

ANNUAL REPORT

2020-21



Bangladesh Fisheries Research Institute

Mymensingh

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Father of the Nation Bangabandhu Sheikh Mujibur Rahman



Sheikh Hasina
Hon'ble Prime Minister of the People's Republic of Bangladesh

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BFRI Annual Progress Report 15

Annual Report 2020-21

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Foreword

Aquaculture is the fastest growing food producing sector in the present world's context and has been recognized for its remarkable contribution in the country's export earnings and GDP. In order to uphold this substantial growth, the Bangladesh Fisheries Research Institute (BFRI) has so far developed 70 improved aquaculture and management technologies and a notable number of technologies have been disseminated to the field through Department of Fisheries (DoF) and NGOs. In this pandemic situation, the Government of Bangladesh is highly committed to meet nutritional food security for ever growing population using the existing fishery resources.

In this regard, the sector has given special emphasis to achieve the combined goals of SDG-2030, the 8th Five Year Plan and Vision-2041. BFRI has been conducting comprehensive research to conserve freshwater fish species from extinction and already developed the artificial breeding and culture technologies of the 31 endangered fish species. As a result, the production has been ameliorated and the availability of these fish species significantly increased in the local market. Bangladesh has also praised with a noteworthy production of hilsa in this Fiscal Year. Currently, BFRI is intensively working to conserve the genetic resources and non-conventional (crabs, seaweeds, oysters, snails etc) fishery items as well to achieve the Government stated goals and targets. Some of the recent research success has been depicted here.

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.

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 thirist 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.

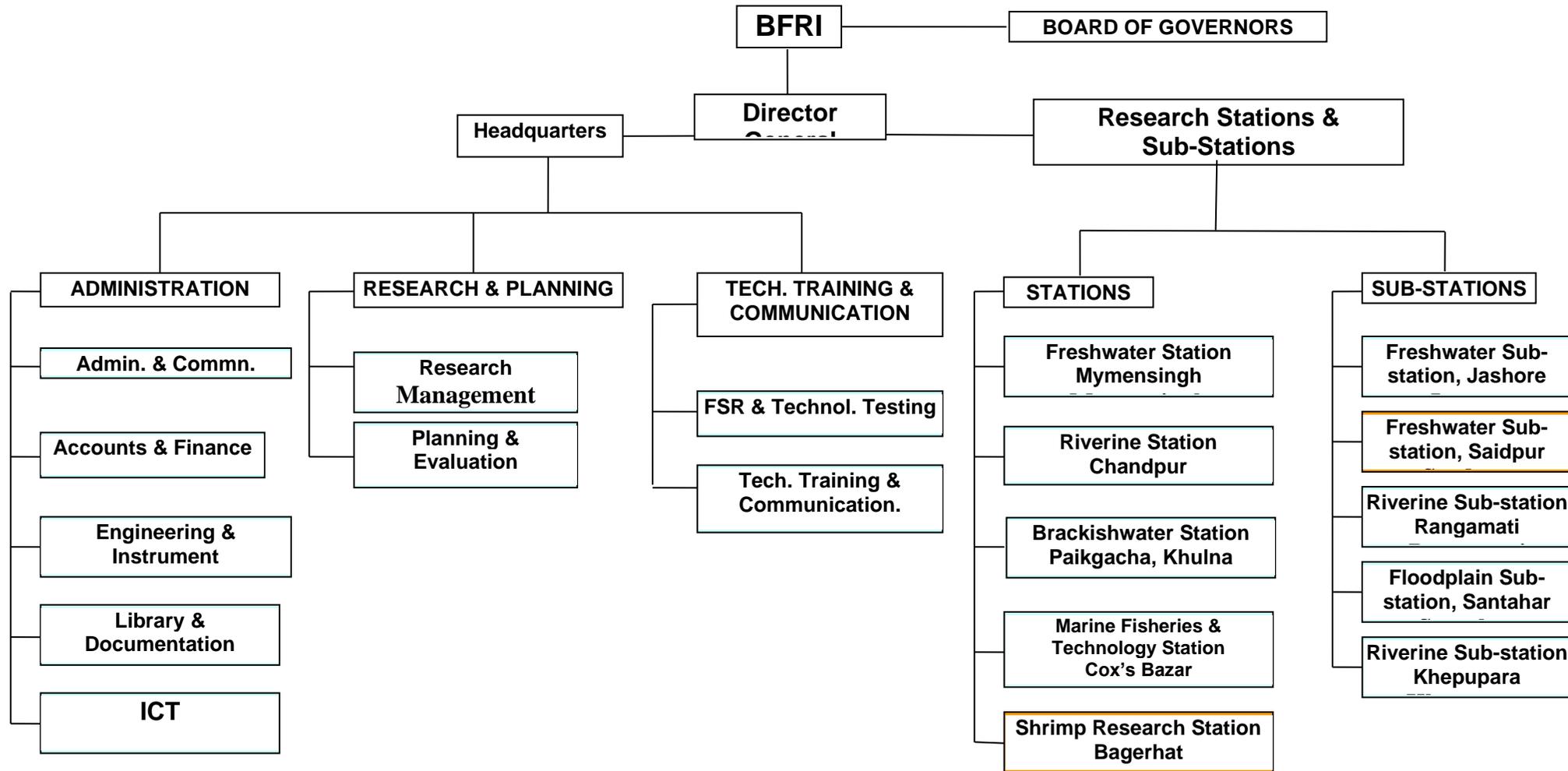
Stations and Sub-stations

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.

ORGANOGRAMME
Bangladesh Fisheries Research Institute
Mymensingh



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.



Mr. S M Rezaul Karim MP, hon'ble Minister for Fisheries & Livrstock inaugurated
The Live Gene Bank of BFRI.

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. The sub-station succeeds in breeding and culture of certain endangered fish species like., *Aspidoparia jaya* , *Neotropius atherinoides* etc.

Freshwater Sub-Station, Jashore: To support freshwater aquaculture farmers and hatchery operators of greater Jashore 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. The sub-station succeeds in breeding and culture of certain endangered fish species like., *Barilius* spp., *Mystus bleekeri*, *Labeo dero*, *Labeo angra* etc.

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 is 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 brackishwater 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, breeding, culture and fattening of mud crab (*Scylla* spp.), breeding and nursing of *Macrobrachium rosenbergii*, improved method of shrimp farming, breeding and culture of brackishwater catfish and green back mullet 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 a crab breeding hatchery, live feed laboratory, outdoor complex with 39 cisterns (200 m² each), residential buildings for officers and staff accommodation, service building and a 8-bed guest house. There is a new 7-storied laboratory cum office building now under construction.

The mandate of the station includes research on marine ecology, seaweeds culture, environmental studies, stock assessment and population dynamics of commercially important species, 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 consists 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	268	257	525	112	186	155	71

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 2020, the Institute has evolved more than 70 aquaculture and fisheries management technologies. Among them, 4 technologies have been developed during 2020-21 period and these are as follows:

- ✓ Artificial breeding and seed production of Jat Punti (*Puntius sophore*)
- ✓ Artificial breeding and seed production of Angus (*Labeo angra*)
- ✓ Artificial breeding and seed production of Kholisa (*Colisa fasciatus*)
- ✓ Artificial breeding and seed production of Boirali (*Barilius barila*)

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.

Award

Bangladesh Fisheries Research Institute was awarded the prestigious National Award Ekushey Padak 2020 in recognition of its outstanding contribution in Fisheries research and the Mercantile Bank Award 2019 as the best Institute for research in fisheries in Bangladesh.

Implementation of Development Project

Following 4 development projects have been implemented by the Institute during the 2020 to 2021:

Project Title	Cost (In Lakh Tk.)	Project Period	Objectives of the Project
Strengthening of Hilsa Research in Riverine Station, Chandpur	3353.90	January 2017-June 2021	<ul style="list-style-type: none"> • 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.
Strengthening Marine Fisheries Research and Infrastructure Development	4930.72	July 2017-June 2021	<ul style="list-style-type: none"> • To strengthen marine fisheries research capability in Bangladesh. • To develop strategy for the management of fisheries resources of the Bay of Bengal of Bangladesh. • To develop technology for the breeding and culture of commercially important marine species.

			<ul style="list-style-type: none"> • To develop post-harvest technology for proper utilization of marine fisheries resources of Bangladesh.
Conservation, Propagation & Culture of Mussels and Snails in Bangladesh	1130.00	July 2017- June 2021	<ul style="list-style-type: none"> • Development of population base line of mussels and snails in Bangladesh. • Development of seed production and culture technology of important mussels and snails. • Conservation of natural stock of mussels and snails. • Awareness development for conservation of mussels and snails, and hands-on training for extension workers, farmer and entrepreneurs.
Seaweed culture and seaweed product development in Bangladesh coast	1686.00	January 2018- December 2021	<ul style="list-style-type: none"> • To survey and identify the economically important seaweed from Bangladesh coast • To select proper culture area and sustainable development of different seaweed culture technology • To ensure the commercial utilization of seaweed derived from Bangladesh coast.

Training Programs

Training on different aspects of fisheries is utmost important for boosting -up of fish production and to ensure better management of aquatic resources. A series of well-structured training programs are organized by the Institute every year to disseminate the research evolved technologies to the end users. Moreover, effective transfer and dissemination of the technologies and management procedures such as training of extension workers both of Government and NGOs, teachers, students and Journalists are also organized by Institute. The training programs organized on different aspects are as follows:

- Improved fish culture and 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
- Seaweed culture and product development
- Effect of sanctuary on Hilsa production
- Culture technique of Mussels and Snails in Bangladesh

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

Training programs conducted: For boosting-up fish production and to ensure better utilization of aquatic resources, BFRI organizes series of training programs every year for farmers, entrepreneurs, unemployed youth, rural women and 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 July 2019-20 a total of 124 training batches were completed and 2,845 nos. of people were trained up by the Institute.

Institutional manpower development: For strengthening the capabilities of scientists, administrative and management personnel, the Institute organizes different in-country and overseas short-term and long-term training programs, study tour and experience-sharing visits. During 2019-20, a total of 13 scientist achieved overseas short-term and long-term training in 4 programs, besides, 14 different in-country training programs have been organized for the scientists and officers. 2 scientists have been awarded PhD from abroad

Workshop/Seminar organized: The Institute organized 8 numbers of National workshops and seminars in different disciplines to identify the problems and sharing and exchanging knowledge generated through research in this year. 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

Public Relations (PR) division of BFRI provides information among different stakeholder of fisheries sector and so on. Public Relations (PR) also give information as well as latest research success to the Press. During 2019-20 a total of 145 news and reports have been published in different print and electronic media including the daily Ittefaq, the daily Prothom Alo, the daily Jugantor, the daily Kaler Kantho, the daily Star, The daily Financial Express, the daily Bangladesh Pratidin and so on. Besides, some well circulated agri news magazines also publish BFRI news for example: Monthly Krishi Surakkha, Krishi Projukti, Monthly Khamar etc. In addition, BTV, ATN Bangla, Ekushey TV, Jamuna TV, Channel i, Channel 24, DBC, Independent etc. also broadcast BFRI news and achievements.

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

ক্রমিক নম্বর	প্রকাশনার নাম	প্রকাশনার ধরণ
১.	বিলুপ্তপ্রায় মাছের প্রজনন ও চাষ প্রযুক্তি নির্দেশিকা	প্রযুক্তি নির্দেশিকা
২.	Bangladesh Journal of Fisheries Research <i>Vol. 19(1-2), 2020</i>	জার্নাল
৩.	বৈরালি মাছের কৃত্রিম প্রজনন ও পোনা উৎপাদন কৌশল	লিফলেট
৪.	জাতপুঁটি মাছের কৃত্রিম প্রজনন ও পোনা উৎপাদন	লিফলেট
৫.	আঙ্গুস মাছের প্রজনন ও পোনা উৎপাদন কৌশল	লিফলেট
৬.	খলিশা মাছের কৃত্রিম প্রজনন ও পোনা উৎপাদন কলাকৌশল	লিফলেট
৭.	Fisheries Newsletter	নিউজলেটার

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, mariculture, 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 8,403 technical and general books 183 titles of scientific periodicals 2,900 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
- Reference service
- Bibliographical service
- Abstracting service
- SDI (Selective Dissemination Information) Service
- Internet Service
- Photocopy Service
- ASFA (Aquatic Sciences and Fisheries

iii) Monthly News
paper Articles

- 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)).
 - Hinari, AGORA, OARE, ARDI and GOALI (The Research4Life programme) Service

During the reporting period of July 2019 to June 2020, 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 programme with more than 75 leading national and international organizations. The category wise list is shown below:

Items	2020-2021
Books	185
Journals	07
Reports/Proceeding of seminars and workshops/papers	09
Newsletters/Bulletins/Reprints/Off prints	43
ASFA (Aquatic Sciences and Fisheries Abstract) DVD	up to 2017
TEEAL (The Essential Electronic Agricultural Library)	up to 2013

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 portion 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.

Receipts and expenditure: The institute received an amount of Tk. 3841.50 lakh during the year 2020-21 from the government revenue budget and the expenditure incurred of the financial year was Tk. 3846.49 lakh.

Income: During the financial year, the institute earned Tk. 28.00 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

Research Progress 2020-21



Freshwater Station

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

Researchers Dr. Md. Khalilur Rahman, Director General
 Dr. Md. Shaha Ali, Chief Scientific Officer
 A K M Saiful Islam, Senior Scientific Officer
 Dr. Jubaida Nasreen Akhter, Chief Scientific Officer

Objectives

- Study of the gonadal development and maturation of *Pangasianodongigas* through diets containing vitamin C and injection containing vitamins A, D and E.
- Development of induced breeding technique for *Pangasianodon gigas*.
- Development of rearing technique for *Pangasianodon gigas*.

Achivements

A total 07 eof fish was stocked and reared in the pond having an area of 40 decimal (P₁). The other pond having an area of 150 decimal (P₂) were harbored 42 fishes. Stocked fishes were fed with home-made feed containing about 28% proteinatat the rate of 1-3% body weight twice daily (Table-1). Locally and commercially available feed ingredients were used to formulate the feed. Feeding rate was 3% body weight in summer and 1% in winter.

Table 1. Ingredients and composition of non-pelleted Home-made feed for *P. gigas*

Feed Ingredients	% Composition	Protein (%)
Fish Meal	20	12.30
Mustard Oil Cake	15	6.36
Rice Bran	35	3.36
Wheat Bran	10	2.96
Maize Powder	20	2.52
Total	100	28.00
Vitamin Premix	1g/10 kg	
Tamarind (Tetul)	200g/10 kg	
Salt	2.50g/kg	
Rate:	1-3 BWD	
Frequency: 15:00-16:00)	2 times (9:00-10:00 &	

Maturity Assessment

In Pond₂, a total of 42 Giant Pangas, averaging 80 to 90 kg were housed with locally available fish feed. According to available literature, breeding season of Mekong Giant Pangas lies between June and August. In this connection fishes were checked from May to onward to get suitable broods for induced breeding. On 11th June 2020, the pond (P₂) was netted to gather all the reared fishes. Individual fish was checked by observing secondary sexual characters like soft & bulging belly, size, shape and color of genital opening.

Generally, female brood contain soft bulging belly with reddish oval genital opening. On the other hand, the male contains protrude and elongated reddish genital opening with running milt when pressed on the abdomen. Among the 42 reared fishes a total of 10 fish were found promising and were checked to get suitable broods for induced breeding. However, suitable and ready brood was not found during sampling (Table 2). It was assumed that the fishes are maturing with age as it takes 15-17 years to get maturity for the first time of their life. Details gonadal maturity is shown in the following table -2.

Table 2: Assessing gonadal maturity of *Pangasianodon gigas*

SL	Sex	Length (m)	Wt. (kg)	Physical Condition	Maturity Assessment
1	Female	1.70	84	Active, Strong & Moving	Oval reddish genital opening with hard belly
2	Female	1.75	89	Active, Strong & Moving	Oval reddish genital opening with hard belly
3	Female	1.74	90	Active, Strong & Moving	Oval reddish genital opening with hard belly
4	Male	1.68	72	Active, Strong & Moving	Distinguish reddish genital papilla, no milt was observed
5	Male	1.60	64	Active, Strong & Moving	Distinguish reddish genital papilla, no milt was observed
6	Female	1.74	94	Active, Strong & Moving	Oval reddish genital opening with hard belly
7	Female	1.78	96	Active, Strong & Moving	Oval reddish genital opening with hard belly
8	Female	1.76	95	Active, Strong & Moving	Oval reddish genital opening with hard belly
9	Female	1.74	94	Active, Strong & Moving	Oval reddish genital opening with hard belly
10	Male	1.63	75	Active, Strong & Moving	Distinguish reddish genital papilla, no milt was observed

One fish weighing 84 kg and 1.70 m long were sacrificed to check gonadal development. An incision was made from operculum to anus to open the belly. After opening the belly; it was found that the gonad was immature which was considering with the development stage II as described by Nikolosky (1963). Two egg lobes were recognised in the abdominal cavity and tiny eggs were found in the egg lobes. On 11th June of 2021, all stocked fish were examined to get ripe brood but no promising brood was found. Two fishes were sacrificed and found as immature male

Water Management in Experimental Pond

Water management has tremendous impacts on gonadal maturation. With view in mind, water shower was provided daily in each pond for 2-3 hours. Moreover, fresh water from a deep tube well was provided once a week to maintain required water depth. Colour of water of the experimental ponds was light greenish having no scum and off odour. The water quality parameters (Table-3) are suitable for culturing *Pangasianodon gigas*.

Table 3. Water Quality parameters of the experimental pond

Parameter	P ₁ (40 acre)	P ₂ (150 acre)
Temperature (°c)	27.50±2.58	27.40±2.32
pH range	7.80±0.35	7.60±0.23
Dissolved oxygen (mg/L)	5.80±0.62	5.70±0.46
Total alkalinity (mg/L)	128.70±3.63	129.90±5.04
Ammonia-nitrogen (mg/L)	0.00	0.00



Fisheries & Livestock Minister Mr. S M Rezaul Karim MP and the Secretary Mr. Rawnak Mahmud visiting the Mekong Giant Cat fish research program of FS, BFRI.

Stock improvement of major carps (Rohu and Catla) and DNA-barcoding of important Freshwater Fishes in Bangladesh

Researchers Dr. Jonaira Rashid, SSO

Objectives of the Project

- To improve Rui and Catla stocks using DNA technology
- To analyze genetic variability of Rohu stocks using DNA markers
- To identify freshwater fishes at the species level based on DNA barcoding data

Achievements

Experiment 1: Stock improvement of Rohu through DNA based protocol

Communal rearing was conducted to improve of BFRI Rohu through genetic selection process. 60 families (produced through single pair mating) of F₄ Rohu are being reared at two different stages over a period of 12 months. In the first stage (July 2020-December 2020), all the fishes were reared in one earthen pond of 50 decimal and a depth of 1m. The stocking density in this period was about 12 fish per decimal. In the second stage (January 2021-June 2021), best selected fishes (5 fish/decimal) are being reared in the new pond of 80 decimal with a water depth of 2 m for 6 months. Fishes were fed with commercial carp feed containing about 25-28 % protein at the rate of 3-5% body weight daily. Thirty fishes were used for monthly sampling. Growth performances of F₄ 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 F₄ Rohu are 37.34±1.68 (cm) and 810.92±34.39 (g), respectively.

Table 1. Growth performances of BFRI F₄ generation of Rohu in communal grow-out pond

Parameters	Initial status (July 2020)	Present status (June 2021)
Length (cm)	34.57±1.42	37.34±1.68
Weight (g)	506.25±49.92	810.92±34.39

Experiment 2: Stock improvement of Catla through DNA based protocol

The stock improvement of Catla fishes are being conducted using wild stocks. The collected wild stocks (The River Halda and Jamuna stocks) are being reared in earthen ponds with an average depth of 1 m located in the pond complex of Freshwater Station, Bangladesh Fisheries Research

Institute (BFRI), Mymensingh following all scientific management practices, including fertilization, liming, supplementary feeding and water management. Fishes were fed with supplementary feed containing 28-30% protein at 5-3% body weight daily. For stock improvement, collected Catla fishes from the River Halda were stocked in a pond having an area of 50 decimal. The average length and weight of stocked fishes were 39.5±5.83 (cm) and 873.50±360.09 (g), respectively. The stocked fishes are being fed with commercially available carp feed @ of 5-3% body weight once daily. The results of the present study on growth performances in terms of mean length and mean weight gain of Catla 46.75±5.12 (cm) and 1385.23±230.37(g), respectively are shown in Table 3.

Table 3. Growth performances of Catla (The River Halda origin) in grow out pond

Parameters	Initial status (July 2020)	Present status (June 2021)
Length (cm)	39.5±5.83	46.75±5.12
Weight (g)	873.50±360.09	1385.23±230.37

Another wild stock of Catla fish was collected from the River Jamuna that are being reared in the well-prepared pond having an area of 50 decimal using lime and fertilizer. Fishes are being fed with commercially available carp feed at 3-5% body weight daily. The results of the present study on growth performances in terms of mean length and mean weight gain of Catla (The River Jamuna origin) are 36.80±3.14 (cm) and 498.68±35.14 (g), respectively are shown in Table 4.

Table 4. Growth performances of Catla (The River Jamuna origin) in grow-out pond

Parameter	Initial Status (July 2020)	Present status (June 2021)
Length (cm)	26.88±2.27	36.80±3.14
Weight (g)	212.40±51.78	498.68±35.14

Experiment 3: Genetic evaluation of wild and BFRI Rohu (F₄) stocks

Genetic analysis of the River Halda, Jamuna and BFRI Rohu (F₄) stocks are being carried out to evaluate genetic variability of wild and BFRI Rohu stocks. To conduct this experiment, fish samples were collected from the Halda and Jamuna stocks during July 2020. In order to perform DNA analysis for genetic characterization, a total number of 30 fish samples were taken randomly from each stock. Fin samples were clipped from caudal fin of each fish without killing the fish using scissors and forceps after that immediately preserved in separate eppendorf tubes containing 95% ethanol. The eppendorf tubes containing fin samples were then brought to the Laboratory of Fish Genetics, Freshwater station, Bangladesh Fisheries Research Institute and were stored at -18°C. Genomic DNAs were extracted from fin tissues using commercially available kit (PureLink™ Genomic DNA Mini Kit, Invitrogen by Thermo Fisher Scientific, USA) following manufacturer's instructions. PCR reactions were performed on each DNA sample in a 20 µl reaction mix containing 1.5 µl of 20 pmol primer, 7.5 µl of DreamTaq PCR Master Mix (2X) (Thermo Fisher Scientific) and 50 ng of genomic DNA and a suitable amount of sterile deionized water. DNA amplification was performed in a thermal cycler (GeneAtlas Type G). The reaction mix was preheated at 94°C for 3 min followed by 40 cycles of 30 sec denaturation at 94°C, 1 min annealing at 34°C and extension at 72°C for 2 min. After the last cycle, a final step of 7 min at 72°C was added to allow complete extension of all amplified fragments. The amplified product from each sample was separated electrophoretically on 1% agarose gel (UltraPure™, Invitrogen by Thermo Fisher Scientific, USA) containing SYBR™Safe DNA Gel Stain (Invitrogen by Thermo Fisher Scientific,

USA) in 1X TAE buffer at 120 V for 30 minutes. A molecular weight marker DNA (1 kb ladder) was electrophoresed alongside the RAPD reactions. DNA bands were observed on UV-transilluminator and photographed with a Gel documentation system (Figure 1). The results of the present study are shown in Table 5.

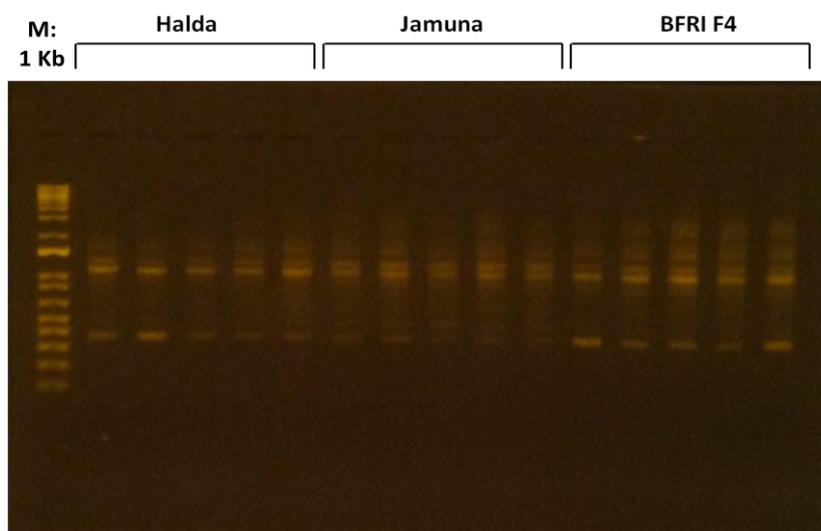


Figure. 1 Electrophoresis of amplified DNA samples of Rohu using OPG 02 primer. M: Molecular weight marker (1Kb DNA ladder)

Table 5: Number and proportion of polymorphic loci for the studied stocks

Stocks	No. of Polymorphic loci	Percentage of Polymorphic loci	Gene diversity (h^*)
Wild (Halda)	18	85.28	0.293±0.205
BFRI Rohu (F ₄)	15	71.43	0.271±0.198
Wild (Jamuna)	14	66.67	0.257±0.209

The highest number of polymorphic loci, Percentage of Polymorphic loci and *Gene diversity* (h^*) were found in the Halda stock, followed by BFRI Rohu (F₄) and Jamuna stocks. The Halda stock showed genetically superior status as compared with those of other two stocks.

