, NH_{4-}-N (mg/ l), pH, Ca^{2+} (mg/ l) and Phytoplankton were ranged from 24.16±0.88-27.33±0.31, 5.09±0.42-5.54±0.04, 123.33±8.81-146.66±6.66,7.15±0.02-7.53±0.06,0.002±0.0009-0.03±0.006,27±2.5-29±3.7 and50.29±1.2-52.18±1.8.

Early Development of Brood of Thai Pangas, *Pangasianodon hypophthalmus* using Green House Concept

Researchers: Dr. David Rintu Das, Senior Scientific Officer
Sonia Sharmin, Scientific Officer

Budget: Tk. 8,00,000.00

Objectives

- To accelerate early matured broods of Thai pangas *Pangasianodon hypophthalmus*
- To improve quality of broods of Thai pangas *Pangasianodon hypophthalmus* between January to February

Achievements

Expt. 1. Enhancement of development of ovary of Pangasianodon hypophthalmus using 'green house' concept

Four equal earthen ponds with an area of 0.08 ha each and average depth of 1.5 m were used for this study. The selected ponds were dried, bottom soil was excavated to increase depth and the dykes were repaired properly. For this purpose, two ponds were fully covered with transparent polyethylene sheet fastened in frame, made of bamboo that was treated as "green house pond" (GP). The other two ponds were kept open and were treated as open pond (OP) as control.

After growing sufficient plankton, all the ponds were stocked with adult and healthy *Pangasianodon hypophthalmus* at the rate of 990 nos/ha (density 12kg/decimal) in October. The ratio of stocked broods (female: male) were 2:1. The size of male Pangas was 2-2.5 kg and that of female was 3-3.5 kg (Table 1). The stocked brood Pangas were fed with commercial pellets feed (28% crude protein) supplemented with vitamin premix daily at a rate of 10 % for the first month, 8% for the second month, 5% for the third month and 3% for rest of the brood development period (Fig. 2). Cod liver oil were added at 1-2 ml/kg feed for augment maturation of eggs. Half of the daily feed was applied in the morning and rest half in the evening. Duration of brood development period was 5 months (Table 1). To keep the pH and others water quality parameters in suitable range, water of all ponds were treated with dolomite @ 15 kg/ha fortnightly. All ponds were fertilized with organic (cow manure) and inorganic fertilizer (Urea and TSP) in each 15 days interval. After one month of stocking, the stocked Pangas were observed frequently by using a seine net to check any development of gonad. After fish stocking of ponds 10% water were exchanged at a time in every 7 days intervals. A number of water quality parameters such as Temperature (^{0}C), pH, total alkalinity, dissolved oxygen (mg/l) and hardness of water were recorded weekly using a commercial kit box (Model: FF-3, USA).

For this study, about 5-6 fishes were examined randomly, particularly during the winter season (January-February). Confirmation of the gonadal maturity of brood depends upon the size of the gonad in length and weight and fecundity. Fecundity was estimated by gravimetric method. Induced breeding that's with the early matured was conducted in the month of February (Fig. 3). After stocking of fish, gonadal development of brood Pangas were checked monthly observing by examining secondary sexual characters. Matured females were identified by their swollen, distended, soft abdomen with reddish and swollen vent. Mature males were identified by their reddish genital opening and oozing of milt with gentle pressure on the abdomen.

In the green house ponds the stocked male and female Pangas started to be matured after stocking and they were found at the end of culture period. All females & males become matured in last February however, 65% females &90%males become ready for induced breeding (Fig. 4).However, no Pangas become matured in the open ponds throughout the culture period. Matured females were identified by their swollen, distended, soft abdomen with reddish, swollen vent as well as dissecting gonad. Matured males were identified by their reddish genital opening and oozing of milt with gentle pressure on the abdomen. For this study, total 3 fishes were examined randomly during the experimental period (October-February). It was evident from the results (Table-2) that gonad weight increased slowly from October to February with the gonadal development of greenhouse reared broods.

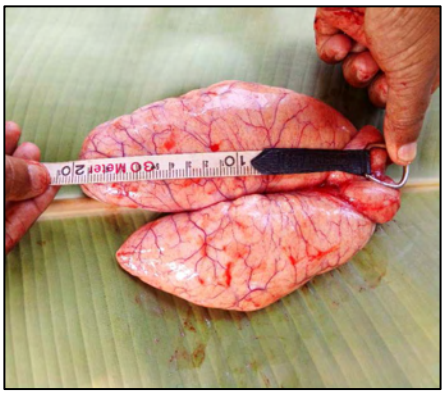



Table 1. Total body length, weight and gonad weight at successive months of greenhouse reared female, *Pangasianodon hypophthalmus*

Month	No. of fish examined	Total length (cm)	Total weight (kg)	Gonad weight (g)
October	3	62.5 ±1.35 (Initial)	2.6 ±3.05 (Initial)	153±0.38 (Initial)
November	3	66.4±1.38	3.3±0.47	226±0.05
December	3	67.3±0.33	3.5±0.16	300±0.42
January	3	66.2±3.01	3.6±0.53	352±1.05
February	3	67.6±1.52	3.8±0.34	378±0.83

Induced breeding was started on 27thFebruary, 2017 in the hatchery complex of the Sub-Station, Santahar. The average weight of females broods were 4.5-5.2kg and males were 3.2-3.7kg during hormone injection. After hormone administration eggs were released by stripping method(Fig. 5).About 60% eggs were come out easily from female brood when stripped. Average fecundity of greenhouse reared broods was 73.33 ova/gm body wt. or 873.01 ova/gm ovary wt. in the end of February.

Ambient water temperature of bottle hatchery was25.2^0 C where hatching rate was found70%. At the first time 30,000-40,000 fries have been produced from greenhouse reared broods(Fig. 6).From the primary finding it is indicated that it will be possible to produce matured Pangas within February if stocking can be done with properly matured Pangas fish in October using greenhouse technique. In greenhouse, it was observed that 65% female and 90 %males were became fully matured in the end of February. However, in open ponds female and males were became fully matured within late April. Hormone injection for female was applied for 1st dose: 1.5 mg cPG + 200 IU HCG/kg BW, 2nd dose: 12 mg cPG /kg BW and in the same time for male 2 mg cPG /kg BW (Fig. 3).

Development of Induced Breeding and Culture Techniques of *Monopterus cuchia*

Researchers: Dr. David Rintu Das, Senior Scientific Officer
Sonia Sharmin, Scientific Officer

Budget: Tk. 11,00,000.00

Objectives

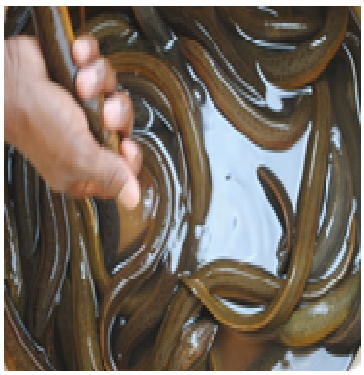
- To develop control breeding technique for seed production of *M. cuchia* in pond ecology
- To develop control breeding technique of *M. cuchia* in cistern ecology
- Refinement of low cost feed technology for cuchia culture

Achievements

Expt. 1. Determination of suitable dosages of hormone for induced breeding of Monopterus cuchia

For the experiment, matured male and female broods were collected from natural sources of Bogra region during March-April period and acclimatized for 3-4 days in the cemented cisterns. The best broods of almost same size were selected based on visual examination of secondary sexual characteristics *i.e.*, abdomen and genital opening. Then the broods (Female Av. Wt. 510 g & Male 280 g) were administered with hormone in deep muscle at the dorsal side of the fishes at different doses of cPG, HCG and Ovaprim as mentioned below in Table 1. Four treatments were used in the present experiment each with the three replications.

After hormone administration, the fishes were stocked in earthen ponds and cemented cisterns for breeding. For feeding of stocked cuchia fry of fishes like as *Channa punctatus, Cyprinus carpio* and *Lepidocephalichthys berdmorei* and earthworm was applied into the ponds and cemented cisterns from next day of stocking as supplementary feed every day in the morning and evening at the rate of 5% of body weight.



During breeding period, cuchia makes hole in the soil at the periphery of pond and lay eggs there. First observations were made after 15 days of stocking to find out nests and presence of hatchlings in the nests. Next, it was done closely everyday on the different stage of hatchlings. After 38 days of injection,1-2 days old larvae were found with yolk-sac absorbing conditions in the nest treated with hormone doses of10 mg cPG/Kg BW+ 200 IU HCG /kg BW for female and 5 mg cPG/Kg BW for male (Fig. 1).Also found fertilized eggs after 38 days of stocking in cistern condition (Controlled).

Fertilized egg and Larvae with yolk sac absorbing condition

The female received single doses of 10 mg cPG/Kg BW+ 200 IU HCG /kg BW and the male received 5 mg cPG/Kg BW showed positive results and collected 150-200 fries from each of the nest in pond and cistern. We also collected fries from the controlled pond and cistern.

Expt. 2. Effects of different foods on growth and survival of M. cuchia spawn in tray

The experiment was carried out for a period of two months with 15 days old spawn. The experiment was conducted in tray. Stocking density was kept at 250/m^2 for all treatments with three replications. The area of each tray was 2m^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.

The experiment was conducted in three treatments with earthworm pest (Treatment-1), zooplankton (Treatment-2), small fish pest (Treatment-3). Feeding rate was adjusted 50% - 20% of body weight/day. Feeding frequency was twice a day. Growth and survival rate were recorded in 15 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 15 days interval. After 60 days of rearing, it was observed that earthworm showed the best performances on growth 1.557±0.01gm and survival rate 75%.

Table 1. Growth performance of *M. cuchia* fry with different feeds reared in tray

Growth parameters	**T_1**	**T_2**	**T_3**
Initial L (cm)	5.70 ± 0.28	5.70 ± 0.28	5.70 ± 0.28
Initial wt (g)	0.892 ± 0.01	0.892 ± 0.01	0.892 ± 0.01
Final L (cm)	8.02±0.24	7.56±0.30	6.84±0.23
Final wt (g)	1.557±0.01	1.094±0.01	1.032±0.01
Survival rate (%)	75	69	63

Expt. 3. Effects of different foods on growth and survival of M. cuchia juvenile in pond and cistern

Six rectangular pond each of 10 dec. and cemented cisterns each of 2.47m x 1.5m x 0.75 m with two replications were used for grow-out culture of *M. cuchia.* Considering the burrowing habit of cuchia, a layer of clay soil of about 50 cm deep were provided at the bottom of each cistern. Ground water was supplied to the cisterns up to 25 cm depth. After dewatering, each of the pond was treated with lime (CaO) @ 250 kg/ha. After then, ponds were filled with underground water up to 70 cm depth. Water of the ponds were treated with 2.0 ppm rotenone to kill cuchia (if any) hiding into the soil. After that, water of the ponds was fertilized with Urea and TSP @ 25 ppm and 30 ppm to enhance the production of

plankton. Water hyacinth were provided to the ponds for suitable and safe shelter of cuchia. Stocking density was kept at 3/m^2 for all treatments with three replications.

The experiment was conducted to know the efficacy of feed on growth and survival rate of *M. cuchia* in three treatments with Earthworm(Treatment-1), Tadpole (Treatment-2), Fish Spawn (Treatment-3). Feeding rate was adjusted @ 20-5% B. Wt. two times in a day. The study was conducted for 6 months. Data on growth performance and water quality parameters such as temperature (°C), dissolved oxygen (mg/L), pH and total alkalinity (mg/L) were recorded in 15 days interval respectively. After 6 months of culture, the final length and weight of *M. cuchia* were 35.9 ± 0.251cmand weight 15.589 ± 0.341 gm for T_1, 31.6 ± 0.231cm and 13.864 ± 0.650gm forT_2 ,29.5 ± 0.716 cmand11.857 ± 0.125 gm for T_3respectively. T_1 showed higher tendency of growth and survival rate (80%) among the three treatments.

Table 3. Growth performance of *M. cuchia* juvenile with different feeds reared in pond and cistern.

Growth parameters	Treatment-1	Treatment-2	Treatment-3
Initial L (cm)	10.4± 0.052	10.4± 0.052	10.4± 0.052
Initial wt (g)	1.610 ± 0.20	1.610 ± 0.20	1.610 ± 0.20
Final L (cm)	35.9 ± 0.251	31.6 ± 0.231	29.5 ± 0.716
Final wt (g)	15.589 ± 0.341	13.864 ± 0.650	11.857 ± 0.125
Survival rate (%)	80	72	65

Optimization of Breeding and Development of Culture Technology of Striped Dwarf Catfish, *Mystus vittatus*

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Budget: Tk. 9,00,000.00

Objectives

- To study brood rearing techniques of *M. vittatus* in captive condition
- To study reproductive parameters of *M. vittatus*

- To determine the reproductive response of suitable doses of hormones and develop mass seed production technique of *M. vittatus* in captive condition
- To study the effect of stocking density and feeds on the growth and survival of the nursery rearing of *M. vittatus* in pond condition; and
- To assess the growth and yield performance under mono and polyculture system of *M. vittatus*

Achievements

Reproductive response of M. vittatus (2♂:1♀ ratio) to double doses of PG

Three different doses of cPG extract were selected for this experiment. The females were injected with cPG extract at the rate of 2, 4 and 5 mg kg^{-1} body weight during 1st dose. After 6 hour, 2nd doses of cPG were injected in females at the rate of 3, 6 and 10 mg kg^{-1} body weight and at the same time, the males were injected with cPG extract at the rate of 2.5, 5 and 7.5 mg kg^{-1} body weight. Immediately after administering the hormones spawners were released into breeding hapa settled in the concrete tanks of the hatchery (capacity:100 liter) containing dechlorinated tap water (temperature: 27-31°C; DO: 5.9-6.5 mg l^{-1}; CO_2: 3.0–4.0 mg l^{-1}; pH: 7.8-8.2). The three different doses of cPG extract at rate of 2.5, 5 and 7.5 mg kg^{-1} in male and 5, 10 and 15 mg kg^{-1} body weight in female respectively were treated as treatment-1 (T_1), treatment-2 (T_2) and treatment-3 (T_3). Different doses were used to optimize desire hormone dose to detect optimum ovulation, fertilization, spawning, hatching, survival to yolk sac absorption. After 9 hrs of injection, ovulation was occurred in all cases. Of them, T_3 (cPG at the rate of 7.5♂ and 15♀ mg kg^{-1}) showed the best breeding performances in terms of ovulation, fertilization rate, hatching rate and survivability of hatchling. After absorption of yolk sac (72 hours), the spawn were fed on boiled egg yolk up to 7 days to optimize rearing condition of larvae. The ovulation rate, fertilization rate, hatching rate and survivability of hatchling is presented in Table 1.

Table 1. Spawning response and performances of *M. vittatus* (2♂:1♀ ratio) using PG

Treatments	cPG (mg kg^{-1})		Latency period (hrs)	Incubation temperature (°C)	% of Ovulation	% of fertilization	% of hatching	% survival of 03 days hatchling	Remarks
	M	F							
T_1	2.5	5 (2+3)	9	29-31	-	-	-	-	Poor ovulation, fertilization and hatching rate were observed
T_2	5	10 (4+6)	9	29-31	80	65	93	50	Comparative better ovulation, fertilization and hatching rate were observed
T_3	7.5	15 (5+10)	9	28-31	85	73	96	63	Successful ovulation, higher fertilization and hatching rate were observed

Reproductive response of M. vittatus to single doses of HCG

Three different doses of HCG were selected for this experiment. The broods (2♂:1♀) were injected with HCG at the rate of 250, 500 and 750 IU kg^{-1} in males and 500, 1000 and 1500 IU kg^{-1} body weight in females respectively. Immediately after administering the hormones spawners were released into well prepared breeding tray (2.15×0.93×0.30 m^3) of the hatchery containing dechlorinated tap water. The three different doses of HCG at rate of 250, 500 and 750 IU kg^{-1} body weight in male and 500, 1000 and 1500

IU kg^{-1} body weight in female respectively were treated as T_1, T_2 and T_3. Different doses were used to optimize desire hormone dose to detect optimum ovulation, fertilization, spawning, hatching, survival to yolk sac absorption. After 10 hrs of injection, ovulation was occurred. Of them, T_3 showed the best breeding performances in terms of ovulation, fertilization rate, hatching rate and survivability of hatchling. After absorption of yolk sac (72 hours), the spawn were fed on boiled egg yolk up to 7 days to optimize rearing condition of larvae. The ovulation rate, fertilization rate, hatching rate and survivability of hatchling is presented in Table 2.

Table 2. Spawning response and performances of *M. vittatus* (2♂:1♀ ratio) using HCG

Treatments	HCG (IU kg^{-1})		Latency period (hrs)	Incubation temperature (°C)	% of egg release	% of fertilization	% of hatching	% survival of 03 days hatchling	Remarks
	M	F							
T_1	250	500	-	-	-	-	-	-	-
T_2	500	1000	-	-	-	-	-	-	-
T_3	750	1500	10	25-28	50	80	73	58	Successful ovulation, good amount of fertilization and hatching were observed

Effect of different feeds on the growth and survival of the nursery rearing of M. vittatus in trays

The study was conducted in metallic trays to observe the growth and survival of nursery rearing of *M. vittatus* at different feeds. For that about, 7 days old fries were stocked in well-prepared metallic trays (2.15×0.93×0.30 m^3) at a stocking density of 8,000 fry dec^{-1}. Three types of feeding viz. locally available commercial feed (containing 35% protein**),** formulated feed (containing 35% protein**)** and mixture of locally available commercial and formulated feed were treated as treatment-1 (T_1), treatment-2 (T_2) and treatment-3 (T_3) respectively and each having three replications. The feeds were fed 15-5% of body weight day^{-1}. Length-weight of fry and water quality data were collected at fortnightly intervals. After a rearing period of 7-8 weeks, the fingerling were harvested and the growth and production parameters *viz.*, average daily growth (ADG), specific growth rate (SGR), health condition (HC), survival were calculated and compared among the treatments. Of them, T_3 showed the better results among the treatments. Water quality parameters like as air temperature, water temperature, pH, and dissolved oxygen (DO) were suitable for fish culture. The results are presented in Tables 3 and 4.

Table 3. Growth performance of nursery rearing of *M. vittatus*

Parameters	Treatments		
	T_1	T_2	T_3
Stocking density (nos. dec^{-1})	8,000	8,000	8,000
Initial length (cm)	0.85	0.85	0.84
Final length (cm)	3.21±0.62	3.39±0.98	3.46±0.88
Initial weight (g)	0.76	0.75	0.75
Final weight (g)	3.97±0.04	3.68±2.28	4.36±2.74
ADG (g day^{-1})	0.06	0.06	0.07
SGR (% day^{-1})	3.31	3.18	3.52
HC (g cm^{-1})	1.23	1.09	1.26
Survival (%)	53.09	61.19	64.04

Table 4. Water quality parameter of nursery rearing of *M. vittatus*

Parameters	**T_1**	**T_2**	**T_3**
Air temperature (^{0}C)	29.5±2.89	28.5±0.58	30.00±2.89
Water temperature (^{0}C)	27.83±2.00	27.3±0.50	28.05±3.97
Dissolved oxygen (mg l^{-1})	7.58±1.73	8.60±0.28	8.5±0.14
pH	7.50±0.22	8.20±0.26	8.28±0.39

The growth and yield performance under monoculture system of M. vittatus

The study was conducted in ponds to observe the growth and yield of *M. vittatus* at different stocking density under monoculture system. About 3-4 g fry was stocked pond in mid of March, 2017 in well-prepared ponds at different stocking densities 800, 1000 and 1200 individuals dec^{-1} under treatment-1 (T_1), treatment-2 (T_2) and treatment-3 (T_3) respectively and each having three replications. The feeding schedule was maintained with commercial catfish feed 10-5% of body weight day^{-1}. Length-weight data and water quality parameters were collected fortnightly. After a rearing period of 5 months, the fish were harvested and the growth and production parameters *viz.*, average daily growth (ADG), specific growth rate (SGR), health condition (HC) and production were calculated and compared among the treatments. The results of *M. vittatus* under monoculture system are presented in Table 5. The survival rate in T_1 showed better result compared to T_2 and T_3 but the production showed better in T_3 followed by T_2 and T_1. Water quality parameters like as air temperature, water temperature, pH, dissolved oxygen (DO) and NH_3 were suitable for fish culture (Table 6).

Table 5. Growth performance under monoculture system of *M. vittatus*

Parameters	Treatments		
	T_1	T_2	T_3
Stock. Density (indi. dec^{-1})	800	1,000	1,200
Initial length (cm)	3.21±0.62	3.39±0.98	3.46±0.88
Final length (cm)	10.8±0.27	11.43±.0.40	11.00±0.50
Initial weight (g)	3.97±0.04	3.68±2.28	4.36±2.74
Final weight (g)	16.18±0.34	19.33±3.51	17.67±3.06
Length gain (cm)	7.59±0.35	8.04±0.58	7.54±0.38
Weight gain (g)	12.21±0.30	15.65±1.23	13.31±0.32
ADG (g day^{-1})	0.09	0.12	0.10
SGR (% day^{-1})	1.04	1.23	1.04
HC (g cm^{-1})	1.50	1.69	1.61
Survival rate (%)	71	62	55
Production (kg dec^{-1})	9.19	11.78	11.22

Table 6. Water quality parameters under monoculture of *M. vittatus* in three treatments (after 135 days)

Parameters	Treatments		
	T_1 (800 fry dec^{-1})	T_2 (1,000 fry dec^{-1})	T_3 (1,200 fry dec^{-1})
Air temp. (ºC)	24.41±3.77	24.41±3.77	24.41±3.77
Water temp. (ºC)	21.69±2.58	21.53±2.97	21.40±2.43
pH	7.54±0.27	7.58±0.33	7.56±0.30
DO (mg l^{-1})	7.09±1.62	6.79±1.45	6.87±1.39
NH_3 (mg l^{-1})	0.17±0.18	0.21±.22	0.30±0.26

Adoption of Suitable Culture Technologies of Some Commercially Important fish Species in the Northern Region of Bangladesh

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Budget: Tk. 10, 0000.00

Objectives

- To adopt the polyculture techniques of short-cycle species in the seasonal water bodies;
- To assess the water quality parameters of cultural water bodies;
- Estimation of cost benefit analysis of culture technologies; and
- To disseminate these polyculture techniques in different aqua-ecological zones in the northern part of the country

Achievements

Polyculture of Vietnamese koi** (Anabus testudineus) **under different stocking densities in the framers ponds

The experiment was conducted in farmer's miniponds of Rangpur and Niphamari areas to observe the growth and yield of Vietnamese koi at different stocking density under polyculture system for a period of 4 months. A total of nine (09) seasonal ponds were selected for this experiment. The area of ponds ranges between 10 and 15 decimal each. The on-farm ponds were selected with the concerning of relevant Senior Upazilla Fishery Officer (SUFO/UFO). After 5 days of liming, cow-dung 6 kg dec^{-1}, urea 100 g dec^{-1} and TSP 75 g dec^{-1} were applied at initial stage during pond preparation. The short-cycle fishes like as Vietnamese koi, GIFT and *Barbodes gonionotus* (shorpunti) were selected for this experiment. About 5-10 cm fingerlings of those fishes were stocked as per experimental design (Table 1) during early May 2017. Fishes were fed commercially available fish feed 15-5% BWT day^{-1} (containing 30-35% protein). Length-weight data and water quality parameters *viz.*, temperature, transparency, pH, DO, CO_2, NH_3 etc. were collected fortnightly. The experimental design is presented in Table 1.

Table 1. Experimental design of Vietnamese koi (*Anabus testudineus*) under polyculture system in different treatments of framers ponds

Treatments	Species composition	Stock. density (nos dec^{-1})	Initial length (cm)	Initial weight (g)	Feeding
T_1	Vietnamese koi	300	1.30	3.8	15-5%
	GIFT	10	3.0	5.5	
	Shorpunti	05	2.0	5.7	
T_2	Vietnamese koi	400			
	GIFT	10			
	Shorpunti	05			
T_3	Vietnamese koi	500			
	GIFT	10			
	Shorpunti	05			

After 04 months of culture, the results of growth performance and water quality parameters are presented in Tables 2 and 3 respectively. The final length and weight of Vietnamese koi (*Anabus testudineus*) were recorded as 19.63 cm, 19.53 cm and 18.90 cm and 198.8 g, 179.7 g and 174.3g respectively in treatments T_1, T_2 and T_3. The final weight was found significantly ($p<0.05$) difference among the treatments (Table 2). The final weight gain and % weight gain of koi were also varied significantly ($p<0.05$) within the treatments. The ADG and HC were also recorded as 1.64 g day^{-1}, 1.48 g day^{-1} and 1.43 g day^{-1} and 10.2 g cm^{-1}, 9.2 g cm^{-1} and 9.1 g cm^{-1} respectively in T_1, T_2 and T_3 and showed significantly ($p<0.05$) difference among the treatments in both the cases. The SGR was found higher in T_1 than that of T_2 and T_3 and significantly ($p<0.05$) differ was in T_1 than T_3. The FCR was found significantly ($p<0.05$) highest in T_3 followed by T_2 and T_1. The highest survival was also observed in T_1 (85.5) and the lowest in T_3 (80.7). The survival was found significant ($p<0.05$) difference in T_1 and T_3 but there was no significant differences between T_1 and T_2 and T_2 and T_3. The production of koi was 12598, 14535 and 17387 kg ha^{-1} in T_1, T_2 and T_3 respectively. The production of koi was significantly ($p<0.05$) higher in T_3 followed by T_2 and T_1 and same picture was also found in case of total fish production. The BCR was found significantly ($p<0.05$) better in T_1 followed by T_2 and T_3 (Table 2). In case of water quality parameters, there were significant ($p>0.05$) difference among treatments, except temperature and transparency (Table 3). The recorded water temperature and transparency were varied between 29.3°C and 31.3°C and 26.3 cm and 30.3 cm respectively within the treatments. The DO was varied between 5.3 mg l^{-1} and 6.1 mg l^{-1} in three treatments and significantly ($p<0.05$) higher in T_1 than that of T_2 and T_3 but there was no significant ($p<0.05$) difference between T_2 and T_3. The values of pH and NH_3 were varied between 7.3 and 7.6 and 0.17 mg l^{-1} and 0.31 mg l^{-1} respectively in three treatments. All the parameters were within the acceptable ranges for the fish culture (Table 3). The BCR results reveal that T_1 was more profitable than that of T_2 and T_3.

Table 2. Growth performances of Vietnamese koi under polyculture system in different treatments

Parameters	T_1	T_2	T_3
Initial length (cm)	3.8±0.0	3.8±0.00	3.8±0.0
Final length (cm)	19.6±0.4	19.5±0.4	18.9±0.2
Initial weight (g)	1.3± 0.0	1.3±0.0	1.3±0.0
Final weight (g)	198.7±3.3^{a}	179.7±9.1^{ab}	174.3±4.3^{b}
Weight gain (g)	197.4±3.3^{a}	178.4±9.1^{ab}	175.7±4.3^{b}
% weight gain	15182±252^{a}	13720±697^{ab}	13310±327^{b}
ADG (g day^{-1})	1.64±0.02^{a}	1.48±0.07^{ab}	1.43±0.03^{b}
HC (g cm^{-1})	10.2±0.08^{a}	9.2±0.06^{b}	9.1±0.25^{b}
SGR (% day^{-1})	4.19±0.01^{a}	4.10±0.04^{ab}	4.07±0.02^{b}
FCR	1.18±0.01^{c}	1.30±0.01^{b}	1.38±0.01^{a}
Survival (%)	85.5±1.5^{a}	81.8±0.9^{ab}	80.7±3.1^{b}
Production of koi (kg ha^{-1})	12598±274^{c}	14535±1205^{b}	17387±598^{a}
Total fish production (kg ha^{-1})	13279±78^{c}	15237±669^{b}	17860±230^{a}
Variable cost (Tk. ha^{-1})	967734±19572^{c}	1224365±51255^{b}	1527737±3884^{a}
Gross return (Tk. ha^{-1})	1591864±9702^{c}	1869503±13224^{b}	2142168±27633^{a}
Gross margin (Tk. ha^{-1})	624130±9961^{b}	645142±64948^{a}	614431±2452^{b}
Benefit cost ratio (BCR)	1.64^{a}	1.53^{b}	1.40^{c}

Table 3. Physicochemical parameters of koi polyculture ponds under different treatments

Parameters	T_1	T_2	T_3
Temperature (^oC)	29.3±0.8	31.3±1.6	30.0± 0.8
Transparency (cm)	30.3±2.7	29.3±1.2	26.3±1.9
Water pH	$7.3±0.2^b$	$7.5±0.3^{ab}$	$7.6±0.1^a$
DO (mg l^{-1})	$6.1±0.32^a$	$5.4±0.15^b$	$5.3±0.1^b$
NH_3 (mg l^{-1})	$0.17±0.05^b$	$0.23±0.04^{ab}$	$0.31±0.037^a$

Culture and Constraints of Commercial Small Fish Species at Farms Level in Jessore Region

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Budget: Tk. 10, 0000.00

Objectives

- To understand the growth and production status of koi (*Anabas* sp.) species at farm level

Achievements

The experiment was conducted to understand the growth and production status of Koi (*Anabas* sp.) species at farm level with three treatments (T_1, T_2 with BFRI recommendation while T_3 was managed by farmers own practices) of each with two replication. A comparative cultural practice of Vietnamese Koi was carried out in the on-station and on-farm level for 120 day during 15 March to 15 July 2017 for tuning of BFRI techniques in the Jessore region. For this purpose, six ponds were selected in Ichali, Bhaturia and Chanchra of sadar upazilla under the Jessore district. The sizes of the each pond was ranged between 149.39 and 277.27 m^2 with almost similar shape and the depth was between 1.0 and 1.20 m. The ponds were drained out completely and aquatic weeds were removed manually. Liming was done in all ponds at the rate of 25 g/m^2. One week after liming the ponds were filled with water and fertilized with urea and TSP at the rate of 2.5 g/m^2 and 1.25 g/m^2 respectively. TSP was soaked overnight, and then urea and TSP were dissolved together and spread manually on surface water at sunny day between 10-10.30 hr. The Vietnamese Koi (*Anabas* sp.) fingerlings with mean initial length and weight of 2.44 cm and 0.22 g were collected from Afil Aqua Ltd hatchery, Sharsha upazilla, Jessore. Fingerlings were stocked at the rate of 22, 55 and 55 individuals per m^2 in the treatment T_1, T_2 and T_3, respectively.

Commercially available supplemental feeds (commercial pelleted feed *Nourish*) containing approximately 30% protein) were supplied in treatments T_1 and T_2. The feed was applied at the rate of 10% of the body weight of fishes at the beginning of the experiment, and then it was reduced to 7% after 30 days and 5-3% till to end of the culture period. However, in treatment T_3, feed was supplied by the farmers as his own initiative. The feed was applied twice a day, in the morning at 9.30 hr and in the afternoon 16.30 hr. Fish were sampled at 15 day intervals by a cast net to monitor the fish growth and to adjust the feeding rate.

Physico-chemical parameters of pond waters were monitored in every 15 day intervals between 9.00 and 10.00 hr (Table 1).

Table 1: Water quality parameters observed during the experimental period.