Component B:

Experiment. 1 Identification and characterization of selected freshwater fishes based on DNA barcoding data

Fish samples are being collected from freshwater habitats, fish landing centers, fish markets or from the local fishermen. Immediately after the collecting the specimens, tissue samples are being stored in absolute ethanol. Approximately 100 mg of white muscle tissue from each specimen were preserved in 95% ethanol for genomic DNA isolation. Total genomic DNA are being extracted from the muscle tissue or fin tissue, using commercially available DNA extraction kit. For DNA barcoding, partial 5' region of COI gene are amplified in a final volume of 50 μ l with final concentration of 1X reaction buffer (10 mM Tris-HCl, 50 mM

KCl), 2.0 mM MgCl₂, 0.2 mM of dNTP mix, 10 pmol of forward and reverse primer, 2U of Taq DNA polymerase and 100 ng of template DNA. The primers for amplification of COI gene were selected as 5'-TCAACCAACCACAAAGACATTGGCAC-3' and 5' TAGACTTCTGGGTGGCCAAAGAATCA-3' (Ward et al., 2005) for sequencing of barcode region. Each reaction included a negative control (no template DNA) and were carried out in an thermal cycler under following thermal cycling conditions: initial denaturation at 95 °C for 4 min, followed by 35 cycles of denaturation at 94 °C for 35 sec, primer annealing at 52 °C for 30 sec and primer extension at 72 °C for 40 sec and final extension for 5 min at 72 °C. Amplified products of COI gene were separated on 1.5% agarose gel.

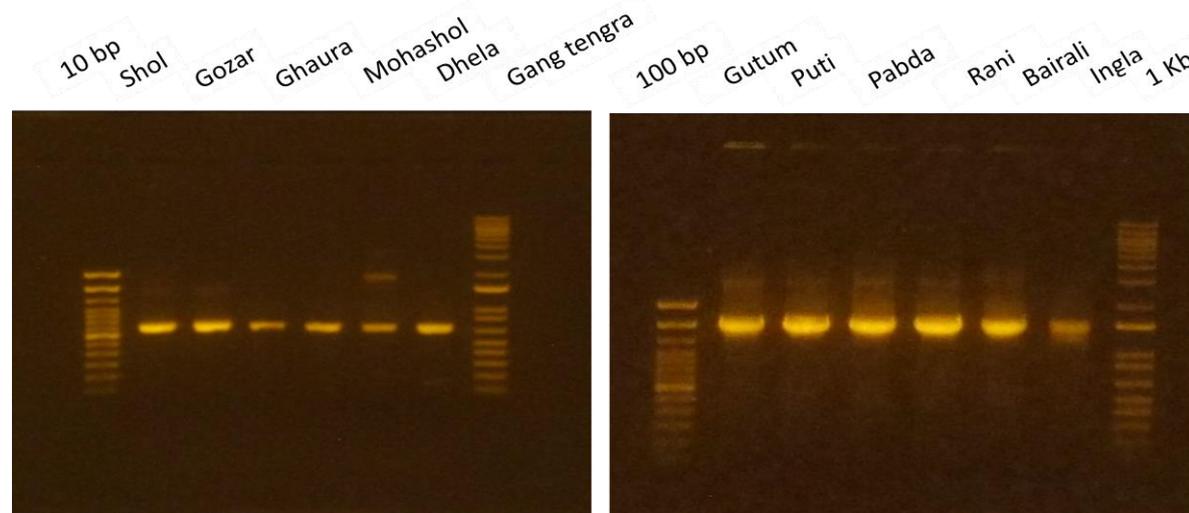


Figure. 2 PCR amplifications of 650 bp amplified product of mt-COI gene of selected fish species M: Molecular weight marker (1Kb and 100 bp DNA ladder)

COI genes were successfully amplified from Shol Gozar (*Channa marulius*), Ghaura (*Clupisoma garua*), Mohashol (*Tor tor*), Dhela, Gang tengra, Gutum, Deshi puti, Pabda, Rani, Bairali and Ingla fishes. The PCR products were purified using PureLink™ PCR purification kit and sequenced from **Apical Scientific Sdn Bhd**, Malaysia. Sequences were checked and aligned using Sequencher v5.4, and the datasets were compared to the NCBI NT database using BLASTn search for GenBank with referred accession numbers (Table 6).

Table 6: Identification and characterization of selected freshwater fishes based on DNA barcoding data

Sample ID	Fish sample collected	Highest BLASTn match with fish species	Similarity (%)	Genebank accession no.
1.	Shol	<i>Channa striata</i>	99	KJ936895.1
2.	Gozar	<i>Channa marulius</i>	99	KX389280.1
3.	Ghaura	<i>Clupisoma prateri</i>	99	KT762369.1
4.	Mohashol	<i>Tor tor</i>	99	KJ936789.1
5.	Dhela	<i>Osteobrama cotio</i>	99	KT762359.1
6.	Gang tengra	<i>Gagata sexualis</i>	99	DQ846703.1
7.	Gutum	<i>Lepidocephalichthys guntea</i>	99	MK572309.1
8.	Sharputi	<i>Puntius sarana</i>	99	KT364773.1

9.	Pabda	<i>Ompok bimaculatus</i>	99	MT654651.1
10.	Rani	<i>Botia dario</i>	99	KP974804.1
11.	Boirali	<i>Barilius bendelisis</i>	99	KJ936749.1
12.	Ingla/Khorsula	<i>Rhinomugil corsula</i>	99	KT364790.1

12 species were successfully identified at species level based on DNA barcoding data. Phylogenetic tree of 12 species were constructed using Multiple Sequence Alignment by ClustalW (Figure 3). The present study confirms the effectiveness of COI gene in identifying the freshwater fish species.

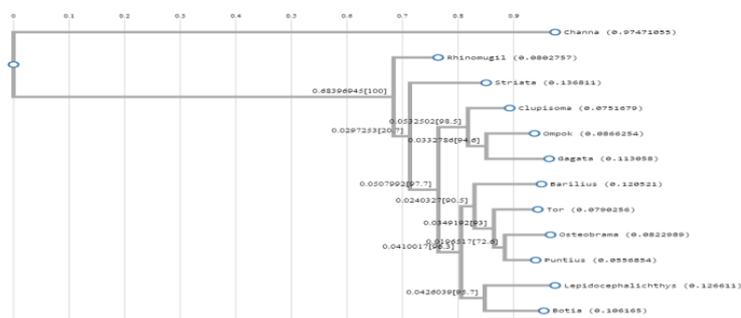


Figure 3. Phylogenetic tree of 12 species constructed using ClustalW.

Production Performance of Hairy River Prawn (*Macrobrachium rude*) with Feed and Fertilizer in Pond Condition

Reseachers MuhammodMominuzzaman Khan, Senior Scientific Officer & PI
Parvez Chowdhury, Senior Scientific Officer
Md. RabiulAwal, Scientific Officer

Objectives

- To determine the production potentials of *Macrobrachium rude* in pond under different stocking density
- To establish the feeding management of *Macrobrachium rude* in pond under different stocking density
- To know the economic benefit in such culture management

Achivements

Production potentials of Gura Chingri (*M. rude*) in pond under different stocking densities

The study was conducted in six earthen ponds situated in the freshwater station of BFRI, Mymensingh for a period of 05 months during the months of January-May, 2021. The ponds were equal in size and shape, depth and basin configuration including water supplyfacilities. The size of each pond was 200-300 m² each. The ponds were prepared by draining out the

water. Lime was applied at the rate of 250 kg/ha. One week after lime application, the ponds were filled with water. The water depth was maintained at 1.2m. To maintain water quality, the pond water was changed at regular intervals using water from a deep tube-well supply.

Collection of small prawn

Small prawn was collected for research from the Brahmaputra River in Mymensingh. Healthy and vigorous small prawn was collected and transported in oxy-polythene bags. The collected prawn then kept in cistern for acclimatization. After 06 hours of acclimatization, small prawns were transferred to the research ponds.

Table 1. Production of small prawn from the experimental pond

Treatments	Stock of small prawn (g)	Final harvesting (g)
T ₁	400	955
T ₂	800	1738
T ₃	1200	2780

After 02 months of stocking 170g, 280g, and 420g of *M. ruda* were partially harvested from T₁, T₂ and T₃, respectively. After completion of the culture period, final harvesting was done and total production was 955g, 1738g and 2780g from treatments T₁, T₂ and T₃ respectively.

Water quality parameters

Water quality parameters of different treatments were summarized in table 2. Water temperature of different ponds was more or less same. The mean temperature was 29.34±4.22°C, 29.62±4.14°C and 29.87±3.21°C in T₁, T₂, and T₃ respectively. The mean values of pH were 7.80±0.43, 7.75±0.38 and 7.78±0.31 in T₁, T₂ and T₃, respectively. The mean values of DO were 5.55±0.61, 5.49±0.72 and 5.75±0.79 in T₁, T₂ and T₃, respectively. The highest mean values of alkalinity were recorded in T₂ (148.7±8.65) and the lowest was T₁ (137.8±13.49).

Table 2. Water quality parameters of experimental ponds during January-May

Treatment	Water Temperature (°C)	pH	DO (mg/L)	Total Alkalinity (mg/L)
T ₁	29.34±4.22	7.80±0.43	5.55±0.61	137.8±13.49
T ₂	29.62±4.14	7.75±0.38	5.49±0.72	148.7±8.65
T ₃	29.87±3.21	7.78±0.31	5.75±0.79	141.4±9.5

Production potentials of *Macrobrachium ruda* in pond under different feeding management

The study was conducted within six earthen ponds situated in the freshwater station of BFRI, Mymensingh for a period of 05 months. The ponds were equal in size and shape. The size of pond is being having 200-300 m² each. The ponds were prepared by draining out the water. Lime was applied at the rate of 250 kg/ha. After lime application, the pond was filled up with

water. The water depth of the ponds was maintained to a maximum of 1.5 m. To maintain water quality, the pond water was changed at regular intervals using water from a deep tube-well supply.

Table 3. The layout of the experiment

Treatments	Replications	Prawn species	Feed Ingredients
T ₁	2 ponds	<i>M. rude</i>	Snails & mussels meat @ 8-3% estimated body weight
T ₂	2 ponds	<i>M. rude</i>	Fertilization
T ₃	2 ponds	<i>M. rude</i>	Commercial feed + Fertilization @ 8-3% estimated body weight

T₁ was conducted using snails & mussels without fertilization. Snails & mussel's meat was applied at the rate of 8-3% of estimated body weight as a supplementary feed. T₂ was conducted using fertilization for production of plankton in the pond water. T₃ was conducted using commercial feed & fertilization at the rate of 8-3% estimated body weight. Better growth rate was shown from T₁ where Snails & mussel's meat was applied. Lower growth rate was shown from T₂ where fertilizer was applied.

Experiment 3. The economic benefit analysis of Gura Chingri

The economic benefit analysis of Gura Chingri were summarized in Table 4 and 5. It appears from the (Table 4) that the total costs of Gura Chingri farming was about Tk. 81150.00. Also appears from the (Table 5) that the total production was 278 kg and its estimated value Tk. 139000. The net returns were Tk. 57850 and BCR was 1.71 from the experiment.

Table 4. Production cost of Gura Chingri

SL. No.	Elements	Taka
01	Pond preparation	3000.00
02	Lime	1700.00
03	Fertilizer	1250.00
04	Seeds	60000.00
05	Feeds	14200.00
06	Other	1000.00
Total		81150.00

Table 5. Sales price of Gura Chingri

Harvest	Production (kg)	Sale price/kg	Total price (Taka)
Partial harvest	42	500.00	21000.00
Full harvest	236	500.00	118000.00
Total=	278	-	139000.00

Net income= (139000.00-81150.00) taka =57850.00 taka

Species composition of *Macrobrachium spp.*

For determining the species composition of *Macrobrachium spp.* in natural condition, a total of 06 kg live *Macrobrachium spp.* were collected from Brahmaputra river during November 2020. After collection, *Macrobrachium spp.* were stocked in 03 ponds (02 kg in each pond) having area of 400 m² each. Before stocking, ponds were prepared properly. After one month of stocking, 50g of *Macrobrachium spp.* sample were collected from each pond using seine net. There after, *Macrobrachium spp.* was brought to the laboratory for species identification.

Results of pond wise species composition are shown in table 6. From T₁ a total number of 285 small prawn samples were examined and 03 species such as *M. lamarrei*, *M. rude* and *M. dayanum* were identified and recorded. The percentage of *M. lamarrei*, *M. rude* and *M. dayanum* were 55.08% 37.89% and 7.03%, respectively. From T₂ a total of 220 sample were examined among which 57.27% *M. lamarrei*, 36.82% *M. rude* and 5.91% *M. dayanum*. While, a total of 188 sample were examined from T₃ among them 42.02%, 46.28% and 11.70% were *M. lamarrei*, *M. rude* and *M. dayanum*, respectively. It was observed that the percentage of *M. lamarrei* was the highest among them 03 species of identified *Macrobrachium spp.*

Table 6. Species composition of *Macrobrachium spp.* identified from the experimental pond.

Species	T ₁	T ₂	T ₃	Average (%)
<i>M. lamarrei</i>	55.08%	57.27%	42.02%	51.46
<i>M. rude</i>	37.89%	36.82%	46.28%	40.33
<i>M. dayanum</i>	7.03%	5.91%	11.70%	8.21



M. rude



M. lamarrei



M. dayanum

Figure: Identified different species of *Macrobrachium spp.*

Determination of breeding intensity of GuraChingri in pond condition

The experiment was conducted within six glass nylon hapain pond condition for a period of 05 months at freshwater station of BFRI, Mymensingh. All the hapa were equal in size and shape including water supply facilities. Aquatic weeds were used in hapa as shelter for small prawn.

Table 7. Breeding intensity of GuraChingri found from the experimental pond

Species	Egg color	Fecundity (Nos.)	Maturity(days)	Breeding season	Temp. (°C)
<i>M. rude</i>	greenish	95±05	85-90	round the year	20-32
<i>M. lamarrei</i>	greenish	235±13	80-95	round the year	20-32
<i>M. dayanum</i>	blackish	195±10	110-120	December-April	18-32

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

Reserchers Dr. A. H. M. Kohinoor, Chief Scientific Officer
Dr. Jonaira Rashid, Senior Scientific Officer
Md. Nahiduzaman, Scientific Officer

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 develop MAS-selected YY super-males

Achivements

Expt. I: Family Selection Program of BFRI-GIFT using family selection protocol

Applying following family selection protocol, F-14 generation of BFRI GIFT was developed:

Breeding pond preparation

For individual family production, breeding pond having an area of 1000m² was prepared through pond drying followed by liming at the rate of 250 kg/ha. After pond preparation, pond was filled upto the depth of 1.0 meter with underground water after three days of liming. Pond was fertilized with Urea and TSP at the rate of 25 kg/ha.

Setting of breeding hapa

In the prepared pond, 50 breeding hapas were set up with bamboo pools. The size of breeding hapa was 1.0m³.

Nursing in hapa

In the hapa, brood Tilapia fish bred naturally. Tiny fry from each progeny group were shifted to a series of nursery hapas in a pond on 31 August 2020. The fry were fed with nursery feed containing 30% protein at the rate of 20% of estimated body weight. After one month of primary nursing (30 September, 2020), the progeny of each family were again shifted to secondary nursery hapas. A total of 150 fry of each progeny group were transferred to 50 rearing hapas (2.0 m³ size). Supplementary feed (Nursery Floating) was supplied in all the hapas at the rate of 15% of estimated biomass.

Communal rearing

A total of 10 male and 10 female of each progeny group were selected and tagged them in the third week of November. Tagged fishes were stocked in a pond (1000m²) for communal rearing. During tagging, tag number, body weight and total length were recorded. Fishes were fed with supplementary feed containing 28% crude proteins at the rate of 4-8% of estimated bodyweight.

Harvesting of fish

In April 2021, all fishes were recaptured by seine netting followed by dry out the pond. Length and weight of fish from each family were recorded.

Data analysis

All recorded data were analyzed for estimating breeding values. On the basis of breeding value, breeding line will be prepared for the production of next generation.

Evaluation of F-14 Generation of GIFT strain in pond ecology

A trial was conducted during July to October for evaluating the growth performances of F-14 generation of GIFT. There were two treatments. Treatment-1 was stocked with F-14 generation of GIFT in 03 net cages (3.0 m³), while treatment-2 with offspring of founder generation in another 03 net cages. In each treatment 50/m³ fry were stocked for rearing. The initial mean weight of upgraded BFRI-GIFT (F-14) and fry of non selected GIFT strain were 4.50±0.75 and 4.40±0.62g, respectively. Fry were fed with supplementary feed (Floating feed) containing 28% crude protein at the rate of 6-8% of estimated biomass at twice daily. Fish were sampled at fortnightly intervals to measure the growth and feed adjustment. Fishes were harvested after five months rearing. Individual weight and number of fish from each cage were recorded. Mean harvesting data showed that growth rate of the selected GIFT was always higher than offspring of founder generation. The mean weight of treatment-1 and treatment-2 were 228±5.21 and 137±7.88g, respectively. The results showed that upgraded fish had 66.42% higher harvest weight than that of the non selected GIFT strain.

Expt. II: YY GIFT production using Marker-assisted selection

The following steps were followed for YY GIFT production

Pseudo female production

In 16 March 2021, 05 hapas were set up in a breeding pond. Then single pair of mature GIFT tilapia was stocked in a hapa. The average weight of Male GIFT tilapia and Female GIFT tilapia were 162 ± 5.20 g and 141 ± 6.87 g, respectively. After 12 days of stocking, full sib fertilized eggs were collected and kept in the hatching jar for incubation. After yolk sac absorption, the 500 offspring of 5 full sib families transferred in 05 minicisterns. Diethylstilbestrol (DES) hormone was fed @ 0.50g/kg feed for 21 days. The hormone feeds were provided to the fry thrice a day from the first feeding stage up to 21 days. A total of 500 offspring of 5 full sib families each also transferred in another 05 cisterns as control group. Fry from this group were fed with normal nursery feed. After 21 days of hormone treatment, both groups of fry were transferred to hapa in pond condition.

Rearing of treated and control Group

For rearing of both treated and control group, 10 net cages having 2.0 m³ were set up in a pond. During second week of June/21, 05 net cages were stocked with treated tilapia and control group were stocked in rest 05 net cages at the density of 300 individual/net cages. During stocking in net cages, the initial weight of treated and control Group were 4.25 ± 0.58 g and 4.10 ± 0 .

Expt. III: Stock improvement of Vietnamese Koi (*A. testudineus*) through Brood Stock Replacement techniques (F-5 generation)

Stock improvements of Vietnamese Koi (*A. testudineus*) through Brood Stock Replacement (BSR) techniques were followed for the production of F-5 generation.

Nursing Pond Preparation

For nursing of F-4 generation of Vietnamese Koi, four nursing ponds were selected having an area of 300m² each. The dried ponds were then limed at the rate of 250 kg/ha. Deep tubewell water was supplied to ponds and filled up to the depth of 1 meter after liming.

Stocking of Selected Fry

F-5 generation of Vietnamese Koi spawn was nursed in four nursery ponds. After nursing, 500 fry from each nursery pond were selected and stocked in one prepared rearing pond during August 2020. The initial mean weight of Vietnamese Koi was 4.22 ± 0.82 g. As such 2000 fry of F-4 generation of Vietnamese Koi were reared in pond for brood development.

Post Stocking Management

Vietnamese Koi was fed with supplementary feed containing 30% protein at 4-10% of estimated body weight. Lime and table salt were applied in the rearing pond at the rate of 50 and 125 kg/ha, respectively. Freshwater from deep tubewell was supplied to the pond at

three days interval to maintain average water depth upto 1.0 meter. After four months of rearing, the sampling weight of Vietnamese Koi is 152 ± 11.20 g.

For the production of F-5 generation, the following protocols were followed during April-May 2021:

- 40 breeding hapas of 2 x 2 x 1 m size were set up in pond.
- The fishes were mated in 5 pair crosses in a single hapa to ensure equal numbers of male and female fish.
- These activities were completed in four batch breeding.
- After breeding, about 20g of hatchlings from each hapa were mixed together and reared in nursery pond for 4 weeks.
- As such four nursery ponds were maintained where each nursery pond was containing 200g larvae (from 10 hapas out of a total of 40 hapas).
- After nursing, randomly selected 500 fry from each batch (each nursery pond) were stocked into the brood stock replacement pond, where 200 pairs of founder brood fish contributing fingerlings in this desired stock.

For evaluating the growth performance of non selected group of Vietnamese Koi and improved F-5 generation of Vietnamese Koi, an experiment was conducted for a period of four months. For this trial, six net cages (3.0 m^3) were used. Among the six net cages, 03 net cages were assigned for Treatment-I (T-1), where F-5 generation of Vietnamese was stocked. While rest 03 cages were stocked with non selected group of Vietnamese Koi, which treated as Treatment-2 (T-2). The stocking density of Koi was $50/\text{m}^3$. After stocking, the fry was fed 30% crude protein enriched feed. After four months rearing, the harvesting means weight of T-1 and T-2 were 92 ± 10.10 and 77 ± 11.60 g, respectively. The harvesting weight of F-5 generation showed 19.48% higher growth over non selected group.

Field Validation Trial of BFRI GIF Tilapia and BFRI Vietnamese Koi at on-farm Management

Field validation trial of BFRI GIF Tilapia and BFRI Vietnamese Koi were conducted for a period of 4 months from July to November, 2020 in six farmers ponds of 400-600 m^2 area with a depth of 1.0-1.5m at Tarakanda and Gouripur upazilla under Mymensingh District. Prior to the trial, all the ponds were cleaned and limed at the rate of 250 kg/ha. After three days of liming, ponds were fertilized with Urea and TSP at the rate of 25.0 and 12.50 kg/ha, respectively. All the six ponds were divided into two groups. Among the ponds, three assigned for BFRI GIF Tilapia, and rest three for three for BFRI Vietnamese Koi. After preparation, BFRI GIF Tilapia and BFRI Vietnamese Koi fingerlings were stocked at the stocking density of 50000 and 100000/ha, respectively. After stocking, supplementary feed containing 28% crude protein was supplied to the fishes at different feeding rates according to their body weight. The ponds were sampled fortnightly by using a seine net to assess the health condition and to adjust the amount of feed. After five months rearing period, ponds were harvested and comprehensive data were recorded and analysed. The mean values for

growth, survival and production, water quality parameters were tested using one-way analysis of variance (ANOVA).

Results

Waterquality

Mean levels of Physico-chemical parameters over the five months culture of BFRI GIF Tilapia, and BFRI Thai Koi are presented in Table 1. The mean water temperature in ponds of BFRI GIF Tilapia, and BFRI Vietnamies Koi were more or less. The mean values of water temperature different ponds of BFRI GIF Tilapia, and BFRI Vietnamies Koi were 29.60 ± 1.40 and 28.87 ± 1.60 , respectively. There was no significant differences among the mean values when ANOVA was performed ($P > 0.05$). Water transparency values of different ponds under the treatments showed variations on different sampling dates. The mean values of transparency were found to be 40.30 ± 6.20 , and 28.11 ± 6.20 cm in ponds of BFRI GIF Tilapia and BFRI Vietnamies Koi, respectively. Significant differences among the mean values were observed when ANOVA was performed ($P < 0.05$). The dissolved oxygen values in morning hours were found to be relatively low in all ponds. The mean values of ponds of BFRI GIF Tilapia, and BFRI Vietnamies Koi were 4.60 ± 1.70 and 4.82 ± 1.65 , mg/l, respectively. The mean data showed significant variation between ponds of BFRI GIF Tilapia with and BFRI Koi ponds. During the study period, the pH values of pond water under different treatments were found to be alkaline. The values ranged from 7.20-8.20 and 7.10-7.85 in ponds of BFRI GIF Tilapia and BFRI Vietnamies s Koi ponds. Despite these variations, water quality parameters in all the ponds were within the suitable range of fish culture.

Table 1: Water quality parameters mean \pm SE of the ponds under different species at on-farm management

Parameters	BFRI-GIF Tilapia	BFRI Thai Koi
Temperature ($^{\circ}$ C)	29.60 ± 1.40	28.87 ± 1.60
Transparency (cm)	40.30 ± 6.20	28.11 ± 6.20
Dissolved oxygen (mg/L)	4.60 ± 1.70	4.82 ± 1.6
pH	7.20-8.20	7.10 –7.85

The growth of different species along with the results of production performances is presented in Tables-2 and 3. The growth performances and production of BFRI GIF Tilapia and BFRI Vietnamies Koi showed more or less similar results in on-station and on-farm trial. The mean weight of BFRI GIF Tilapia at on-station and on-farm were 196 and 190g, respectively. While the mean values of BFRI Vietnamies Koi were 114 and 106g in on-station and on-farm trial, respectively. The on-farm result was very close to on-station results. In all the trials, on-station results did not show any significant difference with on-farm trials. In case of BFRI GIF Tilapia, the average production of on- station and on-farm were 8,624 and 8,075 kg/ha, respectively. While, the production of BFRI Vietnamies Koi in

on-station and on-farm were 9,690 and 8,586 kg/ha, respectively. In all the trials, on-station result was higher than on-farm trial, where significant variation was observed.

Table 2: Treatment wise harvesting weight, survival & production of BFRI GIF Tilapia

Treatments	Initial Wt. (g)	Harvesting Wt. (g)	Survival (%)	Production (kg/ha)
T-1 (On-station)	8.20	196	88	8,624
T-2 (On-farm)	7.59	190	85	8,075

Table 3: Treatment wise harvesting weight, survival & production of BFRI Vietnamies Koi

Treatments	Initial Wt. (g)	Harvesting Wt. (g)	Survival (%)	Production (kg/ha)
T-1 (On-station)	4.15	114	85	9,690
T-2 (On-farm)	4.40	106	81	8,586

Distribution of Improved Germplasm

The improved germplasm of BFRI GIFT and BFRI Vietnamies Koi were distributed among the selected hatchery of Department of Fisheries. Distribution list is shown in below:

Sl. No.	Name of Selected Hatchery	Name of Germplasm	
		Koi	Tilapia
01	Fish Breeding and Training Center, Raipur, Lakshimpur	1500	1500
02	Nimgachi Aquaculture Project, Raigonj, Sirajgonj	2000	2000
03	Fish Training & Extension Center, Faridpur	5000	-

It is worthy mentioned that during the 2020-2021, 1.50 lac of BFRI GIF tilapia and 8.0 kg of spawn and 0.20 lac BFRI Vietnamies Koi were produced.