Parameters	Treatments		
	T_1	T_2	T_3
Air temperature (^{0}C)	29.83±1.95	29.11±1.86	30.88±2.63
Water temperature (^{0}C)	29.94±1.70	30.16±1.35	30.33±1.37
Water pH	7.75±1.00	7.63±0.85	7.39±1.26
Soil pH	6.47±0.46	6.62±0.18	6.62±0.13
DO (ml/L)	3.21±1.70	3.10±1.34	3.10±0.70
Ammonia (ml/L)	0.75±0.22	0.29±0.30	1.00±0.34
Transparency (ml/L)	28.50±0.45	30±0.25	31.50±0.35
Total alkalinity (ml/L)	213.66±26.73	277.00±90.32	258.22±62.32

The water quality parameters were analyzed among the treatments and found within the suitable range for *Anabas* culture. However, in the treatment T_3, ammonia was observed little bit higher than T_1 and T_2. This might be due to higher feeding supplement by the farmers. The dissolved oxygen level was obtained between 3.10 and 3.21 ml/L which seems to be lower and usually remains in the ponds of Koi culture.

Growth of koi were analyzed and shown in the Fig. 1. Among the treatments, T_1 with the stocking density of 22/m^2 showed better than the treatments T_2 and T_3.

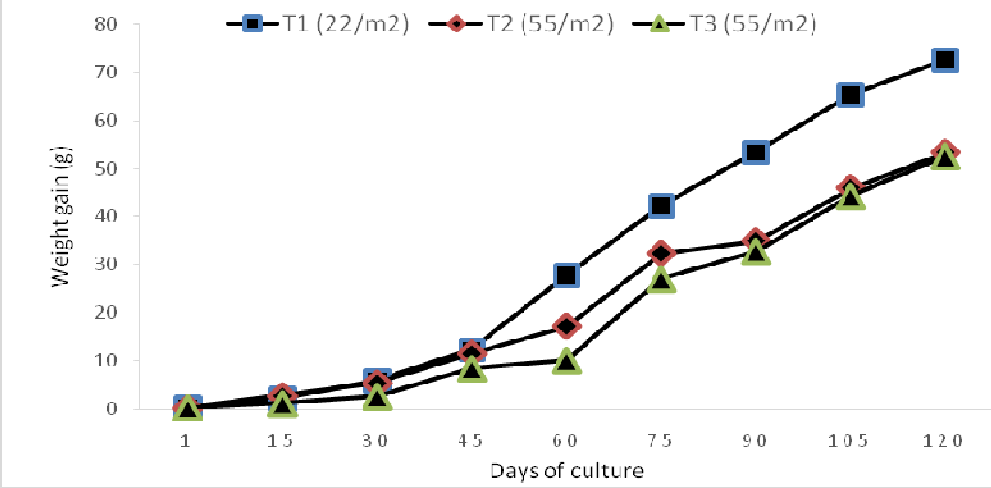

Fig. 1. Weight gain of koi fish in different treatments

Table 2. Growth and production of koi (*Anabas* sp.) in different treatments

Parameters	Treatments		
	T_1	T_2	T_3
Stocking density (No./m^2)	22	55	55
Initial length (cm)	2.5	2.5	2.5
Initial weight (g)	0.22	0.22	0.22
Culture duration (days)	120	120	120
Final length (cm)	15.94±3.72	15.73±0.84	14.50±1.68
Final weight (g)	72.67±6.03	53.39±3.49	52.55±14.12
FCR	2.03±0.67	2.42±0.14	3.38±1.15
SGR (%)	4.83±0.07	4.58±0.05	4.55±0.23
Survival rate (%)	84.73±16.86	64.12±6.36	68.50±25.14
Production (kg/ha)	13492.41±3774.43	16770.58±3134.64	20523.49±12435.78

The final weight obtained of 72.67 ± 6.03 g for T_1, stocking with 22/ m^2, while the fish attained 53.39 ± 3.49 g in weight in T_2 stocking with 55/m^2 and 52.55 ± 14.12 g in weight in T_3 with stocking of 55/m^2 (Table 2). The growth rate in the treatment T_1 was higher than the treatment T_2 and T_3 respectively. SGR% in treatment T_1 (4.83 ± 0.07) was found significantly higher than T_2 (4.58 ± 0.05) and T_3 (4.55 ± 0.23) and was significantly different ($p<0.05$) (Table 2). FCR was comparatively higher in treatment T_3 (3.38 ± 1.15) than T_2 (2.42 ± 0.14) and T_1 (2.03 ± 0.67) respectively (Table 2).

The highest survival rate (%) was observed in T_1 (84.73 ± 16.86) followed by the treatments T_2 (64.12 ± 6.36) and T_3 (68.50 ± 25.14) respectively. However, it was revealed that Vietnamese Koi could be cultured even in comparatively higher stocking density (but less than 55/m^2) rather than recommended stocking density (22/m^2) by BFRI with present management practices in the Jessore region.

Adaptation of BFRI Evolved Cage Culture Technology of High Valued Fishes in Boar

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Budget: Tk. 12, 0000.00

Objectives

- To monitor the water quality parameters
- To study the growth and survival of the selective fish species in the cage culture

Achievements

The experiment was conducted to assess the production performance of indigenous species Gulsha (*Mystus cavasius*) in net cages at different stocking densities. For this study, site has been selected in the

villages Mosshimnagar, adjacent to a fisher community for undertaking the experiment in the Jhapa *baor* of Monirampur Upazilla under the Jessore district. A set of cages had been placed using plastic drums and bamboo frames in the month of February. The cages were made by locally available cages materials, *i.e.* bamboo, knotless nylon net of mesh size (0.5 cm), plastic container as floats, ropes, metallic wires, etc. The area of each floating net cages were 5.0 m^3 covered with another piece of net at the top to prevent escape of fish by jumping and bird predation. The whole structure was 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.

Gulsha fingerlings were collected from Mymensingh and 15 days nursing and acclimatization was done in FSS ponds and hapas. The fingerlings of Gulsha were stocked for optimizing the suitable stocking density (Table 1) in net cages according to the design of experiment during 15 March 2017. The cultured period of the experiment was 120 days.

Table 1. Experimental design

Species	Treatment	Stocking density/m^3	Expt. site	Feed	Duration
Gulsha	T1	300	Jhapa baor (Two different side)	10-5% body weight (floating feed)	120 days
	T2	350	Jhapa baor (Two different side)		
	T3	400	Jhapa baor (Two different side)		

Feeding was done twice daily by the contact fisher women. Feeding were done with pelleted feed containing 30% crude protein at the rate of 10~5 % of body weight for gulsha twice daily. The length and weight of the fishes were measured and recorded. The feed was supplied by the FSS, BFRI Jessore. Fish health and water quality parameters were monitored at 15 day intervals. Water quality parameters like air temperature, water temperature, water pH, soil pH, dissolved oxygen, ammonia, transparency and total alkalinity were analyzed (Table 2).

Table 2. Water quality parameters observed during the experimental period

Parameters	Location		
	In the cages	Outside of the cages	40 m away from the cages
Air temperature (^{0}C)	28.46±5.69	28.46±5.69	28.46±5.69
Water temperature (^{0}C)	27.26±4.33	27.26±4.33	27.23±4.51
Water pH	8.79±0.90	8.79±0.80	8.79±0.85
Soil pH	6.64±0.18	6.64±0.18	6.63±0.18
DO (ml/L)	3.53±0.80	3.53±0.80	3.52±0.75
Ammonia	0.05±0.15	0.05±0.15	0.05±0.15
Total alkalinity	217.20±43.48	217.20±43.48	218.20±41.03
Transparency (cm)	148.33±21.67	149.73±22.62	149.73±21.67

Fishes were harvested after 120 days of the stipulated period. Then total number of fish was counted and length-weight were measured and recorded. The survival and production were calculated as given below (Table 3 and Fig. 1).

Table 3. Growth performance of gulsha in different treatments in cages

Parameters	Treatments		
	T_1	T_2	T_3
Stocking densities (no./m^3)	300	350	400
Initial length (cm)	8.47	8.47	8.47
Initial weight (g)	3.93	3.93	3.93
Culture duration (days)	120	120	120
Final length (cm)	15.00±0.02	14.2±9.20	15.50±0.00
Final weight (g)	32.10±5.00	31.50±4.59	33.80±0.00
SGR (%)	1.75	1.73	1.79
(%) Weight gain	716.80	701.52	760.05

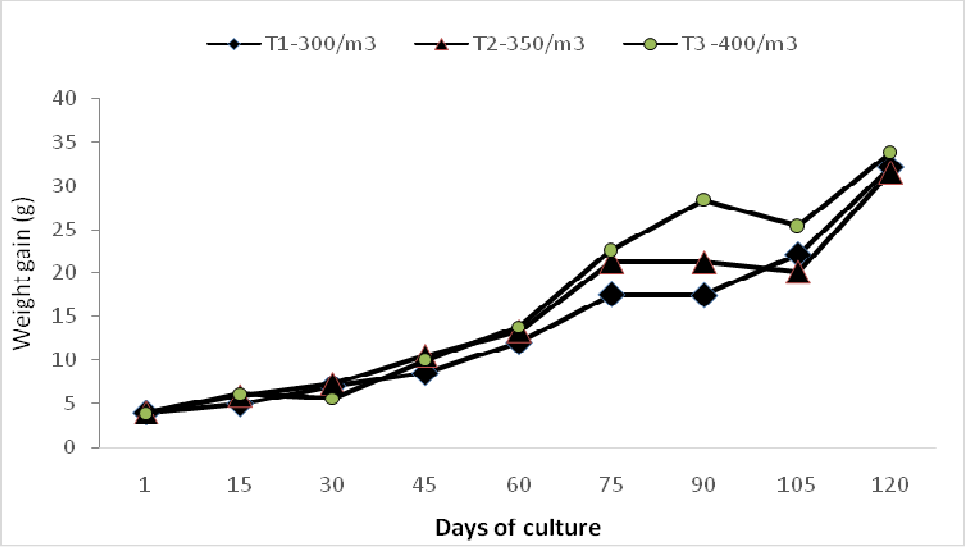


Fig. 1. Weight gain in three treatments of gulsha fish in cages.

In the experiment, the growth was recorded during the experiment and shown in the Fig. 1. However, in the figure it is shown that the growth rate in the treatment T_3 was higher than treatment T_1 and T_2. It was observed that the final weight 32.10 ± 5.00 g in treatment T_1, stocking with 300 individuals/m^3, while the fish attained 31.50 ± 4.59 g of weight in the treatment T_2 at stocking density with 350 individuals/m^3 and 33.80 ± 0.00 g in weight in T_3 stocking of 400 individuals/m^3 (Table 3). SGR% in treatments was estimated 1.75, 1.73 and 1.79 in the treatments T_1, T_2 and T_3 respectively.

At the end of experimental the growth was estimated and seems to be potential, but survival was poor due to mortality throughout the experimental periods. The cause of mortality was unknown. Fishes fed with the recommended antibiotic tetracycline at the rate of 5 g/kg of feed. Due to unexpected findings no inference on production was drawn. However, it is necessary to further experimentation on Gulsha in cages to find the results with the same objectives.

Status of Conservation and Migration of Hilsa in the Meghna River Estuary and Its Potential of Breeding for Stock Enhancement and Aquaculture

Researchers: Dr. Md. Anisur Rahman, Principal Scientific Officer
Tayfa Ahmed, Senior Scientific Officer
Shanur Jahedul Hasan, Senior Scientific Officer
Flura, Senior Scientific Officer
Md. Mehedi Hasan Pramanik, Scientific Officer
Md. Fazle Rabbi, Scientific Officer
Md. Monjurul Hasan, Scientific Officer

Budget: Tk. 49,57,000.00

Objectives

- On-board breeding and early larval rearing of hilsa,
- Hilsa aquaculture to observe growth and survival in brackish water pond.

Achievements

A short summary of the achievements during October 2016 to September 2017 are given below. According to the project proposal, the major works were; on-board breeding and early larval rearing of hilsa to determine the breeding possibility and also hilsa aquaculture to observe growth and survival in coastal pond. The hilsa research team of BFRI, RS, Chandpur were trying hard to breed the brood hilsa. A portable model hatchery was set up in the hilsa research vessel "M.V. Rupali Ilish" with generator, solar panel and necessary all other facilities for smooth running of hilsa breeding trial.

After completing the research of second year of ECOFISH^{BD} project, the third year research trial was also accomplished. During the early breeding trial (river cruise) in September 2017, neither oozing nor spent female hilsa fishes were recorded. In most of the female hilsa, the egg stages were recorded between stages III to V. Some of them were found with stage V^{+}. Motile milt was observed in the male hilsa fishes. The research team was hoping that next new moon day or full moon day during October will be the actual breeding period for hilsa fishes and hoping to achieve a promising result.

In the Riverine Sub-station (RSS) of Khepupara in the Andharmanik river and in nearby coastal pond for juvenile hilsa rearing were set up to check aquaculture potentiality. The growth and survivability of juveniles of hilsa during the first few months were not bad but not like than in the riverine condition. The health condition was found good in normal confined water in the ponds with normal water parameters ranges.

For capacity building of manpower of the institute through this project, one PhD and two MS students from BFRI went in the University Putra Malaysia (UPM) for higher studies on hilsa fisheries and doing well in their academic programs and also in field works. They successfully accomplished the semesters study programs up to September 2017 except one MS program student with weak progress.

Altogether six breeding trial were possible to conduct and the final breeding trial (sixth trial) was done at Katakhali, Chandpur on 01 November, 2016 where 2 male and 1 female hilsa broods were utilized. Collected eggs and milt through stripping were mixed and released in the incubation jar provided with good water circulation and oxygenation. The eggs were fertilized; vitelline membrane and cytoplasmic membrane formed around the egg yolk. Immediately after the fertilization of eggs, these started swelling.

The eggs were very soft, smooth, non-adhesive and almost spherical in shape. After 1.1-1.4 hours of fertilization vitelline membrane were found to be separated from the egg yolk and cleavage occurred which was observed under the electron (compound) microscope. This stage was identified as 2-cell stage of embryonic development. Then further cleavage was observed after 2.2-2.5 hours of fertilization. This stage was identified as 8-cell stage of embryonic development. After 3-3.5 hours of fertilization further cleavage was observed and this stage was identified as 16-cell stage of embryonic development. Then 4.2-4.5 hours of fertilization morula stage of embryonic development was identified. 18-myotome stage of embryonic development was identified after 8-8.5 hours of fertilization. After that, no embryonic development of egg was observed up to 12 hours after fertilization and the eggs were found to be dead filled with fungus.

The total culture period of hilsa juvniles in the experimental ponds of Khepupara sub-station was 7 months. The result showed that the fish in the treatment-1 stocked with the lowest stocking density (20 jatka/dec) resulted in best individual weight gain (170.95±9.62 g) followed by those in treatment-2 (30 jatka/dec) and treatment-3 (40 jatka/dec) respectively where the initial weight was 5.5±1.06 gm for each treatment. Resulted net final weight gain as well as the final weight of fishes in treatment-1 was found to be statistically significantly different ($p=0.043$) at 95% confidence level from that of the treatment-2 and treatment-3. In case of final length increment, fishes under the treatment-1 were the highest and statistically significantly different ($p=0.042$) from that of treatment-3.Though the length increment in treament-1 differed from treatment-2 but not statistically significant. No disease symptom was observed in the experimental ponds during the experiment and all of the essential water quality parameters were found to be within acceptable limit throughout the culture period.

Effect of Climate Change on the Ecology and Biodiversity of Inland Open Water Fishes

Researchers: Tayfa Ahmed, Senior Scientific Officer
Md. Istiaque Haidar, Scientific Officer
Aovijite Bosu, Scientific Officer
Ashikur Rahman, Scientific Officer

Budget: Tk. 6,00,000.00

Objectives

- To study the effects of climatic factors and their associated events on the riverine ecology and biodiversity of fish
- To develop a salinity intrusion map for the river Meghna, lower Meghna, Tentulia, and Agunmukha describing the potential impacts on riverine ecology and fish biodiversity**.**

Achievements

Selection of sampling points/sites: Ten sampling sites in the River Meghna (from upper to lower) and two in Tentulia river with GPS points were selected on the basis of field survey, salinity data, focus group discussion and sharing knowledge with experts. The sampling sites with GPS points in the River Meghna and Tentulia are shown in the Table 1.

Table 1. Sampling sites with GPS points in the Meghna and Tentulia River

Sampling Sites	River	GPS Reading
Shatnol	Meghna	(23 28.770 N 90 35.520 E)
Chandpur	Meghna	(23 14.350 N 90 38.150 E)
Horina Ghat	Meghna	(23 09.938 N 90 38.250 E)
Chor Voirobi	Meghna	(23 02.123 N 90 39.226 E)
Chor Lodhua	Meghna	(22 43.299 N 90 50.475 E)
Chor Alexander	Meghna	(23 39.197 N 90 54.594 E)
Ramgoti	Meghna	(23 02.122 N 91 00.005 E)
Hijla	Meghna	(22 23.780 N 90 35.520 E)
Kaligonj	Meghna	(22 51.320 N 90 36.539 E)
Ilisha Ghat	Meghna	(22 46.320 N 90 39.330 E)
Dhulia	Tentulia	(32 33.719 N 90 32.356 E)
Kaliya	Tentulia	(32 23.689 N 90 35.535 E)

Physico-chemical parameters: Parameters such as temperature, transparency, salinity, dissolved oxygen, free carbon dioxide; total hardness and alkalinity were recorded using water test kit (HACH kit II) on a monthly basis as shown in the Table-2 and Table-3 respectively.

The Table 2 represent the data of Air temperature, Water temperature and Transparency which is commonly known as physical parameters of water depending mainly on three different seasons including summer (Mar-June), rainy (Jul-Oct) and winter (Nov-Feb). Relatively high air temperature was found in summer season whereas water temperature was high in rainy season. Both air and water temperature were low in winter season. Low fluctuation of water temperature than the air temperature due to high latent heat of water. Relatively higher air temperature were shown in the sampling sites which are near to the sea that means near to coastal region.

Table 2. Average Values of Physical Parameters in Meghna and Tetulia river depending on seasons

	Air Temp (^{o}C)			Water Temp (^{o}C)			Transparency (cm)		
	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter
Shatnol	31.9	31.5	23.5	26.5	29.1	21.8	36.5	36.3	42.1
Chandpur	30.8	30.5	22.3	27	28.5	21.5	37.3	32.8	67
Horina Ghat	30.8	30.3	23.5	27.6	29	20.5	36.5	28.9	63.3
Chor Voirobi	31.3	32	22.8	27.5	29	21.6	30.5	23.3	67.8
Chor Lodhua	31.1	31.4	22.8	26.8	29	21.4	16	17.5	42.6
Chor Alexander	31.3	29.5	22.9	26.5	27.9	20.6	13.3	16.4	28.8
Ramgoti	31.5	31	22.3	27	28	21	14.3	13.8	26
Hijla	31.6	31.3	23.8	28	29.1	22	34.3	17.1	44
Kaligonj	32	31.6	22.8	27.5	29.3	22	28.3	16.3	56
Ilisha Ghat	32.1	31.4	22.5	28.4	28.9	21	27.8	19.4	50.3
Dhulia	32	32.3	24.5	27.3	30.2	23.3	14.8	20.5	53.5

Transparency another important physical parameter also measured in our study. Higher level found during the winter season because of there was low precipitation, water current, water turbulence. On the other hand, due to high precipitation, water current and water turbulence in rainy season transparency found at lower degree. The lower limit of transparency (13.8) cm was found at Ramgoti in rainy season.

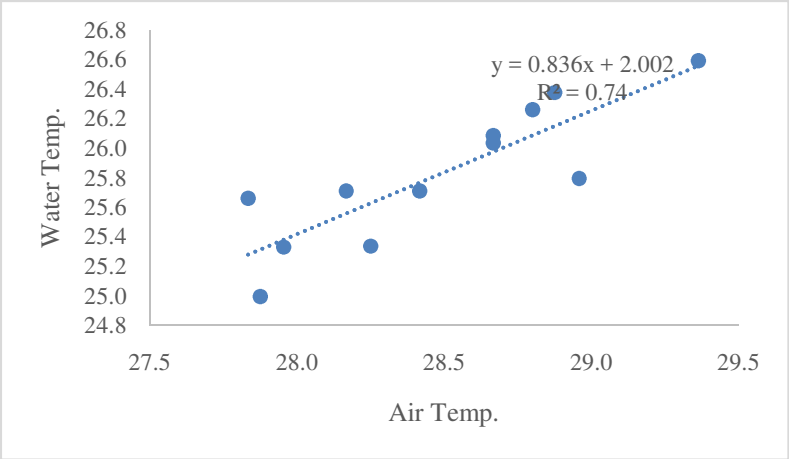


Fig. 1. Relationship Between air and water temperature of sampling points.

A strong relation was lied between the air and water temperature and its coefficient of correlation ***r*** was 0.86 and determination of coefficient $R^2 = 0.74$ which means 73 percent of variation of water temperature is due to variation in air temperature.

Table 3 represents the data of chemical parameters depending on seasons and the parameters are dissolved oxygen (DO), free CO_2, alkalinity and hardness. The value of dissolved oxygen, free CO_2, alkalinity and hardness were varied to 4.1-6.3, 9.5-23.6 and 61.3-524.3 mg/l respectively. Higher amount of DO found in summer season due to available sunlight and photosynthesis in water. The free CO_2 was relatively high in upper Meghna River. Alkalinity, another important chemical parameter ranged between 61.3 to 117.0 mg/l depending on season and sampling points. High level of hardness found in Ramgoti, Alexander and Ludhua during the winter season. It is mainly for the intrusion of saline water from sea which contains calcium and magnesium ions. Low precipitation in winter also another reason of high level of hardness and salinity also.

Salinity map: Salinity found mainly in the samplig spots of lower Meghna river such as Ludhua, Alexander and Ramgoti. Highest level of salinity was found at Ramgoti in february. It was due to the strong tidal action of sea.

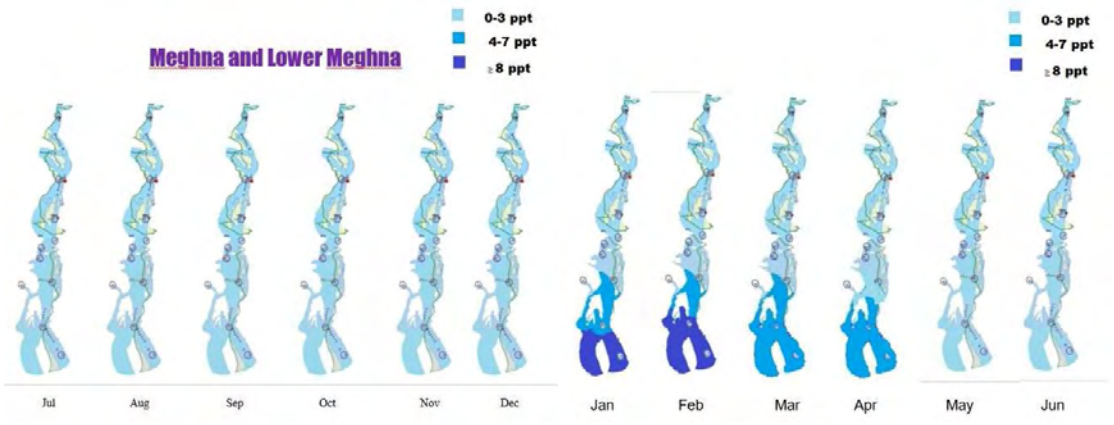


Fig. 2. Salinity map of Meghna River.

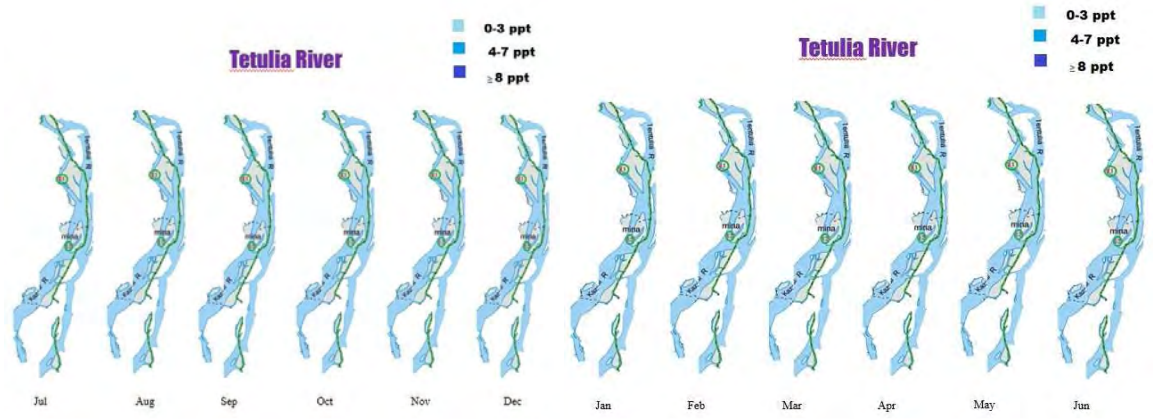


Fig. 3. Salinity map of Tentulia River.

Table 3. Average Values of Chemical Parameters in Meghna and Tetulia River depending on seasons

	DO (mg/l)			Free CO_2 (mg/l)			Total Alkalinity (mg/l)			Total Hardness (mg/l)		
	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter
Shatnol	4.9	4.1	5.4	20.0	18.0	23.6	70.3	97.3	86.5	71.3	78.5	79.0
Chandpur	5.7	4.8	6.1	18.5	15.5	22.4	106.8	81.8	106.3	85.3	73.8	94.0
Horina Ghat	5.7	5.0	5.9	19.0	16.5	19.5	61.3	79.5	102.5	94.0	92.3	88.0
Chor Voirobi	5.3	4.7	6.1	16.0	16.3	19.8	80.0	88.0	110.3	102.0	83.0	108.5
Chor Lodhua	5.6	4.6	5.9	9.5	13.0	17.9	74.5	120.8	101.3	148.3	67.8	244.5
Chor Alexander	5.8	5.0	5.9	15.0	11.8	17.6	61.5	103.3	102.5	250.8	79.0	435.0
Ramgoti	5.3	5.2	6.2	15.8	12.9	15.6	65.0	106.0	114.3	256.0	82.5	524.3
Hijla	5.4	5.4	5.2	13.8	16.0	20.9	69.3	85.3	102.3	91.3	61.3	126.8
Kaligonj	5.6	5.2	5.7	11.0	17.5	18.7	78.5	92.5	92.0	96.5	79.0	130.5
Ilisha Ghat	5.4	5.3	5.4	15.0	16.0	17.6	65.3	88.5	100.8	98.5	83.8	114.5
Dhulia	5.7	6.3	4.9	18.8	19.6	17.7	94.5	91.7	100.8	97.8	93.3	121.5
Kaliya	5.7	4.8	4.8	19.5	19.3	16.3	101.8	117.0	88.3	90.0	79.7	135.0

Fish diversity: Data on availability of fish species were collected by interviewing and visiting fisher and fish market. In the study period 24 fish species were found in the selected sites of the River Meghna and 18 in Tentulia River. Based on observation, no fish species has yet disappeared from the river but amount of catch is decreasing day by day.

Optimization of Breeding and Seed Production Techniques of *Pangasius pangasius*

Researchers: Akhery Nima, Senior Scientific Officer
Md. Mehedi Hasan Pramanik, Scientific Officer
Aovijite Bosu, Scientific Officer
Md. Monjurul Hasan, Scientific Officer

Budget: Tk. 13,50,000.00

Objectives

- To optimize the induced breeding technique of *P. pangasius*
- To develop nursery technique of *P. pangasius* depending on successful breeding.

Achievements

Brood selection and management: Ten pairs of brood Pangas were selected from the RS produced stock on the basis of secondary sex characters. In the brood pond ratio of male and female was 1:1. To maintain water quality and water depth at optimum level ground water was supplied regularly to the rearing ponds. In separate ponds the wild broods were reared with commercially available supplementary feed at the rate of 3% bwt once daily which were collected from the River Meghna. From February to August, health of the brood fish was checked regularly to assess gonadal maturity by examining colour and shape of genital opening and softness of the belly. For proper gonadal development two priming doses of PG were applied intramuscularly in each pair of fish. Both the 1st and 2nd doses of PG were applied 1 mg /kg and 2 mg/kg of body weight for male and female respectively. 1st priming dose was applied at the end of March while the 2nd one was applied at the end of April.

Table 1. Growth performance of brood Pangas in pond-09

Month	Mean length (cm) ±SD	Range (cm)		Mean weight (kg) ±SD	Range (kg)	
		Min	Max		Min	Max
July	79.6±4.87	74.7	84.5	5.82±1.38	4.4	7.2
August	83.4 ±4.81	78.6	88.2	6.48 ±1.28	5.2	7.8
September	83.26 ±2.74	80.5	86.0	6.1 ±0.70	5.4	5.4
October	81.7 ±2.07	79.6	83.8	6.16 ±0.67	5.5	6.8
November	83.4 ±4.45	79.0	87.9	6.85 ±0.85	6.0	7.7
December	79.9 ±3.78	76.1	83.7	5.17 ±1.65	3.5	6.8
January	82.8 ±3.65	79.2	86.5	6.93±0.69	6.2	7.6
February	82.7±5.92	76.9	88.6	6.19±1.56	4.6	7.6
March	81.7 ±4.80	76.9	86.5	6.37 ±1.28	5.0	7.7
April	88.1 ±5.65	82.5	93.8	7.2 ±1.51	5.7	8.7
May	88.0 ±4.67	83.3	92.7	7.4 ±1.0	5.5	6.8
June	87.5±4.55	83.0	92.1	7.3±1.0	6.3	8.3

Table 2. Growth performance of brood Pangas pond -10

Month	Mean length (cm) ± SD	Range (cm)		Mean weight (kg) ± SD	Range (kg)	
		Min	Max		Min	Max
July	79.6±3.57	76.0	83.0	4.83±0.38	4.5	5.2
August	76.4 ±3.43	73.0	79.8	4.84 ±0.71	4.1	5.6
September	77.95 ±3.48	74.8	81.4	4.38 ±0.49	3.9	4.9
October	77.9 ±3.03	74.9	80.9	4.46±0.54	3.9	5.0
November	80.4 ±3.75	76.7	84.2	5.38 ±0.87	4.5	6.3
December	84.3 ±6.34	78.0	90.6	6.63 ±1.36	5.3	8.0
January	82.8 ±5.25	77.6	88.0	6.36±0.90	5.5	7.3
February	79.2±4.0	75.2	83.2	5.01±1.0	4.0	6.0
March	82.7±5.25	77.5	88.0	6.09 ±1.12	5.0	7.2
April	81.3±3.56	77.7	84.9	5.54 ±0.87	4.7	6.4
May	81.8 ±3.55	78.2	85.4	5.12 ±0.85	4.3	5.9
June	80.3±4.31	76.0	84.61	4.95±0.68	4.3	5.6

Table 3. Water quality parameters of brood Pangas pond-09

Month	Water temp (^oC)	DO (mg/l)	Free CO_2 (mg/l)	pH	Total alkalinity (mg/l)	Total hardness (mg/l)	Ammonia (NH_3) (mg/l)
July	28	3.5	15	8. 0	109	85	0
August	27	3.9	11	8. 0	57	70	0
September	30	4.0	7.0	7.5	87	90	0
October	29	3.5	9.0	7.5	82	76	0
November	26	4.5	7.8	7.5	42	60	0
December	20	4.0	8.0	7.5	70	35	0
January	22	5.0	11	7.5	68	41	0
February	24	5.0	12	7.5	66	49	0
March	26	4.5	16	7.5	64	55	0
April	28	4.5	14	7.5	106	71	0
May	33	4.65	16	7.5	65	81	0
June	32	4.25	15	7.5	61	70	0
Average	27.08	4.28	11.82	7.5	73.08	65.25	0

Table 4. Water quality parameters of brood Pangas pond -10

Month	Water temp (^oC)	DO (mg/l)	Free CO_2 (mg/l)	pH	Total alkalinity (mg/l)	Total hardness (mg/l)	Ammonia (NH_3) (mg/l)
July	27	4. 0	12	8.0	70	62	0
August	26	3.75	11	7.5	34	52	0
September	30	3.25	20	8.0	75	42	0
October	29	3.5	12	7.5	70	55	0
November	26	4.0	7	7.5	40	45	0
December	19	4.5	8.5	7.5	55	46	0
January	22	4.5	9	7.5	61	37	0
February	24	4.25	13	7.5	62	46	0
March	26	4.75	12	7.75	53	43	0
April	28	4.75	19	7.5	59	58	0
May	32	4.5	12	7.5	56	69	0
June	32	4.75	13	7.5	54	68	0
Average	26.75	4.23	12.38	7.6	57.41	51.92	0

Induced breeding trial: Maturity of brood Pangas was assessed through rigorous examination of the secondary sexual characters such as softness of abdomen, shape of belly and color of vent.

Table 5. Weight of selected male and female brood Pangas

Weight (kg)	
Male	**Female**
6.0	6.5
6.0	4.5

Selection and conditioning: From the rearing ponds two pairs of brood Pangas were selected and kept into conditioning tank (9:10 hours) with continuous water shower for 6 hours.

Hormone injection: By grinding of cPG and mixing of distilled water cPGE was prepared to obtain the desired concentration of PG. The average weight of each cPG was measured 2.5 mg. After 6 hours of conditioning (15:10 hours) 1st dose (Stimulatory dose) of cPGE was applied intramuscularly at the rate of 2.5 mg/kg body weight to the female Pangas and then kept into the conditioning tank under continuous water shower.

Table 6. PG dose calculation for female brood Pangas (First dose)

cPGE per kg body weight	Calculated dose
2.5×6.5	16.25 mg
2.5×4.5	11.25 mg

After 6 hours of 1st injection, (21:10 hours), female brood received a 2nd dose (resolving dose) of cPG at the rate of 9 mg/kg body while at that time the male brood received a single dose of cPG at the rate of 3 mg/kg body weight. After 2nd injection, both the male and female broods were kept into the conditioning tank under continuous water shower and their breeding behavior was observed.

Table 7. PG dose calculation for female brood Pangas (Second dose)

cPGE per kg body weight	Calculated dose
9×6.5	45.5 mg
9×4.5	40.5 mg

Table 8. PG dose calculation for male brood Pangas

cPGE per kg body weight	Calculated dose
3×6.0	18 mg
3×6.0	18 mg

Female brood Pangas were picked up from the conditioning tank for stripping after 8 hours of 2nd injection (5.10 hours), but no symptom of ovulation was recorded. Vent was not found to be protruded and no change was observed at that time. Vent color was not found to be changed. Little amount of milt was appeared following gentle pressure on the abdominal region of Male brood pangas. It seemed that the brood Pangas was not mature enough to be used for the breeding purpose.

Investigation of Tilapia (*Oreochromis niloticus*) Disease in Cage and other Fish Culture Systems and Control Strategies

Researchers: Dr. Masud Hossain Khan, Chief Scientific Officer
Flura, Scientific Officer
Md. Istiaque Haidar, Scientific Officer
Aovijite Bosu, Scientific Officer
Md. Ashikur Rahman, Scientific Officer

Budget: Tk. 6,50,000.00

Objectives

- To investigate the cage and other fish culture systems and aqua-ecological conditions
- To identify the causative agent(s) associated with disease outbreaks
- To observe the histological changes in different organs of diseased fish
- To Minimize the fish mortality using better management strategies

Achievements

Case -control study: Case –control study was carried out covering Mymensingh, Jessore, Chandpur and Chittagong region in grow out farm and cages of tilapia. Epidemiological parameters were investigated during the sampling period using a pre-tested questionnaire. During the case- control study, 20 case pond and corresponding 20 control pond were investigated in Mymensingh and Jessore region. In Chandpur region, 10 case cages and corresponding 10 control cages were observed.

Epidemiological studies are presented in the following as follows:

Table 1. Epidemiological study of tilapia in pond culture (grow out pond)

Epidemiological characteristics	Affected farms	Unaffected farms	Remarks
Source of fingerlings	Local hatchery, NGO"s	Local hatchery, BFRI hatchery, Government farm	Stocking of apparantly healthy/sick fry might be a risk for disease outbreak
Stocking density	40000-65,000/ha, weight 10-15 gm	37,000-50,000/ha; weight-15-20 gm	Lower density result higher growth, safer for fish
Sources of water	Mainly deep tube well.	Mainly deep tube well.	Protective against disease.
Pond has high embankment	>80%	>95%	Protective against disease;
Pond connected to other water bodies allowing the entry of wild fish	<10%	<10%	Risk for disease outbreak
Holes in pond bank/bottom	> 55% farms	> 45% farms	Risk for spread of pathogen by vector
Pond is dried completely every season	40-65%	50-90%	Complete removal of vector/pathogen and improve water quality

Water is drained from the pond every season	Drained for harvesting	Drained for harvesting	Remove vector/pathogen
Bottom mud is removed from the pond in 2/3 years	20-45%	20-45%	Reduce risk of diease
Pond is limed every season	100% commercial farmers	100% commercial farmers	Protective against disease
Fish nets are dried and disinfected before netting	<9%	<12%	Dried/disinfected net might prevent spread of disease
Workers assigned to specific ponds	no	no	It increases risk of disease
Pond is fenced	30-55%	36-86%-	Prevent vector's entry and reduces chance of disease
Disease Control Measures			
Apply antibiotics	Sometimes	No	Can not cure
Add more water	If necessary	If necessary	Beneficial for fish health
Apply gas reduction treatment	Often/when necessary	Often/when necessary	Reduce stress on fish
Apply disinfectants to water	Often/when necessary	Often/when necessary	Might be useful
Apply Probiotics in pond	Sometimes	Sometimes	Might be useful
Notify public authorities	Sometimes, mostly share with feed dealers or chemical dealers	Sometimes, mostly share with feed dealers or chemical dealers	Farmers have little communication on public authorities
Apply excess feed	No	No	Prevent excessive production of phytoplankton
Use different feed	Mostly tilapia grower feed	Mostly tilapia grower feed	Quality feed is a challenge
Harvest and sell off all fish	If affected sell off immediately/waite for cure	Grow for market size	Affected farmers can reduce the spread of disease / reduce the losses to some extent

In case of ponds, epidemiological characteristics such as high stocking density, fingerlings collected from local hatcheries, uses of substandard feed and pond connected to other water bodies were identified as potential risk for disease outbreak. On the other hand, pond drying, removal of bottom waste, use of disinfectants and liming the pond with standard doses were identified as risk reducing factor for disease outbreak.

Table 2. Epidemiology of tilapia cage in Chandpur (cage)

Epidemiological Characteristics	**Affected cages**	**Unaffected cages**	**Comments**
Cage size	15×8×5 to 20×10×6.5 m^3	15×8×5 to 20×10×6.5 m^3	Not considered risk for disease
Number of cages	50-70	50-65	Not a considered risk for disease

Arrangement of cages	Mostly parallel	Mostly parallel some Zig-zag	More water flow and more hygenic in unaffected zig-zag-cages
Distance between cages	3- 7 inches	4-6 inches	No remarkable differences observed between two groups
Quality of fry	Apparantly healthy	Apparantly healthy	Apparantly healthy fry might contain pathogen in dormant condition
Stocking density	1000-1200/cage	800-1000/cage	Low stock density could be safer for tilapia
Affected culture cycle	Both winter and summer cycle	Both winter and summer cycle	Risk both in cold and hot season
Depth of water	10-12 feet	10-15 feet	Lower depth could be risk for disease
Water flow	Poor	Satisfactory	Insufficient water flow might increase risk of disease
Source of fry	Local hatchery	Local hatchery	No difference found
Cleanliness of cages	Clean Irregularly/Clean monthly	Fortnightly /monthly	Might have little risk for disease
Workers assigned to specific cages	no	no	It increases risk of disease
Huge domestic waste	Pass through cages	Little or no access of domestic waste	Might be a potential risk for disease
Apply antibiotics in feed	Sometimes, when infected	Not applied	Not effective against disease

In case of cages, epidemiological characteristics such as stocking density, water flow and cleanliness of cages and entry of huge domestic waste after opening the sluice gate etc were identified as potential risk for the occurrence of disease. On the other hand, net drying, removal of unused feed from cage bottom, use of probiotics with feed and removal of dead fish from the cages were found to play a significant role in reducing risk of disease outbreak.

Identification of disease producing agent: During investigation, 50 fish were captured and examined with naked eye. In case disease outbreak, prevalence of disease (%), fish size, clinical signs, mortality pattern, seasonality etc. were recorded. Ten affected fish were carried to the laboratory for further pathological investigation.

Clinical sign of diseased tilapia: During investigation, In case of pond, following clinical signs were observed as loss of appetite, spine displacement, darkening of skin and scale loss. In case of cage culture system-spinning, eye protrusion, erratic swimming and hemorrhages at the base of fins and in the opercula.

Seasonality & Disease Occurrence: In case of pond**,** mainly August to December and also May to July. The morbidity and mortality rate varied with season, location, farm design, species, culture system, management practice, etc. In cage culture systems, mainly winter season (Oct- Dec)

Fish mortality: Most of the farms in this year at Tarakanda areas, it was found severally outbreak of tilapia disease. Farmers reported that tilapia morbidity and mortality was observed up to 80-90% within 7-20 days from August to October 2014. However, interestingly the mortality was much lower (20-30%) in the remaining areas of Mymensingh

Most of the farmers reported that tilapia morbidity and mortality in cages ranged between 22-30%. Disease mainly occurs in the month of October to December. A few cage operators mentioned that average 8047 (16%) piece of tilapia died due to disease during October in their farm. The highest mortality was found 442 tilapia/day with an average of 270 fish. During the month of November the number of dead fish was 7059 (17%) and highest mortality was found 387/day, with the average of 235 fish/day

Bacteriology: In cage culture systems, 140-150 g sizes fish are drastically affected by disease. In order to isolate and identify potential bacterial causative agent, affected tissues were inoculated onto Tryptone Soya Agar (TSA) and finally isolated as pure culture for diagnosis. Primary diagnostic tests such as Gram staining, Motility test Indole test, O-F test, Catalase test, Oxidase test etc were done in BFRI laboratory which suggested the bacteria as *Streptoccus* spp. For further authentication of the causative agent (pathogen); Spleen, kidney and brain samples from affected fish were preserved in 80% ethanol and sent to MSD Animal Health Laboratory, Singapore. MSD confirmed the pathogen as *Streptococcus agalactiae* using molecular technique (PCR).

Present Status of Limnology and Natural Breeding Ground of Carps in Kaptai Lake

Researchers: Kazi Belal Uddin, SO
S. Sanjib Basak, SO

Budget: Tk. 7,00,000.00

Objectives

- To know the present status of natural breeding ground of carps in Kaptai Lake
- To identify the specific breeding locations through collecting egg/spawn
- To know the physico-chemical and biological parameters of different breeding ground
- To provide scope for management decision of lake ecosystem.

Achievements

Physico-chemical parameters of spawning ground

The growth of fish and other aquatic organisms strongly depends on the water quality. Mean values and ranges of water quality parameters over the study period are presented in Table 1. The result of the water quality analysis indicated the suitable ranges for fishes in study areas of Kaptai Lake. The water quality parameters remained more or less similar. In the present study we investigations were made on few physical and chemical factors of water of breeding ground of Kaptai Lake. The air and water temperature of experimental areas of Kaptai Lake were found to vary from 20 to 35^{o}C and 19 to 33^{o}C, respectively. These water parameters supposed to be suitable for growth of fishes. Dissolved oxygen and free CO_2 in the experimental sites ranged between 5 and 9 mg/L and 5 and 10 mg/L, respectively. In this study, dissolved oxygen was found suitable for fish throughout the study period. pH and total alkalinity of different areas varied from 7 to 8 and 34.2 to 68.4 mg/L respectively. Total hardness of different areas varied from 34.2 to 85.5. Water depth and transparency ranged from 3.4 to 28.9 feet and 1 to 7.85 feet respectively during the study period.

Table 1. Water quality parameters as obtained from the Chengi channel and Riankhang channel during the study period

Water Quality Parameters	Natural breeding ground of Kaptai Lake	
	Chengi channel	Riankhang channel
Air Temp. (^{0}C)	28.2±4.69 (20-35)	28.9±3.07 (24-33)
Water Temp.(^{0}C)	26.8±4.18 (19-33)	27.8±2.57 (25-32)
DO (mg/l)	6.8±1.23 (5-9)	6.3±0.95 (5-8)
CO_2 (mg/l)	8.9±1.66 (5-10)	8.2±2.15 (5-10)
pH	7.25±0.26 (7-7.5)	7.35±0.34 (7-8)
Total alkalinity (mg/l)	54.72±13.49 (34.2-68.4)	56.43±11.54 (34.2-68.4)
Total Hardness (mg/l)	42.75±9.01 (34.2-51.3)	49.59±18.82 (34.2-85.5)
Water depth (ft)	18.28±7.96 (3.8-28.9)	13.31±5.39 (3.4-19.4)
Transparency (ft)	3.85±2.32 (1-7.85)	3.11±2.23 (1.2-7.4)

Biological parameters of spawning ground

During the study period sampling of plankton assemblage from sub-surface water was done fortnightly by using plankton net (20 µm) for qualitative and quantitative analysis. The phytoplankton populations comprises of four orders: Euglenophyceae, Cyanophyceae, Bacillariophyceae and Chlorophyceae. In Chengi channel phytoplankton populations comprises of four orders: Chlorophyceae 60.69%, Cyanophyceae 23.64%, Bacillariophyceae 9.32% and Euglenophyceae 6.36%. In Riankhang channel phytoplankton populations comprises of four orders: Chlorophyceae 59.85%, Cyanophyceae 23.23%, Bacillariophyceae 11.02% and Euglenophyceae 5.9%. Among the phytoplankton the dominant order in both study areas was Chlorophyceae.

The zooplankton population includes three orders: Rotifers, Copepoda and Cladocera. The zooplankton population in Chengi channel comprised with Rotifers 49.60%, Cladocera 31.62% and Copepoda 18.78%. The zooplankton population in Riankhang channel comprised with Rotifers 55.83%, Cladocera 27.09% and Copepoda 17.08%. Among the zooplankton the dominant order in both study areas was Rotifers.

Collection of juvenile fishes

During post-breeding season juvenile of different carp species were collected from fisher catch and local market to know the availability of carps juvenile in Kaptai Lake. Among Indian Major Carps Juvenile of Kalibaush (*Labeo calbasu)* and Minor Carp *Labeo bata* and *Labeo gonius* were collected from fisher catch and local market during post-breeding season.

Juvenile of *Labeo bata, Labeo calbasu,* and *Labeo gonius*

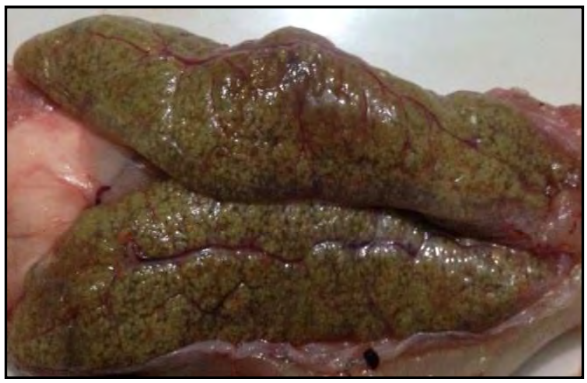
Harvesting of fish sanctuary

Among carps Calibaush and Bata were harvested from the sanctuary of Kaptai Lake


Harvested *Labeo bata and Labeo calbasu* from fish sanctuary

Collection of brood fish sample

Sample of different carps were collected from Kaptai Lake during breeding season when matured fishes were available. For the forecasting of the commencement of breeding of carps in the reservoir, an attempt was made to assess egg-maturity and estimate gonado-somatic index (GSI) of major carps. study of egg-maturity and gonado-somatic index (GSI) was attempted. Samples of brood fish (Kalibaush & Bata) were collected to estimate Gonado-somatic Index (GSI) and gonadal maturity.




Gonad of Kalibaush

Gonad collection of Bata

Present condition of breeding channel

Rubber dam was constructed in 2013 at Panchari, upper area of Chengi channel. Which restricting pre-spawning migration of major carps and nursing of fry and juveniles. Rubber dam also destroyed spawning habitat by regulating water flow during late winter.


Rubber dam in Chengi channel

Depth of breeding ground reduced due to siltation. Siltation may be due to shifting cultivation pattern in hilly areas. In the present study, highest water depth (28.9 feet) was measured in October, 2016 at Chengi channel and lowest water depth (3.8 feet) was measured in May, 2017 (Photograph 6). On the other hand, in Riankhang channel, highest water depth (19.4 feet) was measured in October, 2016 and lowest water depth (3.4 feet) was measured in May, 2017.

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Present condition of natural breeding ground of Kaptai Lake

Re-confirmation of Natural breeding of major carps in Kaptai Lake

In 2 & 3 June, 2017 about 5 kg fertilized eggs of carps were collected from the Kasalong breeding channel, which re-confirmed the success of natural spawning of major carps at Kaptai lake.

Showing fertilized eggs of carps in Kasalong channel at Kaptai Lake

Production of carp fingerlings

After collection of fertilized egg, Pit and BFDC hatchery were used for hatching of fertilized egg. After production of hatchling they were stocked in nursing pond for fingerling production. After 37 days fingerling of different carps (Rui, Catla, Mrigal, Calibaush, Bata) were identified.

Population Dynamics and Stock Assessment of *Labeo calbasu* and *Eutropiichthys vacha* in the Kaptai Lake

Researchers: Kazi Belal Uddin, Scientific Officer
S. Sanjib Basak, Scientific Officer
Md. Abul Bashar, Senior Scientific Officer

Budget: Tk. 6,00,000.00

Objectives

- To estimate the population parameters of *Labeo calbasu* and *Eutropiichthys vacha*
- To assess the stock of *Labeo calbasu* and *Eutropiichthys vacha* in the Lake Kaptai
- To develop a management policy for production and conservation of *L. calbasu* & *E. vacha.*

Achievements

A total of 1,272 specimens of *Labeo calbasu* were collected from the Kaptai Lake, Rangamati during the study. Descriptive statistics on the length and weight measurements are given in Table 1.

Table 1. Descriptive statistics on the length (cm) and weight (g) measurements of *Labeo calbasu* from the Kaptai Lake during August 2016 to April 2017

Sampling	Sex	n	Total length (cm)				Body weight (g)			
			Min	Max	Mean±SD	95%CL	Min	Max	Mean±SD	95%CL
October'16	C	144	17	55	34.71±7.58	33.46-35.96	75	2000	689.20±344.79	632.41-746.00
November	C	150	15	45	30.69±8.71	29.28-32.09	50	1250	532.11±344.05	467.60-578.62
December	C	194	14	60	29.78±8.93	28.52-31.04	56	2365	456.14±385.63	401.53-510.75
January'17	C	181	18	56	31.45±7.60	30.34-32.57	65	2400	475.78±360.02	422.98-528.58
February	C	140	15	42	28.14±7.49	26.89-29.40	82	1150	473.59±287.58	425.53-521.64
March	C	173	18.5	46.5	32.19±7.24	31.10-33.28	74	1346	535.99±344.72	484.25-587.72
April	C	150	12.5	54	32.98±7.81	31.72-34.24	24	2512	550.80±408.26	484.93-616.67
May	C	140	13	48	31.94±6.44	30.86-33.01	26	1440	460.64±290.06	412.17-509.10

n, sample size; Min, minimum; Max, maximum; cm, centimeter; SD, standard deviation; CL, confidence limit for mean value.

Minimum total length (12.5cm) and maximum total length (60cm) of Kalibaush was found in April and December (Table 1). Minimum body weight (24g) and maximum body weight (2512g) of Kalibaush was found in April (Table 1).

Table 2. Descriptive statistics and estimated parameters on the length-weight relationships ($BW = a \times TL^b$) of *Labeo calbasu*) from the Kaptai Lake during August 2016 to April 2017.

Equation	n	Regression		95% CL of a	95% CL of b	r^2	GT
		a	b				
October 2016	144	0.0569	2.62	0.0400-0.0808	2.52-2.72	0.950	-A
November	150	0.0491	2.66	0.0376-0.0640	2.58-2.74	0.968	-A
December	194	0.0447	2.66	0.0338-0.0590	2.58-2.74	0.955	-A
January 2017	181	0.0140	2.98	0.0105-0.0187	2.89-3.06	0.965	-A
February	140	0.0466	2.66	0.0335-0.0649	2.57-2.76	0.955	-A
March	173	0.0054	3.27	0.0042-0.0069	3.20-3.34	0.979	+A
April	150	0.0074	3.15	0.0059-0.0095	3.09-3.22	0.982	+A
May	140	0.0084	3.11	0.0063-0.0113	3.03-3.20	0.974	+A

n, sample size; a, intercept; b, slope; CL, confidence limit for mean values; r^2, coefficient of determination; GT, growth type (-A, negative allometric; +A, positive allometric)

The sample size (*n*), regression parameters *a* and *b* of the LWR, 95% confidence intervals of a and b, the coefficient of determination (r^2), and growth type of fishes are given Table 2 and Figure 1,2,3. All relationships were highly significant ($p<0.01$), with r^2 values being greater than 0.950. The calculated allometric coefficient b ranged from a minimum of 2.62 (for TL) *Labeo calbasu*, to a maximum of 3.27 (for TL) for *L. calbasu*. The b value of LWR for *L. calbasu* was close to 3 indicating the isometric growth. The b values of LWR indicate that, growth pattern of *L. calbasu* are negative allometric except in March, April and May (Positive allometric).

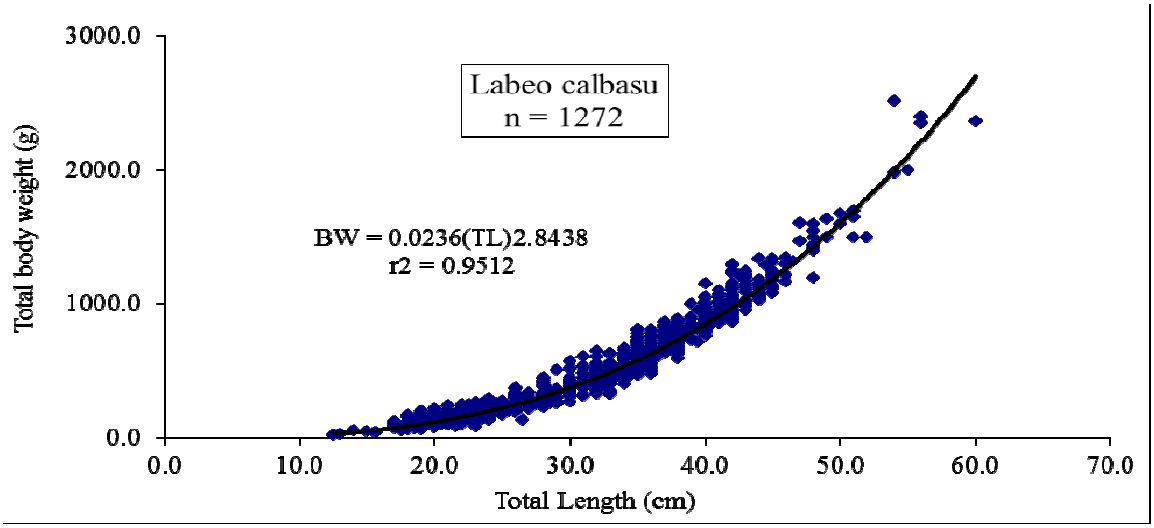


Fig 1. Length-length relationships of *L. calbasu* of Kaptai Lake.

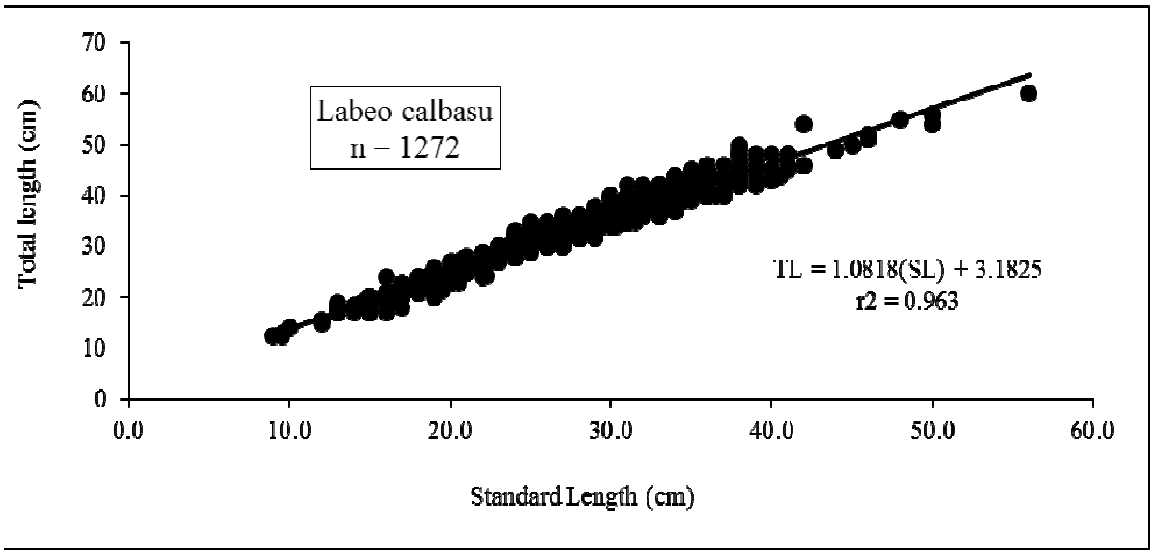


Fig 2. Length-length relationships of *L. calbasu* of Kaptai Lake.

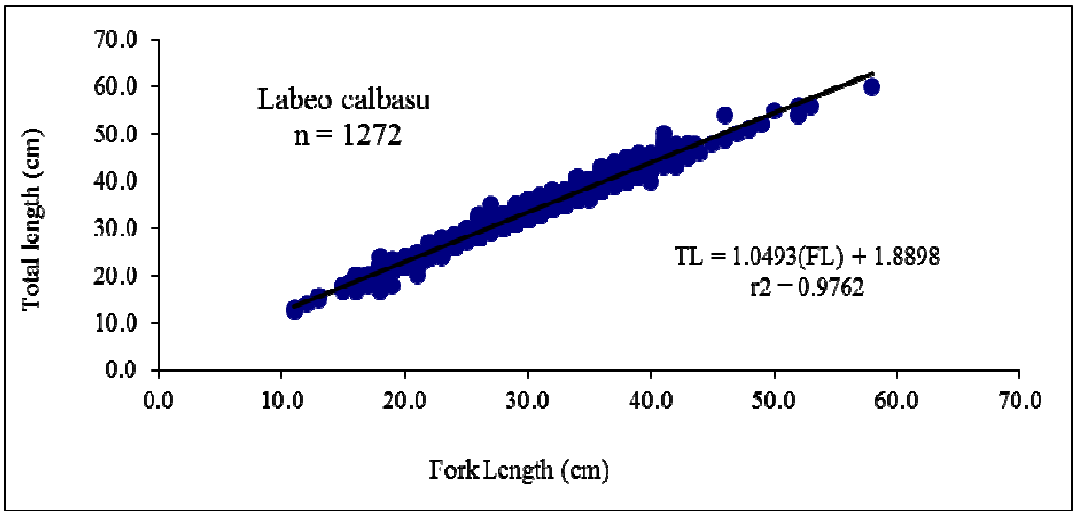


Fig 3. Length-length relationships of *L. calbasu* of Kaptai Lake

The pooled (Combined sexes) length-weight relationship was estimated as $W=0.016\ L^{2.692}$ ($R^2=0.913$). Length frequency distribution data was analyzed by using Microsoft® Excel-add-in-DDXL and GraphPad Prism 6.5 software to estimate von Bertalanffy growth parameters. The L_∞, K, t_o and R_n were estimated at 35.7 cm for pooled.

Condition factor

In Tables 3,4, *L. calbasu* exhibited relative condition factor (K_R), allometric codition factor (K_A) and relative weight condition factor (K_W) were not significant with FL. Non parametric test indicated that the Fulton's condition factor was highly correlated with total length of Labeo calbasu in the Kaptai Lake.. Positive correlations were extracted between K_F-TL.

Table 3. Estimation of correlation for Allometric (K_A), Fulton's (K_F) and Relative (K_R) condition factor with total length (TL, cm) of *Labeo calbasu* (Hamilton, 1822) from the Kaptai Lake during August 2016 to April 2017

Condition factor	n	r_s value	95% CL of r_s	P value	Degree of significance
TL *vs.* K_A	1272	-0.009	-0.066 to 0.048	*P*= 0.745	*ns*
TL *vs.* K_F		**-0.083**	**-0.139 to -0.027**	***P*=0.003**	**
TL *vs.* K_R		0.029	-0.028 to 0.086	*P*=0.300	*ns*
TL *vs.* W_R		0.029	-0.028 to 0.086	*P*=0.300	*ns*

r_S, coefficient of Pearson's rank correlation test; ns, not significant; **, significant

Table 4. Fulton's Condition factors (K during August 2016 to April 2017.F) of *Labeo calbasu* from the Kaptai Lake during August 2016 to April 2017

Month	n	Sex	Min	Max	Mean±SD	95% CL
October 2016	144	Combined	1.19	2.92	1.53±0.30	1.48-1.58
November	150		1.08	2.91	1.58±0.32	1.53-1.63
December	194		1.03	2.75	1.47±0.32	1.42-1.51
January 2017	181		0.71	1.84	1.31±0.19	1.28-1.39
February	140		0.92	2.86	1.52±0.30	1.47-1.57
March	173		0.98	1.89	1.35±0.18	1.33-1.38
April	150		0.72	1.84	1.28±0.14	1.26-1.30
May	140		0.92	1.83	1.24±0.14	1.22-1.27

n, sample size; Min, minimum; Max, maximum; SD, standard deviation; CL, confidence limit for mean values

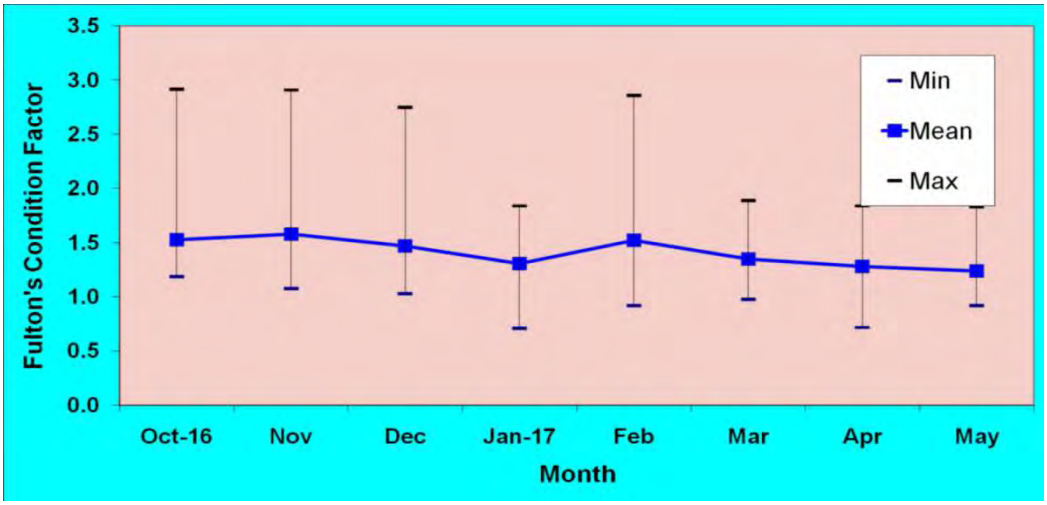


Fig 4. Monthly variations of Fulton's condition factor of *L. calbasu* in Kaptai Lake.