Development and Dissemination of Nursery and Culture Techniques of Cuchia, *Monopterus Cuchia* (Comp. A. FS)

Reserchers Dr. Durin Akhter Jahan, Principle Scientific Officer & PI
Nur-A-Raushon, Scientific Officer

Objectives

- To refine control breeding technique of *Monopterus cuchia*
- To refine grow-out culture technique of *Monopterus cuchia*
- To refine the baby eel rearing technique

06. Details work carried out during reporting period

Expt. 1. Refinement of rearing technique of baby eel using different types of feed

Experimental procedure:

The experiment was conducted in cemented cistern for a period of 30 days during July, 2020. For this experiment a tubifex bed was prepared using 50% sand and 50% cowdung to produce live tubifex. Continuous water flow was provided in the bed for sufficient oxygen of tubifex. On the other hand, six cisterns were prepared with lime and then deep tube well water was supplied and filled up to the depth of 1 meter. In all cisterns water hyacinth (*Eichhorniacrassipes*) were used as shade and shelter of baby eel of cuchia and very limited water hyacinth were also provided in the tubifex bed.

Design of the experiment:

For the experiment three dietary Treatments each with 3 replications were maintained. In Treatment 1, 2 and 3 feed were used live tubifex at *ad libitiam*, spirulina and commercial eel feed, respectively.

Stocking density of baby cuchia:

In the month of 1st July, 2020 baby eel or cuchia fry were stocked at the rate of 50/m² in all Treatments and the stocking weight of baby eel were averagely 0.25g (Table 1).

Feeding:

In Treatment-1, baby eel was fed with live tubifex at *ad libitiam*, in Treatment-2 and 3, fry was fed with spirulina and commercial eel feed respectively.

Performance of growth and survival rate:

During experimental period growth performance were recorded 7 days interval and weighted in an electrical balance. In the Treatment-1, baby eel was reared with live tubifex and growth obtained 1.24g. In the Treatment -2 and 3, where baby eel was reared in cisterns and fed with Spirulina and commercial eel feed respectively, growth performance was obtained 0.76 and

2.44g, respectively. Survivalswere recorded 76.33, 71.33 and 96.33 % in Treatment 1, 2 and 3, respectively. Details results are given in the following Table-1:

Table 1: Effects of different types of feed on growth and survival of *M. cuchia*

Treatments	Initial Weight(g)	Final Weight(g)	Survival (%)
T-1: (Live Tubifex)	0.25±0.09	1.24±0.23	76.33±6.11
T-2 :(Spirulina)		0.76±0.25	71.33±4.04
T-3: (Commercial eel feed)		2.44±0.74	96.33±3.51

Expt. 2. Refinement of grow-out culture technique of *M. cuchia* in without water in plasticdrum

Experimental procedure:

The experiment has been conducted in the plastic drum (100 L. capacity) for a period of 4 months from March to June and the drums have been kept in the cistern complex of Freshwater Station, MymensinghSoil layer has been used 2/3 of each drum and in 1/3 part of each drum, water are being used for keeping the soil in wet condition. Vermi has been produced in vermi compost unit and provided in each drum after fish stocking. Organic fertilizer (cow dung) is being used on the soil for the culture media of vermi and rice straw has been used as shade of vermi.

Design of the experiment:

For the experiment three stocking density like 10, 15 and 20 cuchia/drum has been maintained, each with three replications. In both the Treatments cuchia are being fed comprising with vermi and fish paste.

Stocking size of cuchia: In the month of March about 46.25g of cuchia has been stocked in all the Treatments

Results:

Growth performance: Growth performance has been measured 1 month interval. After 120 days of rearing, sampling has been done and the obtained results are shown in the following Table 2.

Table 2. Sampling weight of *M. cuchia*during rearing period

Treatments	Stocking density/drum	Initial weight (g)	Growth obtained (g)	Survival rate (%)
T-1	10	46.25 ± 5.25	^a 70.33 ±5.72	65.27±6.22
T-2	15		^b 63.805 ±7.64	59.08 ±7.27
T-3	20		^c 58.386 ±6.22	52.87 ±6.58

Expt. 3. Development of grow-out culture technique of *M. cuchia* without water in cistern

Experimental procedure:

The experiment has been conducted in the cistern complex of Freshwater Station, Mymensingh for a period of 4 months from March to June. For the development of grow-out culture technique of *M. cuchia* without water in cistern, soil layer has been used at the bottom of the cistern. In one part of the cistern water are being supplied for keeping the soil in wet condition. Vermi has been produced in the vermi composed unit and then provided after fish stocking. Organic fertilizer (cow dung) is being used on the soil for the culture media of vermi and rice straw has been used as shade of vermi.

Experimental Design:

For the experiment two Treatments each with three replications has been maintained. In Treatment-1, *cuchia* are being fed with vermi and fish paste, Treatment-2: *cuchia* fed with comprising vermi and commercial eel feed.

Stocking size of *cuchia*: About 45.17g of *cuchia* has been stocked in both Treatments in the month of March. Stocking density has been maintained 10/m².

Results:

Growth performance has been measured 1 month interval. After 120 days of rearing, sampling has been done and the obtained results are shown in the following Table 3.

Table-3. Sampling weight of *M. cuchia* during rearing period

Treatments	Stocking density/m ²	Initial weight (g)	Growth obtained (g)	Survival rate (%)
T-1	10	45.17 ± 6.33	161.47±8.02	69.37 ±5.71
T-2			167.56±10.50	62.89 ±6.88

Expt.4. Refinement of *cuchia* culture technology using supplementary feed in pond condition

Experimental Protocol:

The experiment has been conducted in the pond ecology from March to June, 2021 for a period of 4 months. For the experiment 3 ponds have been selected at the Freshwater Station, BFRI, Mymensingh. Soil (1.0-1.5 feet) has been removed from bottom and dyke of the experimental ponds and then in each pond 2 hapa net has been placed. After placing the hapa net, removed soil has been further used on the net and then deep tube well water has been supplied. As a shade and shelter water hyacinth has been provided for the *cuchia*.

Experimental Design:

For the experiment two types of dietary Treatments each with three replications has been maintained. In Treatment-1 *cuchia* are being fed with 100% fish paste, in Treatment-2 *cuchia* are being fed comprising diet with 95% fish paste and 5% vermi. Feed are being applied at the rate of 5% estimated body weight. Live small indigenous species and snail are being provided in all Treatments.

Stocking size of *cuchia*: About 45.17g of *cuchia* has been stocked in both Treatments in the month of March. Stocking density has been maintained 10/m² in both Treatments.

Growth performance:

Growth performance has been measured 1 month interval. After 120 days of rearing, sampling has been done and the obtained results are shown in the following Table 4.

Table-4. Sampling weight of *M. cuchia* during rearing period

Treatments	Initial weight (g)	Growth obtained (g)
T-1	45.17 ± 5.25	169.15±7.05
T-2		172.27±6.63

Expt. 5. Development of control breeding technique of *M. cuchia* without water in cistern

Experimental procedure:

The experiment has been conducted in the cistern complex of Freshwater Station, Mymensingh for a period of 4 months from March to June. For the development of control breeding technique of *M. cuchia* without water in cistern, soil layer has been used at the bottom of the cistern. In one part of the cistern water has been used for keeping the soil in wet condition. Vermi has been produced in the vermi compost unit and then provided after fish stocking. Organic fertilizer (cowdung) has been used on the soil for survival or generated of vermi and fed *cuchia* at *ad libitum*. Rice straw has been used as shade and shelter of vermi.

Experimental Design:

For the experiment two Treatments each with three replications has been maintained. In Treatment-1, *cuchia* has been fed with vermi and fish paste, Treatment-2: *cuchia* has been fed with vermi.

***Cuchia* stocking:** About 275-290g of *cuchia* has been stocked in all Treatments in the month of March. Stocking density has been maintained 10/m² in both Treatments. Male and female *cuchia* has been maintained as 1:1 ratio.



Breeding performance observation:

Observation has been made on the movement of brood cuchia. Generally, cuchia breed during last week of April to June. So, keen observation has been done during breeding period. Baby eel has not obtained from the cistern ecology.

Expt. 6. Refine control breeding technique of *M. cuchia* in pond ecology**Experimental Protocol:**

The experiment has been conducted in the pond ecology from July, 2020 to June, 2021 for a period of 12 months. For the experiment 3 ponds have been selected at the Freshwater Station, BFRI, Mymensingh. Soil (1.0-1.5 feet) has been removed from bottom and dyke of the experimental ponds and then in each pond 2 hapa net has been placed. After placing the hapa net, removed soil has been further used on the net and then deep tube well water has been supplied. As a shade and shelter water hyacinth has been provided for the produced baby eel and for brood cuchia.

Experimental Design:

For the experiment three types of dietary Treatments each with three replications has been maintained. In Treatment-1 cuchia are being fed with 100% fish paste, in Treatment-2 cuchia are being fed comprising diet with 90% fish paste and 10% wheat flour and in Treatment-3 cuchia fed with the comprising diet of fish paste (90%), wheat flour (5%) and earthworm (5%). Feed are being applied at the rate of 5% estimated body weight. Live small indigenous species and snail are being provided in all treatments.

Cuchia stocking:

About 250-290.00g of cuchia has been stocked in both Treatments in the month of March. Stocking density has been maintained 30/decimal in both Treatments. Matured male and female cuchia has been maintained as a ratio of 1:2.

Performance observation

Observation has been made on the movement of brood cuchia. Generally, cuchia breed during last week of April to June. So, keen observation has been done during breeding period. Baby eels have been produced in both Treatments.

Improving Feeds Formulation and Quality from Conventional and Non-Conventional Feed Ingredients Supplementation with Amino Acids for Commercially Important Fish Farming

Researchers Dr. Durin Akhter Jahan, Principle Scientific Officer & PI
 Nur-A-Raushon, Scientific Officer
 Md. Hashibur Rahman, Scientific Officer

Objectives of the Project

- To optimize dietary protein to energy ratio (P/E ratio) for *Oreochromis niloticus*;
- To evaluate the effect of supplementation limiting amino acids in the formulated diets for commercially important fish species;
- To develop feed formulation and quality from conventional and non-conventional feed ingredients in this fish farming;
- To recommend the potential limiting amino acids as feed additives in the formulated diets;
- To develop microalgae culture technique for using as fish feed ingredients

Achivements

Experiment 1: Optimizing dietary protein to energy ratio (P/E ratio) in *Oreochromis niloticus*

Experimental design and methodology

The feeding trail are being carried out in a static indoor rearing system of Freshwater Station, BFRI, consisting a series of cylindrical fibre glass tanks (70-L each) for 8 weeks. Same aged and uniform size of each fish fingerlings *Oreochromis niloticus* has been randomly distributed of 50 fish (av. 3.06-3.33g) per 70-L fiberglass tank. Artificial aeration is being used to maintain an adequate level of dissolve oxygen in each test tank for the study. The fish has been individually weighed at the start of the experiment by weekly. A weekly fish weight (fish sampling) has been done to adjust the daily feed ration for the following week. At the beginning of the experiment, 15 fish has been randomly sacrificed and kept for analysis of initial whole-body composition.

Experimental feeds and feeding

Six experimental diets have been formulated to contain two levels of protein (25 and 30%), each with three levels of lipid (5, 10 and 15%), in order to produce a range of protein to energy ratios. Fish meal and mustard oil cake has been used as protein source. As a Lipid sources, soybean oil has been used. Starch and wheat flour has been used as sources of carbohydrate. Alpha cellulose has been used as filler and carboxymethyl cellulose has been used as a binder at a rate of 2%. Vitamin and mineral premix has been added at a rate of

0.10%. Formulated diets and calculated proximate compositions are shown in the following Table 1. The bite-sized (1.0-2.0 mm) pellet feeds has been made with the help of hand pellet machine. The fish are being offered the test diets two times daily at the rate of 10% of their body weight and sub-divided into three equal feeds at 9.30, 13.00 and 17.00 h. Feeding rate are being adjusted based on weekly sampling weights of fish.

Analytical method for proximate composition

Standard methods were followed for the analysis of proximate composition of the dietary ingredients, experimental diets and fish samples according to AOAC (2003).

Table 1: Formulation and calculated proximate composition of the experimental diets (% dry matter basis)

Dietary Treatments						
Diet no: (Protein/Lipid), (%)	1 (25/5)	2 (25/10)	3 (25/15)	4 (30/5)	5 (30/10)	6 (30/15)
Ingredients:						
Fish meal	20.00	20.00	20.00	22.00	22.00	22.00
Soybean meal	15.00	15.00	15.00	20.00	20.00	20.00
Mustard oil cake	15.00	15.00	15.00	20.00	20.00	20.00
Rice bran (auto)	12.00	12.00	12.00	11.00	11.00	11.00
Starch	30.80	25.38	20.80	19.80	19.80	19.80
Soybean oil	0.00	5.42	10.00	0.00	4.54	9.54
Alpha cellulose	5.00	5.00	5.00	5.00	5.00	5.00
Carboxymethyl cellulose	2.00	2.00	2.00	2.00	2.00	2.00
Vit. and minerals premix	0.20	0.20	0.20	0.20	0.20	0.20
Calculated proximate composition						
Crude protein	25.01	25.01	25.01	30.01	30.01	30.01
Crude lipid	5.20	10.00	15.00	5.50	10.00	15.00
Ash	8.68	8.68	8.68	9.87	9.87	9.87
Crude fibre	8.01	8.01	8.01	8.53	8.53	8.53
Nitrogen free extract	53.10	48.30	43.26	46.06	41.56	36.56

Water quality parameters

Water quality parameters like temperature, dissolved oxygen (DO), ammonia-nitrogen and pH were monitored at weekly interval.

Sampling procedure

Twenty per cent of the stocked fishes of each tank were sampled using a scoop net and excess water was removed from fish body of the fish samples by tissue paper before weighing to the nearest “g” on an electric balance and then data were calculated and tabulated on the basis of growth parameters, feed utilization and protein utilization by the established formula.

Carcass composition

At the beginning of the experiment, 15 fishes from the stock of experimental fishes were randomly sacrificed and used for the analysis of initial carcass composition. At termination of the experiment all the fishes of each replication from all treatments were kept for whole body composition analysis.

Results

Water quality parameters

During experimental period different water quality parameters of 12 fiber glass tanks have been observed where water temperature ranged from 19.0 to 30°C and at the same time air temperature have been ranged from 27.0 to 30°C , dissolved oxygen 2.52 to 2.96 mg L⁻¹, ammonia-nitrogen 0.03 to 0.04 mg L⁻¹ , total alkalinity 130-140 mg L⁻¹ and pH 7.7 to 8.05.

Growth responses

The experiment has been continued and after 60days of the experimental period specific growth rate (SGR), %weights gain, food conversion efficiency (FCR), and protein efficacy ratio (PER) has been calculated up to the last sampling. Growth response of fishes in different dietary Treatments were measured and described under the following sub-headings.

Initial and final weight

In all dietary Treatments initial weight has been found almost similar i.e. 3.10, 3.06, 3.33, 3.17, 3.05, 3.32g in Treatment 1, 2, 3, 4, 5 and 6, respectively (Table 2). After 60days of rearing period weight of *O. niloticus* has been 4.63, 4.25, 5.23, 4.95, 5.27 and 5.65 in different dietary Treatments 1, 2, 3, 4, 5, and 6, respectively (Table 2).

Specific growth rate (SGR %/day)

The SGR (%/day) values of *O. niloticus* has been obtained 23.33, 13.33, 25.00, 26.67, 40.00 and 40.00 in Treatment 1, 2, 3, 4, 5 and 6, respectively (Table 2).

% Weight gain

The % Weight gain values of *O. niloticus* has been obtained 363.00, 342.50, 422.50, 395.50, 427.50 and 465.50 from Treatment 1, 2, 3, 4, 5 and 6, respectively (Table 2).

Survival rate (%)

During the study period mortality was occurred. After 30 days of rearing survival of *O. niloticus* has been 96, 92, 92, 98, 94, and 99% in Treatment 1, 2, 3, 4, 5 and 6, respectively (Table 2).

Feed utilization

Feed utilization is described in the following sub heading such as Feed Efficiency (FE) ratio and Feed Conversion Ratio (FCR). FCR is defined as the amount of dry food fed per unit live weight gain.

Feed efficiency (FE) ratio

Feed efficiency of *O. niloticus* has been obtained 4.56, 4.60, 5.06, 4.65, 5.47 and 5.14 for Treatment 1, 2, 3, 4, 5, and 6, respectively (Table 2).

Feed conversion ratio (FCR)

The FCR values of 0.22, 0.22, 0.20, 0.22, 0.19 and 0.19 as obtained from dietary Treatment 1, 2, 3, 4, 5 and 6, respectively have been calculated after rearing of 30 days. Details results are shown in the Table 2.

Protein utilization

Protein utilization response of the fishes in different Treatments is stated below with the following sub-heads:

Protein efficiency ratio (PER)

The PER values of 4.08, 4.50, 4.01, 3.38, 3.39 and 3.39 as obtained from dietary Treatment 1, 2, 3, 4, 5 and 6, respectively have been calculated after rearing of 30 days. Details results are shown in the Table 2.

Carcass composition

The carcass composition of the experimental fish, *O. niloticus* fry for all the diets have been analyzed. In the following Table 3, initial and final value of moisture, crude protein, crude lipid and ash are shown.

Table 2. Details growth performance of *O. niloticus* fry

Parameters	Dietary Treatments					
	1	2	3	4	5	6
Initial wt. (mg)	3.10 ± 0.33	3.06 ± 1.14	3.33 ± 0.08	3.17 ± 0.02	3.05 ± 0.25	3.10 ± 0.33
Final wt. (mg)	10.64 ±0.63	11.03 ±0.19	10.72 ±1.23	11.79 ±1.83	12.8 ±2.35	10.64 ±0.63
Survival rate (%)	96 ± 0.00	92 ± 2.83	92 ± 8.49	98 ± 0.00	94 ± 2.83	96 ± 0.00
SGR (%/day)	12.63 ± 4.71	12.70 ± 0.00	12.83 ± 2.36	14.37 ± 0.00	15.00 ± 9.43	12.63 ± 4.71
FCR	0.13 ± 0.002	0.14 ± 0.002	0.15 ± 0.018	0.13 ± 0.004	0.14 ± 0.006	0.13 ± 0.002
PER	4.00 ± 0.00	4.00 ± 0.00	3.99 ± 0.00	3.33 ± 0.00	3.33 ± 4.44	4.00 ± 0.00
FE ratio	16.21 ± 0.42	15.77 ± 0.34	17.47 ± 0.46	16.82 ± 0.28	17.02 ± 0.35	16.21 ± 0.42

Table 3. Initial and final carcass composition (\pm SD) of experimental fish *O. niloticus* fry

Parameters		Dietary Treatments					
		1	2	3	4	5	6
Crude protein	Initial	39.40 \pm 0.01					
	Final	44.98 \pm 0.05	45.40 \pm 0.2 0	44.89 \pm 0.1 5	48.38 \pm 0 .02	48.50 \pm 0 .01	48.64 \pm 0. 04
Crude lipid	Initial	8.94 \pm 0.04					
	Final	12.14 \pm 0.12	14.16 \pm 0.0 5	12.21 \pm 0.1 5	14.11 \pm 0 .01	14.18 \pm 0 .10	14.15 \pm 0. 25
Ash	Initial	19.39 \pm 5.32					
	Final	17.36 \pm 0.52	16.26 \pm 2.0 1	16.98 \pm 2.0 5	18.09 \pm 3 .21	14.11 \pm 6 .52	18.19 \pm 0. 02
Moisture	Initial	80.62 \pm 0.32					
	Final	78.61 \pm 0.04	77.25 \pm 0.2 5	76.08 \pm 0.6 1	74.33 \pm 0. 02	74.15 \pm 0. 32	74.33 \pm 0.0 1

Expt. 2: Effects of supplementation of synthetic amino acids in plant protein based formulated diets in *O. niloticus*

Experimental procedure and design:

The follow up feeding trial has been conducted with a series of cylindrical fibre glass tanks (70-L each) for 8 weeks at Freshwater Station, BFRI based on results from previous study (P/E ratio) in lab conditions. The same aged uniform size fingerlings of *O. niloticus* has been randomly distributed into groups of 50 fish (averaging 3.0-4.0 \pm 0.05 g) per fiberglass tank and three replicate tanks used for each test diet. Artificial aeration has been used to maintain an adequate level of dissolve oxygen in each test tank. The fish has been individually weighed at the start and end of the experiment by weekly. Weekly sampling of fish has been done to adjust the daily feed ration for the following week. Water quality parameter such as temperature, pH, dissolve oxygen and total ammonia will be monitored through weekly sampling. At the beginning of the experiment, 15 fish has been randomly sacrificed and kept for analysis of initial whole-body composition. At the end of the feeding trial all fish has been weighed and survivals were determined. Five fishes have been taken out from each tank for determination of whole-body carcass composition.

Experimental feeds and feeding:

Five experimental diets (iso-nitrogenous and iso-energetic) have been formulated to contain 30% crude protein and around 17.50 kJ g⁻¹ gross energy. Feeds has been prepared using locally available fish feed ingredients such as fish meal, soybean meal, mustard oil cake and rice bran in different combinations. Fish meal, soybean meal and mustard oil cake has been used as protein sources. Rice bran and starch has been used as sources of carbohydrate. Alpha-cellulose has been used as filler and carboxymethyl cellulose has been used as a binder at a rate of 2%. Vitamin and mineral premix have been added at a rate of 0.20%. The limiting amino acids: (i) Lysine and (ii) Methionine has been added the diets following the requirement

of fish species. A control diet (diet-1, fish meal based) will be prepared without adding amino acids, diets 2-3 has been prepared partially replace animal protein with plant protein and adding amino acids and diets 4-5 has been prepared fully plant protein based and adding limiting amino acids of lysine and methionine as per requirement levels. The bite-sized (1.0-2.0 mm) pellet feeds has been made with the help of hand pellet machine. The pelleted feeds have been sun-dried or dried in an oven at 40° C for two days. Each dietary treatment has been conducted in duplicate tanks. Feeding rate has been adjusted based on weekly sampling weights of fish. The fish has been offered the experimental and control diets, 2 times daily at the rate of 12% of their body weight and Feeding rate has been adjusted based on weekly sampling (fish weighing) of fish. Data has been analyzed using one way ANOVA. Paired mean comparisons among the treatments will be made using Duncan's Multiple Range Tests (Duncan 1955).

Analytical method for proximate composition

Standard methods were followed for the analysis of proximate composition of the dietary ingredients, experimental diets and fish samples according to AOAC (2003). Formulation and proximate composition of the experimental diets (% dry wt.) are shown in the following Table.

Table 4: Formulation and proximate composition of the expt. diets (% dry wt.)

Diet no: (Protein/Lipid), (%)	Dietary Treatments				
	1 (25/5)	2 (25/10)	3 (25/15)	4 (30/5)	5 (30/10)
Ingredients:					
FM	22.00	11.00	11.00	0.00	0.00
SM	20.80	31.80	31.80	47.20	47.20
MOC	20.00	20.00	20.00	20.00	20.00
RB	11.00	29.00	29.00	24.00	24.00
Starch	16.50	5.00	3.20	5.35	3.00
SO	2.50	1.00	1.50	1.25	1.00
Alpha cellu.	5.00	0.00	0.00	0.00	0.00
Binder	2.00	2.00	2.00	2.00	2.00
Vit. and Min.	0.20	0.20	0.20	0.20	0.20
Lysine				0.90	1.80
Methionine				0.40	0.80
Calculated proximate composition					
Crude protein	30.02	30.05	30.10	30.05	30.05
Crude lipid	10.00	10.07	10.15	10.15	10.10
Ash	6.34	7.48	5.67	6.92	5.92
NFE	37.10	37.05	35.25	37.50	35.05
GE (kjg ⁻¹)	17.40	17.43	17.37	17.50	17.30

Water quality parameters

Water quality parameters like temperature, dissolved oxygen (DO), ammonia-nitrogen and pH were monitored at weekly interval.

Sampling procedure

Twenty per cent of the stocked fishes of each tank were sampled using a scoop net and excess water was removed from fish body of the fish samples by tissue paper before weighing to the nearest “g” on an electric balance and then data were calculated and tabulated on the basis of growth parameters, feed utilization and protein utilization by the established formula.

Carcass composition

At the beginning of the experiment, 15 fishes from the stock of experimental fishes were randomly sacrificed and used for the analysis of initial carcass composition. At termination of the experiment all the fishes of each replication from all treatments were kept for whole body composition analysis.

Results

Water quality parameters

During experimental period different water quality parameters of 12 fiber glass tanks were observed where water temperature ranged from 27.0 to 30°C, dissolved oxygen 2.78 to 3.26 mg L⁻¹, ammonia-nitrogen 0.04 to 0.05 mg L⁻¹, total alkalinity 135-145 mg L⁻¹ and pH 7.8 to 8.15.

Growth responses

The experiment has been continued and after 30 days of the experimental period specific growth rate (SGR), % weights gain, food conversion efficiency (FCR), and protein efficacy ratio (PER) has been calculated up to the last sampling. Growth response of fishes in different dietary Treatments were measured and described under the following sub-headings.