From the Table 4 and Fig. 4, we found that the mean values of Fulton"s condition factor maximum in October (1.53±0.30) and minimum in May (1.24±0.14) of *L. calbasu* in Kaptai lake.

Growth parameters of *L. calbasu*

The analysis of the pooled length-frequency data of *L. calbasu* by the Powell-Wetherall procedure gave an initial TL∞ value of 65.17 (Fig. 5).

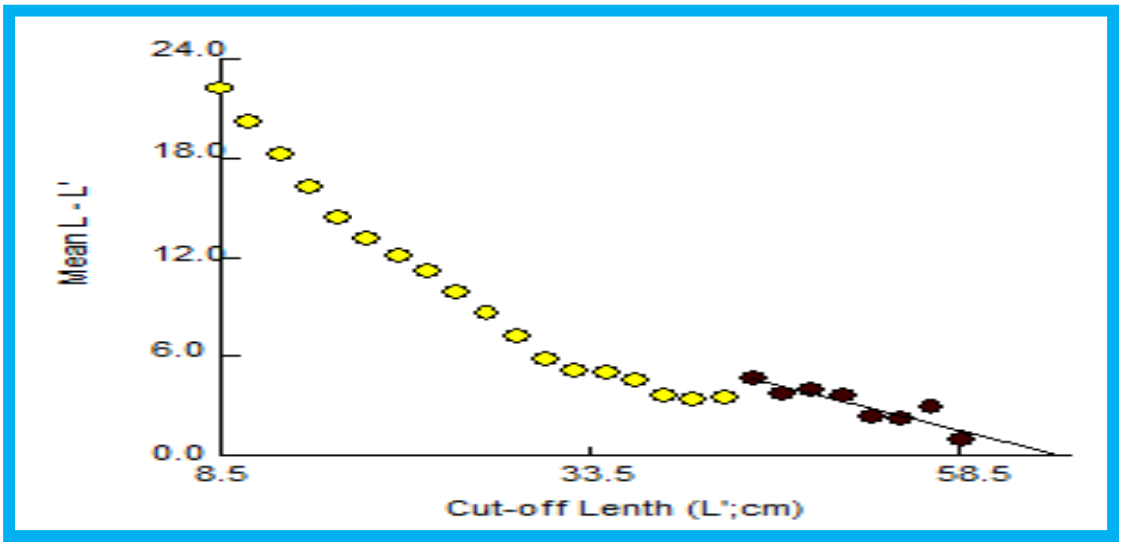


Fig. 5. A Powel-Wetherall plot for the *L. calbasu*. Solid black symbols are used in the regression which provides asymptotic TL of 65.17 cm and Z/K of 3.48

Von Bertalanffy growth curve showed asymptotic: TL∞ = 65.17 (Fig. 5).

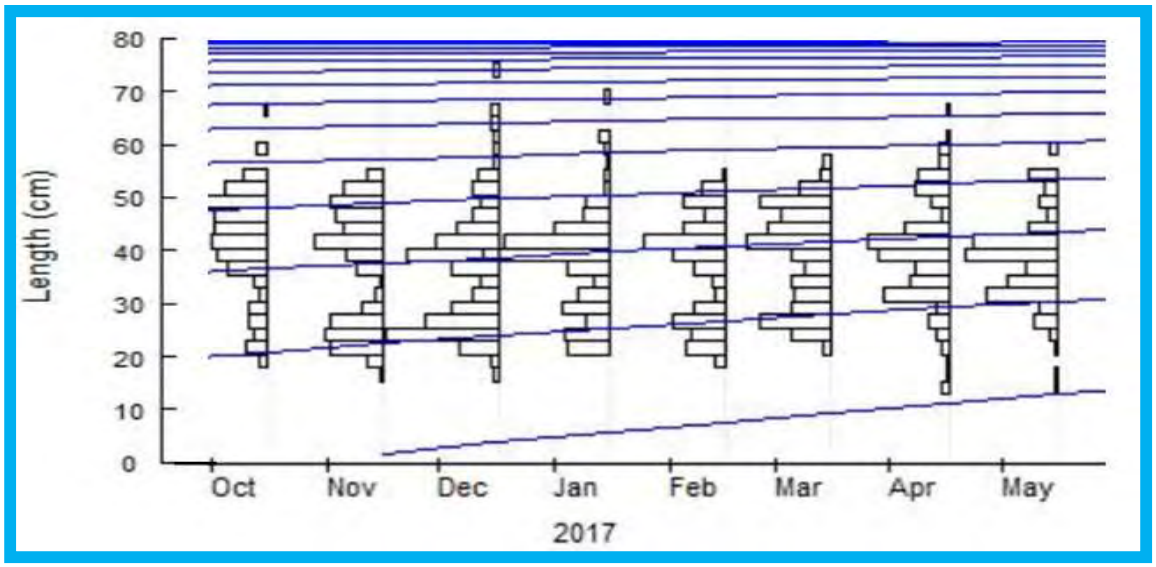


Fig. 6. Von Bertalanffy growth curve (TL∞ = 65.17 cm, K = 1.00 year-1, C = 0, winter point (WP) = 0) of *L. calbasu* in the Kaptai Lake.

Growth Performance

The calculated growth performance index for *L. calbasu* was 3.105, based on asymptotic length.

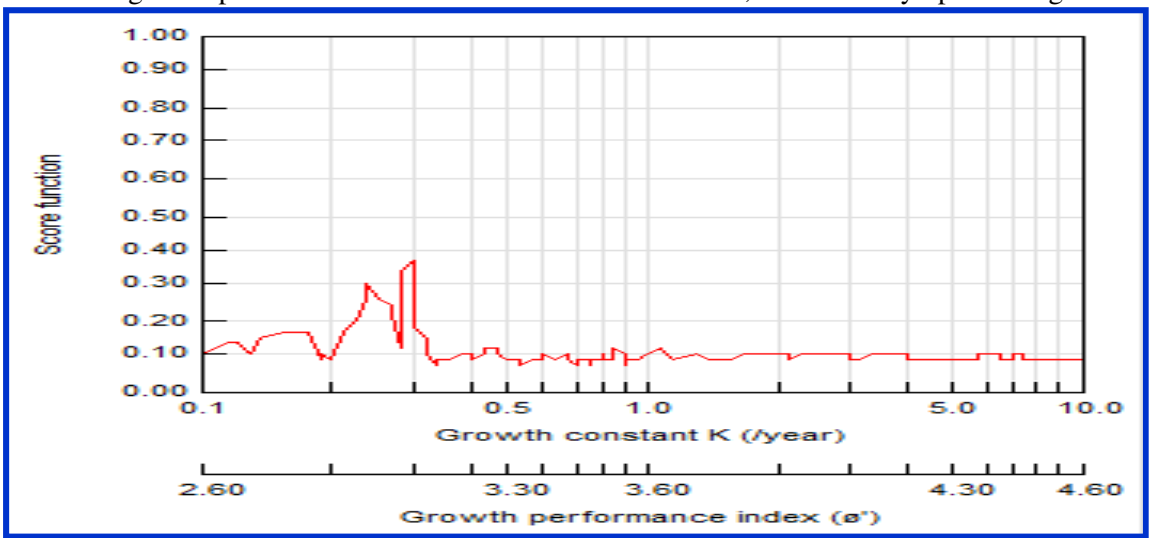


Fig 7. Growth performance index of *L. calbasu* of Kaptai lake.

Growth performance indices for *L. calbasu* was 3.105 for pooled sexes derived as results of the input values of von Bertalanffy growth parameter.

Recruitment pattern

Figure 08 shows the recruitment pattern of *L. calbasu* in Kaptai Lake. For *L. calbasu*, recruitment was found to occur one annually (July). Recruitment occurred between May to October (Figs. 8). During study, we found that *L.calbasu* recruited in the Kaptai Lake almost throughout the year (Fig 8).

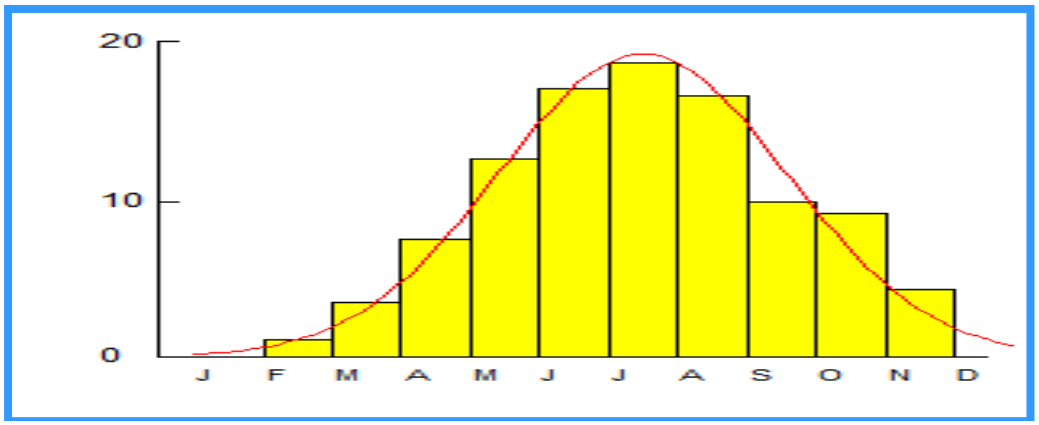


Fig 8. Recruitment pattern of *L. calbasu* in the kaptai lake during August 2016 to April 2017

A total of 1211 specimens of *Eutropiichthys vacha* were collected from the Kaptai lake, Rangamati during the study. Descriptive statistics on the length and weight measurements are given in Table 5.

Table 5. Descriptive statistics on the length (cm) and weight (g) measurements with 95% confidence limit of *Eutropiichthys vacha* (Hamilton, 1822) from the Kaptai Lake during August 2016 to April 2017.

Sampling date	Sex	n	Total length (cm)				Body weight (g)			
			Min	Max	Mean±SD	95%CL	Min	Max	Mean±SD	95%CL
October 2016	C	153	11	35	20.92±4.07	20.27-21.57	10	330	75.70±49.81	67.75-83.66
November	C	130	10	28	19.68±3.30	19.10-20.25	10	175	63.48±31.49	58.02-68.95
December	C	183	**8**	34	21.30±4.93	20.59-22.02	**9**	300	87.42±55.20	79.37-95.47
January 2017	C	191	12	**41**	21.75±5.51	20.96-22.53	12	**510.8**	88.51±84.64	76.43-100.59
February	C	140	13	35	21.45±4.53	20.69-22.21	17	272	80.99±52.31	72.25-89.73
March	C	160	18	32	22.98±3.13	22.49-23.47	42	233	88.19±33.61	82.95-93.44
April	C	114	9.6	**41**	23.33±4.41	22.49-24.16	12	366.8	101.06±47.78	92.19-109.92
May	C	140	10	33	20.22±3.44	19.65-20.80	**9**	238	68.37±30.97	63.19-73.54

n, sample size; Min, minimum; Max, maximum; cm, centimeter; SD, standard deviation; CL, confidence limit for mean values

Minimum total length (8cm) and maximum total length (41cm) of *E. vacha* were found in December and January 2017, April (Table 5). Minimum body weight (9g) and maximum body weight (510.8g) of *E. vacha* were found in December, May and January 2017 (Table 5).

Table 6. Descriptive statistics and estimated parameters on the length-weight relationships ($BW = a \times TL^b$) of *Eutropiichthys vacha* (Hamilton, 1822) from the Kaptai Lake during August 2016 to April 2017.

Equation	n	Regression parameters		95% CL of a	95% CL of b	r^2	GT
		a	b				
October 2016	**153**	**0.0058**	**3.08**	**0.0041-0.0081**	**2.96-3.12**	**0.951**	**I**
November	130	0.0133	2.82	0.0100-0.0175	2.72-2.91	0.965	-A
December	183	0.0252	2.62	0.0195-0.0328	2.54-2.71	0.953	-A
January 2017	**191**	**0.0056**	**3.07**	**0.0042-0.0075**	**2.97-3.16**	**0.956**	**I**
February	140	0.1230	2.83	0.0089-0.0169	2.73-2.94	0.953	-A
March	160	0.0325	2.51	0.0255-0.0414	2.43-2.59	0.963	-A
April	114	0.0339	2.52	0.0246-0.0467	2.41-2.62	0.955	-A
May	140	0.0231	2.64	0.0179-0.0297	2.55-2.72	0.965	-A

n, sample size; a, intercept; b, slope; CL, confidence limit for mean values; r^2, coefficient of determination; GT, growth type (-A, negative allometric, I, isometric)

The sample size (*n*), regression parameters *a* and *b* of the LWR, 95% confidence intervals of *a* and *b*, the coefficient of determination (r^2), and growth type of fishes are given Table 6 and Figure 9,10,11. All

relationships were highly significant ($p<0.01$), with r^2 values being greater than 0.9519. The calculated allometric coefficient b ranged from a minimum of 2.51 (for TL) *E. vacha*, to a maximum of 3.08 (for TL) for *E. vacha*. The b value of LWR for *E. vacha* was close to 3 indicating the isometric growth. The b values of LWR indicate that, growth pattern of *E. vacha* are negative allometric except in October and January (Isometric)

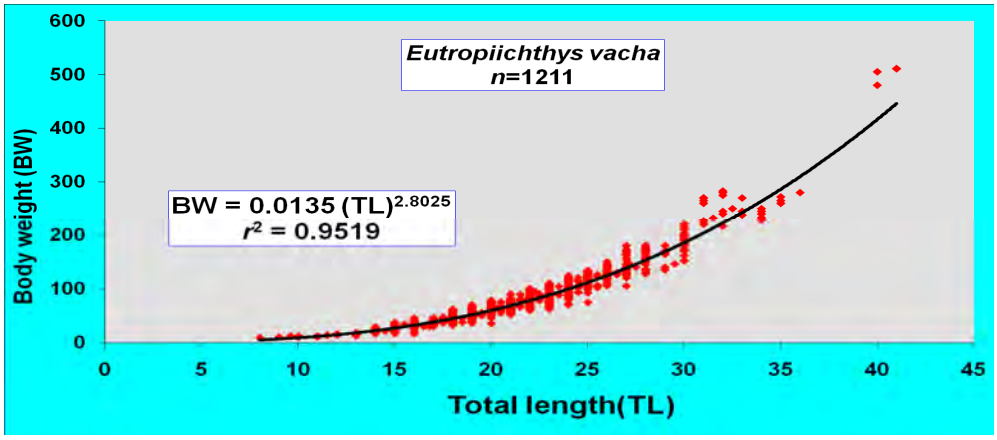


Fig 9. Length-weight relationships of *E. vacha* of Kaptai Lake.

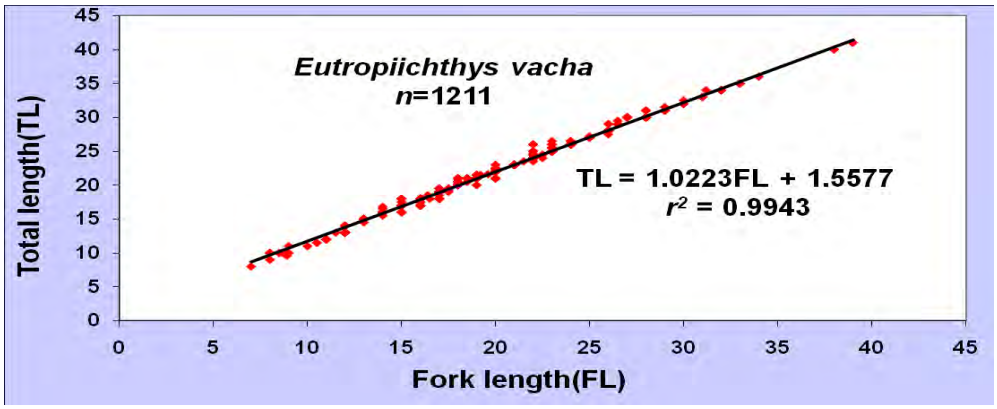


Fig 10. Length-length relationships of *E. vacha* of Kaptai Lake.

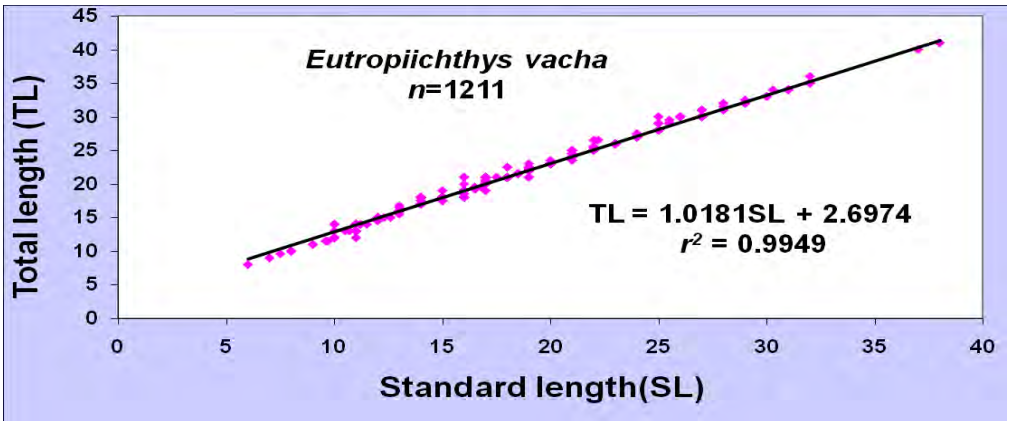


Fig 11. Length-length relationships of *E. vacha* of Kaptai Lake.

Condition factor

These schcibid catfishes exhibited relative condition factor (K_R), allometric codition factor (K_A) and relative weight condition factor (K_W) were not significant with FL. Non parametric test indicated that the Fulton's condition factor was highly correlated with total length. From the table 8 and figure 12, we found that the mean values of Fulton's condition factor maximum in March (4.46±0.30) and minimum in January (0.70±0.11) of *E. vacha* in Kaptai lake.

Table 7. Estimation of correlation for Allometric (K_A), Fulton's (K_F) and Relative (K_R), relative weight (W_R) condition factor with total length (TL, cm) of E. vacha (Hamilton, 1822) from the Kaptai Lake.

Condition factor	n	r_s value	95% CL of r_s	P value	Degree of significance
TL *vs.* K_A	1211	0.030	-0.028 to 0.088	*P*= 0.299	*ns*
TL *vs.* K_F		**-0.229**	**-0.283 to -0.173**	***P*<0.001**	***
TL *vs.* K_R		0.046	-0.012 to 0.104	*P*=0.109	*ns*
TL *vs.* W_R		0.046	-0.012 to 0.104	*P*=0.108	*ns*

r_S, coefficient of Pearson's rank correlation test; ns, not significant; ***, highly significant

Table 8. Fulton's Condition factors (K_F) of *E. vacha* (Hamilton, 1822) from the Kaptai Lake

Month	n	Sex	Min	Max	Mean±SD	95% CL
October 2016	153	Combined	0.55	1.06	0.73±0.10	0.72-0.75
November	130		0.82	1.37	1.00±0.10	0.98-1.02
December	183		0.61	1.76	1.01±0.15	0.99-1.03
January 2017	**191**		**0.39**	**1.02**	**0.70±0.11**	**0.71-0.68**
February	140		0.92	1.76	1.24±0.16	1.21-1.26
March	**160**		**3.80**	**5.51**	**4.46±0.30**	**4.42-4.51**
April	114		0.67	6.30	3.82±0.46	3.74-3.91
May	140		0.62	1.00	0.79±0.80	0.77-0.80

n, sample size; Min, minimum; Max, maximum; SD, standard deviation; CL, confidence limit for mean values

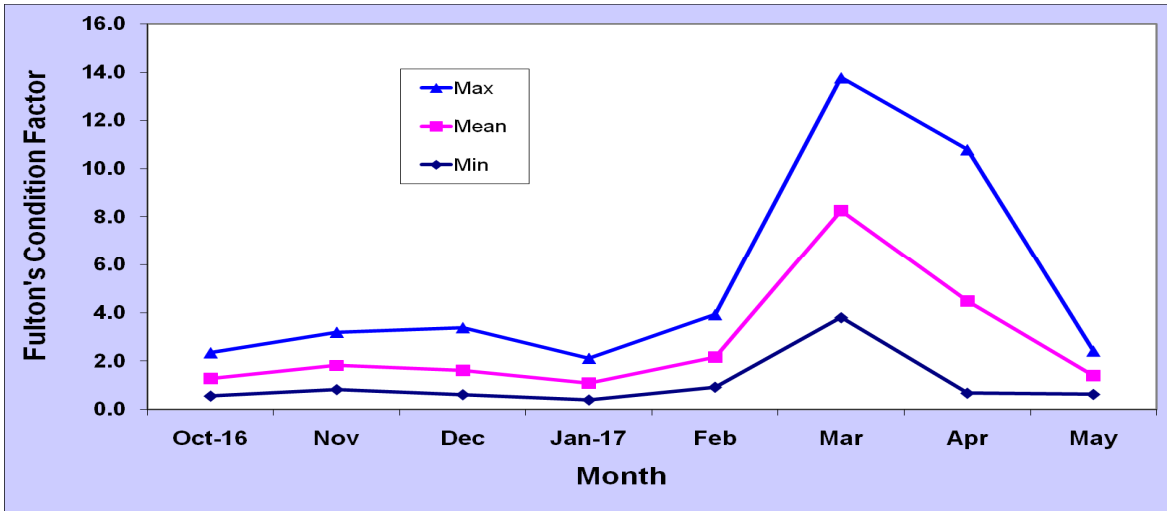


Fig. 12. Monthly variations of Fulton's condition factor for *E. vacha* in the Kaptai Lake

Growth parameters *E. vacha*

The analysis of the pooled length-frequency data of *E. vacha* by the Powell-Wetherall procedure gave an initial TL∞ value of 41.23 (Fig. 13). Von Bertalanffy growth curve showed asymptotic: TL∞ = 43.48 (Fig. 13).

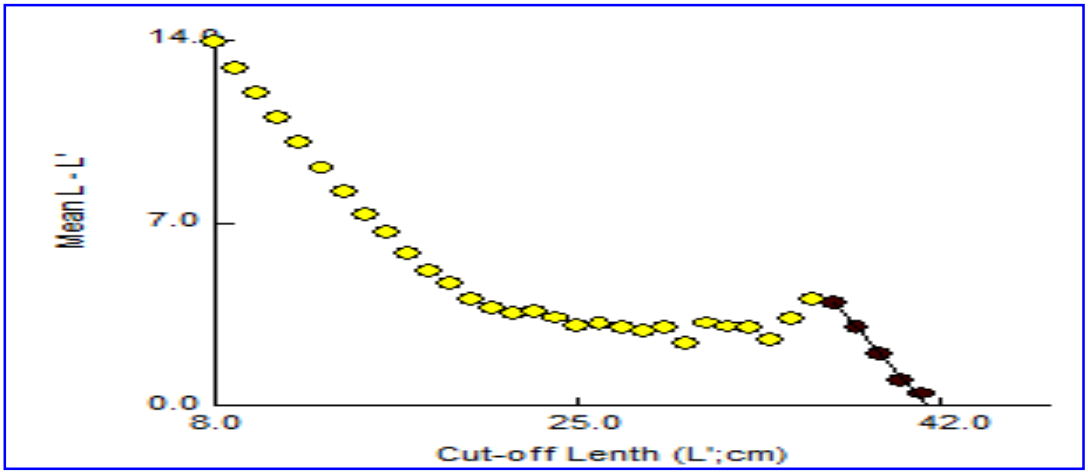


Fig. 13. A Powel-Wetherall plot for the *E. vacha*. Solid black symbols are used in the regression which provides asymptotic TL of 41.23 cm and Z/K of 0.08

Growth performance

The calculated growth performance index for *E. vacha* was 2.58, based on asymptotic length. Growth performance index for *E. vacha* were 2.58 for pooled sexes derived as results of the input values of Von Bertalanffy growth parameter.

Fig 14. Growth performance index of *E. vacha* in Kaptai Lake.

Recruitment pattern

Figure 15 shows the recruitment pattern of *E. vacha* in Kaptai Lake. For E. vacha, recruitment was found to occur twice annually. Two peaks were found, one is April another in September. The first recruitment

occurred between March to June and the second occurred between July to October (Fig. 15). We found that *E. vacha* recruited in the Kaptai Lake almost throughout the year (Fig. 15).

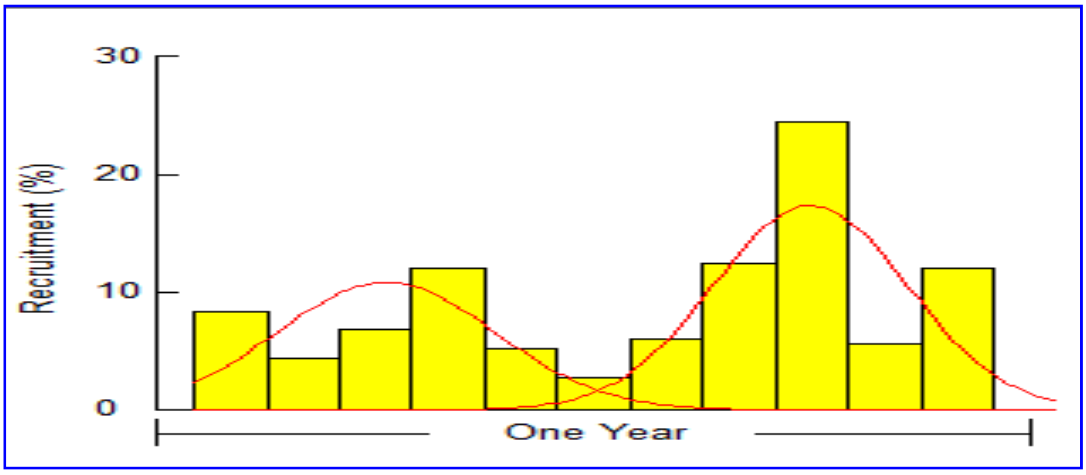


Fig 15. Recruitment pattern of *E. vacha* in the Kaptai Lake.

From our study, we found negative allometric growth for both *L. calbasu* and *E. vacha*. Based on asymptotic length, the calculated growth performance index for *L. calbasu* and *E. vacha* was 3.105 and 2.58 respectively. Both species recruited in the Kaptai Lake almost throughout the year. However, we cannot calculate longevity, mortality, maximum sustainable yield and stock assessment of this two fishes for lacking of 12 month data which will be provided later.

Domestication, Development of Brood and Breeding Technique of Some Commercially Important Coastal Fish Species of Bangladesh

Researcher: Shanur Jahedul Hasan, Senior Scientific Officer
Ahmed Fazla Rabbi, Scientific Officer

Budget: Tk. 8,00,000.00

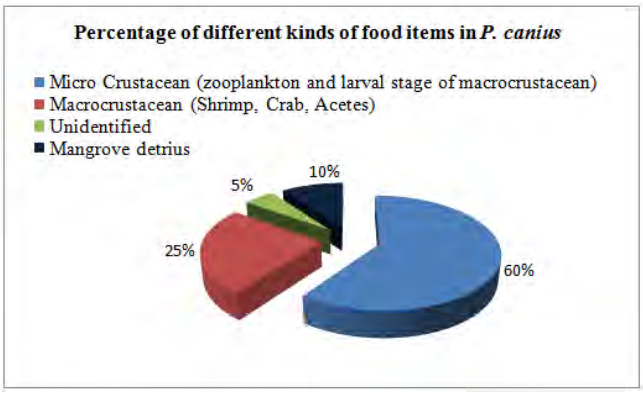
Objectives

- To study the food habit and reproductive biology of *Plotosus canius* and *Sillago domina.*
- To domesticate and brood development in captive condition of *P. canius* and *S. domina.*
- To determine the reproduction response to different doses of hormones in captive condition.
- To develop the breeding and larval rearing technique of *Plotosus canius* and *Sillago domina.*

Achievements

Studies on food and feeding habit and reproductive biology of Plotosus canius:

The collected specimens dissected out for food analysis. Stomach content analyzed following the index of preponderance, a method of grading the food elements.



Study on breeding biology: Gonads of the "Kaun magur" (*Plotosus canius*) which were captured from the wild source were collected after dissecting the fishes. Length of gonad was measured and excess moisture was removed from the gonad before taking the weight of gonads.

Fig. 1. Externally and internally sex identification

Table 1. Avg. Fecundity, Avg. Egg diameter and Avg. Gonad weight per KG of body weight

No of Individual	Avg. Fecundity	Avg. GSI	Avg. Egg diameter	Avg. Gonad weight per KG of BW
5	2518	17.56	5.5mm	176gm/KG

Domestication of brood fishes: About 25 fishes were stocked for domestication, in a brackish water pond with an area of 7 decimal. Fishes which were stocked in the pond differed greatly in terms of weight. Weight of the fishes ranged from 500gm to 6.5kg. Shelter has been provided by placing roots of branching trees (Babla, Hizal). Fishes were supplied with live feed (trash fish, small shrimp and Crab) @ 3-5% of BW daily.

Induced breeding trial: Single trial was initially given for induce breeding, the dosages is given below:

Sex	**Treatment-1 (PG)**	**Treatment-2 (HCG)**
Male	15 mg PG /kg	3500 IU/kg
Female	2mg PG/kg	1500IU/kg

Observation: No response after 16 hours

Assessment of Mud crab, *Scylla* spp. Resources in the Coastal Areas of Bangladesh

Researchers: Dr. Md. Latiful Islam, SSO
Mollah N.S. Mamun Siddiky, SO,
Md. Mizanur Rahman Washim, SO,
Shazad Kuli Khan, SO,
Md. Matiur Rahman, SO and
Ahmad Fazley Rabby,SO

Budget: Tk. 9,00,000.00

Objectives

- To assess the qualitative and quantitative production in major crab harvest areas.
- To assess the stock status of mud crab through estimating the catch per unit efforts (CPUE).
- To identify the breeding biology and spawning seasons of the mud crab in Bangladesh environment.
- To estimate the genetic diversity (composition) of mud crab species in Bangladesh coastal areas.
- To find out occurrence of available disease out breaks in mud crab.

Achievements

Study 1. Estimation of genetic diversity (composition) of mud crab in Bangladesh coastal areas

Genetic diversity of mud crab in Bangladesh was estimated through the morphological features of species identification keys as stated by Keenan (1999). Samples was collected from different sampling sites, live sample was carried to the laboratory and identified therefore. According to the morphological characteristics, 99% of the sample was *S. olivacea* and only 1% belonged to *S. serrata* (Fig. 1). Whereas, *S. paramamosain* and *S. tranquebarica* were not found in the samples. Some of the samples seemed confused to identify from the keys available on morphological features; needs mitochondrial analysis for confirmation.

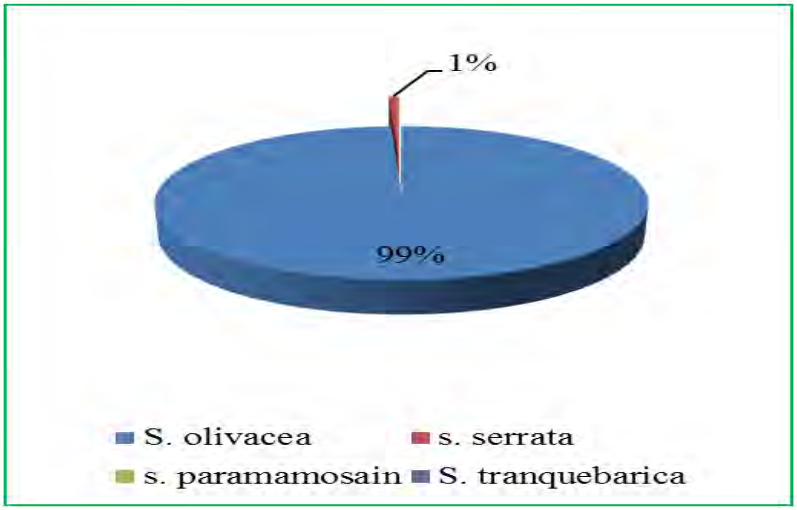


Fig. 1: Status of genetic composition of mud crab species in the sample collected from different sampling sites.

Study 2. Aassessments of qualitative and quantitative production of mud crab in major harvest areas

Assessment of qualitative and quantitative production status of mud crab was done through direct visiting of the *depots* of the sampling sites by a pretested questionnaire. The production or landing of mud crab in 2016-17 revealed highest production in Khulna (3728 ton), Satkhira (2189 ton) and lowest for Patuakhali (635 ton), Barguna (270 ton) region (Fig. 2).

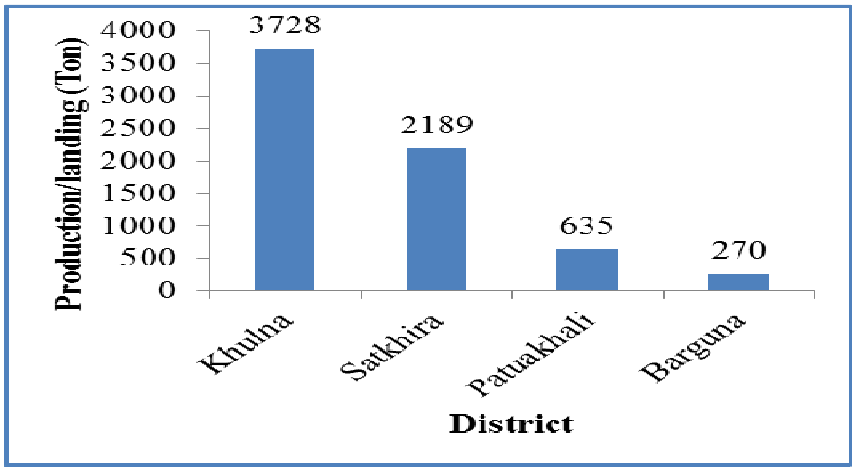


Fig. 2. Landing status of mud crab in different sampling sites.

The male-female ratio in harvested crab sample was 1:1.15 for female and male (Fig. 3-A). A considerable amount of small sized crabs was found in the market/*depot* and that was 10 to 15% of total landing (Fig. 3-B).

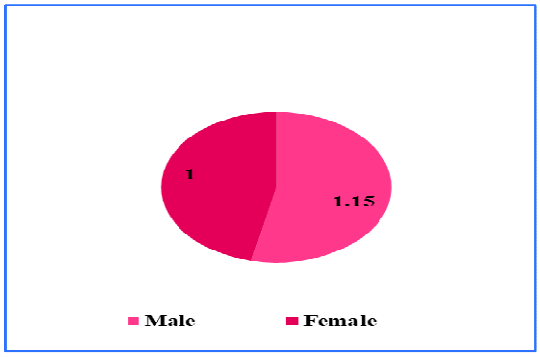


Fig. 3A. Status of male-female ratio of landed mud crabs.

Fig. 3B. Status of Adult and juveniles in landed crabs.

Study 3. Assessments of the stock status of mud crab through estimating the catch per unit efforts

Assessment of the mud crab stock status was performed on monthly collected samples during the full moon period by using long line bait and crab traps. Finally, catch per unit effort (CPUE) was calculated as follows:

CPUE (crab/hour/trap or bait)= (NC/ST)/NT
Where, NC= number of crabs caught; ST= soak time in hours; NT= number of traps/*charu*/bait.

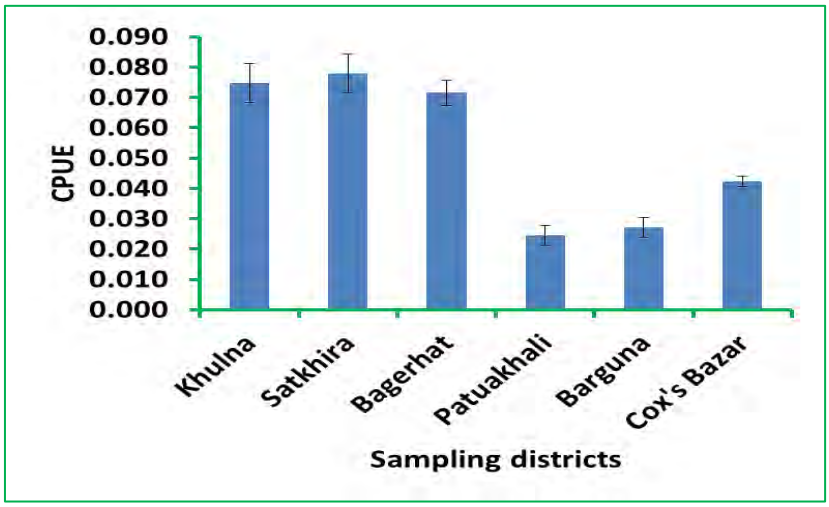


Fig. 4. Catch per unit effort (CPUE) of mud crab in coastal areas.

As shown in Fig. 4, the catch per unit effort (CPUE) was higher in Satkhira (0.078 crab/hour/trap or bait) followed by Khulna (0.075 crab/hour/trap or bait) and Bagerhat (0.072 crab/hour/trap or bait) district. Lowest is for Patuakhali (0.025 crab/hour/trap or bait) and Barguna (0.027 crab/hour/trap or bait).

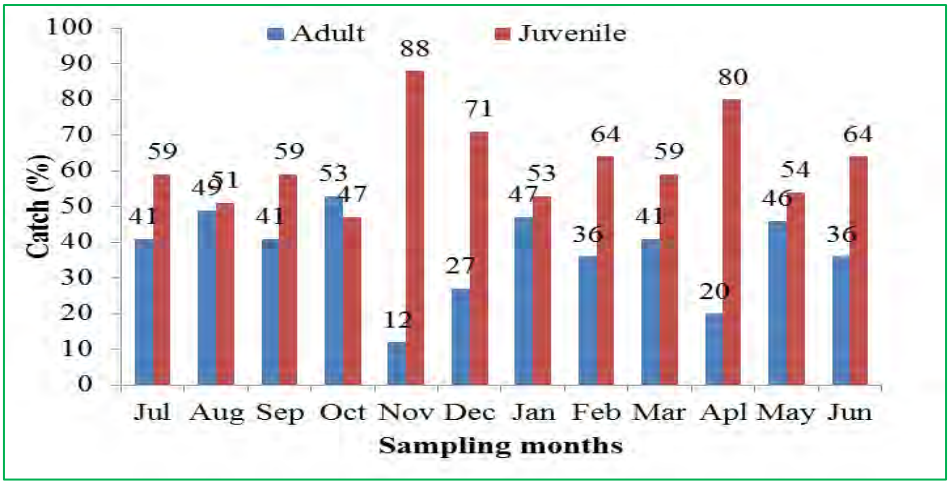


Fig. 5. Proportion of sub-adult/juveniles in (CPUE) of mud crab.

Fig. 5. demonstrates the proportion of sub-adult/juveniles in CPUE of mud crab in the Sundarbans region. Highest proportion (88%) of sub-adult/juveniles was noticed in November followed by Aril and lowest was in the month of August (51%). Indiscriminate harvest of sub-adults and juveniles might reduce the stock and regular recruitment.

Study 4. Iidentification of breeding biology and spawning seasons of the mud crab

Gonad status: Crab samples were collected from different sampling sites, carried in the laboratory, graded and the sexually matures females were dissected. Gonad samples were picked out and categorized following Islam et.al. (2010) and Islam and Yahya (2017). As presented in Fig. 6-A, mud crab attained gonad maturation following five distinct stages of immature, developing, early maturing, late maturing and mature. Among the samples, 18% crabs was in the mature stage. The immature stage augmented the highest proportion (40%). The highest proportion of mature stage was noticed in the month of March

followed by January, February and July, indicated that March might be one of the peaks spawning season (Fig. 6-B).

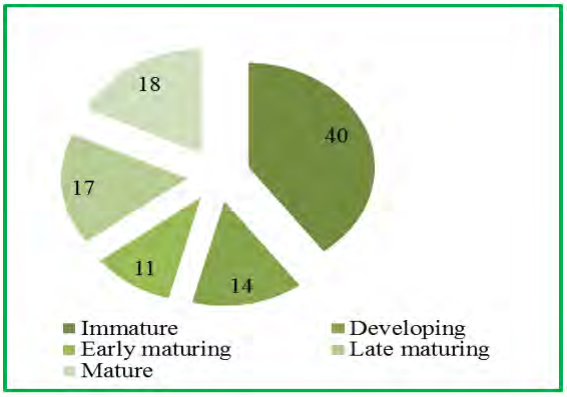


Fig. 6A. Proportion of different gonad maturation stages of mud crab in the sample.

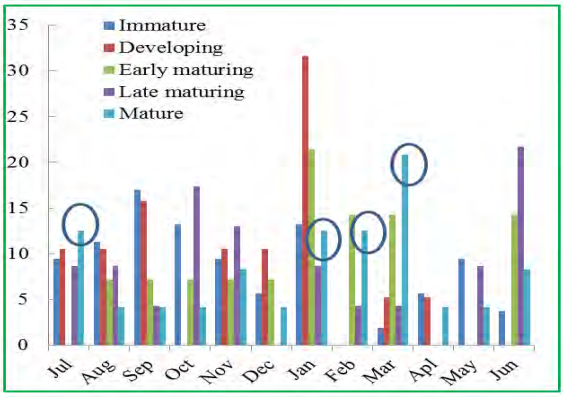


Fig. 6B. Monthly availability of different gonad development stages.

Larva sampling: A 50 meter distance of river near to mangrove of all the sampling sites were sampled with a 1 meter mouth opening push net. Sampling was done in each full moon period. Whole sample was preserved in 10% formalin and carried in laboratory/hatchery. Megalopa, crab instars and crablets were separated and counted.

Fig. 7A. Monthly availability of mud crab larvae in coastal rivers.

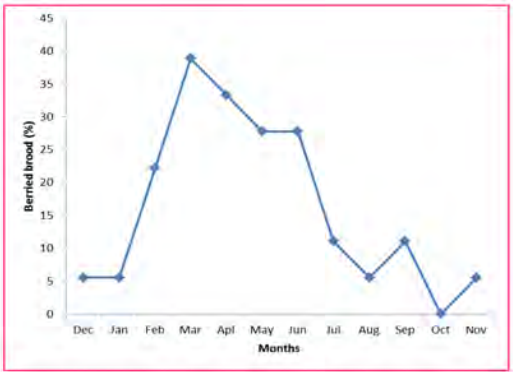


Fig. 7B. Monthly availability of berried mud crab.

As presented in Fig. 7-A, highest mud crab larvae was available in the month of April and May, indicated the previous month might be a peaks of spawning/breeding.

Berried broods sampling: A total of 18 gravid broods were reared in sand bed concrete tanks with sea water. Once a crab turned into berried was picked out and noted down for respective months. A similar sized gravid broods was introduced to maintain the number and density. The process was carried out for year round. Fig. 7-B denotes the availability of berried broods in hatchery condition and highest proportion (39%) of berried brood was available in March, followed by April, May and June 33%, 28% and 28%, respectively. A second narrow peak was in September (11%).

Study 5. Ooccurrences of disease out breaks in mud crab

Whole crab samples harvested by a crab fisher was purchased and carried to the laboratory. Firstly the crabs were observed with naked eye for external fouling on shell or appendages. Later on, crabs were dissected and internal organs (gill, ovary, hepatopancreas) were monitored. The naked eye observation as well as observation under dissection of crab showed that no major disease outbreak was noticed. Among the samples 80% was disease free, 12% was infested with gill parasites (*Zoothamnium*), 5% was black shell disease and 4% was affected with *Barnacles* (Fig. 8).

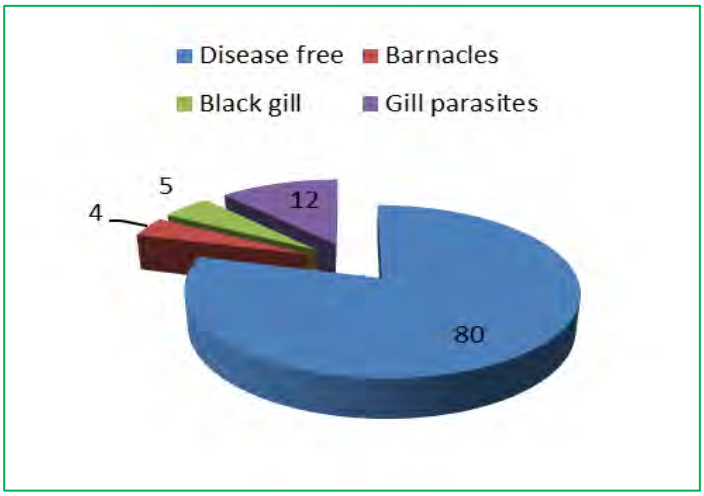


Fig. 8. Outbreak of different diseases of mud crab

Development of Technique for Breeding and Larval Rearing of Mud Crab, *Scylla olivacea*

Researchers: Dr. Md. Latiful Islam, Senior Scientific Officer
Mollah N.S. Mamun Siddiky, Scientific Officer

Budget: Tk. 12,00,000.00

Objectives

- To develop culture protocols and scaling up of live feed for mud crab larvae rearing
- To develop brood of mud crab, *Scylla olivacea* in captivity.
- To develop larval rearing techniques of mud crab, *Scylla olivacea*.

Achievements

Study 1. Effect of different enrichment medium of rotifer on growth, survival and metamorphosis at initial larval stages (Z1 to Z2)

The larvae rearing experiment for the initial stages (Z1 to Z2) was conducted with four treatments, viz, larvae fed with rotifer enriched with commercial fish oil (SELCO) (T1); larvae fed with rotifer enriched with commercial shrimp larvae diet (T2); larvae fed with rotifer enriched with *Nannochloropsis* spp (T3)

and larvae fed with rotifer enriched with *Bacillus* probiotics (T4). Each of the feeding regimes had 3 replications and the stocking density was 100 larvae/l. Larvae rearing protocol was set and maintained as according to standard mud crab larvae rearing procedure mentioned by Quinitio and Parado-Estepa (2001), Nguyen Co Thache (2009) and Islam et al. (2017).

As stated in Table 1, among the tested four different rotifer enrichment medium, rotifers enriched with *Nannochloropsis* spp. (T3) provided highest survival rate of 63% and better growth of (LSI) 4.50 at 7 days of culture followed by rotifer enriched with commercial fish oil (T1) where the survival was 62% and growth was (LSI) 4.35. Lowest survival (59%) and growth (LSI) was recorded for rotifer enriched with commercial shrimp diet (T2) feeding regimens.

Table 1. Growth and survival of larvae (Z1 to Z2) under different feedings regimes: rotifers enriched with different medium

Parameters	**Feeding regimes/Treatments**			
	Commercial fish oil (SELCO)	**Commercial shrimp larvae diet**	***Nanochloropsis* spp**	***Bacillus* probiotics**
Stocking density (nos/L)	100	100	100	100
Survival (%)	62	59	63	61
Growth (LSI)	4.35	4.20	4.50	4.35
Day of Culture	7	7	7	7

Study 2. Rearing of the mud crab larvae (Z3 to M) under different feeding regimes

After successful metamorphosis to Z3 stages, the survived larvae was reared following different feeding regimes to observe the effect on survival and metamorphosis up to initial megalopa stage (M). The larvae rearing experiment for the late stages (Z3 to M) was conducted with four treatments, viz, larvae fed with *Artemia* nauplii (T1); larvae fed with commercial shrimp larvae diet (T2); larvae fed with enriched *Artemia* (T3) and larvae fed with *Artemia* and commercial shrimp larvae diet (T4). Each of the treatment had 3 replications and stocking density of the larvae was 50 ind./l. The procedure followed in this experiment was similar to the standard procedure as described in experiment 1.

Growth and survival of larvae under different feeding schemes has been presented in Table 2. Of the four different feeding schemes, enriched *Artemia* (T3) provided highest survival rate of M was 10% and better growth of (LSI) 4.60 on 12 days of culture followed by T4 where the survival was 8% and growth as expressed with LSI was 4.4. The lowest survival (6%) and growth (LST 4.2) was in commercial shrimp diet feeding schemes (T2). Average survival at C1 stage was recorded as 0.87 (%).

Table 2. Growth and survival of larvae (Z3 to M) under different feedings regimes

Parameters	**Feeding regimes/Treatments**			
	Artemia	**Artificial diet**	**Enriched *Artemia***	***Artemia*+ Artificial diet**
Stocking density (nos/L)	50	50	50	50
Survival (%)	7	6	10	8
Growth (LSI)	4.30	4.20	4.60	4.4
Day of Culture	12	12	12	12

Study 3. Effect of different nursery protocols on growth and survival of mud crab larvae

To observe the effect of different nursery protocols on growth and survival of mud crab larvae (crab instar to C3) an experiment was conducted with a stocking density of 200 crab instars for each. For individual nursery (T1), one crab instars was placed in separate plastic glasses. For combined/communal nursery (T2), the stocking density was 25 instars/m^2 in the concrete tank bed. The communal nursery was sheltered with sufficient pieces of small stones and pieces of plastic pipes. The duration of experiment was 30 days.

Highest survival of 75% was recorded for the individual nursery system and lowest in combined nursery 50%. Highest weight (1.4 g) was recorded for combined nursery and lowest was 0.8 g in individual nursery. For combined nursery, about 60% crablets was found limb broken (Table 3) indicated high cannibalism and aggressiveness in the combined nursery system.

Table 3. Survival of mud crab larvae (crab instars to C3 stage) under different nursery protocols

Parameters	**Combined nursery**	**Individual nursery**
Number stocked	200 (25/m^2)	200 (1/plastic glass)
Number harvested	100	150
Survival rate (%)	50	75
Wt (g)	1.4	0.8
CW (cm)	1.7	1.5
Stage	C3	C3
Proportion of intactness (%)	60	100

Study 4. Growth comparison of three live feed species under indoor and outdoor culture condition

Culture of three microalgae species (*Nannochloropsis* sp.*, Nannochlorum* sp. *and Tetraselmis* sp.) was done under indoor condition with F2 medium and enhanced under outdoor condition with F2 or N:P:K= 20:5:20 media. Under both indoor and outdoor conditions, the experiment was designed with 3 treatments *viz.,* T1= *Nannochloropsis* sp., T2= *Nannochlorum* sp. and T3= *Tetraselmis* sp. Each of the treatment had 3 replications. Under indoor conditions, each of the live feed was cultured in 2 L glass conical flask having an initial inoculums of 5-10% of culture volume with 24 hours lightened by florescent light. For the outdoor culture conditions, each of the live feed was cultured in 60-300 liter fiber glass tanks with initial inoculums of 10-20% of culture volume and exposed under day-night sunlight condition. Performance of microalgae was evaluated considering the cell density and longevity of log phase, stationary phase and lag phase as well as from the total longevity.

Under indoor condition, all three microalgae species (*Nannochloropsis*, *Nannochlorum* and *Tetraselmis*) species started cell division immediate after inoculation and reached to the peak on 9th day of culture. The stationary phase was observed for 9-15 days and then started to collapse. Highest density of 1.44 cells/ml$\times 10^6$ and 1.40 cells/ml$\times 10^6$ was observed for *Nannoclhorum* and *Nannochloropsis* at 14th DoC then collapsed sharply (Fig. 1).

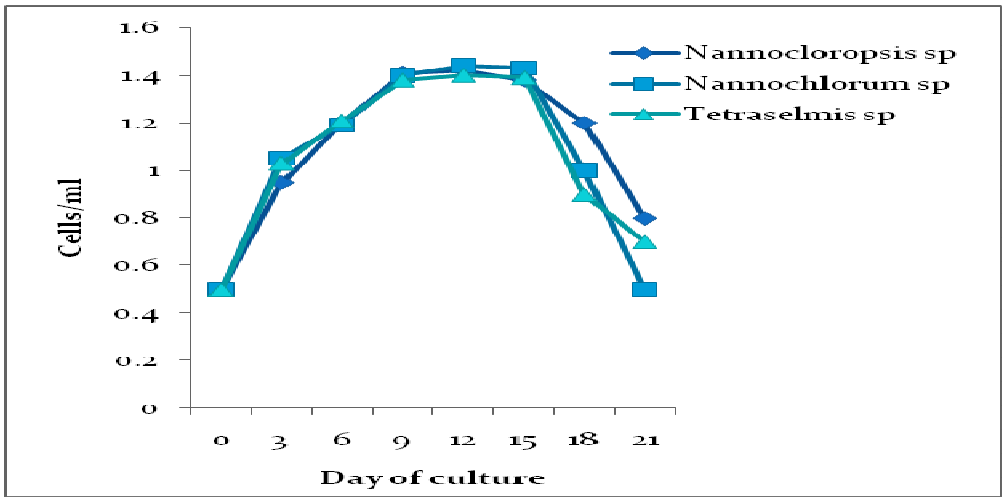


Fig 1. Growth (cells/ml×10^6) of microalgae under indoor culture condition.

Scaling up of three live feed species (*Nannochloropsis*, *Nannochlorum* and *Tetraselmis*) under outdoor condition also started cell division immediate after inoculation and reached to the peak on 9th day of culture. The stationary phase was observed only for 3 day (12-15) days and then started to collapse. Highest density was 1.55 cells/ml×10^7, 1.53 cells/ml×10^7 and 1.51 cells/ml×10^7 was observed for *Nannochloropsis*, *Nannochlorum* and *Tetraselmis*, respectively on 12th day of culture. The density/growth of all three live feed species was higher under outdoor culture condition than indoor and *Nannochloropsis* showed better performance than other two live feed species (Fig. 2).

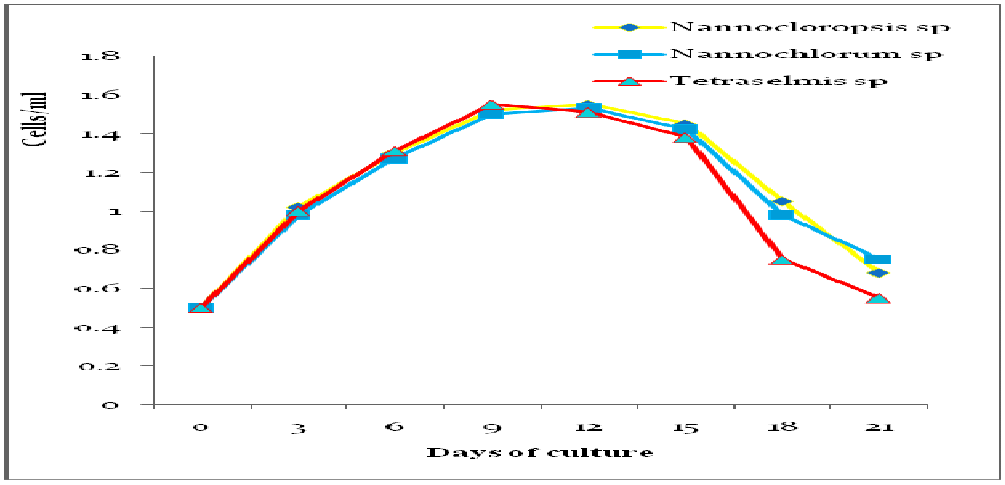


Fig 2. Growth (cells/ml×10^7) of microalgae under outdoor culture condition.

Study 5. Growth performance of live feed, rotifer (Brachionus plicatilis) under different medium

Experiments on culture of live feed, rotifer (*Brachionus plicatilis*) was conducted with 4 different feedings protocols *viz,* rotifer cultured with yeast (T1), rotifer cultured with microalgae (T2), rotifer cultured with yeast+microalgae (T3) and rotifer cultured with yeast+commercial diet (T4). The experiment was conducted in 400 liter fiber glass tank under outdoor condition with the inoculum density of 20 ind/ml.

As shown in Fig. 3, rotifer (*Brachionus plicatilis*) grew faster in yeast+microalgae media (T3) with highest density of 380 ind/ml followed by yeast + commercial diet media (T4, 350 ind/ml) and cultured with microalgae (T2, 320 ind/ml) on 6th day of culture. Lowest growth rate was noticed with baker's yeast media (T1, 250 ind/ml). This is noteworthy to mention that, the rotifer cultured with only microalgae (T2) seemed clean and free of contaminants, while, in other three treatments, rotifer was found to be contamination by insects and protozoans.

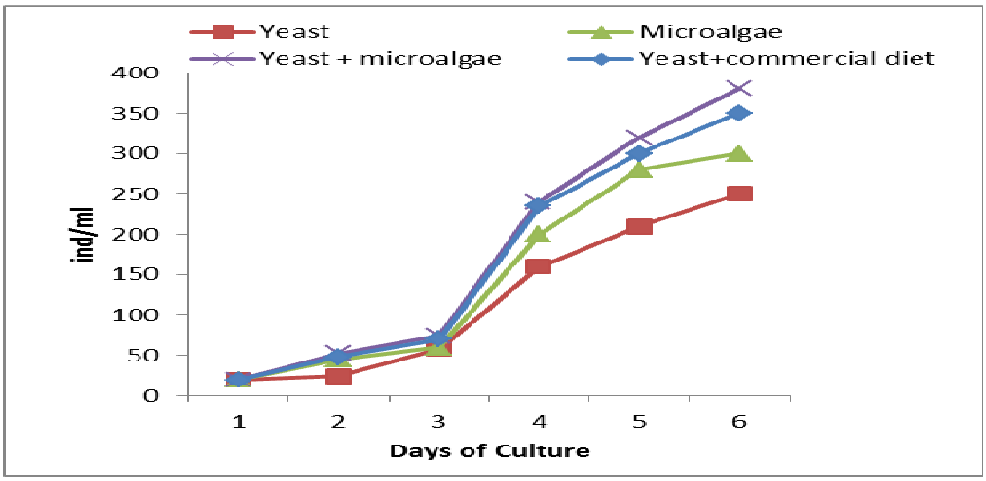


Fig. 3. Growth performance of live feed, rotifer (*Brachionus plicatilis*) under different medium/feedings.

Development of Breeding, Seed Production and Culture Technology of Green Back Mullet *Chelon subviridis* (Val. 1836)

Researchers: Syed Lutfor Rahman, Chief Scientific Officer
Nilufa Begum, Senior Scientific Officer
A.K.M.Shafiqul Alam Rubel, Senior Scientific Officer
Debashis Kumar Mondal, Senior Scientific Officer

Budget: Tk. 8,30,000.00

Objectives

- To evaluate the efficacy of different hormones for the breeding of *C. subviridis.*
- To develop sustainable nursery management and culture technology of *C. subviridis*
- To evaluate the economic feasibility of production of *C. subviridis.*

Achievements

Study 1: Fine tuning of doses of different hormones for breeding of C. subviridis

The salinity (30 ppt) and temperature (26^{o}c) level which was found best in the previous year experiments was used for breeding in this year. In the previous year doses of PG might be insufficient so this year we tried with higher doses (20, 25 and 30 mg/Kg). On the other hand, Ovupin hormone doses (25, 30 and 35

mg/Kg) of previous year were used for fine tuning of breeding performance *viz.,* spawning period, hatching and fertilization rate.

This year comparative performance of two types of hormones (PG and Ovupin) were used for breeding, but only Ovupin showed positive response @ 30 mg/Kg dose and performed 82.66±1.52 % fertility rate, 32±1.15 hours of Spawning period and 97.46±0.57 % hatching success while PG did not respond at any dose. The larvae were reared by using different types of live foods like *Rotifer* and *Artemia* as well as commercial Shrimp larvae feed.

Table 1. Determination of suitable doses of hormones for breeding of *C. subviridis*

Types of hormones	**Doses**		
Carp pituitary extract (PG) (mg/Kg)	20	25	30
GnRHa (Ovupin) (mg/Kg)	25	30	35

Among the two hormone injected Ovupin responded @ 30 mg/Kg dose while, PG did not responded at any doses. The performance of Ovupin hormone is depicted in Table 2.

Table 2. Performance of Ovupin hormones for breeding of *C. subviridis*

Ovupin (mg/kg)	**Spawning period (hrs)**	**Fertility rate (%)**	**Hatching period (hrs)**	**Hatching rate (%)**
30	32±1.15	82.66±1.52	22.25±1.7	97.46±0.57

Study 2: Production of C. subviridis in monoculture management at different artificial feeds

A study on the efficacy of different artificial feeds on the growth and survival of green back mullet, *C. subviridis* was carried out in nine earthen ponds of 0.1 ha each (Table 3)

Table 3. Production of green back mullet, *C. subviridis* in monoculture management at different artificial feeds

Treatments (T)	**Name of feeds**
T_1	Commercial feed (30% protein)
T_2	Natural feed (mustard oil cake @ 187.5 kg/ha, urea @ 25 kg/ha and TSP @ 10 kg/ha)
T_3	Formulated feeds with 30% protein (Fish Meal-20%, MOC-20%, Soya bean Meal-25%, Rice-bran-29%, Flouer-5% and Vitamin Mix-1%)

Pond preparation: The ponds were prepared by sun drying followed by liming the soil with CaO @ 250 kg/ha and then filled with tidal water up to 100 cm. Water of the ponds was treated with rotenone and dipterex, both @ 1.5 ppm to kill all unwanted animals.

Then fry of *C. subviridis* stocked uniformly with the previous best result of stocking density (9000/0.1 ha) in all ponds. From the second day of stocking, fries of treatment T_1 and T_3 were fed daily with commercial feeds and formulated feeds @ 15% of estimated biomass and gradually reduced with the growth of fish and feed was supplied @ 3% of estimated biomass. On the other hand, ponds of T_2 were fertilized with mustard oil cake @ 187.5 kg/ha, urea @ 25 kg/ha and TSP @ 10 kg/ha subsequently.

Water quality and plankton analysis: Physico-chemical parameters of water were analyzed throughout the culture period. Physico-chemical parameters of water *viz*., transparency, temperature, salinity, pH, dissolved oxygen and alkalinity were determined at seven days interval and plankton samples were analyzed at fifteen days interval. Temperature and salinity of water during study period varied from 25-32^{o}C and 3-12 ppt respectively. Transparency ranged from 13 to 45 cm in all the three treatments and found lower during rainy season and clear by chlorination. pH of water of all treatments was found congenial for nursery rearing and varied from 6.1 to 8.5. Alkalinity varied from 125 to 279 mg/L in all treatments.

Concentration of phyto- and zooplankton of the ponds used for nursing of hatchlings at different fed treatments were 6.1-12.2*10^3 No/l and 1.2-5.2*10^3 No/l respectively. Lowest phytoplankton counts were found in T_2 (6.1*10^3 No/l) and highest in T_3 (12.2*10^3 No/l). Similarly, zooplankton counts were found in T_1 (1.2*10^3 No/l) and highest in T_2 (5.2*10^3 No/l).