Initial and final weight

In all dietary Treatments initial weight was found almost similar i.e. 1.61, 1.53, 1.68, 1.58 and 1.58g in Treatment 1, 2, 3, 4 and 5, respectively (Table 5). After 30 days of rearing period weight of *O. niloticus* were 6.00, 6.75, 6.10, 6.78 and 7.24g in different dietary Treatments 1, 2, 3, 4 and 5, respectively (Table 5).

Specific growth rate (SGR %/day)

The SGR (%/day) values of *O. niloticus* were obtained 15.40, 15.16, 15.24, 17.24 and 18 and in Treatment 1, 2, 3, 4 and 5, respectively (Table 5).

Expt. 4: Effects of supplementation of synthetic amino acids in plant protein based formulated diets in *O. niloticus*

Design and methodology

The feeding trial has been carried out in the pond complex of Freshwater Station, Bangladesh Fisheries Research Institute (BFRI), Mymensingh for a period of 12 weeks. During experimental period water quality parameter and whole-body composition has been observed.

Five experimental diets have been formulated to contain 30% crude protein and around 17.50 kJ g⁻¹ gross energy. FM, MOC, SM, starch, WF, alpha cellulose, vitamin and mineral premix has been used as diet ingredients. Limiting amino acids: Lysine and Methionine has been added in the diets and a control diet (diet -1; fish meal based) has been prepared without adding amino acids. Diets 2-3 has been prepared partially replace animal protein with plant protein and Diets 4-5 has been prepared fully plant protein based and adding limiting amino acids of lysine and methionine Pellet feeds (1.0-2.0 mm) made with hand pellet machine. The fish has been offered the test diets two times daily at the rate of 10%.

Results

Water quality parameters

During experimental period different water quality parameters of pond has been observed where water temperature ranged from 28 to 30°C, dissolved oxygen 5.00 to 5.79 mg L⁻¹, ammonia-nitrogen 0.0187 to 0.12 mg L⁻¹, total alkalinity 185-200 mg L⁻¹ and pH 7.8 to 8.20.

Growth responses

The experiment has been continued and after 60 days of the experimental period specific growth rate (SGR), % weights gain and food conversion efficiency (FCR) has been calculated up to the last sampling. Growth response of fishes in different dietary Treatments were measured and described under the following sub-headings.

Specific growth rate (SGR %/day)

The SGR (%/day) values of *O. niloticus* has been obtained 84.97, 80.62, 80.37, 87.20 and 84.13 in Treatment 1, 2, 3, 4 and 5, respectively (Table 7).

Survival rate (%)

During the study period mortality has been occurred. After 60 days of rearing survival of *O. niloticus* are 92, 93, 90, 96 and 95 in Treatment 1, 2, 3, 4 and 5, respectively (Table 7).

Feed utilization

Feed conversion ratio (FCR)

The FCR values of 0.5, 0.49, 0.46, 0.52 and 0.57 as obtained from dietary Treatment 1, 2, 3, 4 and 5, respectively has been calculated after rearing of 60 days. Details results are shown in the Table 7. The FCR values of 0.5, 0.49, 0.46, 0.52 and 0.57 as obtained from dietary Treatment 1, 2, 3, 4 and 5, respectively has been calculated after rearing of 60 days. Details results are shown in the Table 7.

Table 7. Growth performance of *O. niloticus* fry fed on experimental diets for 60 days.

Components	Diets				
	1	2	3	4	5
Initial weight (g)	1.52 ±0.04	1.63 ±0.72	1.78 ±0.09	1.68 ± 0.02	1.52 ±0.05
Final weight (g)	52.5±0.11	50 ±0.13	50±0.33	52 ±0.71	51 ±0.09
Survival rate (%)	92.00±2.87	93.00±3.24	90.00±2.88	96.00±2.83	95.00±1.41
SGR (%/day)	84.97±4.74	80.62±5.66	80.37±4.99	87.20±8.54	84.13±6.47
FCR	0.5±0.00	0.49±0.00	0.46±0.00	0.52±0.00	0.57 ±0.00

Expt. 5: Development of microalgae culture technique for using as fish feed Ingredients

Spirulina platensis are being used for the last ten years as a model organism in many studies on outdoor cultivation of alga biomass as a source of protein and chemicals. Although much progress has been done in this field, resulting in a set-up of several commercial production sites all over the world (Israel, Thailand, Taiwan, USA). The *S. platensis* were cultured in various concentrations of fish meal medium, the ultimate goal for producing a cheap alternative source of protein has not yet been achieved, and the cost of production is still higher than that of conventional and non-conventional sources of protein. So it is needed to identify a culture media for *S. platensis* to spare the high cost of inorganic media. So, attempt has been made to find out any inexpensive organic media containing high amount of protein for *Spirulina* culture. Therefore, the present work has been undertaken to study the growth performance of *S. platensis* in various concentrations of fish meal medium.

Materials and Methods

Experimental site

The experiment has been conducted for 50 days from January to March, 2021 in the laboratory of the Nutrition Division of Bangladesh Fisheries Research Institute, Freshwater Station Mymensingh.

Experimental design of *S. platensis* culture

The two types of media viz. Fish Meal Medium (FMM) and Kosaric medium (KM) were used for the culture of *S. platensis*. For FMM, 3 Treatments each of 3 replications and for KM 1 Treatment of 3 replications were used. For both the culture media 12 days culture period was maintained. Inoculum of *S. platensis* was collected from BAU, Mymensingh for the pure stock culture.

Preparation of FMM and KM for *S. platensis* culture

Fish meal was collected from local market of Mymensingh and dried in an oven at 50°C for overnight. For complete drying, these fish meals were dried under sun for another seven days. Then HamamDista was used to make powder of the dried fish meal. For getting very fine particle of fish meal, it was sieved through a sieve. Then it was kept in a 5-liter capacity reagent bottle and added 4-liter distilled water. Aeration was provided for 22 days for preparing Fish Meal Medium (FMM). About 600 ml distilled water was added into the conical flask having capacity 1.0 L volume and then prepared Fish Meal Medium was added 15, 20 and 25% each with three replications and then sterilized at 120°C for 15 minutes with moist heat autoclave. After cooling of the prepared media *S. platensis* were inoculated and mixed well gently.

The KM was prepared by adding required amount of different chemical ingredients with distilled water. Then mixing, sterilization and then cooling of the prepared media *S. platensis* were inoculated and mixed well gently. These cultured bottles were continuously aerated using electric aerator. Samplings were taken at every alternative day from each bottle to observe *S. platensis* cell density, water quality parameters of culture media. All the glassware's used in the experiment were sterilized by dry heat in an oven at 70°C.

Collection of *S. platensis* under Order-Volvocales, Class-Chlorophyceae was collected from the laboratory of the Department of Aquaculture, BAU, Mymensingh. For purity, the pure stock culture maintenance, the stock culture of *S. platensis* was maintained in the laboratory in Kosaric medium (KM). Growth of *S. platensis* was monitored and it was then checked under microscope to confirm its purity.

Estimation of *S. platensis* cell weight (g/L)

For cell weight 10 ml of *S. platensis* sample from each Treatment has been taken and filtered with an electric filtration unit using filter papers and shifted to the oven at 105°C for 24 hours. The samples have been then transferred to the desiccator for cooling and weight has been measured using an electric balance. The weight of the paper filter was taken prior to filtering.

Physico-chemical parameters

The physico-chemical parameters i.e., pH, temperature, dissolved oxygen (DO), measuring the voltage between a pH sensitive glass electrode (MVPH), total dissolved solid (TDS), electric conductivity (EC), hectopascal pressure unit (hpa%) and salinity have been recorded.

Results

Physico-chemical parameters of culture media

The physico chemical parameters i.e., temperature have been ranged 28.00-29.39°C, pH: 9.33-9.44, dissolved oxygen (DO): 5.97-6.58mg^l⁻¹, measuring the voltage between a pH sensitive glass electrode (MVPH): 129.70-149.47, total dissolved solid (TDS): 1025.00-3862.00, electric conductivity (EC): 1899.17-5726.67, hectopascal pressure unit (hpa%):

1009.50-1017.33 and salinity:0.60-4.32 have been recorded. Details results are shown in Table 8.

Table 8: Water quality parameters of different Treatments during experimental period

Observed parameters	Treatments			
	T-1 (15% FMM)	T-2 (20% FMM)	T-3 (25% FMM)	T-4 (KM)
pH	9.13±0.05	9.44±0.02	9.42±0.01	9.42±0.13
Temperature	28.00±0.08	29.39±0.37	28.47±0.40	28.16±0.84
DO	5.97±0.10	5.86±0.22	6.47±0.35	6.58±2.03
MVPH	129.70±4.62	143.18±11.59	149.47±0.43	147.13 ±5.75
TDS	1070.67±72.60	1101.00±90.80	1025.00±103.11	3862.00±1554.52
EC	1899.17±146.37	2218±208.88	2011.33±193.41	5226.67±515.89
hpa%	1009.50±0.50	1010.33±1.04	1010.17±1.26	1017.33±2.08
Salinity	0.60±0.08	0.88±0.32	0.64±0.20	4.32±1.86

Cell weight of *S. platensis*

The range of cell weight of *S. platensis* in different concentrations of FM medium viz., in concentration of 15% has been 0.038 to 0.533 g/L; in concentration of 20% was 0.038 to 0.417 g/L; in concentration of 25% has been 0.038 to 0.378 g/L and in KM has been 0.038 to 0.689 g/L. The growth of cell was varied in different media and different concentrations. This variation might be due to different nutrient composition and concentrations of different media. The growth rate of *S. platensis* has been higher in KM than various concentrations of FMM which might be due to the availability of more nutrients in KM than various concentrations of FMM. On the other hand, the growth rate has been higher in concentration of 15% FMM than other concentrations of FMM. It might be due to the favorable growth parameter (pH, temperature, DO) and also suitable amount of nutrients in FMM (15%L) than other concentrations of FMM. Details cell weight of *S. platensis* in different concentrations of FMM and KM are shown in the following Table 9.

Table 9: Cell weight of *S. platensis* in different concentrations of FMM and KM

Treatments	Initial weight (g L ⁻¹)	Final weight (g L ⁻¹)
T-1: (15% FMM)	0.038±0.009	0.533±0.045
T-2: (20% FMM)		0.417±0.117
T-3: (25% FMM)		0.378±0.069
T-4: (KM)		0.689±0.122

Culture of Indigenous Small Fishes in Biofloc Aquaculture System (Comp. A)

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Objectives

- To optimize the stocking density of Shing, *Heteropneustes fossilis* and Pabda, *Ompok pabda*/Gulsha, *Mystus cavasius* in Biofloc system
- To evaluate the growth & production of Prawn, *M. rosenbergii* in Biofloc system
- To evaluate the growth & production of Magur, *Clarias batrachus* in Biofloc system (2021-2022)
- To analyse the economic benefits of Biofloc system

Achievements

Expt.1. Evaluation of the growth & production performance of Gulsha, (*Mystus cavasius*) under different stocking density in Biofloc system

Water Quality Parameter

The results of water quality parameters such as water temperature, dissolved oxygen (DO), pH, total ammonia nitrogen (TAN) and total dissolved solids (TDS) are shown in table 1. The values indicate that all the observed water quality parameters were very much congenial for fish growth.

Table 1. Water quality parameters of different tanks in Biofloc System

Parameters	T-1		T-2		T-3	
	Tank 1	Tank 2	Tank 3	Tank 4	Tank 5	Tank 6
W. Temp (°C)	28.1±1.2	30.1±3.0	28.7±1.2	29.6±0.3	29.8±0.5	29.6±0.5
DO (mg/l)	5.1±1.2	5.44±0.6	5.24±0.4	5.40±0.5	4.98±0.7	4.58±1.1
pH	7.55±0.4	7.66±0.2	7.91±0.7	7.59±0.5	7.78±0.3	7.70±0.0 0
TAN (mg/l)	0.11±0.1	0.14±0.1	0.11±0.1	0.01±0.01	0.16±0.01	0.10±0.0 9
TDS (mg/l)	256±12. 7	298±11.2	258±27.8	269±11.8	298±32.0	293±21.2

Growth Performance

Table 2 shows the sampling weight of Gulsha under different treatment after Four months of rearing. On the basis of sampling weight, treatment 1 showed the best results in terms of growth. Where, Treatment-3 attained the lowest growth in biofloc system. The average sampling weight of Treatments-1, 2 and 3 were 21±0.5: 18.2±1.2 and 16±1.2 g,

respectively. Feed conversion ratio indicating the effectiveness of feed management and economic performance in aquaculture. In this experiment the best FCR comes from Treatment 1.

Table 2. Harvesting result of Gulsha under different treatments

Parameter	T ₁	T ₂	T ₃
Stocking density	4800	6000	7200
Initial Wt. (g)	3.2 ±0.6	3.3 ±0.41	3.3 ±0.47
Harvesting Wt. (g)	21±0.5 (86.31Kg)	18.2±1.2 (91.18Kg)	16±1.2 (94.72Kg)
No. of Fish harvested	4110	5010	5920
Survivability	85.63	83.50	78.93
FCR	1.04	1.15	1.1
Feed Required (kg)	90	105	104
Electricity Requirement	43.20 KW/Month	43.20 KW/Month	43.20 KW/Month

Benefit Cost Ratio (BCR)

Several variable costs like stocking cost chemical cost, labour and electricity cost were estimated during the period of farming. There were some fixed costs such as land rent, pond preparation as well. Cost and return analysis were performed on both variable and total cost basis. To achieve the objectives of the study a simple tabular analysis was done (Table3). The benefit cost ratios were estimated as 1.16, 1.10 and 1.12 for T1, T2 and T3 respectively.

Table 3. BCR analysis for Gulsha under different Treatments

Inputs	T ₁		T ₂		T ₃	
	Qty.	Cost (Tk.)	Qty.	Cost (Tk.)	Qty.	Cost (Tk.)
Fingerling (Nos.)	4800 @1.00	4800	6000	6000	7200	7200
Feed (Kg)	89.5 kg@58	5091	105 kg	6090	103.5 Kg	6003
Molasses	40kg@ 35	1400	42kg	1470	45 kg	1575
Probiotics	3.0 kg	3600	3.8 kg	4560	5.20 kg	4160
Electricity	173K W@11	1093	173KW @11	1093	173KW @11	1093
Others cost (labour, harvesting, Depreciation etc.)	-	4000	-	4000	-	4000
Total cost	-	20263	-	23423	-	22513
Sell price of fish	83		94 kg @		93.5 kg	

	kg @ 285 tk/Kg	23655	275 tk/Kg	25850	@ 270 tk/Kg	25245
Net benefit/6000 liter		3392		2427		2732
BCR		1.16		1.10		1.12

Expt. 2. Evaluation of growth & production of Prawn, *M. rosenbergii* in Biofloc system

Water Quality Parameter

The results of water quality parameters such as water temperature, dissolved oxygen (DO), pH, total ammonia nitrogen (TAN) and total dissolved solids (TDS) are shown in table 8. The values indicate that all the observed water quality parameters were very much congenial for fish growth.

Table 4. Water quality parameters of Shrimp tanks in Biofloc System

W. Temp (°C)	29.7±1.2
DO (mg/l)	5.56±1.1
pH	8.21±0.2
TAN (mg/l)	0.16±0.2
TDS (mg/l)	320±52.5

Fish Growth

The Initial wt. PL was 1±0.21 with a stocking density of 0.5 PL/Liter. of the average growth of Prawn after Six months of culture was 40±1.23. The total production of shrimp was 96kg.

Table 5. BCR analysis for Prawn at Biofloc

Sl No	Description	Amount	Price
1	PL (Prawn)	3000 @ 2 tk	6000
2	Feed	100 kg @ 90 tk	9000
3	R-salt+Molasses+Probiotics		4000
4	Electricity	216 Unit @ 11 tk	2376
5	Other		5000
	Total		26376

Sl. No.	Description	Quantity	Total
1.	Total Cost	26376	
2.	Production	96 kg @ 435 tk	41760
3.	Profit		15384
	BCR		1.58

Assessment of Health Hazard substances in Biofloc

The concentrations of heavy metals Such as Cd, Cr, Co, and Pb were measured in the muscles of cultured fish species at Biofloc System. The samples of Pabda, Shing and Koi (200g sample of each species) were taken from the cultured tanks and send it to the laboratory of SGS Bangladesh Ltd. for analysis of heavy metals. The results showed that there were no presences of heavy metals in fish muscles of samples species except copper. Results revealed that in all the fish species, the limit of Copper were higher than the allow able limit (Table-6). The source of excessive amount of copper deposited in fish muscle may be from molasses or fishfeed.

Table 6. Concentration of heavy metal at muscles of Shing, Pabda and Koi

	Cadmium (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)
Shing-1	ND	ND	0.80	ND
Shing-1	ND	ND	0.82	ND
Pabda-1	ND	ND	1.23	ND
Pabda-2	ND	ND	1.25	ND
Koi-1	ND	ND	1.24	ND
Koi-1	ND	ND	1.25	ND
LOD	0.5	0.5	0.5	0.5

Ecological assessment of inland open water fisheries population with bio-physicochemical properties to frame EBFM approach (Comp-A)

Reserchers

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Objectives

- To estimate population ecology and diet composition of commercially significant inland (*haor & beel*) open water fishes
- To assess bio-physicochemical properties of inland waterbodies with the seasonal variation
- To assess stock of commercially significant open water fish groups through using modern techniques based on catch and CPUE data
- To assist for framing or formulating ecosystem-based management approach for inland open waters with emphasizing to increase productivity and conservation of fisheries resources

Achievements

Selected Study Areas (2020-21): Netrokona (Mohanganj, Khaliyhuri), Kishoreganj (Nikli, Bajitpur)

Name of the <i>Haors</i> and <i>Beels</i> (2020-21)	
Netrokona (Mohanganj, Purbadhola)	Kishoreganj (Nikli-Bajitpur)
Dingapota (Mohanganj)	Olua (Nikli)
Khaliyhuri (Khaliyhuri)	Mahmudpur (Nikli)
Mara Daria (Khaliyhuri)	Laskori Somai (Nikli)
Tetulia, Highzda (Mohanganj)	Surma Baula (Nikli)
Karachapur (Mohanganj)	Shampur-Khasapur (Nikli)
Gozaria, Mallikpur (Mohanganj)	Charigram, Charkatkhal (Nikli)
Dubail (Mohanganj)	Dynegaon, Borogop (Nikli)
Shibpur (Mohanganj)	Dholai-Bogadia (Nikli)
Rajdhola, Bhawal (Purbadhala)	Atpasha, Humaipur (Bajitpur)

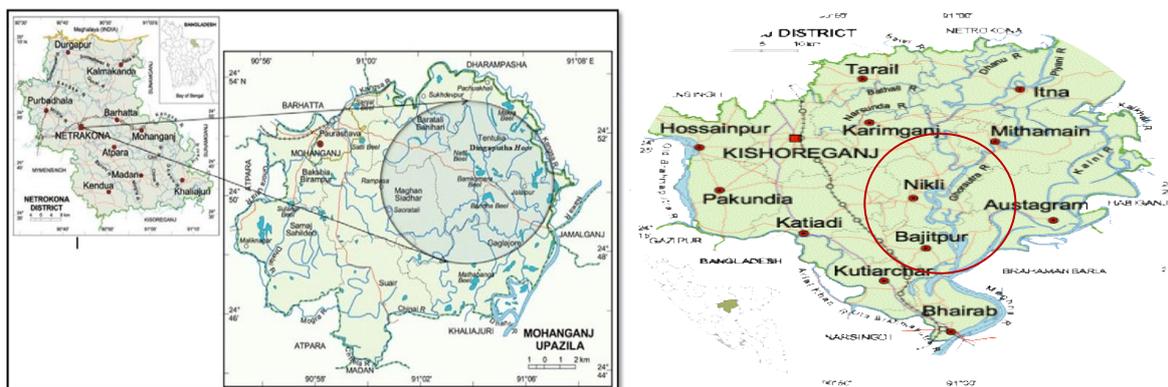


Fig 01: Map of the study areas

Study1: Field data collection to estimate catch composition, population ecology of commercially significant *haor & beel* resident fishes

Achievement:

All of the biological data of most commercially significant ecological fish groups (i.e. Planktivores/Herbivores, Detrivores, and Carnivores& Omnivores), the landing sites were visited fortnightly during the study period and all species were recorded together with their respective catch in weight and size in length. The fish samples were measured the total length (*TL*) to the nearest 0.1 cm and body weight (*W*) to the nearest 0.1g by following the method - fish was placed ventral side down and the upper lobe of the caudal fin depressed in line with the body axis. Identification of resident as well as migratory fishes were executed through

collection of different species directly from fisher's catch, landing centers, experimental fishing, and surveying local fish markets.



Fig 02: Fish catch & length-weight data collection of the selected haor areas

Table 01: Group wise average fish catch composition of available haor resident species of Netrokona (Mohanganj, Khaliajhuri) and Kishoreganj (Nikli, Bajitpur) during 2020–21 are given below---

No.	Order	Family	Species	Catch Composition (%)
1	Cypriniformes	Cyprinidae	<i>Cirrhinus cirrhosus</i>	22.5
2			<i>Gibelion catla</i>	
3			<i>Amblypharyngodon mola</i>	
4			<i>Labeo rohita</i>	
5			<i>Labeo calbasu</i>	
6			<i>Labeo gonius</i>	
7			<i>Labeo bata</i>	
8			<i>Puntius sophore</i>	
9			<i>Puntius terio</i>	
10			<i>Esomus danricus</i>	
11			<i>Rasbora rasbora</i>	
12			<i>Pethia ticto</i>	
13			<i>Ctenopharyngodon idella</i>	
14			<i>Hypophthalmichthys molitrix</i>	
15	Cyprinodontiformes	Aplocheilidae	<i>Cyprinus carpio</i>	0.9
16			<i>Chela cachius</i>	
17			<i>Salmophasia bacaila</i>	
18			<i>Danio dangila</i>	
19	Notopteridae	Notopteridae	<i>Aplocheilus panchax</i>	2.4
20			<i>Notopterus notopterus</i>	
21	Osteoglossiformes	Ambassidae	<i>Chanda nama</i>	1.6
22			<i>Parambassis baculis</i>	
23			<i>Anabas testudineus</i>	
24	Channidae	Anabantidae	<i>Anabas testudineus</i>	0.9
25			<i>Channa punctata</i>	
26			<i>Channa orientalis</i>	
27			<i>Channa striata</i>	
			<i>Channa marulius</i>	4.3

28	Beloniformes	Belonidae	<i>Xenentodon cancila</i>	0.3
29			<i>Gudusia chapra</i>	2.1
30		Clupeidae	<i>Corica soborna</i>	
31			<i>Setipinna phasa</i>	0.6
32		Engraulidae	<i>Setipinna taty</i>	
33			<i>Botia dario</i>	0.8
34	Clupeiformes	Cobitidae	<i>Lepidocephalichthys guntea</i>	
			<i>Apocryptes bato</i>	15.2
35				
36			<i>Pseudapocryptes elongatus</i>	
37			<i>Glossogobius giuris</i>	
38			<i>Stigmatogobius sadanundio</i>	
39			<i>Odontamblyopus rubicundus</i>	
40		Gobiidae	<i>Trypauchen vagina</i>	
41		Nandidae	<i>Nandus nandus</i>	
42		Osphronemidae	<i>Trichogaster fasciata</i>	
43	Perciformes	Sciaenidae	<i>Johnius coitor</i>	
44	Pleuronectiformes	Polynemidae	<i>Polynemus paradiseus</i>	0.9
45	es	Cynoglossidae	<i>Cynoglossus cynoglossus</i>	
46			<i>Sperata aor</i>	4.1
47			<i>Mystus vittatus</i>	
48			<i>Mystus tengara</i>	
49		Bagridae	<i>Mystus gulio</i>	
50		Clariidae	<i>Clarias batrachus</i>	2.6
51		Heteropneustidae	<i>Heteropneustes fossilis</i>	
52		Pangasiidae	<i>Pangasius pangasius</i>	2.5
			<i>Neotropius atherinoides</i>	2.1
53				
54		Schilbeidae	<i>Eutropiichthys vacha</i>	
55			<i>Clupisoma garua</i>	
56			<i>Silonia silondia</i>	15.6
57			<i>Ailia coila</i>	
58			<i>Wallago attu</i>	
59			<i>Ompok pabda</i>	
60	Siluriformes	Siluridae	<i>Ompok bimaculatus</i>	
			<i>Mastacembelus armatus</i>	4.1
61				
62	Synbranchiformes	Mastacembelidae	<i>Macrognathus aculeatus</i>	
63	es	Synbranchidae	<i>Monopterus cuchia</i>	1.3
		Others		15.1

Catch Composition of the Kishoreganj Haor Area (Nikli-Bajitpur)