Fish production: After five months of rearing, all fishes were harvested by draining out the ponds and growth and production of fishes were estimated and compared**.**

Table 4. Growth parameters of green back mullet, *C. subviridis* in monoculture management at different artificial feeds in different treatments (after 150 days of stocking)

Treatment	Initial wt. (g)	Final wt. (g)	Survival (%)	FCR	Culture period (month)	SGR (%)	Production (kg/ha)
T_1	0.25	15.88±0.89^{a}	84.66±2.5	1.85^{a}	5	2.76^{a}	1209.4^{b}
T_2	0.25	17.13±0.73^{b}	86.33±2.08	1.77^{b}	5	2.81^{a}	1331.4^{a}
T_3	0.25	14.93±0.135^{a}	83±2.65	1.88^{a}	5	2.725^{a}	1115.4^{c}

Values in the same row having the same superscripts are not significantly different (P>0.05).

At the end of five months rearing period, growth performance observed on the basis of three different feeding strategy *viz.,*Commercial feed (30% protein) in T_1, Natural feed (mustard oil cake @ 187.5 kg/ha, urea @ 25 kg/ha and TSP @ 10 kg/ha in T_2 and formulated feeds with 30% protein (Fish Meal-20%, MOC-20%, Soya bean Meal-25%, Rice bran-29%, Flour-5% and Vitamin premix-1%) in T_3. Average final weight was 15.88±0.89 g, 17.13±0.735 g and 14.93±0.135 g in T_1, T_2 and T_3 respectively. In case of final weight, T_1 and T_3 were significantly ($p<0.05$) different from T_2 and no significant difference ($p>0.05$) was found between T_1 and T_3. During the period of study, higher survival rate (86.33±2.08) was found in T_2. Survival rates were found 84.66±2.51 and 83±2.65 in T_1 and T_3 respectively. Significantly ($p<0.05$) highest production was found in T_2 (1331.4 kg/1 ha) followed by T_1 (1209.4 kg/1 ha) and T_3 (1115.4 kg/1 ha).

Polyculture of Shrimp (*Penaeus monodon*) with Prawn (*Macrobrachium rosenbergii*) and Brackishwater Catfish (*Mystus gulio*)

Researchers: Nilufa Begum, Senior Scientific Officer
Debashis Kumar Mondal, Senior Scientific Officer

Budget: Tk. 7,00,000.00

Objectives

- To diversify the cropping pattern of coastal Shrimp ghers through introduction of polyculture system.
- To increase productivity of Shrimp ghers in the coastal area of Bangladesh.

Achievements

Study 1. Impact of stocking density of brackish water catfish on growth and production of tiger Shrimp, green back mullet and fresh water giant prawn in poly culture

The study was conducted in the pond complex of the Bangladesh Fisheries Research Institute (BFRI), Brackish water Station, Paikgacha with the following experimental design:

Table 1. Experimental design

Treatments	Replications	Species	Stocking density (Nos/ha)
T1	3	*P. monodon*	20,000
		M. rosenbergii	10,000
		M. gulio	5,000
		C. subviridis	10,000
T2	3	*P. monodon*	20,000
		M. rosenbergii	10,000
		M. gulio	10,000
		C. subviridis	10,000
T3	3	*P. monodon*	20,000
		M. rosenbergii	10,000
		M. gulio	15,000
		C. subviridis	10,000

The experiment was carried out in six earthen ponds of 0.1 ha each. Ponds were prepared following drying, liming (Cao@ 250 kg/ha) and then filling with tidal water up to a depth of one meter. The water of the ponds was treated with chlorine @ 20 ppm. The buffering capacity of water of the ponds was strengthened by applying dolomite @ 20 ppm. Fertilization with urea and TSP was done @ 2.5 ppm and 3.0 ppm respectively. After production of sufficient plankton required quantity of SPF shrimp PL was acclimatized with the pond water and stocked to the in-pond nursery made of nylon net fastened in bamboo frame on 1st April. Prawn and mullet were also stocked at 01 April whereas; catfish were stocked at 01 May, 2017.

In the nursery, the stocked PL and fries were fed with CP nursery feed. Feed was supplied by spreading @ 100%, 80% and 60% of the estimated biomass at 6 h intervals daily in the 1st, 2nd 3rd week respectively. After three weeks of nursery rearing, the juveniles were released to the whole pond by opening the nylon net enclosure. But after six weeks of rearing mass mortality of Shrimp was observed due to bacterial disease. Then 2nd batch of Shrimp PL was stocked in 12 June following the aforementioned procedure.

Shrimp, Prawn and catfish were fed with commercial CP shrimp feed, CP carp feed and quality feed @ 10-2% of estimated body weight. Feed was fed thrice a day. Water quality parameters *viz.* temperature, dissolved oxygen, depth, salinity, pH, transparency, free carbon dioxide and alkalinity were determined weekly (Table 2). Water quality parameters were determined following standard methods (APHA 1992). Growth of fish was monitored at weekly interval and feed was adjusted accordingly. Average body weight (ABW) of different treatments is shown in Table 3. At the end of 90 days culture period for Shrimp, 180 days for Prawn and mullet and 150 days for catfish were harvested and their growth and production were estimated and compared.

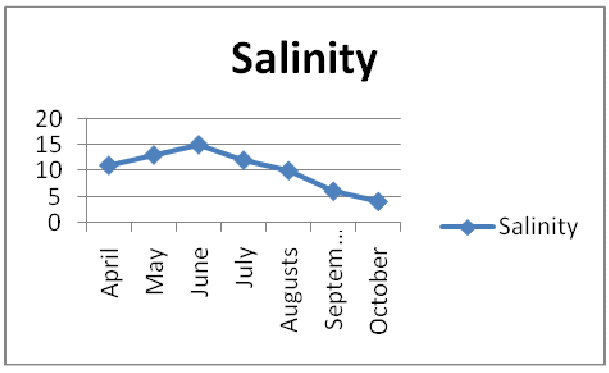
Shrimp, Prawn, green back mullet and brackish water catfish in polyculture.

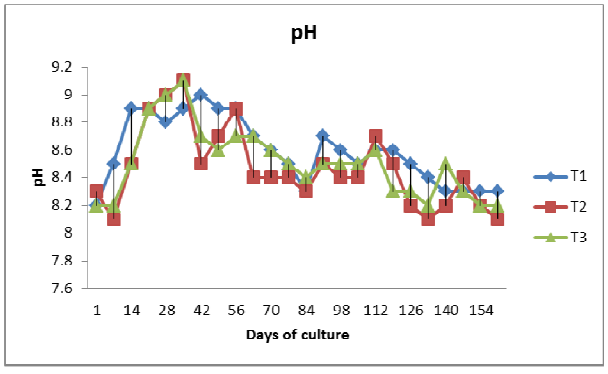
Water temperature of different ponds varied from 30-35° C. Salinity of water was almost same in all ponds which varied from 04-15 ppt (Table-2). Salinity steadily increased from April until reached its peak at June (15 ppt) then it showed sharp fall till October due to the onset of monsoon. Depth of water was recorded 80-96 cm in T_1, 85-104 cm in T_2 and 85-105 cm in T_3. Water transparency was found to vary from one pond to another. Transparency of water was recorded 28-37 cm in T_1, 27-36 cm in T_2 and 29-38 cm in T_3 which indicate the prevalence of sufficient plankton. Dissolved oxygen was congenial throughout the culture period and varied from 5.62-8.62 mg/l, 5.61-9.34 mg/l and 5.36-9.84 mg/l in T_1, T_2 and T_3 respectively. Alkalinity level of water was found sufficient to support the primary production for all ponds, found to vary from 98-168 mg/l in T_1, 100-170 mg/l in T_2 and 96-156 mg/l in T_3. Water pH of all ponds slightly decreased with the progress of culture period but it did not decrease below critical value and was always alkaline. The pH value varied from 7.9 to 9.04 in T_1, 7.9 to 8.9 in T_2 and 7.8 to 9.40 in T_3. Free carbon dioxide of water of all ponds was recorded 0.0 mg/l.

Table 1. Water quality characteristics of different treatments

Parameters	T1	T2	T3
Temperature (°C)	30-35	30-35	30-35
Salinity (ppt)	4-15	4-15	4-15
Depth (cm)	80-96	85-104	85-105
Transparency (cm)	28-37	27-36	29-38
pH	8.2-9.1	8.1-9.2	8.1-9.1
Total Alkalinity (mg/l)	98-168	100-170	96-156
Dissolved oxygen (mg/l)	5.62-8.62	5.61-9.34	5.36-9.84
Free CO_2(mg/l)	0.0-0.0	0.0-0.0	0.0-0.0

Changing trends of different water quality parameters are graphically shown in Fig. 1.





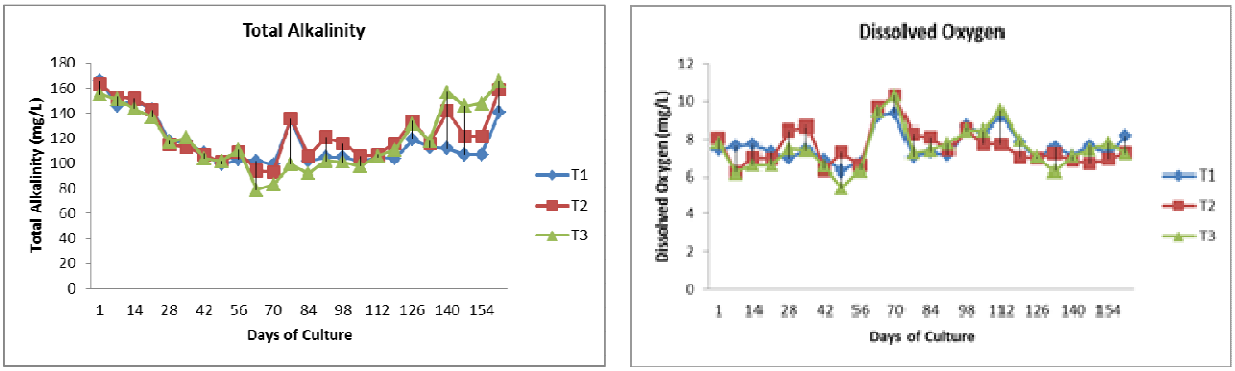


Fig.1. Water quality variables of the rearing ponds during culture period.

Stocking density, growth, survival, production and culture period of Shrimp, Prawn, mullet and catfish under different treatments are furnished in Table 3.

Table 3. Details of Stocking density, growth, recovery rate, production and culture period of Shrimp, Prawn, mullet and catfish under different treatments

Treatment	Species	Stocking density/ha	Initial weight (g)	Final weight (g)	Survival (%)	Production species wise (kg/ha)	Total production (kg/ha)
T_1	Shrimp	20000	0.008	20.5±3.5	45.5±4.6	186±8.2	955.2^{c}
	Prawn	10000	0.037	110±33.48	28±2.8	308±14.8	
	Catfish	5000	0.001	59.2±4.24^{a}	73.7^{a}±5.2	217^{c}±13.8	
	mullet	10000	0.14	43.6±3.63	56.0±4.3	244.2±12.9	
T_2	Shrimp	20000	0.008	15.6±1.71	64.9±4.8	202.5±10.5	1352.1^{a}
	Prawn	10000	0.037	97.6±13.75	65.5±4.7	639.3±16.8	
	Catfish	10000	0.001	45.8±6.05^{b}	68.5^{b}±3.9	313.7^{a}±9.6	
	mullet	10000	0.14	27.5±4.03	71.5±6.3	196.6±8.7	
T_3	Shrimp	20000	0.006	18.5±1.9	38±2.7	140.6±7.8	1078.5^{b}
	Prawn	10000	0.05	62.5±14.69	45±3.6	562.5±14.1	
	Catfish	15000	0.001	29.8±4.37^{c}	60.5^{c}±4.5	270.4^{b}±12.5	
	mullet	10000	0.14	15.0±3.20	53±4.1	105±8.9	

Different superscript differ significantly (P<0.05).

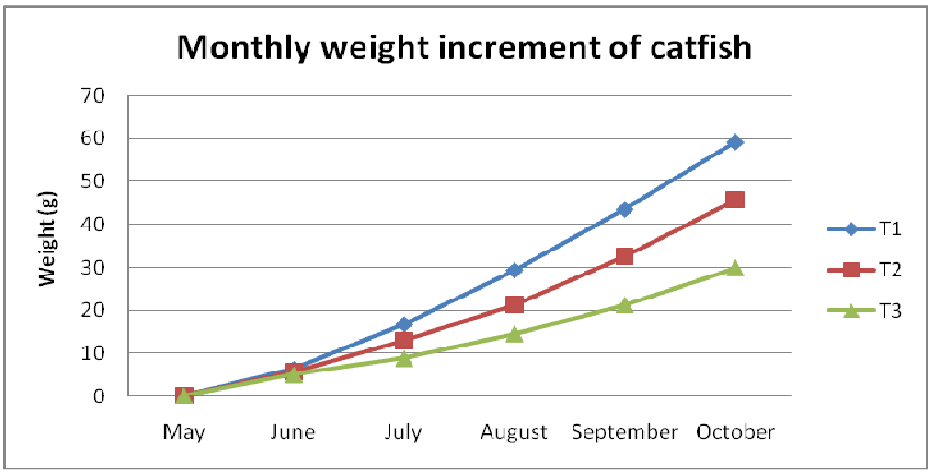


Fig. 2. Monthly weight (g) increment of catfish (*M. gulio*).

Final weight of Shrimp, Prawn, catfish and mullet were highest in T_1 than other treatments (Table 3). Survival of Shrimp (64.9 %), Prawn (65.5 %) and mullet (71.5 %) was highest in T_2 whereas, survival of catfish (73.7%) was highest in T_1 than other treatments. Survival of Shrimp was lowest among all species due to bacterial disease. On the contrary, lower survival of Prawn might be due to transportation stress. Final weight of mullet was 43.6 g, 27.5 g and 15 g in T_1, T_2 and T_3 respectively. This lower growth might be happened probably due to interspecies interaction to mullet when it attained juvenile stage. Final weight (59.2g) and survival (73.7%) of catfish was found significantly ($p<0.05$) highest in T_1 than other treatments. Total production was 955.2, 1352.1 and 1078.5 kg/ha at T_1, T_2 and T_3 respectively. Production of catfish was significantly ($p<0.05$) highest in T_2 than other treatments. In this experiment catfish showed higher survival with lower stocking density, whereas, production of catfish showed density dependent augmentation. Therefore, it can be conclude that polyculture of Shrimp, Prawn, mullet and catfish with a combine stocking density of 50000/ha would be suitable for coastal aquaculture.

Diversification of Culture Practice for Optimizing Production of the Shrimp (*Penaeus monodon*) Culture System in the Coastal *Ghers*

Researchers: Syed Lutfor Rahman, Chief Scientific Officer
AKM Shafiqul Alam Rubel, Senior Scientific Officer
Md. Mizanur Rahman Washim, Scientific Officer

Budget: Tk. 8,50,000.00

Objectives

- To study the ecology and production feasibility of different cropping patterns in *Penaeus monodon* culture system in the coastal *ghers*
- To maximize production capacity and profitability from the coastal *ghers*
- On station and on farm demonstration of crop diversification technology.

Achievements

Study 1: Fine tuning and validation of crop diversification of shrimp (Penaeus monodon) through on station trial and on farm demonstration

The experiment was conducted in 8 on-station and 4 on farm ponds of 0.1 ha each following the design as given in Tables 1 and 2.

Table 1. Experimental design for on station

Treatments	Stocking densities (No/m^2)	Culture period (days)	Crop(s)	Replications
T1	5	60	Double	2
T2				2
T1		120	Single	2
T2				2

- One farmer was selected in a suitable location of Paikgacha upazila for the study
- All the culture activities was performed according to on station trial

Table 2. Experimental design for on farm

Locations	Experiment	Stocking densities (No/m^2)	Culture period (days)	Crop(s)	Replications
Bandikhati, Paikgacha, Khulna	T1	5	60	Double	2
	T2		120	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. In the nursery the stocked PL were fed with CP nursery feed. After 2nd 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 whenever necessary. Unexpectedly between 35 to 45 days of culture (DOC) period all the culture ponds both short and long cycle affected by unknown disease and total culture system severely disrupted. The affected shrimp sample was send to Shrimp Research Station, Bagerhat to investigate and identify the disease causing factor. They reported that shrimp was affected by early mortality syndrome (EMS) disease.

The water quality variables *viz*., temperature, depth, transparency, salinity, pH and total alkalinity were monitored at seven days interval following standard methods (APHA). The recorded average water quality parameters are shown in table 3. All water quality variables except dissolved oxygen (DO) and salinity were congenial for culture of shrimp in all stocking ponds in both short cycles and long cycle culture systems.

Table 3. Hydrographical parameters in different treatments of on station and on farm shrimp culture ponds between 35 and 45 days of culture

Parameters	On-station				On-farm	
	60 DOC		120 DOC		60 DOC	120 DOC
	T1	T2	T1	T2	T1	T2
Temperatures (^{o}C)	27.5-29.5	27.2-31.0	28.5-30.5	27.4-29.8	29.2-30.2	28.4-29.0
Salinity (ppt)	12-14	12-14	12-14	12-14	13-16	13-17
Transparency (cm)	35-50	36-44	35-50	36-44	25-30	26-30
pH	7.8.-8.6	8.2-9.0	7.8.-8.6	8.2-9.0	8.1-8.9	8.3-9.0
Alkalinity (mg/l)	122-140	104-122	122-140	104-122	155-180	110-140
Morning DO (mg/l)	4.5-6.8	3.8-5.8	4.5-6.8	3.8-5.8	4.3-6.2	4.0-6.6

The growth performances of shrimp in different on station and on farm ponds up-to 35-45 days of culture are shown in Tables 4 and 5.

Table 4. Growth performance of shrimp in on-station ponds

Treat-ment	Stocking densities (No/m^2)	Culture period (days)	Replications	ABW (g)	Survival (%)	Production (Kg/ha)
T1	5	60	R1	11.60	Outbreak of disease between 35-45 days of culture	
			R2	12.33		
T2			R1	12.46		
			R2	13.10		
T1		120	R1	10.50	Outbreak of disease between 35-45 days of culture	
			R2	14.12		
T2			R1	10.86		
			R2	09.78		

Table 5. Growth performance of shrimp in on-farm ponds

Treat-ment	Stocking densities (No/m^2)	Culture period (days)	Replications	ABW (g)	Survival (%)	Production (Kg/ha/crop)
T1	5	60	R1	10.82	Outbreak of disease between 35-45 days of culture	
			R2	09.58		
T2		120	R1	12.10	Outbreak of disease between 35-45 days of culture	
			R2	10.38		

Assessment of Production Performance in Relation to Limnological Properties in Low Depth Shrimp Ghers

Researchers: Dr. Khan Kamal Uddin Ahmed, Chief Scientific Officer
Md. MotiurRahman, Scientific Officer
Rakhi Das, Scientific Officer

Budget: Tk. 8,00,000.00

Objectives

- To survey and categorize the existing shrimp ghers based on water depth using altitude reading of GPS (Global Positioning System) meter
- To determine the limnological parameters of waters and chemical properties of soil in the ghers
- To generate inter-relationship between production performances and water depths
- To express the production performance of low depth gher through GIS mapping

Achievements

A comprehensive study was conducted to survey and categorize the existing shrimp ghers based on water depth using altitude reading of GPS meter in November/2016. For achieving objectives under this project, 120 ghers of Tala Upazila covering each Union were randomly surveyed in the year 2016-17. Among the ghers, 56% found between >1.5 to ≤ 3 ft depth, 19% below ≤ 1.5 ft and 25% > 3 ft.

Water quality parameters: The recorded mean water quality parameters are shown in Table 1. The mean water temperature recorded 23.77±1.1^{0}C, 24±1.18^{0}C and 24.27±1.14^{0}C in T_1, T_2 and T_3 treatments respectively. The pH of T_1, T_2 and T_3 ghers were recorded 8.08±0.19, 7.85±0.36 and 8.0±0.33 respectively. Dissolved Oxygen was found minimum in T_2 5.88±0.45mg/l, maximum in T_1 6.38±0.87mg/l and ammonia was recorded 0.01±.03, 0.014±.03 and 0.53±05 mg/l in T_1, T_2 and T_3 ghers respectively. The maximum salinity fluaction was recorded in T_3 3.86±0.72 ppt whereas the minimum salinity fluaction was observed at T_2 2.97±0.41ghers. The mean alkalinity was observed of 120±11.99, 117.77±16.12 and 134.44±21.23mg/l in T_1, T_2 and T_3 respectively. Presence of Iron found as 0.28+0.09, 0.22+0.05 and 0.33+0.05mg/l in T_1, T_2 and T_3 ghers respectively

Table1. Water quality parameters of low depth shrimp farms of Khesra Union, Tala, Sathkhira, Bangladesh

Parameters	T1 ≥3 Feet Depth Gher	T2 >1.5 to<3 Feet Depth Gher	T3 ≤ 1.5Feet Depth Gher
Water level	1.22±.38	0.67±0.55	0.32±.15
Temperature(^{o}C)	23.77±1.1	24±1.18	24.27±1.14
pH	8.08±0.19	7.85±0.36	8.0±0.33
DO (mg/l)	6.38±0.87	5.88±0.45	6.05±0.68
Salinity (ppt)	2.83±0.48	2.97±0.41	3.86±0.72
Alkalinity(mg/l)	120±11.99	117.77±16.12	134.44±21.23
Ammonia (mg/l)	0.01±.03	0.014±.03	0.53±05
Iron (mg/l)	0.28+0.09	0.22+0.05	0.33+0.05
Nitrate	0.29±0.17	0.25±0.19	0.38±0.11
PO_4^-	0.27+0.04	0.24+0.06	0.25+0.04

*Average values of 12 samples collected from December/2016 to May/2017. Sampling frequencies: Twice in every month

Soil quality parameters: The recorded average soil parameters are shown in Table 4. The values of organic matter were found as 2.23±0.32, 2.54±0.47 and 2.78±0.47% in T_1, T_2 and T_3 ghers respectively. The mean value of pH recorded as 8.04±0.09, 8.09±.06 and 8.05±.07 in T_1, T_2 and T_3 ghers respectively. The average value of soil salinity found higher in T_3 9.32±1.69 ds/m than those of T_1 (8.91±1.24ds/m) and T_2 (8.52±1.44ds/m). The average value of phosphorus was found higher in T_1 (20.29±5.62µg/g) followed by T_2 (15.16±3.06µg/g) and T_3 (14.78±5.26µg/g). Mean total nitrogen was found 0.12±0.01, 0.14±0.01 and 0.15±0.01% in T_1, T_2 and T_3 ghers respectively. The maximum potassium recorded at T_2 (0.64±0.10 m.eq./100g), whereas the minimum observed at T_2 (0.64±0.07eq./100g) during the experimental period. The presence of sulfur was maximum at T_3 (110.01±40.08µg/g) compared to T_1 (93.04±29.46/g) and T_2 (91.13±25.51 µg/g) ghers as well. The presence of iron was higher at T_1 (103.94+14.90µg/g) than those of T_2 (97.56±9.02 µg/g) and T_3 (89.52±7.27µg/g) ghers.

Table 2. Soil characteristics of low depth shrimp farms of Khesra Union, Tala, Sathkhira

Parameters	**T1 ≥3 Feet Depth Gher**	**T2 >1.5 to<3 Feet Depth Gher**	**T3 ≤ 1.5Feet Depth Gher**
Organic matter. (%)	2.23±0.32	2.54±0.47	2.78±0.47
pH	8.04±0.09	8.09±.06	8.05±.07
Salinity (EC) (ds/m*)	8.91±1.24	8.52±1.44	9.32±1.69
Phosphorus (µg/g)	20.29±5.62	15.16±3.06	14.78±5.26
Total N_2 (%)	0.12±0.01	0.14±0.01	0.15±0.01
Potassium (m.eq./100g)	0.64±0.08	0.64±0.10	0.64±0.07
Sulfur (µg/g)	93.04±29.46	91.13±25.51	110.01±40.08
Iron(µg/g)	103.94+14.90	97.56±9.02	89.52±7.27

* Average value of samples from December/16 to May/17Sampling frequencies: once in every month;1 ds/m equivalent 0.64 ppt

Qualitative and quantitative plankton counting of low depth shrimp farms: A number of zooplankton groups were found dominated over phytoplankton groups in low depth shrimp farming systems. Among the Zooplankton groups, Euglenophyceae, Rotifers, Copepods, Crustaceans and Phytoplankton groups Bacillariophyceae, Cyanophyceae, Chlorophyceaewere available in three treatments and higher quantities of zooplankton compared to phytoplankton were recorded which might be due to availability of nutrients and favorable water quality parameters in the low depth shrimp farms.

Table 3. Production performance of low depth shrimp ghers of Khesra Union of Tala Upazilla at Sathkhira District in Bangladesh

Gher categorization based on water depth	**Area/ha (Mean)**	**Stocking (Shrimp+ Tilapia)**	**Production**		**Production (Kg/ha)**	**Crop /Year**	**BCR**
			Shrimp Kg	Tilapia Kg			
≤ 1.5Feet	0.26	19266+600	-	70	269	Rice single, Fishes single	0.35
>1.5 to < 3 Feet	0.13	9730+350	13	50	484		1.05
≥3Feet	0.53	40582+1400	80	180	490		1.20

Development of Domesticated Quality Broods for Better Breeding Performance of Prawn (*Macrobrachium rosenbergii)*

Researchers: Md. Wahed Ali Pramanik, Deputy Director
Md. Motiur Rahman, Scientific Officer
Md. Shariful Islam, Scientific Officer

Budget: Tk. 9.00,000.00

Objectives

- To develop suitable technique for brood stock management
- To develop improved stock of prawn through selection programme
- To identify the optimum maturation age for better breeding performance
- To compare the breeding performance of wild and domesticated brood stock of prawn

Achievements

Domesticated quality brood development: In the year 2016-17, development of domesticated brood stock was one of the most important objectives of the research programme. Therefore, under the project good quality broods from three different sources viz. Balaswar river, Payra river and Local Ghers were collected and safely carried to the Shrimp Research Station (SRS) Hatchery. Brood from three different sources along with the brood developed in SRS pond complex were reared until hatching. Number of hatched larvae was approximately 30-35, 12-14, 45-50 and 60-65 thousand from Balaswar river, Payra river, Local ghers and SRS Brood (F2) where survival rate were 44%, 15%, 27% and 27% respectively. Number of PL produced in this year was 4875, 5650, 12800 and 16415 nos. from Balaswar river, Payra river, Local ghers and SRS F2 Brood respectively (Fig. 3). Some interesting findings revealed from the study were stage variation of the same age group larvae of different sources (Fig. 2).

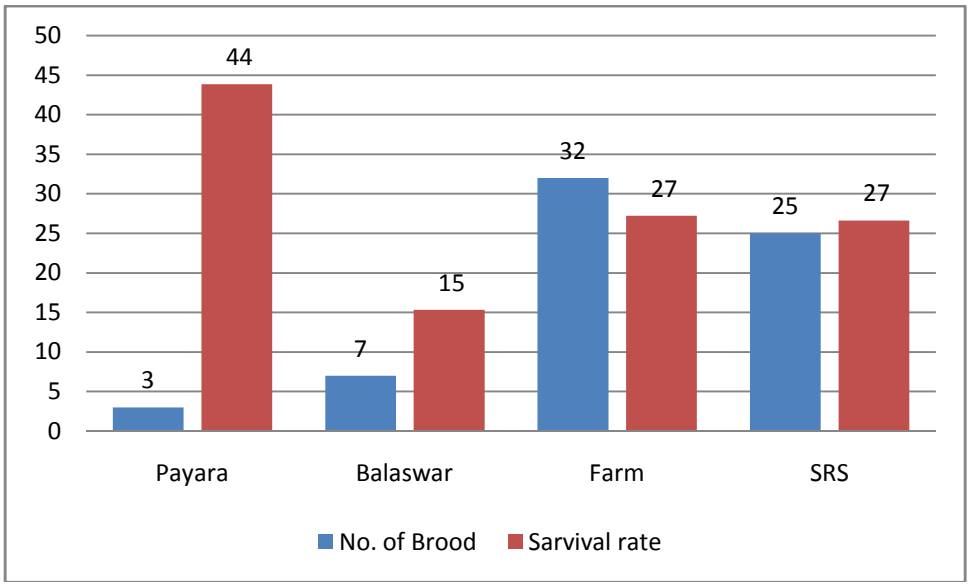


Fig. 1. Number of brood from different source and survival rate of PLs.

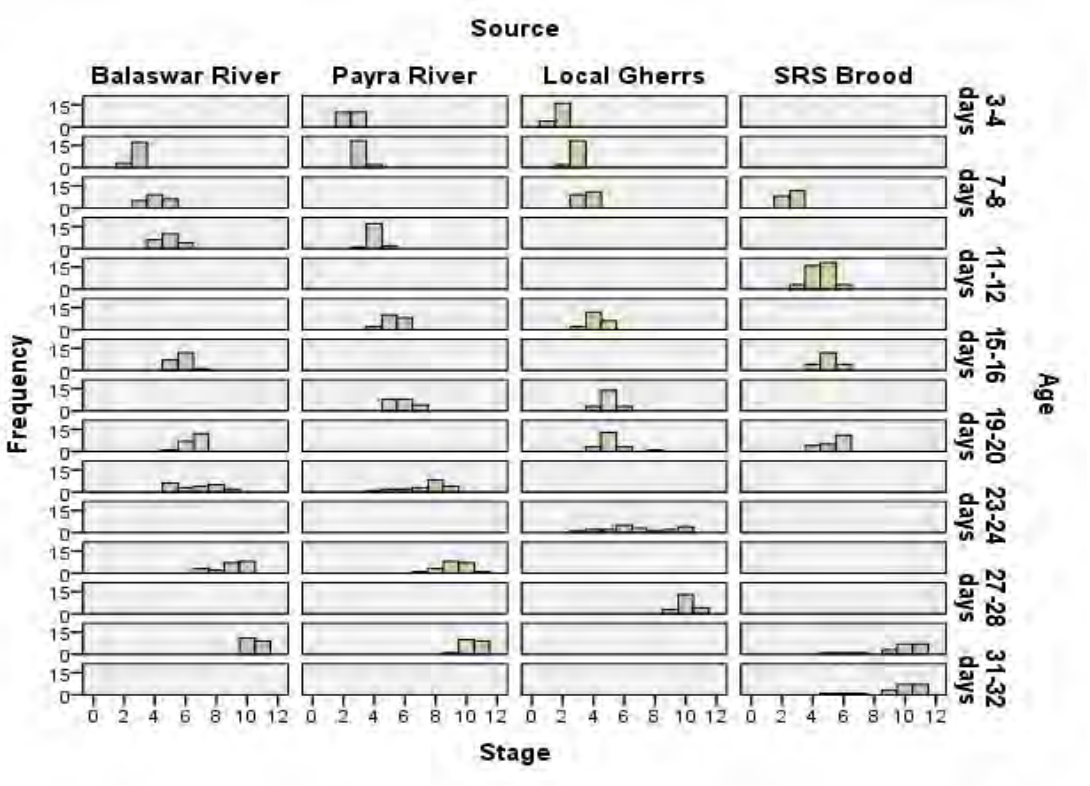


Fig. 2. Stage variation of different sources PLs.