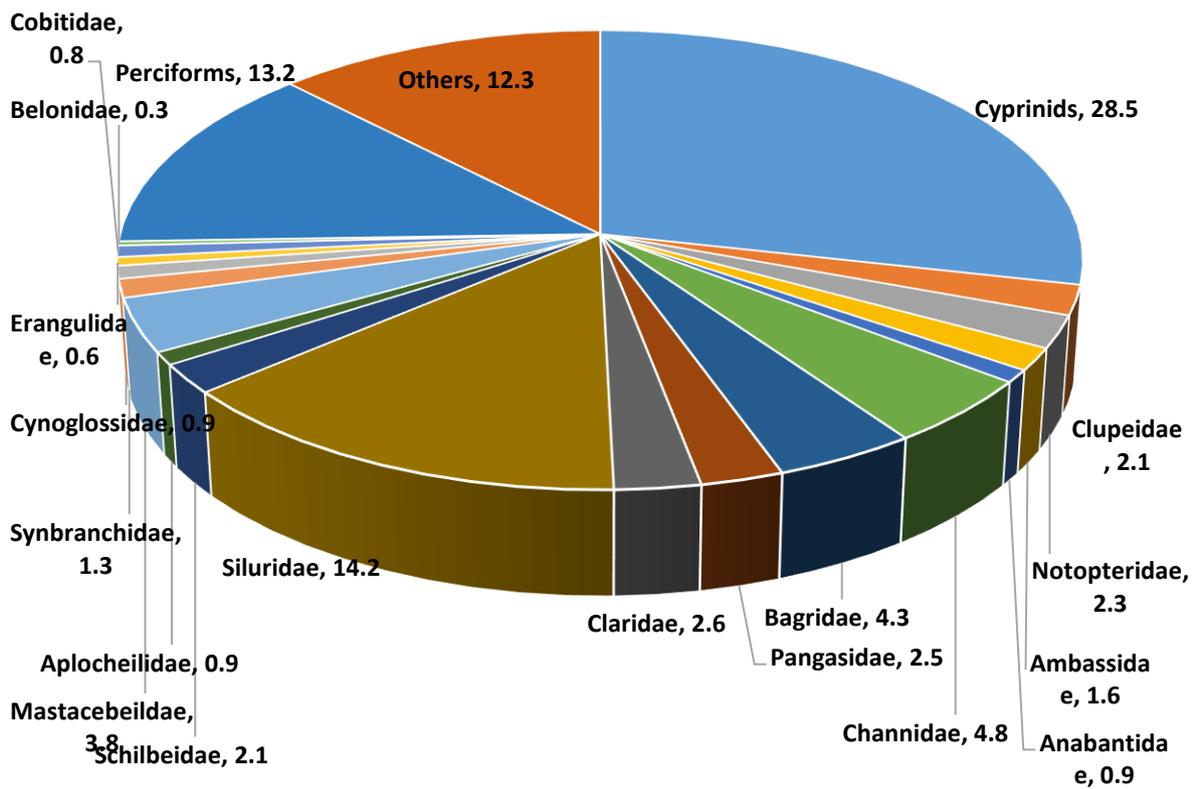
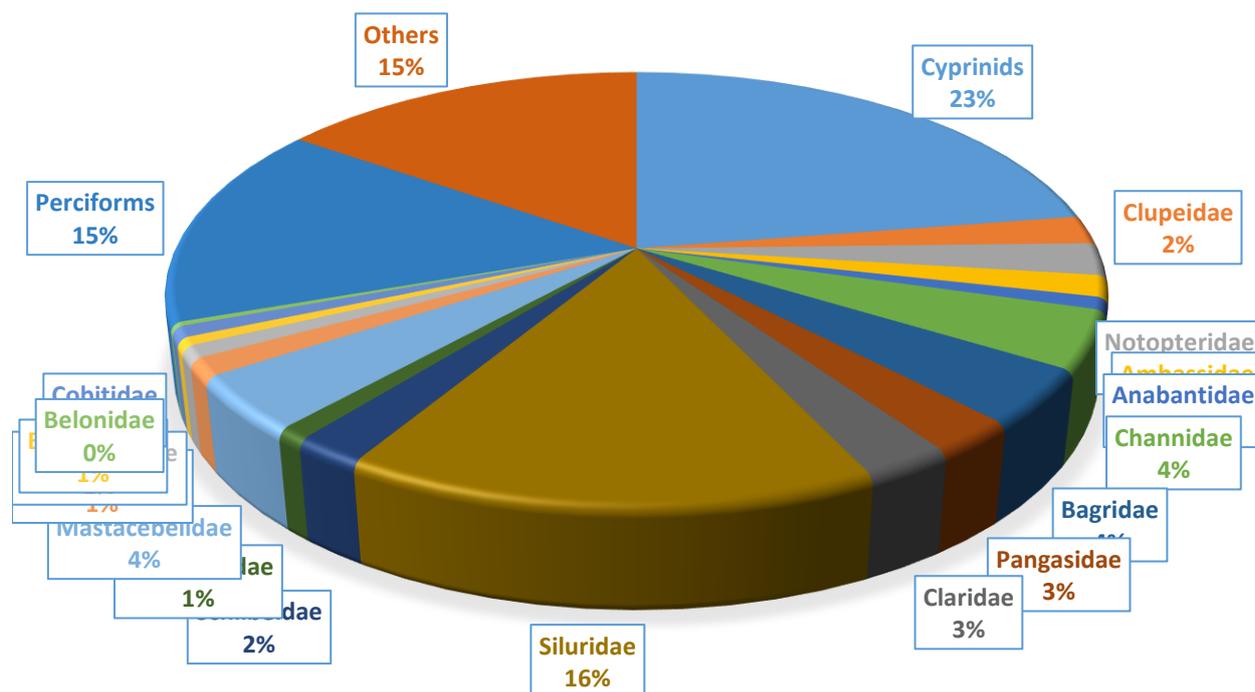


Fig 03: Group wise average fish catch composition of available *haor* resident species of Kishoreganj (Nikli, Bajitpur) during July, 2020 – June, 2021

Catch Composition of Netrokona (KhaliAjhuri, Mohanganj) Haor Area**Fig 04:** Group wise average fish catch composition of available *haor* resident species of Netrokona (Mohanganj, KhaliAjhuri) during July, 2020 – June, 2021**Table 02: Analysis of Species Diversity and Distribution:**

Sl. No	Variable	Kishoreganj (Nikli, Bajitpur)	Netrokona (KhaliAjhuri)	Netrokona (Mohanganj, Purbadhola)
1	Taxa of Sampled Spp	44	58	62
2	Individuals	6435	5312	6854
3	Simpson's dominance Index (D)	0.06	0.06	0.05
4	Simpson's Diversity Index (D')	0.94	0.94	0.95
5	Shannon Diversity Index (H')	3.29	3.37	3.49
6	Evenness index (e)	0.61	0.50	0.53
7	Margalef Richness Value	6.60	7.85	7.91

Major findings:

From the above analysis of the different biodiversity indices, it can be concluded that sampling station Netrokona (Mohanganj, KhaliAjhuri) is comparatively rich in fish biodiversity.

Table 03: Morphological details of some commercial species (length in cm and weight in g measurements) of Netrokona *haor* (Khaliajuri and Mohanganj) during 2020–21 are given below

Species	Sample Size	Measurements Type	Minimum	Maximum	Average
<i>Puntius sophore</i>	485	TL (cm)	6.5	13	9.84
		BW (g)	2	27	11.76
<i>Mastacembelus armatus</i>	364	TL (cm)	27	72	37.76
		BW (g)	16	804	155.71
<i>Amblypharyngodon mola</i>	621	TL (cm)	5	8	6.45
		BW (g)	1	5	3.5
<i>Macrognathus aculeatus</i>	134	TL (cm)	14	27.5	19.41
		BW (g)	8	65	23.62
<i>Wallago attu</i>	86	TL (cm)	35	75	53.96
		BW (g)	100	2100	863.14
<i>Glossogobius giuris</i>	241	TL (cm)	7.50	16	11.92
		BW (g)	2	33	14.30
<i>Mystus vitatus</i>	563	TL (cm)	7	18	10.49
		BW (g)	3	31	9.78
<i>Gudusia chapra</i>	676	TL (cm)	8	13	10.51
		BW (g)	5	14	8.85
<i>Anabus testudineus</i>	412	TL (cm)	11	15.5	12.90
		BW (g)	17	68	35.20
<i>Xenentodon cancila</i>	365	TL (cm)	16	27	21.22
		BW (g)	8	40	20.46
<i>Salmostoma bacaila</i>	103	TL (cm)	10	24	12.79
		BW (g)	4	77	19.45
<i>Channa punctata</i>	608	TL (cm)	12	30	19.03
		BW (g)	9	109	56.52
<i>Labeo calbasu</i>	46	TL (cm)	20	48	28.48
		BW (g)	86	1522	350.15
<i>Botia dario</i>	352	TL (cm)	7	13	10.08
		BW (g)	5	18	11.22
<i>Cyprinus carpio</i>	52	TL (cm)	30	49	41.81
		BW (g)	500	3000	1772.54

Table 04: Morphological details of some commercial species (length in cm and weight in gram measurements) of Kishoregonj (Nikli, Bajitpur) *haors* during 2020–21 are given below

Species	Sample Size	Measurements Type	Minimum	Maximum	Average
<i>Puntius sophore</i>	736	TL (cm)	7	11	8.81
		BW (g)	3	15	8.60
<i>Mastacembelus armatus</i>	451	TL (cm)	21	80	46.49
		BW (g)	25	1200	311.80
<i>Amblypharyngodon mola</i>	846	TL (cm)	5	7	6.41
		BW (g)	2	6	4.26
<i>Macrognathus aculeatus</i>	112	TL (cm)	15.5	28.5	21.94
		BW (g)	11	77	37.76
<i>Wallago attu</i>	95	TL (cm)	43	81	53.89
		BW (g)	356	3270	951.84
<i>Glossogobius giuris</i>	245	TL (cm)	6	20	10.35
		BW (g)	3	35	9.95
<i>Mystus vitatus</i>	813	TL (cm)	7	24.5	13.70
		BW (g)	3	83	19.56
<i>Gudusia chapra</i>	326	TL (cm)	6.5	16	10.88
		BW (g)	12	35	12.14
<i>Anabus testudineus</i>	316	TL (cm)	10	17	12.86
		BW (g)	15	71	32.93
<i>Xenentodon cancila</i>	267	TL (cm)	15.5	27.5	22.82
		BW (g)	8	48	25.12
<i>Salmostoma bacaila</i>	149	TL (cm)	9.5	14.5	11.24
		BW (g)	3	14	6.59
<i>Channa punctata</i>	492	TL (cm)	18.5	30	16.64
		BW (g)	5	93	44.84
<i>Labeo calbasu</i>	84	TL (cm)	16	66	27.53
		BW (g)	56	1490	273.13
<i>Botia dario</i>	531	TL (cm)	14	13	9.23
		BW (g)	3	17	10.14
<i>Cyprinus carpio</i>	43	TL (cm)	37.5	53	44.34
		BW (g)	1120	2698	1789.95

Table 05: Percentages of the ecological fish groups i.e., Planktivores /Herbivores, Detrivores, Carnivores & Omnivores based on catch data of the selected *haor* area during2020–21are given below---

Fishing Area	July					August					September					October					November					December					January					February					March				
	Plantivore	Herbivore	Carnivore	Detrivore	Omnivore	Plantivore	Herbivore	Carnivore	Detrivore	Omnivore	Plantivore	Herbivore	Carnivore	Detrivore	Omnivore	Plantivore	Herbivore	Carnivore	Detrivore	Omnivore	Plantivore	Herbivore	Carnivore	Detrivore	Omnivore	Plantivore	Herbivore	Carnivore	Detrivore	Omnivore	Plantivore	Herbivore	Carnivore	Detrivore	Omnivore										
Kishoreganj <i>haors</i> (Nikli, Bajitpur)	22.78	1.54	43.36	15.48	16.81	25.64	1.36	47.67	14.01	11.62	11.28	1.52	52.02	15.97	18.10	15.00	1.87	37.77	9.17	14.07	24.12	0.84	41.97	12.24	18.09	19.13	1.36	52.93	11.39	11.18	15.85	1.58	52.27	12.06	21.83	17.63	4.71	38.52	13.99	20.96	9.21	4.79	49.90	18.23	15.35
	July					August					September					October					November					December					January					February					March				
Netrokona <i>haor</i> (Mohanganj, Khaliaghuri)	19.62	1.47	45.56	118.98	11.81	10.86	1.11	45.06	18.71	15.57	35.42	4.90	42.60	17.99	22.48	18.84	2.03	40.82	8.67	30.50	17.71	1.31	46.87	11.94	122.14	15.14	1.16	45.09	22.62	13.96	13.12	0.88	48.81	12.38	33.50	9.31	2.87	43.01	15.57	26.07	10.38	4.50	41.02	4.60	32.65

Study 2: Sampling of Bio-Physicochemical properties of selected *haor&beel* waterbodies

Collection of hydrological data: Bio-physicochemical and hydrological data of *haor & beel* ecosystem was monitored fortnightly by using a high equipped Multi-Parameter Water Quality Meter. In each sampling day water quality data (depth, water temperature, turbidity, TDS, pH, DO, nitrate, Algae/Chlorophyll and primary productivity was collected from the selected study

Table 06. Maximum and minimum values of the Physico chemical properties of haor areas of Netrokona in 2020-21

Variables	Pre-monsoon (Jan-Mar)			Monsoon (Jun-Oct)			Post-Monsoon (Nov-Dec)		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Water temperature	18	21.65	19.77	28	32	30	25	28	25
pH	7.41	8.74	7.96	7.11	8.29	8.04	7.16	8.93	7.82
DO	4.02	5.43	4.87	5.56	9.49	7.92	5.27	6.87	5.93
Depth	2.2	3.4	2.33	5.2	12.1	7.72	2.1	5.3	3.39
Turbidity	37.5	46.1	42.2	24.3	34.1	29.2	30.2	38.1	34.3
Ammonia	0.01	0.02	0.02	0.01	0.03	0.018	0.011	0.03	0.018
Alkalinity	54	65	61	90	110	102	50.5	64.1	56.2
TDS	80	82	80	70	76	79	55	62.2	61.4

Table07. Maximum and minimum values of the physico-chemical properties of haor areas of Kishorgonj in 2020-21

Variables	Pre-monsoon (Jan-Mar)			Monsoon (Jun-Oct)			Post-Monsoon (Nov-Dec)		
	Min.	Max.	Avg.	Min	Max.	Avg	Min	Max	Avg
Water temperature	19	21	20	29	32	30	27	28	27.5
pH	7.21	7.78	7.52	7.79	8.54	8.32	7.09	8.75	8.15
DO	4.25	5.46	4.73	6.78	7.56	7.16	3.38	4.5	4.13
Depth	2	3	2.61	6	15	10	5	6	5
Turbidity	38	45	48	26	34	32	35	40	35
Ammonia	0.01	0.03	0.02	0.01	0.02	0.02	0.011	0.03	0.03

Alkalinity	64	78	71	90	110	130	120	80	79
TDS	75	86	84	72	84	79	52	69	61

Major findings:

From the above statistics, it can be concluded that Sep-Oct is the pick time of fishing and exploitation and also sampling station Netrokona (Khaliajhuri) is comparatively higher landing spot.



Fig 05: Sampling of Physicochemical water quality parameters of the selected *haor* area

Assessment of plankton community dynamics:

Two liters of water was collected from the surface water for phytoplankton samples and preserved in 3% neutral formalin. Then, the preserved phytoplankton samples was taken in cylindrical measuring jars and allowed to settle for 16–20 h. After that, samples were concentrated 10 ml by careful filtration and decantation. After preparing a homogeneous mixture by stirring the concentrated sample, an aliquot of 1 ml was removed with a Stem cell pipette and taken on a Sedgwick Rafter cell under a compound microscope for counting. A zooplankton net with 353 μm mesh size was used for zooplankton collection. All zooplankton

samples were preserved in 5% neutralized formalin, and sorted and enumerated through following standard procedures of APHA(1976) and Lind(1979). Plankton density estimated by-

$$N = (A \times 1000 \times C) / (V \times F \times L)$$

Where, N=no. Of plankton cells or units per liter of original water

A=Total no of plankton counted

C=Volume of final concentrate of the sample in ml.

V=volume of a field in cubic mm.

F=No. Of fields counted. L=Volume of original water in liter

Table 08: List of identified Phyto & Zooplankton genera found in the selected haors of Netrokona and Kishoreganj during 2020 – 21.

Plankton	Group	Genera/species
Phytoplankton	Bacillariaophyceae	<i>Navicula sp.</i>
		<i>Nitzschia sp.</i>
		<i>Chaetoceros sp.</i>
		<i>Cyclotella sp.</i>
		<i>Gyrosigma sp.</i>
		<i>Synedra sp.</i>
		<i>Bacillaria sp.</i>
		<i>Rhizosolenia sp.</i>
		<i>Fragilaria sp.</i>
	Chlorophyceae	<i>Spirogyra sp.</i>
		<i>Ulothrix sp.</i>
		<i>Volvox sp.</i>
		<i>Spirulina sp.</i>
		<i>Chlorella sp.</i>
		<i>Coleochaete sp.</i>
		<i>Microspora sp.</i>
		<i>Melosira sp.</i>
		<i>Cosmarium sp.</i>
	Cyanophyceae	<i>Oscillatoria sp.</i>
		<i>Anabaena sp.</i>
<i>Microcystis sp.</i>		
Euglenophyceae	<i>Euglena sp.</i>	
	<i>Phacus sp.</i>	
	<i>Trachelomonas sp.</i>	
Zooplankton	Rotifera	<i>Brachionus sp.</i>
		<i>Keratella sp.</i>
		<i>Filinia sp.</i>
		<i>Asplanchna sp.</i>
		<i>Polyarthra sp.</i>
	Cladocera	<i>Moina sp.</i>
		<i>Daphnia sp.</i>
<i>Bosmina sp.</i>		

	Copepoda	<i>Diaphanosoma sp.</i>
		<i>Cyclops sp.</i>
		<i>Diaptomus sp.</i>
		<i>Mesocyclops sp.</i>
		<i>Macrocyclus sp.</i>

Table 09: Monthly abundance of phytoplankton and zooplankton (cellsL⁻¹) of the selected haors during 2020 – 21

Plankton groups	Months					
	July	August	September	October	November	December
Phytoplankton						
<i>Navicula sp.</i>	9x10 ⁴	6 x10 ⁴	8 x10 ⁴	6 x10 ⁴	4 x10 ⁴	7 x10 ⁴
<i>Gyrosigma sp.</i>	8x10 ⁴	5 x10 ⁴	3 x10 ⁴	4 x10 ⁴	2 x10 ⁴	10 ⁴
<i>Nitzschia sp.</i>	10 ⁵	6 x10 ⁴	2 x10 ⁴	4 x10 ⁴	2 x10 ⁴	10 ⁴
<i>Synedra sp.</i>	8x10 ⁴	2 x10 ⁴	2 x10 ⁴	3 x10 ⁴	10 ⁴	10 ⁴
<i>Cyclotella sp.</i>	6x10 ⁴	7 x10 ⁴	6 x10 ⁴	4 x10 ⁴	2 x10 ⁴	2 x10 ⁴
<i>Bacillaria sp.</i>	10 ⁵	8 x10 ⁴	3 x10 ⁴	5 x10 ⁴	2 x10 ⁴	10 ⁴
<i>Rhizosolenia sp.</i>	6x10 ⁴	2 x10 ⁴	2 x10 ⁴	1 x10 ⁴	10 ⁴	10 ⁴
<i>Chaetoceros sp.</i>	4x10 ⁴	3 x10 ⁴	2 x10 ⁴	1 x10 ⁴	10 ⁴	10 ⁴
<i>Fragilaria sp.</i>	4x10 ⁴	5 x10 ⁴	3 x10 ⁴	2 x10 ⁴	10 ⁴	10 ⁴
Bacillariophyceae	6.5x10⁵	4.4x10⁵	3.1x10⁵	3x10⁵	1.5x10⁵	1.6x10⁵
<i>Spirogyra sp.</i>	8x10 ⁴	8 x10 ⁴	4 x10 ⁴	8 x10 ⁴	6 x10 ⁴	4 x10 ⁴
<i>Ulothrix sp.</i>	7x10 ⁴	10 ⁵	8 x10 ⁴	6 x10 ⁴	4 x10 ⁴	2 x10 ⁴
<i>Volvox sp.</i>	6x10 ⁴	3 x10 ⁴	3 x10 ⁴	1 x10 ⁴	2 x10 ⁴	10 ⁴
<i>Spirulina sp.</i>	4x10 ⁴	2 x10 ⁴	2 x10 ⁴	2 x10 ⁴	10 ⁴	10 ⁴
<i>Chlorella sp.</i>	1.1x10 ⁵	6 x10 ⁴	6 x10 ⁴	6 x10 ⁴	8 x10 ⁴	6 x10 ⁴
<i>Coleochaete sp.</i>	3x10 ⁴	4 x10 ⁴	2 x10 ⁴	10 ⁴	10 ⁴	10 ⁴
<i>Microspora sp.</i>	6 x10 ⁴	2 x10 ⁴	3 x10 ⁴	2 x10 ⁴	10 ⁴	10 ⁴
<i>Melosira sp.</i>	4 x10 ⁴	3 x10 ⁴	2 x10 ⁴	2 x10 ⁴	10 ⁴	10 ⁴
<i>Cosmarium sp.</i>	10 ⁵	8 x10 ⁴	4 x10 ⁴	2 x10 ⁴	2 x10 ⁴	8 x10 ⁴
Chlorophyceae	5.9x10⁵	4.6x10⁵	3.4x10⁵	3x10⁵	2.6x10⁵	2.5x10⁵
<i>Oscillatoria sp.</i>	8 x10 ⁴	10 ⁵	4 x10 ⁴	6 x10 ⁴	3 x10 ⁴	2 x10 ⁴
<i>Anabaena sp.</i>	8 x10 ⁴	9 x10 ⁴	7 x10 ⁴	6 x10 ⁴	8 x10 ⁴	2 x10 ⁴
<i>Microcystis sp.</i>	6 x10 ⁴	4 x10 ⁴	3 x10 ⁴	4 x10 ⁴	2 x10 ⁴	1.4 x10 ⁴
Cyanophyceae	2.2x10⁵	2.3x10⁵	1.4x10⁵	1.6x10⁵	1.3x10⁵	5 x10⁴
<i>Euglena sp.</i>	4 x10 ⁴	8 x10 ⁴	6 x10 ⁴	4 x10 ⁴	3 x10 ⁴	10 ⁴
<i>Phacus sp.</i>	3 x10 ⁴	6 x10 ⁴	2 x10 ⁴	1 x10 ⁴	10 ⁴	10 ⁴
<i>Trachelomonas sp.</i>	2 x10 ⁴	3 x10 ⁴	4 x10 ⁴	10 ⁴	10 ⁴	10 ⁴
Euglenophyceae	9 x10⁴	1.7x10⁵	1.2x10⁵	6x10⁴	5 x10⁴	3 x10⁴
<i>Brachionus sp.</i>	1.2x10 ⁵	6 x10 ⁴	4 x10 ⁴	3 x10 ⁴	2 x10 ⁴	10 ⁴
<i>Keratella sp.</i>	8 x10 ⁴	8 x10 ⁴	7 x10 ⁴	2 x10 ⁴	3 x10 ⁴	2 x10 ⁴
<i>Filinia sp.</i>	4 x10 ⁴	7 x10 ⁴	3 x10 ⁴	2 x10 ⁴	2 x10 ⁴	10 ⁴
<i>Asplanchna sp.</i>	8 x10 ⁴	4 x10 ⁴	3 x10 ⁴	2 x10 ⁴	3 x10 ⁴	2 x10 ⁴
<i>Polyarthra sp.</i>	4 x10 ⁴	7 x10 ⁴	2 x10 ⁴	10 ⁴	10 ⁴	4 x10 ⁴
Zooplankton						
Rotifera	3.6x10⁵	3.2x10⁵	1.9x10⁵	10⁵	1.1x10⁵	10⁵
<i>Moina sp.</i>	1.4x10 ⁵	1.2x10 ⁵	1.2 x10 ⁴	9 x10 ⁴	3 x10 ⁴	8 x10 ⁴
<i>Daphnia sp.</i>	1.2x10 ⁵	8 x10 ⁴	8 x10 ⁴	10 ⁵	4 x10 ⁴	6 x10 ⁴
<i>Bosmina sp.</i>	6 x10 ⁴	1.1x10 ⁵	1.1x10 ⁵	4 x10 ⁴	2 x10 ⁴	4 x10 ⁴
<i>Diaphanosoma sp.</i>	1.1x10 ⁵	9 x10 ⁴	9 x10 ⁴	6 x10 ⁴	4 x10 ⁴	9 x10 ⁴

Cladocera	4.3x10⁵	4x10⁵	4x10⁵	2.9x10⁵	1.3x10⁵	2.7x10⁵
<i>Cyclops sp.</i>	1.4x10 ⁵	7 x10 ⁴	1.1x10 ⁵	1.2x10 ⁵	1.1x10 ⁵	8 x10 ⁴
<i>Diaptomus sp.</i>	8 x10 ⁴	1.3x10 ⁵	8 x10 ⁴	4 x10 ⁴	8 x10 ⁴	5 x10 ⁴
<i>Macrocyclops sp.</i>	8 x10 ⁴	6 x10 ⁴	4 x10 ⁴	4 x10 ⁴	4 x10 ⁴	6 x10 ⁴
<i>Mesocyclops sp.</i>	10 ⁵	4 x10 ⁴	2 x10 ⁴	3 x10 ⁴	3 x10 ⁴	3 x10 ⁴
Copepoda	4x10⁵	3x10⁵	2.5x10⁵	2.3x10⁵	2.6x10⁵	2.2x10⁵

Table 10. Quantitative analysis of zooplankton (Indv. /100 ml) in four size groups in two seasons

Genera	Total (cellsL⁻¹)	Percentage (%)
Copepods	5.6x10 ⁴	50.04
Cladocera	2.6 x10 ⁴	23.10
Chaetognaths	1.3 x10 ⁴	11.55
Ostracods	1.0 x10 ⁴	8.33
Rotifers	0.5 x10 ⁴	4.83
Protozoans	0.3 x10 ⁴	2.15

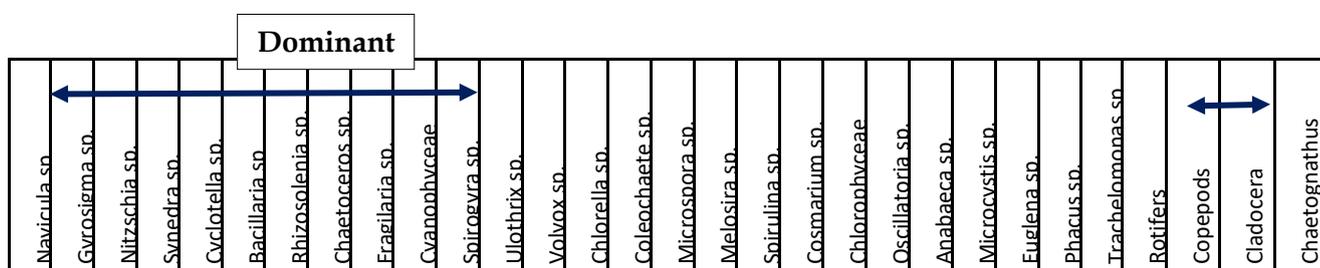


Fig 06: Dendrogram of the plankton distribution and abundance of each species during (2020 - 21) in the different haor regions

Major findings:

The above tables (9 & 10) and Fig. 06 illustrated that beneficial phyto-plankton groups for fisheries (i.e., Bacillariophyceae, Chlorophyceae etc) shows the dominance over harmful/non-beneficial groups (i.e., Cyanophyceae, Euglenophyceae etc). On the other hand, zooplankton groups Copepods shows dominancy than other groups which proves the productive character of those haors.

Study 3: Assessment of stock of commercially significant inland open water fishes

Major findings: The haors of Netrokona district shows greater primary productivity and biomass than the Haors of Kishoreganj district.

Yield per recruit analysis:Table 11. Estimates of yield, effort and remaining biomass proportion for E_{MY} (Effort corresponding to maximum yield) and $E_{0.1}$ strategy for selected *haor* areas

Parameter	Unit	Kishoreganj (Nikli)	Netrokona (Mohanganj)	Netrokona (Khaliajhuri)	Habitat average
Net Primary Production	t. ha ⁻¹ yr ⁻¹	63.4	71.05	72.36	68.93
Total Biomass	t. ha ⁻¹ yr ⁻¹	6.67	6.96	6.98	6.87
MY (Maximum Yield)	t. ha ⁻¹ yr ⁻¹	1.46	1.52	1.63	1.54
E_{MY} (Effort corresponding to maximum yield)	day ha ⁻¹ yr ⁻¹	836	892	927	885
$E_{0.1}$	$Y_{E_{0.1}}$	1622	1734	1779	1711
	CPUE _{$E_{0.1}$} (Kg/day)	0.81	0.88	0.93	0.87
	CPUE _{max} (Kg/day)	1.83	1.92	2.08	1.94
	CPUE _{$E_{0.1}$} /CPUE _{max}	0.44	0.46	0.45	0.45

Conservation and Seed Production of Indigenous Fish Species in Bangladesh

Researchers Dr. Salina Yeasmine, Senior Scientific Officer & PI
Md. RabiulAwal, Scientific Officer

Objectives

- To refine breeding and nursery technique for mass seed production of Gazar (*C. marulius*).
- To develop culture technique of JaitPunti in ponds under different stocking density
- To study the reproductive biology of Dhela (*Osteobrama cotio*), Rani (*Botia dario*) & Bele (*Glossogobius giuris*)
- To collect & domesticate the *Tor tor*, *O. cotio*, *B. dario* & *G. giuris*
- To develop induced breeding technique of *M. armatus*, *T. tor*, *O. cotio*, *B. dario* & *G. giuris*
- To collect indigenous freshwater fish species from different regions for live gene-bank

Achievements

The following research works were carried out under the project during July 2020 to June 2021.

Experiment 1. Study on reproductive biology of Dhela (*Osteobrama cotio*), & Bele (*Glossogobius giuris*)

A total number of 10 female and 10 male of each species of Dhela (*Osteobramacotio*), and Bele (*Glossogobiusgiuris*) were collected from Mohonganjhaorof Netrokona and Brahmaputra River of Mymensingh in each month, through the fishermen.

Laboratory studies

Individual fish was measured for total length to the nearest cm with a measuring scale and body weight to the nearest g by an electronic balance (Figure 1-6).

Gonado-Somatic- Index (GSI)

Total body weight and gonad weight of collected fishes in each month was considered to calculate the mean Gonado-Somatic Index (GSI). Gonado-Somatic Index (GSI) was calculated according to the formula:

$$\text{GSI} = \frac{\text{Weight of gonad}}{\text{Weight of fish}} \times 100$$

Gonado-Somatic Index (GSI) of female and male Dhela (*Osteobramacotio*) was calculated during September 2020 to May 2021 and month-wise changes in mean GSI values of female and male are presented in Table 1 and 2. The mean values of GSI of Dhela (*Osteobramacotio*) ranged from 0.22±0.42 to 9.25±2.51 (Table 1) in female and 0.005±0.003 to 7.47±0.31 (Table 2) in male during September 2020 to May 2021. The highest GSI in female of Dhela (*O. cotio*) was 9.25±2 obtained in the month of May. The Fecundity of Dhela (*Osteobramacotio*) was recorded from 6883.80±1650.636 to 7529.30±1110.076.

Table 1. GSI values of female Dhela (*Osteobramacotio*) from September 2020 to March 2021.

Month	No. of fish examined	Body Length of fish (cm)	Body wt. of fish (g)	Ovary wt. (g)	GSI (%)
September	10	5.12±0.18	2.11±0.59	-	-
October	10	5.41±0.31	2.56±0.8	-	-
November	10	6.46±0.12	3.13±1.01	0.008±0.02	0.22±0.42
December	10	6.29±0.24	3.42±1.19	0.112±0.13	2.57±2.55
January	10	7.19±0.58	4.2±1.38	0.44±0.18	7.47±2.71

February	10	7.26±0.48	5.5±0.88	0.41±0.08	7.55±3.42
March	10	7.22±0.22	9.55±0.76	0.81±0.06	8.48±2.21
April	10	8.25±0.76	9.8±0.92	0.88±0.05	8.75±2.32
May	10	7.56±0.41	9.22±0.84	0.86±0.02	9.25±2.51

Table 2. GSI values of male Dhela (*Osteobrama cotio*) from September 2020 to March 2021.

Month	No. of fish examined	Body Length of fish (cm)	Body wt. of fish (g)	Ovary wt. (g)	GSI (%)
Sept.	10	3.13±0.35	1.19±0.26	-	-
Oct.	10	4.11±0.24	1.53±0.36	-	-
Nov.	10	4.42±0.31	1.86±0.56	0.0001±0.0003	0.005±0.003
Dec.	10	5.13±0.45	2.14±0.58	0.0012±0.002	0.056±0.008
Jan.	10	5.71±0.44	2.78±0.35	0.209±0.012	7.51±0.54
Feb;	10	5.82±0.33	2.35±0±.611	0.190±0.108	8.08±0.24
Mar.	10	6.09±0.40	3.29±0.15	0.251±0.07	8.69±0.43
Apr.	10	6.03±0.70	3.45±0.15	0.241±0.07	7.01±0.23
May	10	5.89±0.20	3.51±0.15	0.262±0.07	7.47±0.31



Fig.1.Length (cm) measurement of Dhela (*O. cotio*)



Fig.2.Weight (g) measurement of Dhela (*O. cotio*)



Fig.3.Position of ovary of Dhela (*O. cotio*)



Fig.4.Collected ovary of Dhela (*O. cotio*)



Fig.5.Position of testis of Dhela (*O. cotio*)



Fig.6.Collected testis of Dhela (*O. cotio*)

Gonado-Somatic Index (GSI) of female and male Bele (*Glossogobiusgiuris*) was calculated during September 2020 to March 2021 and month-wise changes in mean GSI values of female and male are presented in Table 3 and 4. The mean values of GSI of Bele (*G. giuris*) ranged from 0.17 ± 0.01 to 0.31 ± 0.3 (Table 3) in female and 0.01 ± 0.012 to 0.22 ± 0.2 (Table 4) in male during September 2020 to March 2021. The highest GSI in female of Bele (*G. giuris*) was 0.31 ± 0.3 obtained in the month of March.

Table 3. GSI values of female Bele (*Glossogobiusgiuris*) during study period (September 2020 to March 2021)

Month	No. of fish examined	Body wt. of fish (g)	Ovary Wt. (g)	GSI (%)
September	10	2.49 ± 0.7	-	-
October	10	2.85 ± 0.79	-	-
November	10	3.59 ± 1.1	-	-
December	10	4.87 ± 2.53	0.009 ± 0.01	0.17 ± 0.01
January	10	10.6 ± 1.94	0.024 ± 0.03	0.2 ± 0.18
February	10	14.2 ± 2.14	0.035 ± 0.03	0.22 ± 0.2
March	10	12.6 ± 2.5	0.04 ± 0.05	0.31 ± 0.3

Table 4. GSI values of male Bele(*Glossogobiusgiuris*)from September 2020 to March 2021

Month	No. of fish examined	Body wt. of fish (g)	Ovary Wt. (g)	GSI (%)
September	10	1.58±0.29	-	-
October	10	1.79±0.36	-	-
November	10	2.59±0.68	-	-
December	10	3.65±1.61	0.0005±0.012	0.01±0.012
January	10	9.20±1.39	0.004±0.01	0.04±0.03
February	10	11.05±1.68	0.02±0.01	0.19±0.15
March	10	12.08±0.92	0.04±0.03	0.22±0.2

**Figure 7. Collected ovary of Bele (*Glossogobiusgiuris*)****Experiment 2. Development of induced breeding technique of Dhela *Osteobrama cotio*, & Rani (*Botia dario*)****Collection and domestication of Dhela (*Osteobrama cotio*) and Rani (*Botia dario*) Dhela (*Osteobrama cotio*)**

A total of one thousand (1000) Dhela (*Osteobrama cotio*) were collected from Brahmaputra River of Mymensingh and stocked at the rate of 30-35/decimal in the pond at Freshwater Station, BFRI having an area of 10 decimal and 1m water depth. Fishes were reared with supplementary feed @ of 4-5% body weight twice daily for raising gonad development. Supplementary feed was used twice a day at 8.00am and 4.00pm. During rearing period, lime and fertilizer were properly applied. Fertilization with urea and TSP at the rate of 100g/decimal and 50g/decimal respectively were applied at 15 days interval. Physico-chemical parameters of pond water (temperature, pH, DO, Ammonia) were monitored at weekly interval.

Rani (*Botia dario*)

A total of 500 Rani (*B. Dario*) were collected from Kongsho River of Netrokana district and stocked at the rate of 30-35/decimal in the previously prepared pond at Freshwater Station, BFRI having an area of 10 decimal and 1m water depth. Fishes were reared by supplying commercial feed @ of 2-3% body weight twice daily.

ii. Development of induced breeding technique of Dhela (*Osteobrama cotio*)

The present experiment was undertaken to develop induced breeding technique of Dhela (*Osteobrama cotio*). Induced breeding trials of Dhela (*Osteobrama cotio*) were conducted to optimize hormone doses during May, 2021. In this experiment for the ovulation of females different doses (2, 4 and 6 mg/kg body weight of fish) of PG was used to confirm the optimum PG dose. On the other hand, male fish were treated with 2mg/kg body weight. Single dose was applied in both male and female fishes. Three different treatment doses viz. T₁, T₂, and T₃ were used and each dose were triplicated. Matured male and female fishes were collected from the pond early in morning and weighted. After five hours of conditioning, PG was used for induced breeding of Dhela (*Osteobrama cotio*) with three different doses. The efficacy of PG doses and observed and collected data on ovulation, fertilization, hatching and survival rates are summarized and shown in Table 5.

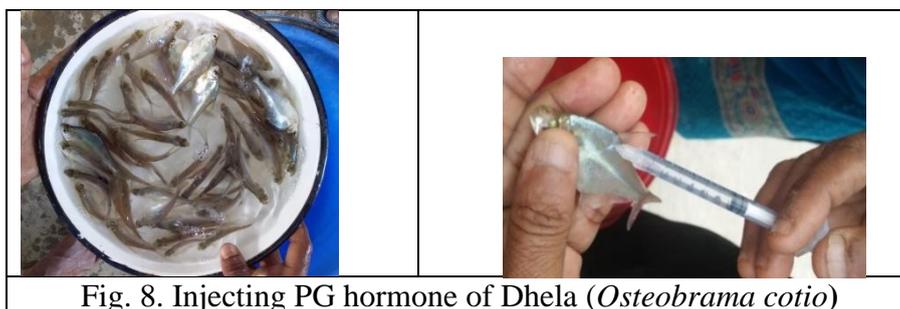


Fig. 8. Injecting PG hormone of Dhela (*Osteobrama cotio*)

Table 5. Details of PG doses on Dhela (*Osteobrama cotio*) and corresponding data on ovulation, fertilization, hatching and survival rates during study period

Treatment	Mean Body weight (g)		1 st Injection dose (mg/kg ⁻¹)		Ovulation period (hr)	Ovulation rate (%)	Fertilization rate (%)	Hatching period (hr)	Hatching Rate (%)	Incubation Temp. (°C)	Remarks
	Male	Female	Male	Female							
T ₁	5.01±0.61	10.24±2.2	2	2	7-8	-	-	-	-	-	No Ovulation
T ₂	5.07±0.22	11.42±2.1	2	4	7-8	50.1 ±4%)	50.62 ±5.07 %	22	43.44 ±10.73	32	Partial Ovulation

T ₃	4.83±0.74	10.03±4.0	2	6	7-8	95.5±.5%)	97.22±11.10	22	95.36±11.26	32	Complete Ovulation, Successful fertilization & hatching
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Fish did not show any response with the dose applied in T₁ but with the doses applied in T₂, and T₃ showed minimum and good response respectively in consideration of ovulation, fertilization & hatching.

Experiment 3. Development of induced breeding technique of *Rani (B. dario)*

Induced breeding trials of *Rani (B. dario)* were conducted during May-June, 2021. In this trials, different dose of synthetic hormone viz. 0.8, 1.0 and 1.5 ml/kg body weight of female fishes were used. On the other hand, male fishes were treated with 0.5 ml/kg body weight. Single dose was applied in male and female fishes. Matured male and female fishes were collected from the pond early in the morning. After five hours of conditioning, different doses of synthetic hormone were used for induced breeding of *Rani (B. dario)*. The efficacy of synthetic hormone doses on *Rani (B. dario)* and observed and collected data on ovulation, fertilization, hatching and survival rates are summarized and shown in Table 6.

Table 6. Details of synthetic hormone doses on *Rani (B. dario)* and corresponding data on ovulation, fertilization, hatching and survival rates during study period

Treatments	Mean Body weight (g)		1 st Injection dose (ml/kg ⁻¹)		Ovulation period (hr)	Ovulation rate (%)	Fertilization rate (%)	Hatching period (hr)	Hatching Rate (%)	Incubation Temp. (°C)	Remarks
	Male	Female	Male	Female							
T ₁	6.01±0.40	12.84±2.10	0.5	0.80	-	-	-	-	-	-	No Ovulation
T ₂	5.90±0.82	11.61±2.90	0.5	1.0	6	70.4±7%	75.4±7%	22	63.54±.13.79%	32	Ovulation, Successful fertilization & hatching
T ₃	5.73±0.24	11.30±4.20	0.5	1.5	6	-	-	-	-	-	No Ovulation

Experiment 4. Development of induced breeding technique of *T. tor*

i. Collection and domestication of *Tor torin* pond

A total of 25 *T. tor* was collected from Sumessweri River of Netrokana district. Collected fish were transported to Freshwater Station in oxygenated drum. After transportation, the fish

were acclimatized in a pond for 2 hour. After acclimatization, the collected fish were stocked in a pond having an area of 40 decimal. During stocking initial length and weight of the collected fish was recorded and average body weight of collected fish was 1500 ± 325 g. Fishes were reared by supplying commercially floating feed @ of 2-3% body weight twice daily. Physic-chemical parameters of pond water viz-water temperature, pH, DO and ammonia were monitored at monthly interval. Feed ration were adjusted monthly. After maturing the fish induced breeding technique will be carried out for seed production.

Identification of etiological agents responsible for fish diseases using PCR techniques and mitigation measures

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Objectives

- To isolate and identify the causal agents responsible for fish diseases
- Detection of etiological agents based on PCR techniques
- To find out the protective measures against diseases

Achivements

Expt. 1: Isolation and identification of causal agents

Investigation of physicochemical parameters of infected farms

The Physicochemical parameters (water temperature, dissolved oxygen, pH, alkalinity, total ammonia and total hardness) measured during sampling by using a portable HACH kit.

Collection, transportation and preservation of diseased fin fish

Diseased Shing, Koi, Tilapia, Pangus and gulsha were collected from different farms under Mymensingh, Gazipur, Netrokona and Kisorganj districts during the period of July 2020 to June 2021. From each affected farms, twenty infected or freshly-dead fish were sampled randomly by scooping blindly with a net. Whole freshly dead fish samples were transported in sterile plastic bags (one fish per bag) using ice packs, whereas, infected live fish was transported in clean plastic water gallons containing freshwater (to ensure oxygenation) in different groups as collect from farms to avoid cross-contamination.

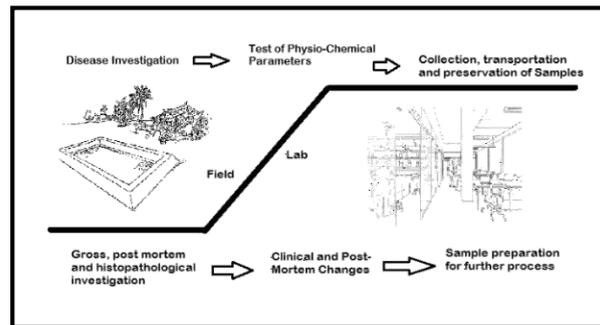


Fig. 1 Overview of Methodology

Primary Isolation and Identification of bacteria from infected fishes

Fish sampling and primary isolation of bacteria were done under complete aseptic condition from the body (Ulcer), swabs were inoculated on Tryptic Soy Broth (TSB) that incubated at 28-37°C for 24-48h. Characterization of the pure isolates was performed and involved colonial characteristics, bacterial cell morphology, motility test, biochemical tests (catalase test, glucose, sucrose and lactose utilization, citrate test, indole test, urease test, hydrogen sulfide production, TSI (gas production), methyl red (MR) test, voges praskaure (VP) test and coagulase test) and staining morphology by gram reaction. The biochemical tests were carried out to identify the pathogens following the Bergey’s manual of Bacteriological classification (John *et al.*, 1998).



Fig. 2 Samples in broth culture



Fig. 3 Biochemical test

Result

Study Area: Tilapia, Koi, Shing, Magur, Pangas and gulsha were collected from the affected ponds of 12 upazilla under 4 different districts and having mortality 80-90%. Location are shown in following table.

Table 1: Area of Sample Collection

Name of Districts	Name of Upazila	Pond/ Gher	Total Pond
Mymensingh	Trishal	8	15
	Gouripur	3	
	Tarakanda	2	
	Phulpur	1	
	Muktagacha	1	
Netrokona	Purbadhala	5	08
	Kendua	3	
Kishoreganj	Hossainpur	3	05
	Pakundia	2	
Gazipur	Sreepur	3	07
	Kaliakair	3	
	Kapasias	1	
4 Districts		12 Upazilas	31

Number of Collected Sample: Of the total 430 fish samples, Tilapia (n=180, bwt=90±10gm) and V.Koi (n=150, bwt=80±5gm) Shing (n=110, bwt=40±5gm), Magur (n=100, bwt=60±5gm), Pangas (n=108, bwt=150±10gm) and Gulsha (n=45, bwt=30±5gm) were collected from 31 affected ponds.

Table 2: Different organs collected from different fish species

Organ/ Tissue samples	Tilapia	Koi	Shing	Magur	Pangas	Gulsha	Total sample tested
Liver	30	15	30	25	14	15	129
Kidney	20	23	20	20	18	8	109
Spleen	20	22	20	15	8	5	90
Brain	5	5	5	8	5	10	38
Skin Tissue	5	10	10	12	20	7	64
Total Samples	80	75	85	80	65	45	430

Water quality parameters of diseased fish of different farms

The Physico-chemical parameters were measured from infected farms under different districts by using a portable HACH kit (Model FF-2). Water quality parameters of diseased fish (Vietnamese Koi, Shing, Tilapia, Pangas and Magur) observed in different farms of Mymensingh, Netrokona, Kisorganj and Gazipur region. Present study showed that, optimum range of temperature for fish (Vietnamese Koi, Shing, Tilapia, Pangas and Magur) are similar whereas, obtained values vary within species and region. Moreover, sometimes temperature shows slight variation (increase or decrease) as it is dependent on some factor such as solar radiation, air temperature etc. pH value in experimental fish (Vietnamese Koi, Shing, Tilapia, Pangas and Magur) were within range which is a positive finding for fish health. Since, if the pH of water is too high or too low, the aquatic organisms living within it will die. In present conducted study, DO concentration range were varying from species to species which sometimes fall below requirement level that possess risk for fish. The results of this study showed that, ammonia concentrations were so much higher from permissible limits for all of these (Vietnamese Koi, Shing, Tilapia, Pangas and Magur) species which causes serious health alteration of fish.

Table 3. Water Quality Parameter of Infected Vietnamese Koi farms

Parameters	Result			Suitable range
	Tarakanda	Muktagacha	Trisal	
Temp ($^{\circ}$ C)	26-32	25-29	26-29.5	28-32
pH	6.5-9.0	8.5-9.5	6.5-8.0	7.5-8.5
Dissolved oxygen (mg/L)	2.2-5.8	2.0-4.5	2.0-5.5	5.0-10.0
Un-ionized ammonia (toxic) (mg/L)	0.04-2.40	0.6-3.0	0.31-2.5	0.00-0.02

Table 4. Water quality parameters of diseased Shing farms

Parameters	Result				Suitable range
	Tarakanda	Muktagacha	Gouripur	Purbadhala	
Temp ($^{\circ}$ C)	24-35	25-34	24.5-32	16-32	28-32
pH	7.5-9.0	8.5-12	7.6-8.0	5.5-9.0	7.5-8.5
Dissolved oxygen (mg/L)	1.0-5.0	3.0-4.5	1.5-5.0	2.0-5.0	5.0-10.0
Un-ionized ammonia (toxic) (mg/L)	0.04-1.2	0.6-2.2	0.31-1.5	0.4-2.0	0.00-0.02

Table 5. Water quality parameters of diseased Pangas farms

Parameters	Result					Suitable range
	Bhaluka	Muktagacha	Trisal	Kapasias	Kaliakour	
Temp ($^{\circ}$ C)	15-31	16-32	26-29.5	26-29.5	26-29.5	28-32
pH	6.2-9.5	6.5-9.0	7.6-8.0	7.6-8.0	7.6-8.0	7.5-8.5
Dissolved oxygen (mg/L)	3.2-5.5	2.0-5.0	2.0-5.0	1.0-5.0	2.0-5.0	5.0-10.0
Un-ionized ammonia (toxic) (mg/L)	0.04-2.40	0.4-2.0	0.31-2.0	0.2-0.02	0.31-0.02	0.00-0.02

Table 6. Water quality parameters of diseased Tilapiafarms

Parameters	Result				Suitable range
	Tarakanda	Muktagacha	Trisal	Kendua	
Temp (⁰ C)	24-35	25-34	22-32	26-29.5	28-32
pH	7.5-9.0	8.5-12	7.6-8.0	7.6-8.0	7.5-8.5
Dissolved oxygen (mg/L)	1.0-5.0	3.0-4.5	1.5-5.0	1.0-5.0	5.0-10.0
Un-ionized ammonia (toxic)(mg/L)	0.04-1.2	0.6-2.2	0.31-1.5	0.2-0.02	0.00-0.02

Table 7. Water quality parameters of diseased Gulsha farms (July-Dec 2020)

Parameters	Result				Suitable range
	Tarakanda	Shreepur	Hossainpur	Pakundia	
Temp (⁰ C)	21-35	25-34	24.5-32	22-29.5	28-32
pH	5.5-9.0	6.5-10	7.6-8.0	7.6-8.0	7.5-8.5
Dissolved oxygen (mg/L)	1.0-5.0	3.0-4.5	2.6-5.0	2.3-5.0	5.0-10.0
Un-ionized ammonia (toxic)(mg/L)	0.04-1.2	0.6-2.2	0.31-1.5	0.2-0.02	0.00-0.02

Post Mortem Findings

Clinical signs of the infected Shing

The clinical examination of diseased fish exhibited:

1. Loss of equilibrium, grayish white spot (Figs. 04 &05),
2. Slight lesion on body (Fig.06),
3. Body and tail erosion, hemorrhage in base of fin and edge of head (Fig.07),
4. Movewithwhirling&heavymortalitiesoffishoccurshortlyaftertheadventoflesions;
5. Congestion and enlargement in internal organs were appeared in postmortem examination (Figs. 08 &09).

In the laboratory, each diseased Shing fish was rinsed with distilled water and the surface of the fish was decontaminated by dipping it in ethyl alcohol and lightly flamed. Swabs from the different organs of each diseased Shing were inoculated on Tryptic Soya Agra then incubated at 30°C for 24 hours for bacterial growth.