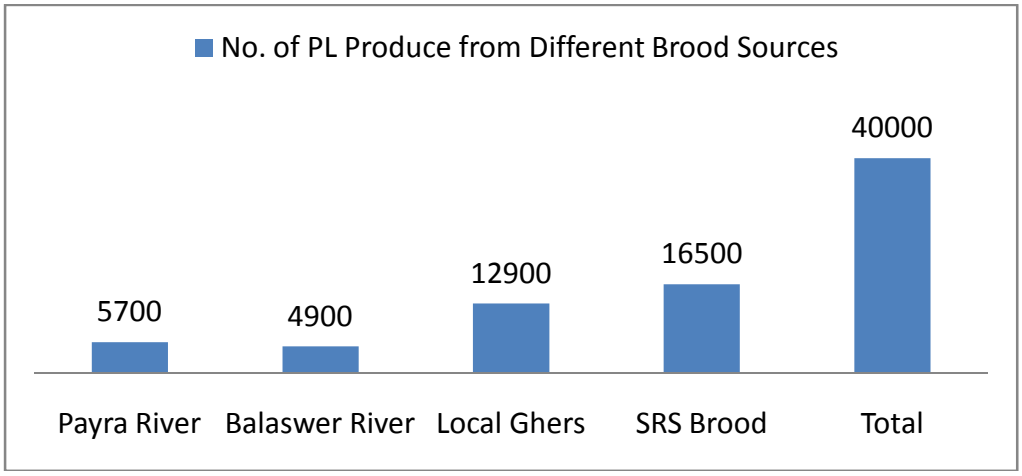


Fig. 3. Number of produce PLs from different sources.

Out of the four different sources survival rate of the PL from Pyara river found higher followed by SRS F2 generation and the brood from the local farm. Brood from Balaswar river gave poor result. For the presence of pathogenic bacteria, two different agar media were used to determine gram negative pathogenic enterobacter and vibrios (Tables 2-3). Bacterial loads of SRS Hatchery of different brood sources found lower than other hatcheries which indicates good hatchery management, however, larvae became reluctant to metamorphosis into PL even after 35 days of post hatching, thereby, ending to unpleasant conclusion.

Table 1. Water quality parameters of different hatcheries

Temperature	pH	Alkalinity	Nitrite	Nitrate
29.63±0.92	8.4±0.59	190±9.26	0.34±0.11	3.25±1.04
29.65±0.85	8.5±0.45	195±8.81	0.33±0.10	3.45±1.00
29.78±0.78	8.1±0.51	190±9.15	0.35±0.13	3.25±1.08
29.88±0.67	8.4±0.48	190±8.50	0.31±0.09	3.00±1.01

Table 2. Bacterial Load of different source (EMB Agar media)

Date	Balaswar River	Payra River	Local -1	Local-2	SRS Brood	BRAC Hatchery	Kakchira Hatchery
05-05-17	2.69×10^3	8.87×10^2	1.65×10^3				
07-05-17	1.48×10^4	4.91×10^2	1.21×10^4	1.34×10^4		7.84×10^4	
09-05-17	1.45×10^4	1.60×10^4	3.10×10^4	2.32×10^4			
14-05-17	8.91×10^4	1.80×10^4	9.58×10^3	1.97×10^4			
18-05-17	3.61×10^3	1.18×10^4	1.50×10^4	3.00×10^3			
22-05-17	1.24×10^4	3.34×10^4	8.09×10^4	2.00×10^5	1.04×10^4		1.78×10^5
26-05-17	7.65 x 10	2.93×10^3	7.62×10^3	1.00×10^2	1.18×10^5		
30-05-17	2.35×10^4	9.71×10^3	3.58×10^3	3.58×10^3	1.74×10^4		

Table 3. Bacterial load of different source (TCBS Agar media)

Date	Balaswar River	Payra River	Local -1	Local-2	SRS Brood	BRAC Hatchery	Kakchira Hatchery
05-05-17	1.26	1.69×10^2	2.06×10^3				
07-05-17	4.49×10^2	5.25×10^2	3.71×10^2	4.10		4.38×10^3	
09-05-17	26.66	3.000	1.10×10^2	1.16×10^2			
14-05-17	63.021	13.75	No Colony	No Colony			
18-05-17	No Colony	No Colony	No Colony	No Colony			
22-05-17	No Colony	2.288×10^2	No Colony	No Colony	No Colony		2.95×10^2
26-05-17	7.32	28.81	No Colony	1.61 x10	26.76		
30-05-17	72.16	39.71	7.41 x 10	No Colony	13.20		

*Allowable Range-10^3-10^4 cfu

Those PLs will be reared to develop domesticated brood through cross breading program. Where juveniles from different sources *viz.* Balaswar river, Payra river, Local ghers and SRS (F2) male will be reared with alternative sources female juvenile until attaining maturity. So, continuation of hatchery operation will be carried out in this year.

Surveillance and Distribution of Pathogenic Agents (Virus/Bacteria) of Shrimp/Prawn Disease in Bangladesh

Researchers: Dr. Khan Kamal Uddin Ahmed, Chief Scientific Officer
Md. Ariful Islam, Scientific Officer
Subrina Khatun, Scientific Officer
Md. Shariful Islam, Scientific Officer

Budget: Tk. 9.00,000.00

Objectives

- To Investigate the emerging diseases of shrimp and prawn
- To identify the pathogenic agent of NHP, EMS /AHPND and EHP using PCR
- To identify the Risk-factors of the disease invasion
- To identify the available strains of White Spot Syndrome Virus (WSSV) causing shrimp (*P. monodon*) mortality

Achievements

Investigation of emerging diseases was one of the most important objectives under this research program. Therefore, under the project 49 shrimp ghers and 9 hatcheries of Bagerhat, Khulna, Satkhira district were investigated randomly in context to aqua ecology and pathogens. From the sampling area samples were collected for PCR identification. From every sample, one set of Hepatopancreas (HP) was crushed and incubate over night at TCBS Agar Media. After overnight culture, greenish colonies collected and make pellet. Then these pellets were stored use for PCR identification by using IQ2000 toxin kit suggested method. Along with the bacterial pellets, raw HP and gill sample was used for PCR identification for EMS and WSSV detection (Fig. 1A).

Among those, 67% of them are EMS and WSSV positive where 32% found only EMS Positive, 16% found only EMS Toxin Positive, 12% found both EMS and WSSV Positive & 7% WSSV Positive (Fig.1B).

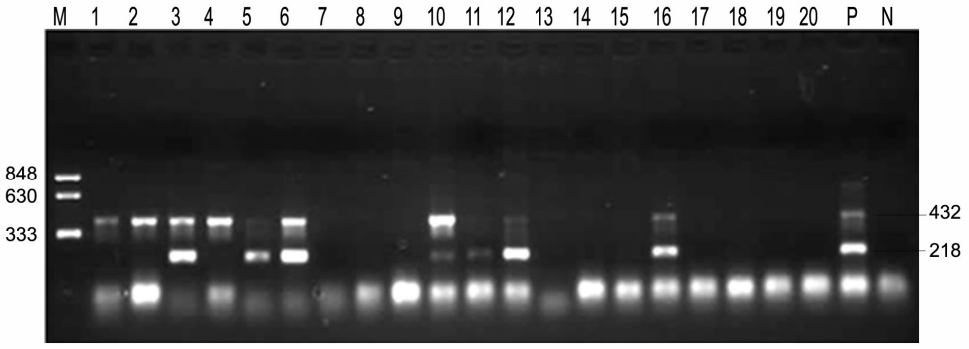


Fig. 1A. PCR identification report of 20 shrimp ghers samples collected from Satkhira, Khulna, Bagerhat. Here, B-reagent blank, P- positive control, N-negetive control, M -DNA Marker & number of samples. DNA amplicons at 432 and 218 bp refer to EMS positive. Amplicon at 432 is the representative of Toxin one deleted plasmid resembling amplicon at 218 for EMS Toxin plasmid.

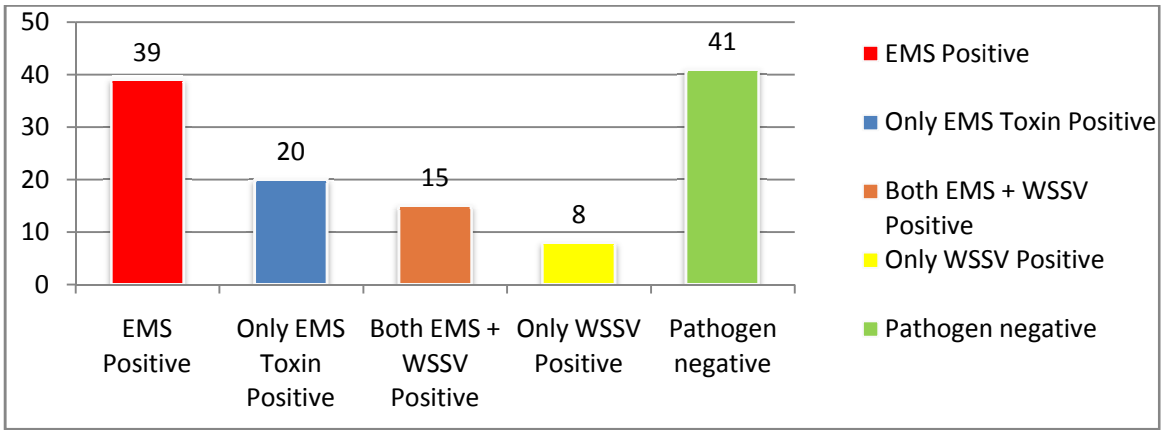


Fig. 1B. Status of the investigated shrimp ghers.

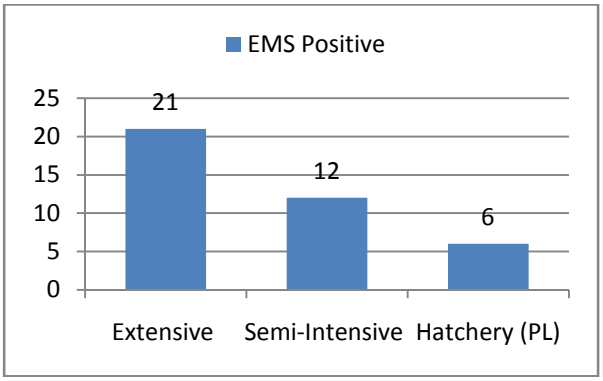


Fig. 2. Type of sampling area

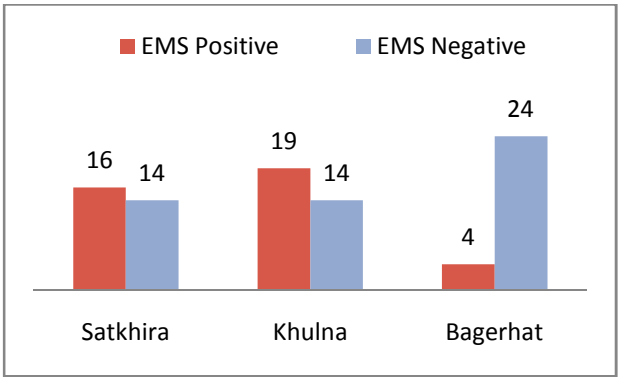


Fig. 3. Prevalence and distribution of EMS

Among the investigated ghers, 32 were Extensive ghers, 17 were Semi-intensive ghers and 9 were Bahda Hatchery (Fig.2). In Satkhira district, 16 samples found EMS positive out of 30 samples where 19 samples out of 33 were positive from Khulna districts. In case of Bagerhat districts, 4 samples were EMS positive out of 28 samples (Fig.3).

Apart from the disease identification of shrimp gher and hatcheries, three prawn hatcheries including SRS golda hatchery, BRAC hatchery and Kakchira hatchery was investigated for mass larval mortality issue. Bacterial colony count and MrNV viral test using PCR was carried out. Vibrio load was under the allowable limit, however, bacterial load for enteric bacilli was 1.34 x 10^4, 7.84x10^4 and 1.78 x 10^5 cfu for SRS golda hatchery, BRAC hatchery and Kakchira hatchery respectively. PCR showed few inspecific bands resembling MrNV positive (Fig. 4). More investigation along the line is therefore required.

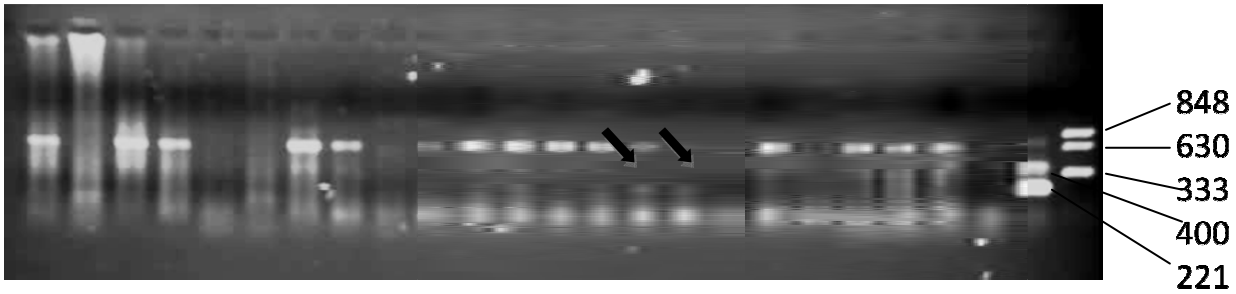


Fig. 4. PCR identification report of MrNV in *Macrobrachium rosenbergii* brood

Investigation of Shrimp/Prawn Farming Status in South-West Region of Bangladesh in Context with its Quality Control and Food Safety Issues

Researchers: Md. Ariful Islam, Scientific Officer
Subrina Khatun, Scientific Officer
Rakhi Das, Scientific Officer

Budget: Tk. 9.00,000.00

Objectives

- To survey the existing shrimp farms for exploration of its present farming status based on GAqP
- To assess the hazardous antibiotics/chemicals and pesticides residues for determination of shrimp/prawn quality of GAqP and non GAqP farms
- To explore the post-harvest management techniques of shrimp/prawn for ensuring its food safety issues

Achievements

Survey of the existing shrimp farms for exploration of its present farming status based on GAqP

A comprehensive survey was conducted randomly among 210 farms of Bagerhat Sadar Upazila covering 10 Unions. On the basis of surveyed data, the surveyed farms were categorized into 03 categories *viz. Category-A, Category-B and Category-C* where *Category-A* indicates the farms which comply 90-100% GAP criteria; *Category-B* indicates the farms which comply 70-< 90% GAP criteria and *Category-C* indicates the farms which comply 50-<70% GAP criteria. Then from the surveyed data, it was found that 1% farms were under Category-A, 40% farms were under Category-B and 50% farms were under Category-C. Rest of the farms are not follow the criteria of GAP. In Bagerhat Sadar Upazila, it was found that 05 semi-intensive farms are fully complying the 100% GAP criteria. Among those farms 02 farms has switched into finfish culture and only 03 farms are farming Shrimp.

Table 1. Present status of Shrimp farms at Bagerhat Sadar Upazila

Category of farms	Percentage of farms (%)
Category-A	1%
Category-B	40%
Category-C	50%
Out of GAP Category	9%

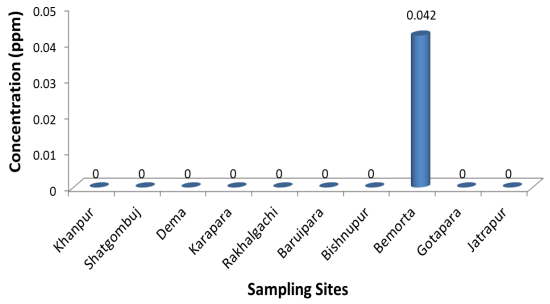
Assessment of the hazardous antibiotics/chemicals and pesticides residues for determination of shrimp/prawn quality of GAqP and non GAqP farms

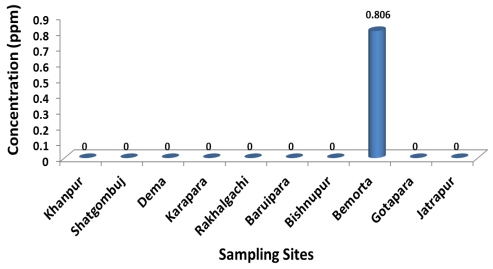
For analysis of banned antibiotic Nitrofuran, Shrimp/Prawn and water samples were collected from the selected 10 Unions of Bagerhat Sadar Upazila. Then samples were analyzed by LC-MS Machine using standard analysis protocol. No hazardous Nitrofuran metabolites were found from 40 nos. shrimp and water samples collected from sampling farms.

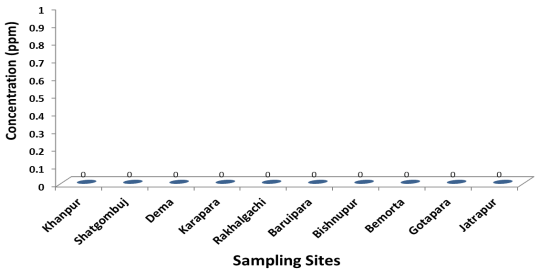
Table 2. Available pesticides used by the farmers in these selected sampling sites

Brand Name	Active Ingredients	Purpose of Use
WINTIN 3% WG	Ebamectin+Beta-cypermethrine	to control the insects of rice and vegetables
Valor 40 WG	Emamectin Benzoate 20% + Thiamethoxazam 20%	to control the insects
Nitro 50 EC	Chlorpyriphos + Cypermethrine	-do-
Dare 550 EC	Chlorpyriphos + Cypermethrine	to control the insects of rice and potato
Sydeor 550 EC	Chlorpyriphos + Cypermethrine	To control pest in rice field
HARVEST 50 SP	500 g Cartap per Kg	-do-
Sumithion 50 EC	Phenitothrione	-do-
Deovit 90 WP	90% Sulfer + 10% Bentonite	As growth enhancer of agro crops
SULFAVIT 80 WG	Active Sulpher	To control the fungal rotten of rice leaf
Dimethion	40 g active Dimrthoate/Litre	To control pest of rice

Water and Shrimp/Prawn samples were collected from 10 Unions of Bagerhat Sadar Upazila for pesticidal residue analysis. Analyses report from MS detector of Gass Chromatography shows that no residual concentrations of Heptachlor, Endrin, Dieldrin and DDT were found in water sample. In case of Prawn sample the residual concentration of Heptachlor was found as 0~0.042 ppm, concentration of Dieldrin was found as 0~0.806 ppm and Endrin residue concentration was found as 0~1.391 ppm from the samples collected from Bemarta Union only which was more than the EU acceptable limit (0.01 ppm). It is suspected that this is happened because farmers used few off labeled chemicals. From these chemicals this adulterant may occur because few stocks of banned dirty dozen are still remaining in Chittagong port. No residual concentration of others pesticides were found in the samples collected from the other Unions of Bagerhat Sadar Upazila.







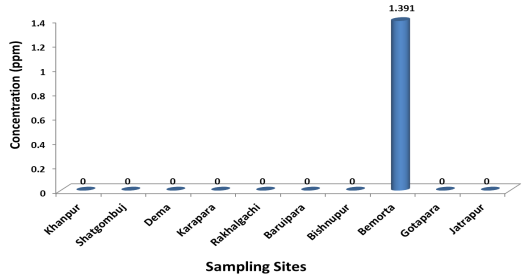


Table 3. Detected Pesticides concentration and risk based consumption limits for the contaminated shrimp/prawn.

Sampling Sites	Pesticides	ARL	BW (Kg)	CSF	Pesticides concentration Cm (ppm)	CR_{lim} (Kg/day)	CR_{mm} (Kg/yr)
B'hat Sadar	Heptachlor	0.00001	70	2	0.042	0.0083	13.35
	Dieldrin	0.00001	70	2	0.806	0.00043	0.692
	Endrin	0.00001	70	2	1.391	0.00025	0.402

Assessment of risk based consumption limits were conducted based on local and country-wide consumption rates for key species (DoF 2013) using the following two equation.

$$CR_{\text{lim}} = \frac{ARL \times BW}{CSF \times Cm}$$

Where CR_{lim} is the maximum allowable fish consumption rate (Kg/day), ARL the maximum acceptable individual lifetime risk level (10^{-5}), BW is the consumer body weight (70kg), Cm is the measured concentration of contaminant m in a given species of fish (mg/kg or ppm), and CSF is the cancer slop factor $[mg/kg\text{-}day)^{-1}]$

$$CRmm = \frac{CR\text{lim} \times Tap}{Ms}$$

Where CRmm is the maximum allowable fish consumption rate (meals per year). CR_{lim} is the maximum allowable fish consumption rate (kg/d). Tap is the time averaging period (365.25 days per year), and MS is the meal (0.227kg fish/meal)

This is mentioned that Cancer Slope factor, CSF for DDT=0.34, for others=2.0 (Hardell et al. 2010), Per capita fish consumption in Bangladesh is 51.89 g/day.

The experiment about the exploration of post-harvest management techniques of shrimp/prawn for ensuring its food safety issues is continued still now as final harvesting of shrimp and prawn is not completed yet. So far the bacterial loads are counting from different shrimp carrying media such as bamboo made basket, plastic box etc.

Cataloguing Marine Fisheries Resources of Bangladesh

Researchers: Dr. Md. Zulfikar Ali, Chief Scientific Officer
Mohammed Ashraful Haque, Senior Scientific Officer
JakiaHasan, Scientific Officer
Md. Mohidul Islam, Scientific Officer

Budget: Tk. 6,50,000.00

Objectives

- To create an up-to-date and complete species catalog of the fisheries resources with photographs, illustrations, taxonomic and relevant information
- To assess the temporal and spatial fisheries diversity in the marine ecosystem of Bangladesh
- To facilitate continued research and assessment at MFTS and IMSF through creating/improving fisheries museum and geo-informatics laboratory.

Achievements

Participatory workshop at MFTS, Cox's Bazar

Participatory workshop was held at the Marine Fisheries Technology Station (MFTS) Cox's Bazar on 09 April 2017. The team members from IMSF and MFTS were actively participated and discussed in details on objectives, methodology and activities.

Collection of fish specimen for systematic analysis

Fish samples from the selected locations have been collected following the protocol. Photography, morphometric and meristics database development are underway.



Photographs of some sampling activities of marine fish MFTS, Cox's Bazar

Identification of fish species

A total of 109 fish species under 51 families and 13 orders were preliminary identified.

Table 1. Identified fish species with class, order and family

Class	Order	Family	Species
Elasmobranchii	Orectlobiformes	1	1
	Carcharhiniformes	3	13
	Mylobatiformes	5	15
	Rhinobatiformes	2	2
Actinopterygii	Anguilliformes	2	2
	Aulopiformes	1	2
	Beloniformes	3	4
	Clupeiformes	5	11
	Mugiliformes	1	2
	Perciformes	23	49
	Pleuronectiformes	3	5
	Siluriformes	2	2
	Tetraodontiformes	1	2
Total	13	51	109

Table 2. Identified marine fish species

SL	Order	Family	Scientific name	Identifying character
1	Orectolobiformes	Hemiscyllidae	*Chiloscylliumgriseum*	Dorsal fins fairly large and rounded, somewhat smaller than pelvic fins.
2	Carcharhiniformes	Alopiidae	*Alopiaspelagius*	Length from caudal fork to upper caudal fin tip about as long as or longer than remaining body.
3	Carcharhiniformes	Carcharhinidae	*Prionaceglauca*	Body fusiform, moderately slender. First dorsal fin origin varying from just anterior to just behind pectoral fin free rear tips.
4	Carcharhiniformes	Carcharhinidae	*Scoliodonlaticaudus*	A small shark, with a very long, flat, laterally expanded and a stocky compressed body.
5	Carcharhiniformes	Carcharhinidae	*Carcharhinusam blyrhynchoides*	Snout short, pointed, inter dorsal ridge absent. Second dorsal fin origin about over or slightly in front of anal fin origin.
6	Carcharhiniformes	Carcharhinidae	*Carchahinusleucas*	Snout short and blunt, No inter dorsal ridge. Upper caudal fin with a thin dusky posterior margin.
7	Carcharhiniformes	Carcharhinidae	*Carchahinusamblyrhyn chos*	Snout moderately round, inter dorsal ridge week or absent. First dorsal fin origin over pectoral fin inner margins.
8	Carcharhiniformes	Carcharhinidae	*Rhizoprionodonacutus*	Relatively large eyes. Pectoral, pelvic, anal and lower caudal fin tips pale.Inter dorsal ridge absent. Second dorsal fin smaller than anal fin.
9	Carcharhiniformes	Carcharhinidae	*Carcharhinussorrah*	Moderately long pointed snout, inter dorsal present. First dorsal and upper caudal fins with dusky margin.
10	Carcharhiniformes	Carcharhinidae	*Carcharhinuslimbatus*	Snout long, pointed, inter dorsal ridge absent. First dorsal fin origin usually over or just behind pectoral fin insertion.
11	Carcharhiniformes	Carcharhinidae	*Carcharhinusmelanopte rus*	Snout short and bluntly rounded, No inter dorsal ridge. First dorsal fin and lower caudal fin tips distinctly black.
12	Carcharhiniformes	Carcharhinidae	*Galeocerdo cuvier*	Inter-dorsal ridge present between first dorsal fin and second dorsal fin.
13	Carcharhiniformes	Sphyridae	*Sphyrna lewini*	Anterior margin of head convex.
14	Mylobatiformes	Dasyatidae	*Himantura undulata*	2-3 slightly small thorns on central disc

15	Mylobatiformes	Dasyatidae	*Himanturauarnacoides*	Snout narrowly triangular moderately long. 1-3 large pearl thorns on central disc.
16	Mylobatiformes	Dasyatidae	*Himantura javaensis*	Snout long and broadly pointed. 1-3 small, seed or heart-shaped supras capular denticles.
17	Mylobatiformes	Dasyatidae	*Neotrygonkuhlii*	Snout short, broadly triangular with black bar through eyes. Few short thorns confined to midline disc. Bright blue sports on upper disc.
18	Mylobatiformes	Dasyatidae	*Himanturagerrardi*	Disk profile quadrangular. Upper disc usually with numerous white spots. Central disc usually with two 1-5 small thorns.
19	Mylobatiformes	Dasyatidae	*Himanturaleoparda*	Snout broadly triangular. Upper surface of disc almost straight. Board band of flat denticles on central disk with two heart-shaped thorns.
20	Mylobatiformes	Dasyatidae	*Himanturauarnak*	Snout broadly triangular. Anterior margin of disc leopard-like marking. Central disk with row of up to 15 heart-shaped thorns.
21	Mylobatiformes	Dasyatidae	*Himanturapolylepis*	Snout with long, sharp pointed tip. Central disc usually with two heart-shaped thorns.
22	Mylobatiformes	*Gymnur*idae	*Gymnura japonica*	Tail length from cloaca to tip half as long as snout-vent length or less. Tail with 9-10 dark bands.
23	Mylobatiformes	Gymnuridae	*Gymnurapoecilura*	Tail length from cloaca to tip nearly as long as snout-vent length. Tail with about 9 dark bands.
24	Mylobatiformes	Myliobatidae	*Aetobatusocellatus*	Snout moderately long, broadly rounded. Dorsal disc surface usually with numerous white spots. Nasal curtain V- shaped.
25	Mylobatiformes	Myliobatidae	*Aetomylaeusmaculatus*	Spiracles lateral on head. Upper surface brown with white spots. Tail more than twice body width.
26	Mylobatiformes	Rhinopteridae	*Rhinopterajavanica*	Snout strongly notched medially to form two lobes. Posterior margin of dorsal fin strongly concave.
27	Mylobatiformes	Mobulidae	*Mobula japonica*	Anterior margin of snout almost straight and wide. Dorsal fin conspicuously white tipped. Outer anterior margin of pectoral fin with slightly concavity.
28	Mylobatiformes	Mobulidae	*Mobulakuhlii*	Anterior margin of snout slightly concave. Dorsal fin not white tipped. Outer anterior margin of pectoral fin almost straight.
29	Rhinobatiformes	Rhynobatidae	*Glaucostegussp*	Snout tip pointed.Pectoral and Pelvic fins touching or overlapping. Spiracle with two low, widely separated distinct.
30	Rhinobatiformes	Rhynobatidae	*Rhinobatosobtusus*	Snout short, broad tipped and obtusely angular. Pectoral length less than 2 times mouth width.
31	Anguilliformes	Muraenesocidae	*Muraenesoxcinereus*	Teeth on vomer triangular
32	Anguilliformes	Muraenesocidae	*Muraenesoxtalabonoides*	Teeth on vomer needle-like
33	Clupeiformes	Clupeidae	*Tenualosaillsha*	Dorsal and ventral profile of body equally convex.Caudal fin as long as head
34	Clupeiformes	Clupeidae	*Hilsakelee*	A black spot on shoulder
35	Clupeiformes	Dussumieriidae	*Dussumieriaacuta*	Back iridescent blue with a shiny gold-brass line
36	Clupeiformes	Engraulididae	*Coiliamacrognathos*	Pectoral fin long, extends to anal fin origin
37	Clupeiformes	Engraulididae	*Setipinnataty*	Dorsal fin with scales. Pectoral fin long, extends to mid-part of the anal fin base
38	Clupeiformes	Engraulididae	*Stolephorus tri*	Cross section of body is oval .Caudal fin margin black
39	Clupeiformes	Engraulididae	*Thryssahamiltonii*	Upper jaw long, but not reaching to pectoral fin base.
40	Clupeiformes	Chirocentridae	*Chirocentriusdorab*	The black marking of the upper part of the dorsal

				fin.
41	Clupeiformes	Chirocentridae	*Chirocentriusnudus*	No black marking of the upper part of the dorsal fin.
42	Clupeiformes	Pristigasteridae	*Ilishaelogata*	Body rather deep, more than 2/5 BL.
43	Clupeiformes	Pristigasteridae	*Opisthopterustardoore*	Mouth superior, lower jaw projecting and upper jaw short
44	Siluriformes	Auriidae	*Arius thalassinus*	Anal fin-rays15-18, black spot on adipose fin pale or absent.
45	Siluriformes	Pangasiidae	*Pangasius pangasius*	
46	Aulopiformes	Harpadonthidae	Harpadon nehereus	Scales distributed only over posterior half of body
47	Beloniformes	Belonidae	*Tylosurusacusmelanotus*	No lateral keel present on caudal peduncle.
48	Beloniformes	Belonidae	*Ablenneshians*	Lateral keel present on caudal peduncle
49	Beloniformes	Exocoetidae	*Cypselurusnaresii*	No lateral keel present on caudal peduncle
50	Beloniformes	Hemiramphidae	*Hyporhamphusquoyi*	No blotches on body
51	Mugiliformes	Mugilidae	*Chelonsubviridis*	Body moderately compressed. Head nearly flet above.
52	Mugiliformes	Mugilidae	*Mugilcephalus*	Body slender elongated. Head wide , much compressed and pointed.
53	Perciformes	Serranidae	*Epinepheluscoioides*	Body spots large and yellowish brown, no pale spots scattered on body.
54	Perciformes	Rachycentridae	*Rachycentroncanadum*	Head depressed, spines of first dorsal fin isolated. Two silvery bands on flanks
55	Perciformes	Echeneidae	*Remora remora*	Sucking disc with16-20 laminae.
56	Perciformes	Echeneidae	*Echeneisnaucrates*	Sucking disc with 20-28 laminae.
57	Perciformes	Carangidae	*Parastromateusniger*	Gill opening large, reaching right down to ventral side of head.
58	Perciformes	Carangidae	*Elagatisbipinnulata*	Dorsal and anal fins with a finlet. snout very pointed
59	Perciformes	Carangidae	*Caranxignobilis*	Gill opening large, reaching right down to ventral side of head.
60	Perciformes	Carangidae	*Caranxsexfasciatus*	.Adipose tissue covers posterior part of eye opening.
61	Perciformes	Carangidae	*Selaroidesleptolepis*	A bright yellow bands on lateral line. Adipose tissue covers 1/3 of eye
62	Perciformes	Carangidae	*Megalaspiscordyla*	Dorsal and anal fins with several finlets.
63	Perciformes	Coryphaenidae	*Coryphaenahippurus*	Body compressed, back brilliant metallic blue/green in life.
64	Perciformes	Coryphaenidae	*Coryphaenaequiselis*	. Body compressed. Dorsal and anal fin black, head showing increase in steepness.
65	Perciformes	Drepaneidae	*Drepanepunctata*	Body with dark dotted cross lines
66	Perciformes	Haemulidae	*Pomadasysmaculatum*	Black bands across nape and back of body above lateral line.
67	Perciformes	Nemipteridae	*Nemipterusjapanicus*	Upper lobe of caudal fin extended into a filament.
68	Perciformes	Nemipteridae	*Nemipterusnematophorus*	First two spine of dorsal fin close together to form a long filament.
69	Perciformes	Sciaenidae	*Protonibeadiacanthus*	Numerous black spots on upper half of body and caudal fin and dorsal fin.
70	Perciformes	Sciaenidae	*Protonibeamaculatus*	Body slender, somewhat elongated, no bands on body, black spots on upper half of body.
71	Perciformes	Sciaenidae	*Otolithoidesbiauritus*	Caudal fin pointed and long. Lateral line golden yellow
72	Perciformes	Ephippididae	*Plataxtiera*	Snout slight convex. no dark band on caudal fin base.
73	Perciformes	Ephippididae	*Drepanepunctata*	Body with dark dotted cross line.
74	Perciformes	Ephippididae	*Ephippuorbis*	Dorsal fin spines distinguished from dorsal fin