Fig. 04: Grayish white spot on body



Fig. 05: Grayish white spot on head region



Fig. 06: Lesion or ulcer on body



Fig. 07: Hemorrhage in base of fin



Fig. 08: Liver and kidney enlarge of infected Shing

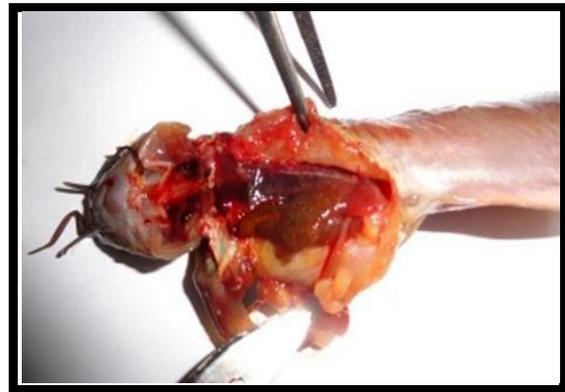


Fig.09: Pale color and enlarge liver of infected Shing

Clinical signs of the infected Tilapia:

Most of the collected samples were observed gross signs include multifocal to coalescing dermal hemorrhage with erosions and ulcers, ocular alterations including opacity of the lens and shrinkage of the eyes (Figs. 10 & 11). In the infected farms, most of the Tilapia exhibited loss of appetite, pale color, gathering in the bottom, slow movement, and stopped schooling prior to death. Mass mortality (60-90%) of the cultured Tilapia in the infected farms was recorded within 12-15 days.



Fig. 10 Moribund or freshly death Tilapia at infected cultured ponds



Fig. 11 Haemorrhage and erosions on body

After post mortem of the collected samples showed severe haemorrhages, pale and enlarged liver, gall bladder distended and enlarged 20 times than normal, destruction of kidney, thin and watery blood in the body cavity (Figs.12 &13).



Fig. 12 Healthy Tilapia (normal liver and gall bladder)



Fig. 13 Infected Tilapia (pale and enlarged liver and gall bladder)

Clinical Sign of Vietnamase Koi

Most of the collected field samples were observed their gross lesions included multifocal to coalescing dermal haemorrhage with erosions and ulcers in skin and fins (Figs. 14). No mortality was noticed for this infection. With that, 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, ulcer on body (Fig.14) the infected fishes ultimately died 50-60% within 3-15 days in the cultured ponds. In post mortem findings, it was observed that the stomach and gut become nearly empty and the peritoneal cavity filled with ascitic fluid.

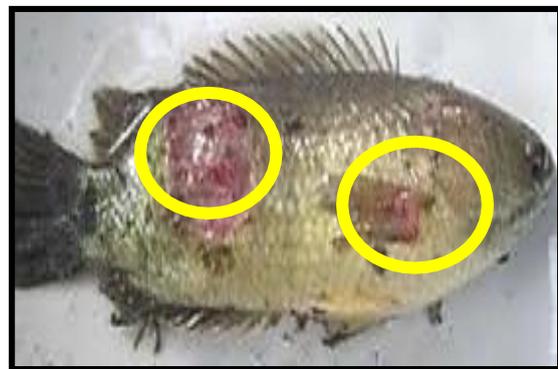


Fig. 14 Pop eye and Ulceration in body

Clinical Sign of Magur, Pangas and Gulsha fish Magur

The clinical examination of diseased fish exhibited:

1. Heavy lesion on body
2. Body and tail erosion, hemorrhage in base of fin and edge of head



Fig. 15 External Change in Diseased Magur

Pangas

1. hemorrhage in base of fin and edge of head
2. Ulceration in whole body
3. Heavy fat accumulation in body



Fig. 16 External Change in Diseased Pangas

Gulsha

1. Whitish line in body
2. Hemorrhage and lesion throughout the body
3. Unusual movement

Expt. 2: Detection of etiological agents based on PCR techniques

Methodology

Growth of bacteria

Bacterial samples were cultured (on TSA agar plate) from glycerol stock for desired growth. On next day, optimum bacterial growth was observed which was ready for polymerase chain reaction.

PCR reaction

Amplification of each sample was performed in a 20 µl reaction mixture containing (sterilized distilled water, master mix, primer forward, primer reverse) and prepared sample. The amplifications were carried out in a thermal cyclerset with the following parameters: 2min of initial denaturation at 95°C followed by 40 cycles of 30 s at 95°C, 30s at the annealing temperature 53°C and 1 min at 72°C. A final elongation of 5 min at 72°C was added. The amplified products were stored at 4°C. Band patterns were photographed under UV light. The amplified products were resolved on 2% agarose gels using a TBE buffer system. The size of the restriction fragments was estimated by comparison to a 50-bp-sizeladder.



Fig. 15 Thermal cycling reaction



Fig. 16 Gel Documentation

Molecular identification

After Bacterial isolation and primary testing by Gram stain, %3 KOH and catalase tests on all samples (430 samples), 206 positive specimens (various species of bacteria) were obtained. Following biochemical characterization of pure or dominant colonies, ten species were determined including *E. coli*, *S. saprophyticus*, *Enterobacter sp.*, *S. succinus* *K. gibsonii* *S. arlettae*, *S. saprophyticus*, *S. sciuri*, *Bacillus sp.*, *S. arlettae* (Table3). Following PCR assay 10 pathogenic species have been identified and confirmed, including *E. coli* species in Ishwarganj, *S. saprophyticus* species in Gazipur, Mymensingh *Enterobacter sp* species in Ghagra *S. succinus* species in Netrokona *K. gibsonii* species in Sadar, Mymensingh *S. arlettae* species in Fulbaria *S. saprophyticus* species in Fulbaria *S. sciuri* species in Gouripur *Bacillus sp.* species in Trishal and *S. arlettae* species in Hossenpur, Kisorganj.

Table 8. Result of molecular identification of Bacteria from Fish

Sample ID	Fish species	Organ source	Location	Highest BLASTn match with Bacteria	Similarity (%)	Genebank accession number
1.	Shing	Brain	Issawrganj	<i>Escherichia coli</i> strain Y8-2	99.77	MT192518.1
2.	Shing	Liver	Gazipur, Mymensingh	<i>Staphylococcus saprophyticus</i> strain PaKu3	99.43	MK841545.1
3.	Pabda	Brain	Ghagra	<i>Enterobacter</i> sp. XC141028	99.50	KU245733.1
4.	Shing	Brain	Netrokona	<i>Staphylococcus succinus</i> subsp. <i>succinus</i> strain NC2	99.03	MN326709.1
5.	Koi	Liver	Sadar, Mymensingh	<i>Kurthia gibsonii</i> strain C5	99.77	JF418156.1
6.	Shing	Kidney	Fulbaria	<i>Staphylococcus arlettae</i> strain CT11	99.58	MT072173.1
7.	koi	Liver	Fulbaria	<i>Staphylococcus saprophyticus</i> strain 95B (BP2)	99.92	KF254616.1
8.	Gulsha	Brain	Gouripur	<i>Staphylococcus sciuri</i> strain LH-T3	99.67	KF876871.1
9.	Pangas	Brain	Trisal	<i>Bacillus</i> sp. RHH58	98.52	HQ202550.1
10.	Gulsha	Liver	Hossenpur, Kisorganj	<i>Staphylococcus arlettae</i> strain CT11	99.67	MT072173.1

Stock improvement of major carps (Rohu and Catla) and DNA-barcoding of important Freshwater Fishes in Bangladesh

Researchers Dr. Jonaira Rashid, SSO & PI

Objectives

- To improve Rui and Catla stocks using DNA technology
- To analyze genetic variability of Rohu stocks using DNA markers
- To identify freshwater fishes at the species level based on DNA barcoding data

Achivements

Experiment 1: Stock improvement of Rohu through DNA based protocol

Communal rearing was conducted to improve of BFRI Rohu through genetic selection process. 60 families (produced through single pair mating) of F₄ Rohu are being reared at two different stages over a period of 12 months. In the first stage (July 2020-December 2020), all the fishes were reared in one earthen pond of 50 decimal and a depth of 1m. The stocking density in this period was about 12 fish per decimal. In the second stage (January 2021-June 2021), best selected fishes (5 fish/decimal) are being reared in the new pond of 80 decimal with a water depth of 2 m for 6 months. Fishes were fed with commercial carp feed containing about 25-28 % protein at the rate of 3-5% body weight daily. Thirty fishes were used for monthly sampling. Growth performances of F₄ 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 F₄ Rohu are 37.34±1.68 (cm) and 810.92±34.39 (g), respectively.

Table 1. Growth performances of BFRI F₄ generation of Rohu in communal grow-out pond

Parameters	Initial status (July 2020)	Present status (June 2021)
Length (cm)	34.57±1.42	37.34±1.68
Weight (g)	506.25±49.92	810.92±34.39

Experiment 2: Stock improvement of Catla through DNA based protocol

The stock improvement of Catla fishes are being conducted using wild stocks. The collected wild stocks (The River Halda and Jamuna stocks) are being reared in earthen ponds with an average depth of 1 m located in the pond complex of Freshwater Station, Bangladesh Fisheries Research Institute (BFRI), Mymensingh following all scientific management practices, including fertilization, liming, supplementary feeding and water management. Fishes were fed with supplementary feed containing 28-30% protein at 5-3% body weight daily. For stock improvement, collected Catla fishes from the River Halda were stocked in a pond having an area of 50 decimal. The average length and weight of stocked fishes were 39.5±5.83 (cm) and 873.50±360.09 (g), respectively. The stocked fishes are being fed with commercially available carp feed @ of 5-3% body weight once daily. The results of the present study on growth performances in terms of mean length and mean weight gain of Catla 46.75±5.12 (cm) and 1385.23±230.37(g), respectively are shown in Table 3.

Table 3. Growth performances of Catla (The River Halda origin) in grow out pond

Parameters	Initial status (July 2020)	Present status (June 2021)
Length (cm)	39.5±5.83	46.75±5.12
Weight (g)	873.50±360.09	1385.23±230.37

Another wild stock of Catla fish was collected from the River Jamuna that are being reared in the well-prepared pond having an area of 50 decimal using lime and fertilizer. Fishes are being fed with commercially available carp feed at 3-5% body weight daily. The results of the present study on growth performances in terms of mean length and mean weight gain of Catla (The River Jamuna origin) are 36.80 ± 3.14 (cm) and 498.68 ± 35.14 (g), respectively are shown in Table 4.

Table 4. Growth performances of Catla (The River Jamuna origin) in grow-out pond

Parameter	Initial Status (July 2020)	Present status (June 2021)
Length (cm)	26.88 ± 2.27	36.80 ± 3.14
Weight (g)	212.40 ± 51.78	498.68 ± 35.14

Experiment 3: Genetic evaluation of wild and BFRI Rohu (F₄) stocks

Genetic analysis of the River Halda, Jamuna and BFRI Rohu (F₄) stocks are being carried out to evaluate genetic variability of wild and BFRI Rohu stocks. To conduct this experiment, fish samples were collected from the Halda and Jamuna stocks during July 2020. In order to perform DNA analysis for genetic characterization, a total number of 30 fish samples were taken randomly from each stock. Fin samples were clipped from caudal fin of each fish without killing the fish using scissors and forceps after that immediately preserved in separate eppendorf tubes containing 95% ethanol. The eppendorf tubes containing fin samples were

Freshwater Sub-station, Joshore

Development and Dissemination of Nursery and Culture Technique of *Cuchia*, *Monopterusuchia* (Comp. D. FSS)

Reserchers Dr. Md. Robiul Awal Hossain, Principal Scientific Officer
 Md. Shariful Islam, Senior Scientific Officer
 Shishir Kumar Dey, Scientific Officer & PI

Objectives:

- To develop nursery technique of *M. cuchia*
- To develop grow-out technique of *M. cuchia*
- To analyze the benefit-cost ratio (BCR)

Achievement

Mud eel locally known as Cuchia (*Monopterusuchia*) fishes were stocked in 06 (six) selected contact farmers' pond at the end of the February/2021 in Chapakona and Joypur villages of Monirampurupazilla, Jashore. After pond preparation one-fourth water surface area of each pond also covered with water hyacinth as providing shelter for Cuchia. The stocking density was 400/decimal. The initial average length and weight of Cuchia were 42.36 cm and 90.02 g respectively when released. Fishes were fed with small fish (50%), along with supplementary feed formulated with fish meal (20%), wheat flour (30%), vitamin premix and also with live earth worm @ 5% body weight daily. After every one month, the Cuchia of each selected farmer's pond were sampled and collected length-weight data to observe their growth performance.

Experiment: Development of grow-out culture technique of *M. cuchia* in farmer's pond.

Methodology

Pond selection and preparation

For this trial, ponds were selected in farmer's field at outside of the BFRI campus. Six (06) farmers were selected in Chapakona and Joypur village of Manirampur Upazilla at Jashore. Size of each pond were about 1 decimal. Due to the burrowing habit of Cuchia, at least one feet bottom soil was removed from each pond then synthetic tripal were placed in the bottom. After setting the synthetic tripal, removed soil were further used on the synthetic tripal. After that, water of the ponds was fertilized with lime, cow dung, Urea and TSP to enhance the production of plankton. Water hyacinth was provided for suitable and safe shelter of Cuchia as its shadow loving nature.

Water quality parameters monitoring

Water quality parameters such as DO, temperature, pH, Total Alkalinity, Total hardness; Ammonia were recorded fortnightly.

Growth Parameter monitoring

Length weight of Cuchia were monitored at monthly basis.

Stocking and management

Cuchia were stocked at the end of February 2021. The baby Cuchia were stocked at 400 individuals/ Decimal.

Feeding

The Cuchia were fed with live small fish, minced fish, earthworm and tubifex @ 5-3% body weight concurrently twice daily. The stocked Cuchia were also fed on prepared feed (minced fish

500g+ fishmeal 400g+rice bran 50g + wheat flour 50g and vitamin premix) @ 3-5% body weight. Fish sampling were done at monthly interval to know the fish growth status and also to adjust feed ration.

Harvesting

Cuchia will be harvested after six months of culture period by dewatering the ponds. The harvested Cuchia will be counted and recorded. Data will be analyzed through statistically

Results

The growth performance of Cuchia in three farmers ponds of the Chapakona village are almost similar. Among them the Cuchia of the pond of farmer 1 (F1) was shown better performance in terms of ADG (g) and SGR (%/day) (Table-1). The water quality data also collected fortnightly basis (Table-3). On the other hand, the growth performance of Cuchia in three farmers ponds of the Joypur village are also similar. Among them the Cuchia of the pond of farmer 4 (F4) was shown better performance in terms of ADG (g) and SGR(%/day) (Table-2). The water quality data also collected fortnightly basis (Table-4). All the water quality parameters of the Cuchia pond waters of both Chapakona and Joypur villages of MonirampurUpazila were found within suitable range for fish culture.

Table 1: Mean length-weight data of Cuchia in Farmers' Pond of Chapakonavillageof Monirampur, Jashore

Months	F1		F2		F3	
	L (cm)	W (g)	L (cm)	W (g)	L (cm)	W (g)
Feb/2021	42.36±5.23	90.02±27.16	42.36±5.23	90.02±27.16	42.36±5.23	90.02±27.16
March/2021	44.64±5.49	93.24±26.96	44.10±5.10	91.58±24.22	43.74±4.54	92.02±22.17
April/2021	47.60±5.25	117.48±22.25	47.24±4.82	118.68±22.16	46.98±4.45	119.80±20.55
May/2021	51.28±3.63	155.64±23.44	49.08±4.61	136.30±33.45	49.40±4.48	139.82±32.38
June/2021	51.52±3.70	160.14±23.08	49.30±4.61	141.44±31.76	49.72±4.39	147.80±30.66
ADG (g)	0.58 ± 0.27		0.42± 0.32		0.48± 0.33	
SGR (% day ⁻¹)	0.51±0.28		0.39± 0.31		0.43± 0.33	

Table 2: Mean length-weight data of Cuchia in Farmers' Pond of Joypur village of Monirampur, Jashore

Months	F4		F5		F6	
	L (cm)	W (g)	L (cm)	W (g)	L (cm)	W (g)
Feb/2021	42.36±5.23	90.02±27.16	42.36±5.23	90.02±27.16	42.36±5.23	90.02±27.16
March/2021	44.20±4.93	96.50±20.53	44.02±4.98	94.88±20.38	43.70±4.62	92.28±18.82
April/2021	47.24±4.89	121.86±23.22	47.04±4.92	119.94±24.96	46.54±4.50	119.76±23.03
May/2021	51.04±3.43	153.10±22.57	49.64±4.24	141.34±32.00	48.92±4.51	135.68±32.65
June/2021	51.52±3.39	159.08±23.18	49.88±4.20	146.72±30.89	49.33±4.51	142.46±31.92
ADG (g)	0.57± 0.29		0.47± 0.28		0.43± 0.33	
SGR (% day ⁻¹)	0.50± 0.29		0.43± 0.29		0.40±0.33	

Table 3: Monthly average water quality parameters of Cuchia in Farmers'pond of Chapakona, Monirampur, Jashore

Parameter	February/2021			March/2021			April/2021			May/2021			June/2021		
	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3	F1	F2	F3
Temp. (°c)	25 ±00	24 ±00	23 ±00	28.55 ±2.12	28.25 ±1.06	28.25 ±1.76	32.25 ±0.35	32.0 ±00	32 ±00	31 ±00	31 ±00	31.1 ±0.14	30.45 ±0.07	30.50 ±00	30.55 ±0.07
DO (mg/l)	4.4 ±00	4.5 ±00	4.0 ±00	4.50 ±0.21	4.65 ±0.07	4.45 ±0.21	4.35 ±0.21	4.4 ±00	4.3 ±0.14	4.55 ±0.07	4.5 ±0.14	4.5 ±0.14	4.4 ±00	4.5 ±00	4.55 ±0.07
pH	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.5 ±00	8.50 ±00	8.0 ±00	8.12 ±0.17	8.12 ±0.17	8.12 ±0.17	8.0 ±00	8.0 ±00	8.0 ±00
TA (mg/l)	164 ±00	162 ±00	166 ±00	166 ±2.82	161 ±2.82	162 ±2.12	166 ±2.82	163 ±1.41	165 ±1.41	161 ±1.41	163 ±1.41	161 ±1.41	163 ±1.41	162.5 ±0.70	163 ±1.41
TH (mg/l)	171 ±00	173 ±00	176 ±00	173 ±2.12	171 ±1.41	170 ±2.12	171 ±1.41	171 ±1.41	172 ±2.82	167 ±1.41	171 ±1.41	167 ±1.41	169 ±1.41	168.5 ±0.70	169 ±1.41
NH ₃ (mg/l)	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

Table 4: Monthly average water quality parameters of Cuchia in Farmers'pond of Joypur, Monirampur, Jashore

Parameter	February/2021			March/2021			April/2021			May/2021			June/2021		
	F4	F5	F6	F4	F5	F6	F4	F5	F6	F4	F5	F6	F4	F5	F6
Temp. (°c)	23.5 ±00	25.0 ±00	24.0 ±00	29.25 ±1.76	29.25 ±1.76	29.0 ±1.41	32.0 ±00	32.25 ±0.35	32.0 ±00	31.05 ±0.07	31.2 ±00	31.05 ±0.07	30.70 ±0.14	30.75 ±0.07	30.70 ±0.14
DO (mg/l)	4.0 ±00	4.4 ±00	4.6 ±00	4.15 ±0.07	4.65 ±0.21	4.5 ±0.14	4.10 ±0.14	4.30 ±0.14	4.10 ±0.14	4.5 ±0.14	4.55 ±0.07	4.3 ±0.14	4.45 ±0.07	4.4 ±00	4.45 ±0.07
pH	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.5 ±00	8.5 ±00	8.5 ±00	8.12 ±0.17	8.12 ±0.17	8.12 ±0.17	8.0 ±00	8.0 ±00	8.0 ±00
TA (mg/l)	163 ±00	163 ±00	166 ±00	162 ±2.82	163 ±1.41	163 ±2.12	163 ±1.41	166 ±2.82	165 ±1.41	163 ±1.41	161 ±1.41	161 ±1.41	163 ±1.41	163 ±1.41	163 ±1.41
TH (mg/l)	171 ±00	175 ±00	176 ±00	171 ±4.24	170 ±2.82	172 ±2.82	171 ±1.41	172 ±2.82	173 ±1.41	171 ±1.41	167 ±1.41	169 ±1.41	171 ±1.41	169 ±1.41	170.5 ±2.12
NH ₃ (mg/l)	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

Ecological Assessment of Open water Fisheries (Baor) Population with Bio-Physicochemical Properties to Frame EBFM Approach (Comp.-C)

Researchers Dr. Md. Robiul Awal Hossain, Principal Scientific Officer
Md. Shariful Islam, Senior Scientific Officer
Shishir Kumar Dey, Scientific Officer & PI

Objectives:

- To estimate population ecology and diet composition of some commercially significant inland open water fishes (especially Baorresident fishes)
- To assess bio-physicochemical properties of some selected Baor including seasonal variation and agro-chemicals impact level

- To assess stock of some important ecological fish groups i.e., Planktivores/Herbivores, Detrivores, Carnivores & Omnivores based on catch and CPUE data
- To assist for framing or formulating ecosystem-based management approach of some commercially significant inland open water bodies with emphasizing to increase productivity, stock enhancement and conservation of the fisheries resources

Achievements

All the water quality parameters were found within suitable ranges for fish culture in both the Bukbhara and JhapaBaor of Jashore Sadar and Monirampurupazila respectively (Table 1 and Table 2). The phytoplankton and zooplankton genera identified of both Bukbhara and JhapaBaor are similar and belonging from seven groups and three groups respectively (Table .3, Table 4, Table 6 and Table 7). The abundance of phytoplankton and zooplankton were found in BukbharaBaor within the ranges from lowest in the month of November 2020 (143×10^2) and (23×10^2) and highest in March 2021 (215×10^2) and (75×10^2) respectively (Table-5). The abundance of phytoplankton and zooplankton were found in Jhapa Baor within the ranges from lowest in the month of November 2020 (163×10^2) and (46×10^2) and highest in March 2021 (280×10^2) and (72×10^2) respectively (Table-8).

The production of nine cultured carp fish species in BukbharaBaor at April 2021 was recorded 50480 kg, where highest production was recorded from silver carp (28000 kg) and lowest was found (160 kg) from Black carp (Table-9). On the other hand, the production of different captured fish with SIS was recorded highest (5630.4 kg) in the month January 2021 and lowest (3040.0 kg) in the month May 2021 (Table-10). The production of seven cultured carp species in JhapaBaor was recorded 73480 kg in March 2021 and 97000kg in April 2021 (Table-11). On the other hand, the production of different captured fish with SIS was recorded in JhapaBaor highest 8076.4 kg in the month January 2021 and lowest 6063.2 kg in May 2021 (Table-12).