75	Perciformes	Sphyraenidae	*Sphyraenaputnamiae*	Dorsal, caudal fins grayish
76	Perciformes	Sphyraenidae	*Sphyraenajello*	Dorsal, caudal fins blackish
77	Perciformes	Latidae	*Latescalcarifer*	Maxilla beyond eyes , nostril close together.
78	Perciformes	Lutjanidae	*Lutjanuserythtopterus*	Dorsal profile of head angular, snout steeply sloped. Caudal fin slightly forked.
79	Perciformes	Lutjanidae	*Lutjanusguilcheri*	Dorsal profile of head steeply sloped. Caudal fin slightly forked.
80	Perciformes	Lutjanidae	*Lutjanusjohnii*	Dorsal profile more convex than that of the abdomen. A round black spot on back.
81	Perciformes	Lutjanidae	*Lutjanuslemniscatus*	Dorsal profile of head steeply sloped. Caudal fin with broad lunar-shaped black marking.
82	Perciformes	Lutjanidae	*Lutjanusmalabaricus*	Mouth oblique. Dorsal and anal fins with a black edge and white external margin.
83	Perciformes	Priacanthidae	*Pricanthusmacracanthus*	Strongly compressed, oblong body. Mouth oblique. Caudal fin emarginated.
84	Perciformes	Polynemididae	*Polydactylusplebeius*	Medium to large size species with oblong. Free pectoral rays are five in number.
85	Perciformes	Polynemididae	*Filimanusxanthonema*	Body oblong. snout projecting, mouth large with small teeth, upper lip absent.
86	Perciformes	Polynemididae	*Leptomelanosomaindicum*	Slightly compressed body, snout prominent, pointed. Mouth large. Caudal deeply forked,
87	Perciformes	Polynemididae	*Polynemusparadiseus*	Elongated. Snout prominent, obtusely pointed.
88	Perciformes	Siganidae	*Siganuscorallinus*	White or whitish blue spots small, with darker margin.
89	Perciformes	Siganidae	*Siganuscanaliculatus*	White or whitish blue spots small, with darker margin
90	Perciformes	Siganidae	*Siganus javas*	Spots on lower half of body becoming short wavy horizontal bands
91	Perciformes	Trichiuridae	*Trichiurusjaponicus*	Pectoral fin short, about 1/3 head length
92	Perciformes	Trichiuridae	*Trichiurusjaponicus*	Pectoral fin short, about ½ head length.
93	Perciformes	Scombridae	*Euthynnusaffinis*	Black spot present below pectoral fin.
94	Perciformes	Scombridae	*Scomberomorusguttatus*	Body depth less than head length.
95	Perciformes	Scombridae	*Scomberomoruscommerson*	Lateral line abruptly bent downwards below second dorsal fin
96	Perciformes	Scombridae	*Gymnosardaunicor*	Posterior half of lateral line straight but wavy
97	Perciformes	Xiphidae	*Xiphiasgladius*	Eye large, upper jaw prolonged into a long bill. Two widely separated dorsal and anal fins in adults.
98	Perciformes	Istiophoridae	*Istiophorusplatypterus*	Two dorsal fins, close together, the first much longer than the second, greatly enlarge in the form of a sail.
99	Perciformes	Menidae	*Menemaculata*	Body extremely compressed Anal fin very long and low
100	Perciformes	Stromateidae	*Pampusargenteus*	Anterior part of dorsal and anal fins elongated to appear as sickle-shaped. Caudal fin well forked.
101	Perciformes	Stromateidae	*Pampuschinensis*	Anterior part of dorsal and anal fins not sickle-shaped but triangular. Caudal fin not forked.
102	Perciformes	Uranoscopidae	*Ichthyscopuslebeck*	Body cylindrical and tapering towards tail. Canary yellow with buffer brown enclosing white round spots.
103	Pleuronectiformes	Paralichthyidae	*Pseudorhombuselevatus*	A small dark blotch at junction of straight and curved part of lateral line.
104	Pleuronectiformes	Cynoglossidae	*Paraplagusiabilineata*	Lips without fringed tentacles.
105	Pleuronectiformes	Cynoglossidae	*Cynoglossusarel*	Body flat and elongate, rather pointed.
106	Pleuronectiformes	Cynoglossidae	*Cynoglossus lingua*	Body tongue-shaped, flat and elongate.
107	Pleuronectiformes	Soleidae	*Brachirus pan*	Body elongate and thick. Eyes on right side and close together.
108	Tetradontiformes	Tetradontidae	*Takifuguoblongus*	Fins stained with orange. Head and body covered with long spines.
109	Tetradontiformes	Tetradontidae	*Lagocephaluslunaris*	A yellowish line from eye to middle of caudal.

Investigation on the Spawning Season of Commercially Important Marine Fishes of the Bay of Bengal, Bangladesh Coast

Researchers: Dr. Shafiqur Rahman, Senior Scientific Officer
Md. Md. Shahzad Kuli Khan, Scientific Officer
Md. Mozammel Hoque, Scientific Officer

Budget: Tk. 5,00,000.00

Objectives

- To identify the spawning season of commercially important marine fishes through reproductive biology
- To determine justification of existing imposed banning period through assessing catch of marine fishes of bay of Bengal.

Achievements

Interview based survey for local knowledge and sample collection from different locations

Interview (with structured questionnaire) was conducted with the local fishermen, boatman & owners, aged group, businessmen, exporters over the major fish landing centers of Bangladesh i.e. Cox's Bazar (Fishery ghat, Nuniarchar, Bhora-chara, RejuKhal, Sona-para, Inani, Shaplapur, Teknaf), Chittagong (Fishery ghat,) for gathering local knowledge of commercially important marine fish, their habitat (place of the catch), lunar periodicity, catch trends and breeding seasons. The landing sites were visited fortnightly in all the seasons considering lunar cycle and species availability. Twenty three commercially important fish were identified under the six scheduled groups: pomfret, croaker, sardine, hilsa, scads & mackerels and ribbon fish. Group wise local Name, English name, scientific name and breeding seasons are given bellow:

Stromateidae and Carangidae: Pomphrets

Local Name	English Name	Scientific Name	Breeding season
Fali chanda	Silver pomfret	*Pampus aregentatus*	Peaks: April - June; late winter - summer
Rup chanda	Chinese pomfret	*Pampus chinensis*	Peaks: April - June; late winter - summer
Hail chanda	Black Pomfret	*Parastromateus niger*	Peak: August to Sept. Spawns July - Oct.

Sciaenidae: Jew fishes/croakers

Local Name	English Name	Scientific Name	Breeding season
Ketipoa	Hammer croaker	*Johniuse vogleri*	June to August
Bola/kuizza poa	Cuja bola	*Macrospinosa cuja*	Peak : Apl.-May; Lean :Oct.-Nov.
Kala poa	Sin croaker	*Johnius dussumieri*	June to August
LalPoa	Silver croaker	*Johnius argentatus*	Peak : April-May; Lean :Oct.-Nov
Gutipoa/ blotch	spotted croaker	*Pterolithusm aculatus*	spawning from June to August
Rupalipoa	Belanger's croaker	*Johnius belangerii*	Peak :Apl.-May; Lean: Oct.-Nov.

Sardine: Clupeidae

Local Name	English Name	Scientific Name	Breeding season

Sagar Chapila/ Jatrik	Fringe-scalesardine	*Sardinella fimbriat*	Nov. - May ; Pick : Oct. - Feb.
Colombo/Nailla	Rainbow sardine	*Dussumieria acuta*	Nov. - May ; Pick: Oct.-Feb
Taakia	Gold stripe-sardine	*Sardinella gibbosa*	April to Oct.; Peak : June -July
Khoira/Phansha	Black stripe sardine	*Sardinella melanura*	April to Oct; Peak : June -July

Shads

Local Name	English Name	Scientific Name	Breeding season
Padma Ilish	Shad	*Tenualosa ilisha*	April to June; Peak. Aug. to Oct.
Chandana /Kajl Iilish	Toli Shad/ Chinese herring	*Tenualosa toli*	Peak: Jun-Jul; April to October.
Gorta Ilish	Kelee Shad	*Hilsa kelee*	Peak : February

Scombridae: Mackerels

Local Name	English Name	Scientific Name	Breeding season
Aila/ Champa/ Kangkon	Indian Mackerel	*Rastrelliger kanagurta*	Peak: Jun-Sept; Lean :Apr-May
Champa	Short mackerel	*Rastrelliger brachysoma*	do
Champakadri	Queen fish	*Scomberoides commersonianus*	do
Maaita	king Mackeral	*Scomberomorus commerson*	Peak: Jun-Sept; Lean :Apr-May

Trichiuridae: Hairtail/Ribbon fishes

Local Name	English Name	Scientific Name	Breeding season
Gray (Kala) churi	Ribbon fishes	*Eupleurogrammus muticus*	Round of the year ; Peak: Jan.-June
White (Shada) Suri		*Lepturacanthus savala*	Round of the year; Peak: Dec -Jun
Big (Bhora) Churi)	ribbon fish	*Trichiurus lepturus*	Year round; Peak: Dec.-May/June.

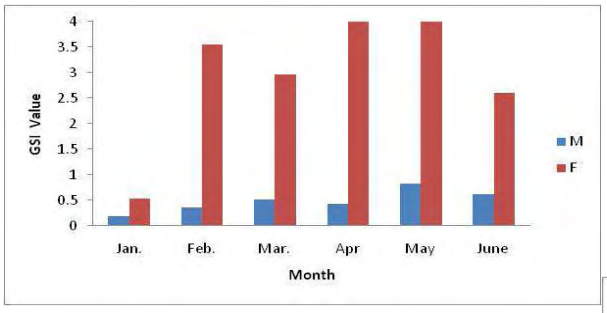
Gonadal biology study (based on histological analysis)

Two species of fish, *P. chinensis* and *J. argentatus,* were selected for the study of reproductive biology based on histological analysis in this year. Fresh fish sample were collected from daily fishing landing sites at Kalatoli area of Cox's Bazar. The length and weight of the fish and gonad were recorded with the help of a measuring tap (precision 0.1 mm) and sensitive electronic balance (accuracy 0.1 g).Ventral side of the fish was cut open from the anus towards the lower jaw by using scissors and the gonads were taken out carefully. The length and weight of the gonad was also recorded. Fecundity of fish during the breeding season was calculated by direct count (but if the eggs are tiny - followed methodical count). GSI was calculated using the following formula.

GSI= Weight of gonad (mg)/Weight of fish (mg)/ × 100

The sampled gonads was cut into small pieces of 1 cubic cm and was preserved in Bouin's fluid for at least 72 hours in a standard bottle and exchange the Bouin's fluid after that with 70% Ethanol. An exchange schedule was maintained with new 70% ethanol as delay for sending for histological analysis. For tissue histology, gonads were passed through graded alcohol series following standard protocol. After clearing, infiltration, embedding and sectioning the tissues was stained using routine haematoxylin-eosin protocol. Finally, the gonads tissue was observed under microscope after mounting. An electronic microscope equipped with a camera was used to capture histo-snaps of observed gonad sections. Interpretations of histo-snaps may provide precise results of spawning season of those species.

Fluctuation of GSI values reflects the aggregation-dispersion pattern of those fish (aggregation in March and April, dispersion in May and June) (Fig 1 & 2). So, besides histo- biological study, a year round catch assessment i.e. knowledge of quantitative aspects such as length-weight relationship, condition factor, growth, recruitment, and mortality may provide more precise information on aggregation-dispersion pattern of those fish.



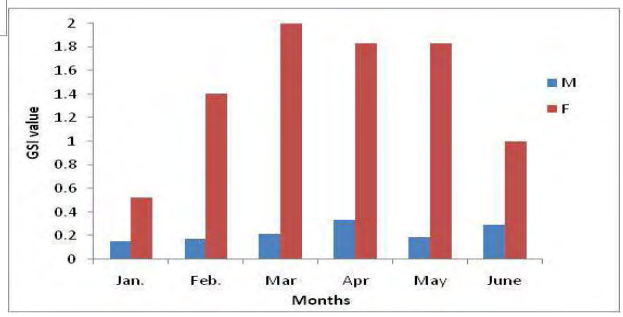


Fig. 1. GSI values of different months *P. chinensis* Fig. 2 GSI values of different months *J. argentatus*

Development of Culture of Seaweeds in North-eastern Coast of Bangladesh

Researchers: Dr. Md. Zulfikar Ali, Chief Scientific Officer
Md. Mohidul Islam, Scientific Officer
Jakia Hasan, Scientific Officer

Budget: Tk. 7,00,000.00

Objectives

- To make a detailed inventory of available seaweed species in Bangladesh coast
- To develop culture technique of seaweed in St. Martin and other suitable areas
- To investigate the nutritious value of seaweeds.

Achievements

Inventory of available seaweed

A detailed survey was conducted in and around Cox's Bazar (St. Martin Island, Shaporir dip, Inani, Bakkhali and Moheshkhali) during November 2016 to April 2017, two new seaweed species *Ulva lactuca* and *Chaetomorpha aerea* identified, a total 65 different species of seaweed i.e. *Actinotrichia fragilis,*

Asparagopsis taxiformis, Caulerpa sp., *Colpomenia* sp., *Chrysymenia* sp., *Enteromorpha* sp., *Gracilaria* sp., *Galauxara sp., Hypnea* sp., *Jania* sp., *Padina* sp., *Porphyra* sp., *Sargassum* sp., *Ulva* sp. (Table1) were collected randomly by hand-picking from the study area at the time of low-tide. Fresh samples were taken into plastic jars and then kept into icebox for laboratory work. In the laboratory, samples were gently brushed under running seawater, rinsed with distilled water, dried with paper tissue and finally preserve by open air drying.

Table 1. Seaweed species availability in different months

Scientific name	Type	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Actinotrichia fragilis	RSW		+	++	+	+	
Asparagopsis taxiformis	RSW			+	**+++**	++	
***Caulerpa* (3 sp).**	GSW		+	**+++**	**+++**	++	+
Chrysymenia sp.	RSW			+	++	+	
***Colpomenia* (2 sp).**	BSW		+	**+++**	+		
Dictyota (2 sp).	BSW		+	++	++	+	
***Enteromorpha* (3 sp).**	GSW	+	+	**+++**	**+++**	+	+
Galauxara sp.	RSW		+	++	++	+	
Gracilaria sp.	RSW			+	++	+	
Helimeda (2 sp).	GSW		+	+	+		
Hydroclathrus sp.	BSW		+	**+++**	**+++**	+	
***Hypnea* (4 sp).**	RSW	+	**+++**	**+++**	**+++**	**+++**	**+**
Jania sp.	RSW			++	+		
***Padina* (2 sp).**	BSW		+	**+++**	**+++**	+	
Peyssonellia sp.	RSW			+	+	+	
Porphyra sp.	RSW		+	+	+		
***Sargassum*(3 sp).**	BSW			++	**+++**	**+++**	**+**
Ulva sp.	GSW		+	++	+		
Jania rubens	RSW			+	++	+	

RSW = Red Seaweeds
BSW = Brown Seaweeds
GSW = Green Seaweeds

+ Normally available
++ Moderately available

Hydroclathrus clathratus *Padina tetrastromatica* *Jania rubens*

Fig. 1. Seaweed species collected from St. Martin, Inani, Bakkhali and Moheshkhali.

Seaweed culture

Experimental culture sites of seaweeds were sheltered intertidal zones of Saint Martin (N20°37.043, E092°19.715), Bakkhali river estuary (N21°28.500, E091°57.941) and Inani beach (N21°13.941, E092°02.596). Date of culture experiment set up was 01 January 2017, 15 and 30 December 2016 respectively. Coir rope was used as net material for substrate with horizontal net size of square (4m×4m). Four corners of the nets were tied with rocks or bamboo with plastics floats placed 25 cm above from the bottom. Micronutrients enriched seaweed species *Hypnea* sp. in three sites and *Caularpa racemosa* in Saint Martin were selected for culture. Seeding was done by inserting the young fragments of *Hypnea sp* & *Caularpa racemosa* with an average of 4±0.5kg fw (fresh weight) and 5cm length in the twists of the coir ropes with short length of string at a density of seaweed seed were 35-40 seed/m^2. Partial harvesting was done every 15 days of total 90 days culture period. Seaweed mean biomass was recorded at the end of 90 days of experiment and expressed as wet weight of seaweed per unit culture area (Kgm^{-2}) and computed with the following formula:

$$Y = (W_t - W_0)/A$$

Where: Y = biomass production;
W_t = wet weight at day t;
W_0 = initial wet weight;
A = area of 4 m^2 net.

Daily growth rate (DGR) % was calculated every 15 days of culture using a formula Hung *et al.* (2009).

$$DGR = [(W_t/W_0)^{1/t} - 1] \times 100 \text{ \% day}^{-1}$$

Where: W_0 is the initial weight, W_t is the final weight, and t is days of culture

Three (03) replications were trialed for each culture area of the species. The hydrological data and culture results are shown in Table 2.

Table 2. Hydrological data of the culture sites

Experimental sites	Mean values of hydrological data						
	Temperature (°C)	Salinity (‰)	DO (mg/l)	pH	Alkalinity (ppm)	Transparency (cm)	Depth (cm) at max. high tide
St. Martin	25.8	31.5	6.5	7.25	115	83.5	120
Bakkhali	24.8	28.5	5.5	5.9	110	65	135
Inani	25	30.0	6.3	6.5	120	73	110

Between December 2016 and March 2017, a total of 18 partial harvests of *Hypnea* sp. were made in three sites (Saint Martin, Bakkhali and Inani), 6 partial harvests in each sites. In Saint Martin, the maximum partial harvesting was recorded as 15.63±0.57 kg fresh wt at 75th day; the minimum 7.33±0.42 kg fresh wt. occurred at 15th day. In Bakkhali, a maximum 12.52±0.34 kg fresh wt. was partially harvested at 60th day; the minimum was 5.12±0.09 kg fresh wt. at 15th day. In Inani, the partial harvesting peaked at 10.62±0.41 kg fresh wt. at 60th day and the lowest was 5.28±0.20 kg fresh wt. at 15th day (Table.3)

Table 3. Shows the partial harvesting (Kg) of *Hypnea* sp. on 90 days of culture period in three sites

Culture sites	Partial harvesting *Hypnea* sp. (Mean±SD) Kg					
	15th day	30th day	45th day	60th day	75th day	90th day
St. Martin	7.33±0.42	9.30±0.22	12.88±0.32	15.46±0.10	15.63±0.57	12.65±0.23
Bakkhali	5.12±0.09	6.35±0.17	10.27±0.20	12.52±0.34	10.57±0.21	7.27±0.15
Inani	5.28±0.20	5.95±0.23	8.37±0.23	10.62±0.41	7.47±0.06	7.21±0.10

Maximum daily growth rate of *Hypnea* sp. 3.69±0.35% day^{-1} at 15th day and minimum daily growth rate 1.15±0.02 % day^{-1} was observed at 90th day in Saint Martin. In Bakkhali, the DGR value peaked at 1.90±0.04% day^{-1} at 45th day and the lowest was 0.59±0.02% day^{-1} at 90th day. In Inani, the DGR was at a maximum 1.68±0.22% day^{-1} at 15th day and minimum daily growth rate 0.59±0.02% day^{-1} was observed at 90th day harvest (Fig.2)

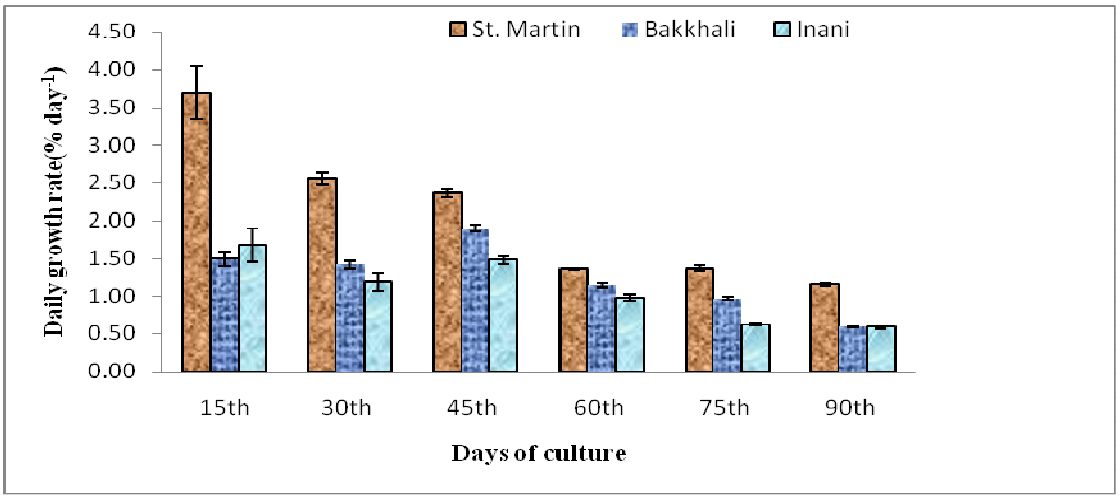


Fig. 2. Shows the daily growth rate % day^{-1}of *Hypnea* sp. on 90 days of culture period in three sites.

Harvest at the end of 90-day duration of culture period in three sites resulted in the absolute maximum biomass yields (17.31±0.23 kg fresh wt.m^{-2}) yielded in Saint Martin and the lowest biomass (10.23±0.53 kg fresh wt.m^{-2}) in Inani of *Hypnea* sp (Table 4).

Table 4. Shows the biomass production (Kg m^{-2}) of *Hypnea* sp. on 90 days of culture period in three sites

Culture sites	Biomass production (Mean±SD) Kg m^{-2}
St. Martin	17.31±0.23
Bakkhali	12.02±0.46
Inani	10.23±0.53

In Saint Martin, the maximum partial harvesting of *Caularpa racemosa* was recorded as 14.98±0.10 kg fresh wt at 60th day; the minimum 7.53±0.25 kg fresh wt. occurred at 90th day (Table 5) and Maximum daily growth rate 4.60±0.19% day^{-1} at 15th day and minimum daily growth rate 0.63±0.04 % day^{-1} was observed at 90th day in Saint Martin (Fig.3) Harvest at the end of 90 day duration of culture period in three sites resulted in the absolute biomass yields15.58±0.12 kg fresh wt.m^{-2}.

Table 5. Shows the partial harvesting (Kg) of *Caularpa racemosa* on 90 days of culture period in Saint Martin

Culture sites	*Hypnea* sp. DGR % day^{-1} (Mean±SD)					
	15th day	30th day	45th day	60th day	75th day	90th day
St. Martin	3.69±0.35	2.56±0.08	2.36±0.05	1.36±0.01	1.37±0.01	1.15±0.02
Bakkhali	1.49±0.10	1.42±0.06	1.90±0.04	1.14±0.03	1.14±0.03	0.59±0.04
Inani	1.68±0.22	1.19±0.12	1.48±0.05	0.98±0.04	0.98±0.04	0.59±0.02

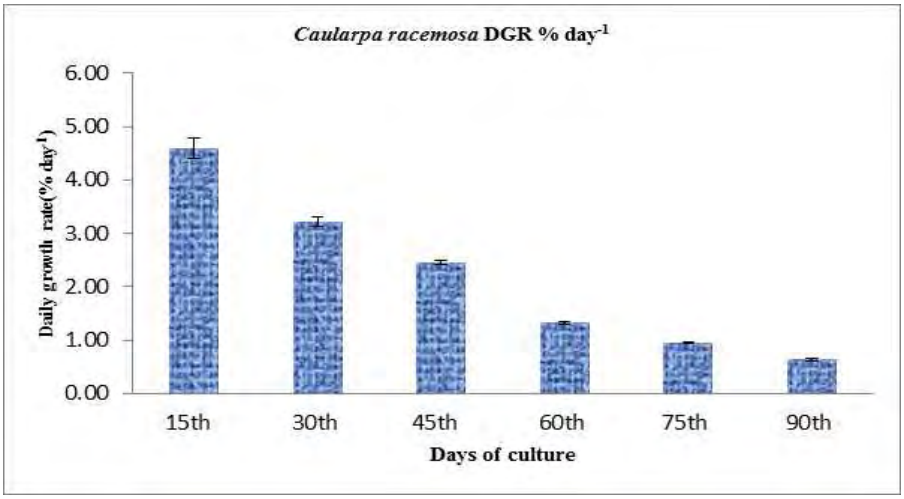


Fig. 3. Shows the daily growth rate % day^{-1}of *Caularpa racemosa* on 90 days of culture period in Saint Martin

Micronutrients contents

In Cox's Bazar coast *Hypnea sp* were cultured three locations (Saint Martin, Inani and Bakkhali) and *Caularpa racemosa* were cultured in Saint Martin and analyzed micro nutrient Calcium (Ca), Potassium (K), Iron (Fe), Copper (Cu), Zinc (Zn) and Iodine(I) content. Which shows that the rich amount of micronutrient and the highest found in Saint Martins cultured species (Table 3).

Table 3. Micronutrients in selected locations from Bangladesh coast

Parameter (mg/kg)	***Hypnea musciformis***			***Caularpa racemosa***
	Bakkhali	**Inani**	**Saint Martin**	**Saint Martin**
Calcium (Ca)	405	4969.33	19831.82	16248.93
Potassium (K)	891	16299.59	20525.94	9546.24
Iron (Fe)	3.03	62.41	540.61	436.08
Copper (Cu)	3.24	6.95	10.70	9.34
Zinc (Zn)	4.65	3.77	12.69	8.53
Iodine (I)	180	225	1125	1350

Seaweed product development: After washing by clear sea water then seaweeds (*Hypnea* sp. & *Caularpa racemosa)* washed by running tap water and finally washed by clean freshwater for used as an ingredient in various foods item to enrichment of food product and stored after air drying at room temperature for further use. Seaweed soup, seaweed pizza, seaweed pudding was prepared.

Fine Tuning of Mud Crab (*Scylla* spp.) Fattening Practices in Cox's Bazar Region

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Dr. Shafiqur Rahman, Senior Scientific Officer
Md. Mozzammel Hoque, Scientific Officer

Budget: Tk. 8,00,000.00

Objectives

- To demonstrate and standardize mud crab fattening (in pen and cage) in Cox's Bazar region
- To develop crab nursing technique for culture practice
- To build-up awareness and knowledge back-up of crab fatteners on improved crab fattening practices.

Achievements

During the crab fattening practice concurrently in pen and cages at Chaufoldondi, the water temperature was fluctuated between 27.5^0 to 35.5^0C. The salinity was ranged between 27‰ to 30‰. Dissolved oxygen content varied from 5.5 to 6.5 mg/l. The alkalinity was ranged between 110 to 130 mg/l and the pH values were between 6.5 to 7.2. The mean values of temperature, salinity, dissolved oxygen, alkalinity and pH was 32.29±1.16^{0}C, 29±2.01‰, 6.9±1.07 mg/l, 119±1.90 mg/l and 6.9±0.28, respectively during March 2017 to June 2017. Gonad development performance & survival of crabs in the 03 different trials is shown in Table 1.

Table 1. Crab fattening practice concurrently in pen and cages at Chaufoldondi, Cox's Bazar

Trial No.	Experiment (E_1- Pen culture, E_2- Cage culture)	Gonad development (%) in days			Survival (%)
		07 days	14 days	21 days	
01.(Mean weight of crabs 148g.)	E_1 (02 crabs/m^2)	--	30	78	78
	E_2 (1 crab/cage)	--	17	42	62
02.(Mean weight of crabs 158g.)	E_1 (02 crabs/m^2)	--	58	82	81
	E_2 (1 crab/cage)	--	42	68	69
03.(Mean weight of crabs 160g.)	E_1 (02 crabs/m^2)	--	66	80	82
	E_2 (1 crab/cage)	--	52	72	75

During the crablet nursing from 29 March, 2017 to 15 May, 2017 at Chaufoldondi, the highest temperature was recorded as 33.5 ^{0}C and the lowest temperature was 28.5 ^{0}C. The salinity was varied between 27‰ to 30‰. Dissolved oxygen content was 6.0 to 6.5 mg/l. The alkalinity was varied from 110 to 135 mg/l and the pH value was ranged between7.5 to 8.6. The mean values of temperature, salinity, dissolved oxygen, alkalinity and pH was 30.5±0.56^{0}C, 29±2.01‰, 6.21±0.19mg/l, 120.90±1.28 mg/l and 8.11±0.64 respectively.

The initial mean weight of crablet was 0.17 g. After feeding with trash fish in different trial in Earthen pond (E_1) & Hapa (E_2) the weight after 47 days was 7.5 g and 3.9 g and survival rate was 69% & 48% respectively is shown in Table 2.

Table 2. Crablet nursing trial in hapa at Nuniyarchara,Cox's Bazar

Experiment nos.	Crablets for each experiment	Initial weight (g)	Final Weight (g)	Survival (%)	Mean values of water quality parameters				
					Water temp. (°C)	Salinity (‰)	DO (mg/l)	Alkalinity (mg/l)	pH
E_1 (Earthen pond)	400	0.17	7.5	69	30.5±0.56	29±2.01	6.21±0.19	120.90±1.28	8.11±0.64
E_2 (Hapa)	90	0.17	3.9	48					

The crab fattening practice with the farmer in pen at Bodorkhali, the water temperature was fluctuated between 25.5^0 to 31.5^0C. The salinity was ranged between 26‰ to 30‰. Dissolved oxygen content varied from 6.5 to 7.5 mg/l. The alkalinity was ranged between 85 to 115 mg/l and the pH values were between 5.8 to 7.2 during February 2017 to May 2017 at the end of the trial period. Gonad development performance survival of crabs is shown in Table 3.

Table 3. Crab fattening practice in pen at Badorkhali, Chakariya, Cox's Bazar

Trial no.	Treatments	Gonad development (%)		Survival (%)
		7 days	14 days	
01	E1(2crab/m^2,Developed by BFRI)	48	90	86
	E2 (traditional method)	36	56	40
02	E1(2crab/m^2,Developed by BFRI)	53	87	82
	E2 (traditional method)	42	61	52
03	E1(2crab/m^2,Developed by BFRI)	59	92	88
	E2 (improved traditional)	56	67	63

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