Table 1. Monthly water quality parameters of BukbharaBaor

Parameters	Nov/ 2020	Dec/ 2020	Jan/ 2021	Feb/ 2021	Mar/ 2021	April/ 2021	May/ 2021	June/ 2021
Temp. ($^{\circ}$ c)	26.5	21.16	21.20	27.83	35.19	32.5	32.5	33
Trans. (cm)	41	45	43	42	47	48	47	46
DO (mg/l)	7.8	8.9	7.5	4.4	5.07	4.8	5.2	5.4
CO ₂ (mg/l)	11.20	11.33	11.57	11.00	9.25	8.10	7.95	8.0
pH	7.5	8.5	8.0	8.5	7.5	8.0	8.0	7.5
NH ₃ (mg/l)	00	00	00	0.1	00	00	00	00
TA (mg/l)	161	160	164	166	166	170	166	167
TH (mg/l)	167	166	172	172	178	178	174	175

Table 2. Monthly water quality parameters of JhapaBaor

Parameters	Nov/ 2020	Dec/ 2020	Jan/ 2021	Feb/ 2021	Mar/ 2021	April/ 2021	May/ 2021	June/ 2021
Temp. (°c)	26.5	21.16	21.20	27.83	35.19	32.5	32.0	33.0
Trans.(cm)	40	43	43	40	45	45	47	46
DO (mg/l)	5.6	6.2	7.5	5.9	5.88	5	5	5.0
CO ₂ (mg/l)	8.5	8.8	11.57	8.1	8.55	8.0	7.92	8.2
pH	8.0	8.0	8.0	7.5	8.0	8.0	8.0	7.5
NH ₃ (mg/l)	00	00	00	00	00	00	00	00
TA (mg/l)	160	162	166	164	164	172	168	170
TH (mg/l)	169	170	170	172	174	178	176	179

Table 3. Phytoplankton genera found in Bukbhora Baor

Group	Genera	Total
Bacillariaophyceae	<i>Diatoma, Navicula, Nitzschia, Chaetoceros, Cyclotella, Gyrosigma, Synedra, Bacillaria, Fragilaria</i>	09
Chlorophyceae	<i>Oscillatoria, Eudorina, Gomphosphaeria, Pleodorina, Anabaena, Oedogonium, Microcystis, Ankistrodesmus, Oocystis, Chlamydomonas, Coelastrum.</i>	11
Cyanophyceae	<i>Spirogyra, Anacystis, Ploycystis, Ulothrix, Volvox, Spirulina, Chlorella, Pediastrum, Microspora, Scenedesmus, Merismopedia</i>	11
Zygnematophyceae	<i>Zygnema, Staurastrum, Closterium, Euastrum, Desmidium, Mougeotia</i>	06
Euglenophyceae	<i>Euglena, Phacus, Trachelomonas</i>	03
Trebouxiophyceae	<i>Crucigenia, Actinastrum</i>	02
Dinophyceae	<i>Ceratium</i>	01

Table 4. Zooplankton genera found in BukbhoraBaor

Group	Genera	Total
Rotifera	<i>Brachionus, Keratella, Filinia, Asplanchna</i>	04
Cladocera	<i>Moina, Daphnia, Bosmina, Diaphanosoma</i>	04
Copepoda	<i>Cyclops, Mesocyclops, Macrocyclus, Diaptomus, Pseudodiaptomus, Nauplius</i>	06

Table 5. Plankton abundance in Bukbhora Baor

Plankton	Nov/ 2020	Dec/ 2020	Jan/ 2021	Feb/ 2021	Mar/ 2021	April/ 2021	May/ 2021	June/ 2021
Phyto (No./L)	143x10 ²	148x10 ²	150x10 ²	191x10 ²	215x10 ²	175x10 ²	187x10 ²	174x10 ²
Zoo (No./L)	23x10 ²	34x10 ²	57x10 ²	68x10 ²	75x10 ²	42x10 ²	49x10 ²	44x10 ²

Table 6. Phytoplankton genera found in the Jhapa Baor

Group	Genera	Total
Bacillariaophyceae	<i>Diatoma, Navicula, Nitzschia, Chaetoceros, Cyclotella, Gyrosigma, Synedra, Bacillaria, Fragilaria</i>	09
Chlorophyceae	<i>Oscillatoria, Eudorina, Gomposphaeria, Pleodorina, Anabaena, Oedogonium, Microcystis, Ankistrodesmus, Oocystis, Chlamydomonas, Coelastrum.</i>	11
Cyanophyceae	<i>Spirogyra, Anacystis, Ploycystis, Ulothrix, Volvox, Spirulina, Chlorella, Pediastrum, Microspora, Scenedesmus, Merismopedia</i>	11
Zygnematophyceae	<i>Zygnema, Staurastrum, Closterium, Euastrum, Desmidium, Mougeotia</i>	06
Euglenophyceae	<i>Euglena, Phacus, Trachelomonas</i>	03
Trebouxioophyceae	<i>Crucigenia, Actinastrum</i>	02
Dinophyceae	<i>Ceratium</i>	01

Table 7. Zooplankton genera found in JhapaBaor

Group	Genera	Total
Rotifera	<i>Brachionus, Keratella, Filinia, Asplanchna</i>	04
Cladocera	<i>Moina, Daphnia, Bosmina, Diaphanosoma</i>	04
Copepoda	<i>Cyclops, Mesocyclops, Macrocylops, Diaptomus, Pseudodiaptomus, Nauplius</i>	06

Table 8. Plankton abundance in Jhapabaor

Plankton	Nov/2020	Dec/2020	Jan/2021	Feb/2021	Mar/2021	April/2021	May/2021	June/2021
Phyto (No./L)	163 x10 ²	183 x10 ²	225x10 ²	252x10 ²	280 x10 ²	214x10 ²	221x10 ²	216x10 ²
Zoo (No./L)	46 x10 ²	51x10 ²	60 x10 ²	69x10 ²	72 x10 ²	58x10 ²	61 x10 ²	56x10 ²

Table 9. Cultured fish and their production in BukbhoraBaor

SL. NO.	Local name	Scientific name	Species wise catch (kg)	
			Nov/2020	April/2021
1	Silver Carp	<i>Hypophthalmichthys molitrix</i>	52000	28000
2	Katol	<i>Catlacatla</i>	20800	11200
3	Rui	<i>Labeo rohita</i>	12400	7600
4	Bighead Carp	<i>Hypophthalmichthys nobilis</i>	3200	1600
5	Grass Carp	<i>Ctenopharyngodon Idella</i>	1000	600
6	Common Carp	<i>Cyprinus carpio</i>	1000	600
7	Mrigal	<i>Cirrhinusmrigala</i>	720	480

8	Black Carp	<i>Mylopharyngodonpiceus</i>	240	160
9	Kalibaush	<i>Labeo calbasu</i>	360	240
Total			91720	50480

Table 10. Captured fish with SIS & their production in BukbhoraBaor

SL. No.	Local name	Scientific name	Species wise catch (kg)							
			Nov/2020	Dec/2020	Jan/2021	Feb/2021	Mar/2021	Apr/2021	May/2021	Jun/2021
1	Icha	<i>Macrobrachium spp.</i>	330	620	600	580	490	290	270	400
2	Shing	<i>Heteropneustesfossilis</i>	11.6	17.2	20	30	40	14	12.4	18.8
3	Magur	<i>Clariasbatrachus</i>	34	48	66	74	104	34	32	30
4	Koi	<i>Anabustestudineus</i>	204.8	254.8	250	212.8	186.8	50	30	26
5	Shol	<i>Channa striata</i>	168	310	340	310	330	228	216	132
6	Gozar	<i>Channa marulius</i>	124	130	180	146	138	96	90	84
7	Taki	<i>Channa punctatus</i>	110	140	172	150.4	142	90	84	76
8	Mola	<i>Amblypharyngodon mola</i>	114	144	166	154.8	144	88	76	80
9	Chapila	<i>Gudusiachapra</i>	1186	1500	1372	1276	1092	924	738	704
10	Dhela	<i>Crprinuscotio</i>	41.6	50.8	44.8	48	38	25.2	18	14.4
11	Punti	<i>Puntius spp</i>	568	618	626	596	554	464	376	364
12	Tengra	<i>Mystus spp.</i>	18	34.4	56	58	64.8	52.8	34.4	36.4
13	Pabda	<i>Ompok spp.</i>	70.4	154	152	146	130	112	96	74
14	Chanda	<i>Chanda spp.</i>	191.2	372	380	364	349.2	330	252	218
15	Meni	<i>Nandus nandus</i>	126.8	212	228	216	196	136	120	88
16	Pholi	<i>Notopterusnotopterus</i>	146	224	237.2	221.6	194	144.8	129.6	104
17	Kakila	<i>Xenentodoncancila</i>	10.8	6.8	6.4	5.2	4.4	4.8	5.6	1080
18	Ayre	<i>Sperataaor</i>	634.8	755.6	734	684	592.8	586	460	392
Total			4090	5591.6	5630.4	5272.8	4790	3669.6	3040	3921.6

Table 11. Cultured fish & their production in JhapaBaor

SL. NO.	Local name	Scientific name	Species wise catch (kg)		
			Nov/2020	March/2021	June/2021
1	Silver Carp	<i>Hypophthalmichthys molitrix</i>	93834	28000	62166
2	Bighead Carp	<i>Hypophthalmichthys nobilis</i>	61516	17600	41284
3	Rui	<i>Labeo rohita</i>	21734	6960	15066
4	Catla	<i>Catlacatla</i>	18371	5600	12829
5	Common Carp	<i>Cyprinus carpio</i>	19188	6000	12412
6	Mrigal	<i>Cirrhinusmrigala</i>	15188	4280	10412
7	Grass Carp	<i>Ctenopharyngodonidella</i>	18801	5400	12199
Total			248632	97000	166368

Table 12. Captured fish with SIS & their production in the JhapaBaor

Sl No.	Local name	Scientific name	Species wise catch (kg)							
			Nov/2020	Dec/2020	Jan/2021	Feb/2021	Mar/2021	Apr/2021	May/2021	June/2021
1	Shol	<i>Channa striata</i>	390	290.0	492.0	514.0	475.2	337.2	340.0	330
2	Gozar	<i>Channa marulius</i>	182	14.0	292.0	284.8	262.0	238.0	232.0	178
3	Taki	<i>Channa punctatus</i>	32.4	34.0	98.0	90.0	84.0	77.2	74.4	72
4	Ayre	<i>Sperataaor</i>	494	50.0	620.0	585.2	494.0	404.4	332.8	290
5	Tengra	<i>Mystus spp.</i>	38.8	228.0	88.0	78.4	85.2	71.2	68.0	50
6	Pabda	<i>Ompok spp.</i>	90	96.0	125.2	117.2	94.8	64.4	62.0	48
7	Shing	<i>Heteropneustesfossilis</i>	32.4	90.0	52.0	41.2	36.4	32.8	30.8	28.4
8	Sal biam	<i>Mastacembelusarmatus</i>	238.8	88.0	252.8	202.0	196.0	164.8	134.0	121.2
9	Chapila	<i>Gudusiachapra</i>	3180	924.0	3448.8	3206.0	3010.0	2888.0	2765.2	2670.4
10	Icha	<i>Macrobrachium spp.</i>	1150.8	25.2	1132.4	1188.8	1020.0	1044.0	921.2	728.8
11	Meni	<i>Nandus nandus</i>	82.4	464.0	112.0	103.2	70.8	61.2	40.8	36.8
12	Punti	<i>Puntius spp</i>	887.2	52.8	1296.0	1201.2	1180	1121.2	1020.0	885.2
13	Chela	<i>Salmostoma spp.</i>	14	112.0	19.6	12.4	11.2	8.8	8.0	7.6
14	Ek-thota	<i>Hyporhamphuslimbatus</i>	19.6	330.0	22.8	20.8	20.4	18.4	16.8	14.8
15	Kakila	<i>Xenentodoncancila</i>	11.6	136.0	10.4	19.6	19.6	13.2	11.2	10.8
16	Bele	<i>Glossogobiusgiuris</i>	8.4	144.8	14.4	14.0	8.4	6.8	6.0	5.2
Total			6852.4	7922	8076.4	7678.8	7068.0	6551.6	6063.2	5477.2

Domestication and Breeding of Needle Fish and Queen Loach

Researchers Dr. Md. Robiul Awal Hossain, Principal Scientific Officer & PI
Md. Shariful Islam, Senior Scientific Officer
Shishir Kumar Dey, Scientific Officer

Objectives

- To domesticate and brood development of Kakila and Rani fish in captive condition
- To develop breeding and larval rearing technique of Kakila and Rani fish in captive condition

Achievements

Exp. 1: Domestication and brood development of *Xenentodoncancila* in captive condition

Methodology

Kakila fish (*Xenentodoncancila*) is a freshwater fish, primarily inhabits in rivers. The study was conducted to observe growth and gonadal maturation of *X. cancila*. For this study, one pond was

selected in BFRI, FSS campus, Jashore with an area of 10 dec. Pond was prepared by drying followed by liming (1 kg dec⁻¹), fertilization with organic fertilizer (5-6 kg dec⁻¹) as well as inorganic fertilizer (100g decimal⁻¹ urea & 75g dec⁻¹ TSP). Kakila fishes were collected from Charmaspara Kol (Baor), Pabna. This fish is very much light, oxygen and heat sensitive. After collection, those fishes were transported and released in the prepared ponds of FSS, Jashore with the stocking density 120 dec⁻¹. The initial average size of the collected Kakila fishes were ranged from 16.2 to 19.6 cm in length and 7.95 to 20.88 g in weight. Fishes were fed with hatchery produced live carp fry and collected live small fishes from ponds of FSS campus @ 5% body weight daily.

Results

The length-weight data were collected monthly basis for the Kakila fishes to observe their growth performances. Randomly five Kakila fishes were collected monthly by netting from the Kakila fish pond of the FSS and sacrificed by dissecting them to estimate gonado-somatic index (GSI) (Table-1). The highest GSI were found at the months of August-September 2020. Breeding trial of Kakila fishes were made several times with different hormone (both cPG and synthetic) doses but ovulation did not occur (Table-2). Water quality data were also collected fortnightly in every month to observe water quality parameters of the Kakila fish pond (Table-3). All the water quality parameters were found in suitable ranges of fish culture.

Table 1: Mean length-weight data of Kakila fish and gonad of pond at FSS, Jashore

Months	Length (cm)	Weight (g)	Gonad weight (g)	GSI (%)
July/2020	17.74±1.80	13.44±5.42	0.78±0.19	5.80
August/2020	17.81±1.80	13.80±6.50	0.87±0.25	6.30
September/2020	17.89±2.15	14.28±6.51	0.90±0.33	6.30
October/2020	18.02±1.83	14.62±5.58	0.68±0.14	4.65
November/2020	18.22±1.70	14.45±5.42	0.51±0.13	3.52
December/2020	18.38±1.75	14.55±3.68	0.42±0.07	2.88
January/2021	18.65±1.19	15.42±3.06	0.20±0.06	1.29
February/2021	19.04±1.29	15.99±3.19	0.27±0.08	1.68
March/2021	19.34±1.09	16.34±3.15	0.38±0.11	2.32
April/2021	19.94±1.14	18.12±1.21	0.52±0.09	2.85
May/2021	20.49±1.42	18.84±1.65	0.61±0.12	3.23
June/2021	23.07±1.76	24.43±6.67	0.78±0.15	3.19

Table 2: Induced breeding trial of Kakila fish

Trial No.	No. of Pairs	Dose No.	Hormone dose Carp PG (mg/kg)		Hormone dose Ovotide/ one time (ml/kg)		Observations
			Female	Male	Female	Male	
01. (May/21)	03	1	6.0	3.0	1.0	0.5	No ovulation occurred

		2	8.0	4.0	0.5	0.25
		3	10.0	5.0	-	-
02. (May/21)	07	1	8.0	4.0	0.5	0.25
		2	16.0	8.0	1.0	0.50
		3	24.0	12.0	1.5	0.75
		4	48.0	24.0	-	-
03. (June/21)	06	1	6.0	2.0	-	-
04. (June/21)	06	1	6.0	2.0	-	-
05. (June/21)	03	1	-	-	1	0.5
	03	2	-	-	1.5	0.5

Table 3: Monthly average water quality parameters of Kakila fish pond water of FSS, Jashore

Parameter s	July / 2020	Aug/ 2020	Sep/ 2020	Oct/ 2020	Nov/ 2020	Dec/ 2020	Jan/ 2021	Feb/ 2021	Mar / 2021	Apr/ 2021	May / 2021	June / 2021
Temp (°c)	31.2 5 ±0.3 5	31 ±00	31 ±1.4 1	30 ±00	26 ±00	21 ±1.4 1	19 ±00	23 ±1.4 1	28 ±1.4 1	32.2 5 ±0.3 5	30.5 ±0.7 7	30.9 5 ±0.6 3
DO (mg/l)	4.4 ±00	4.4 ±00	5.3 ±1.6 9	4.5 ±00	4.4 ±0.1 4	4.6 ±0.1 4	4.7 ±0.1 4	4.8 ±00	4.7 ±0.1 4	4.9 ±0.1 4	5.05 ±0.6 3	5.45 ±0.0 7
pH	7.5 ±00	7.25 ±00	7.5 ±00	7.5 ±00	7.5 ±00	7.5 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00	8.0 ±00
TA (mg/l)	178 ±2.8 2	169 ±1.4 1	161 ±11. 3	168 ±4.2 4	164 ±2.8 2	158 ±2.8 2	160 ±00	163 ±0.7 0	165 ±1.4 1	167 ±1.4 1	165 ±1.4 1	169 ±1.4 1
TH (mg/l)	186 ±2.1 2	175 ±4.2	182 ±7.0 7	180 ±4.2 4	172 ±2.8 2	162 ±5.6 5	163 ±0.7 0	169 ±4.9 4	174 ±2.8 2	175 ±1.4 1	173 ±1.4 1	177 ±1.4 1
NH₃ (mg/l)	00	00	00	00	00	00	00	00	00	00	00	00

Exp. 2: Domestication and brood development of *Botiadarío* in captive condition

Methodology

The study was conducted to observe growth and gonadal maturation of Rani fish (*Botiadarío*). For this study, one pond was selected in BFRI, FSS campus, Jashore with an area of 10 dec. Pond was prepared by drying followed by liming (1 kg dec⁻¹), fertilization with organic fertilizer (5-6 kg dec⁻¹) as well as inorganic fertilizer (100g decimal⁻¹ urea & 75g dec⁻¹ TSP). Juveniles of

Botiadarior were collected from the river Jamuna of Belkuchi, Sirajganj and stocked in the pond of BFRI, FSS, Jashore with the stocking density of 120 dec⁻¹. The size of the collected juveniles of Rani fishes were ranged from 2.1 to 4.5 cm in length and 22 to 822 mg in weight. Fishes were fed with 0.5mm size commercial pelleted supplementary feed @ 5% of body weight daily.

Results

The Length-weight data were recorded monthly to observe their growth (Table-4) and water quality parameters (temperature, DO, pH, alkalinity, ammonia, transparency) weremonitored fortnightly (Table-5). All the water quality parameters were found in suitable ranges of fish culture.

Table 4: Mean length-weight data of Rani fish of pond at FSS, Jashore

Months	Length (cm)	Weight (g)
July/2020	2.88 ± 0.57	0.19 ± 0.15
August/2020	5.64 ± 0.65	1.80 ± 0.63
September/2020	6.12 ± 0.55	1.92 ± 0.51
October/2020	6.58 ± 0.50	2.59 ± 0.52
November/2020	7.14 ± 0.45	3.14 ± 0.45
December/2020	7.44 ± 0.25	3.29 ± 0.37
January/2021	7.39 ± 0.24	3.33 ± 0.28
February/2021	7.43 ± 0.20	3.37 ± 0.26
March/2021	7.43 ± 0.19	3.39 ± 0.25
April/2021	7.53 ± 0.19	3.61 ± 0.27
May/2021	7.65 ± 0.18	3.78 ± 0.23
June/2021	7.68±0.16	3.83±0.21

Table 5: Monthly average water quality parameters of Rani fish pond water of FSS, Jashore

Parameters	July/2020	Aug / 2020	Sept/ 2020	Oct/ 2020	Nov / 2020	Dec/ 2020	Jan/ 2021	Feb/ 2021	Mar / 2021	Apr/ 2021	May/ 2021	June / 2021
Temp (°c)	31.25 ± 0.35	31.0 ± 0.00	30.5 ± 0.70	30.0 ± 0.00	26.0 ± 1.41	21.0 ± 1.41	19.0 ± 0.00	23.0 ± 1.41	28.0 ± 1.41	32.25 ± 0.35	30.65 ± 0.77	30.5 ± 0.14
DO (mg/l)	4.35 ± 0.07	4.35 ± 0.07	4.25 ± 0.07	4.5 ± 0.14	4.4 ± 0.14	4.6 ± 0.28	4.7 ± 0.14	4.8 ± 0.00	4.9 ± 0.14	4.7 ± 0.14	5.1 ± 0.42	5.55 ± 0.07
pH	7.5 ± 00	7.25 ± 00	7.5 ± 00	7.5 ± 00	7.5 ± 00	7.5 ± 00	8.0 ± 00	8.0 ± 00	8.0 ± 00	8.0 ± 00	8.0 ± 00	8.0 ± 00

TA (mg/l)	177. 5 ± 3.53	167 ± 2.82	161. 5 ± 9.19	168 ± 2.82	164 ± 5.65	158 ± 2.82	159 ± 1.41	163 ± 1.41	163 ± 1.41	167 ± 1.41	164. 5 ± 0.70	167.5 ±0.70
TH (mg/l)	187 ± 1.41	174 ± 0.70	180 ± 11.3	180 ± 2.82	172 ± 5.65	162 ± 2.82	163 ± 1.41	170 ± 2.82	174 ± 2.82	174. 5 ± 0.70	173 ± 1.41	176.0 ±1.41
NH₃ (mg/l)	00	00	00	00	00	00	00	00	00	00	00	00

Freshwater Sub-station, Bogura

Ecological assessment of inland open water fisheries (Beel) population with bio-physicochemical properties to frame EBFM approach (Comp. B. FSS)

Researchers Md. Moniruzzaman, Scientific Officer & PI
Dr. David Rintu Das, Principal Scientific Officer
Maliha khanom, Scientific Officer

Objectives

- To estimate population ecology and diet composition of some commercially significant *beel* fishes.
- To assess stock of some important ecological fish groups i.e.Planktivores/Herbivores, Detrivores, Carnivores & Omnivores based on catch and CPUE data.
- To assess bio-physicochemical properties of above water bodies including seasonal variation
- To assist for framing or formulating ecosystem based management approach of some commercially significant *beel* water bodies with emphasizing to increase productivity, stock enhancement and conservation of the fisheries resources

Achievements

Experimental design and Methodology

Study area

Roktodaho, Hasaigari, Chalan, Subeel, Atrai, Tulshigangabeels of Bogra, Naogaon and Natore district.

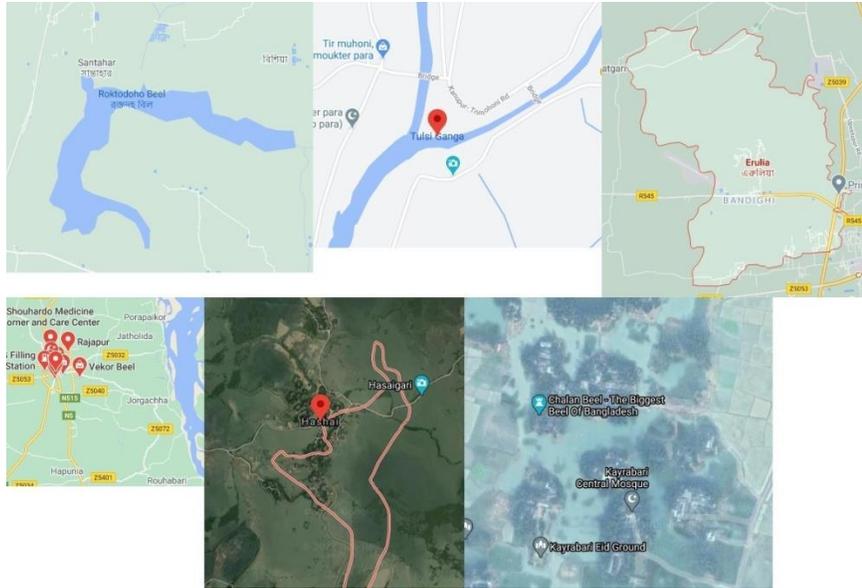


Figure 01: Study area of the project.

Sampling of Bio-Physicochemical properties of inland open waters collection of hydrological data:

Water quality parameter such as Transparency, Temperature, Dissolved Oxygen, pH, CO₂, Alkalinity, Hardness, Ammonia, Conductivity and TDS of sampling site was recorded monthly.

Water quality of Beels:

Water quality parameters of six sampling spot were collected monthly from Ruktodaho, Hasaigari, Chalan, Subeel, Eruliabeels of Bogra, Naogaon and Natore district. Almost all water quality parameter were in acceptable range for fish growth. Some exception was observed in case of transparency among the sampling spot. Highest transparency was 60 cm in case of Ruktodaho beel, this result may be due to the presence of less planktonic community which indicates a high density of fish population among the sampling spot of six different beel water (Figure 2-5). Some exception was observed in case of Alkalinity and Hardness among the sampling spot. Highest value of Alkalinity was 40 mg/L and the highest value of Hardness was 32. Lower values of alkalinity and hardness indicating beel water to be less nutrient enriched. Some exception was also observed in case of transparency among the sampling spot. This result may be due to the vice versa relationship among planktonic community and fish density of a water body.

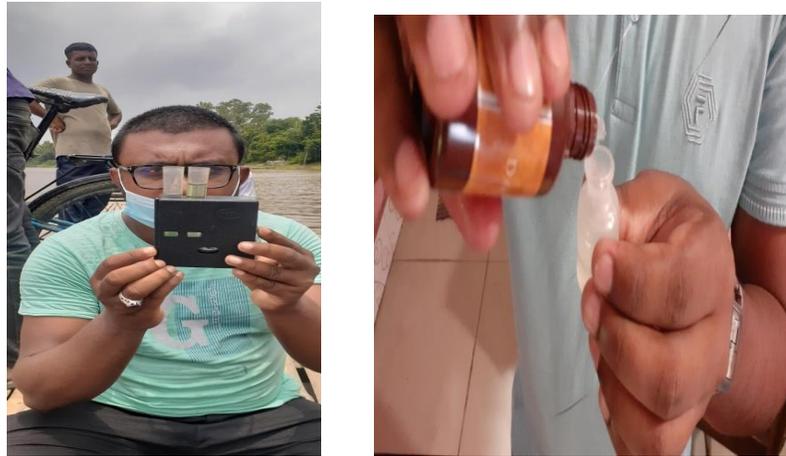


Figure 02: Water quality parameters were tested in different beel.

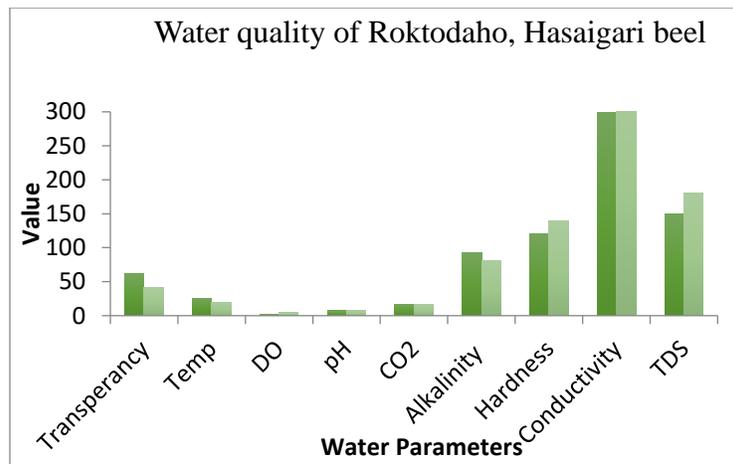


Figure03: Water quality parameters of Roktodaho and Hasaigari beel of Bogura and Naogaon.

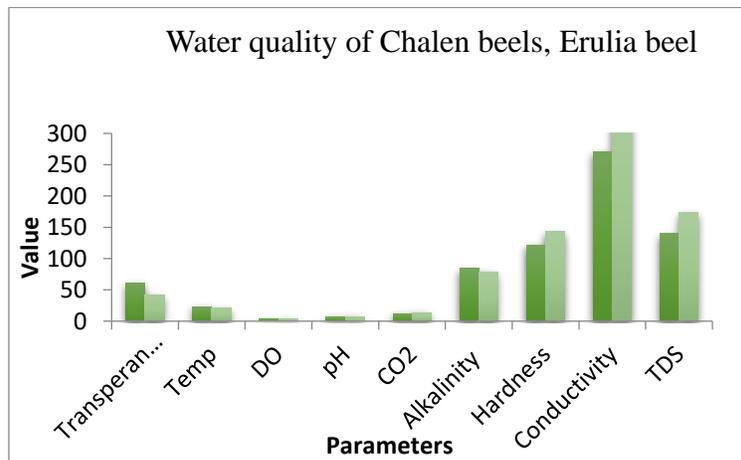


Figure 04: Water quality parameters of Chalen beel and Erulia beels of Natore and Naogaon.

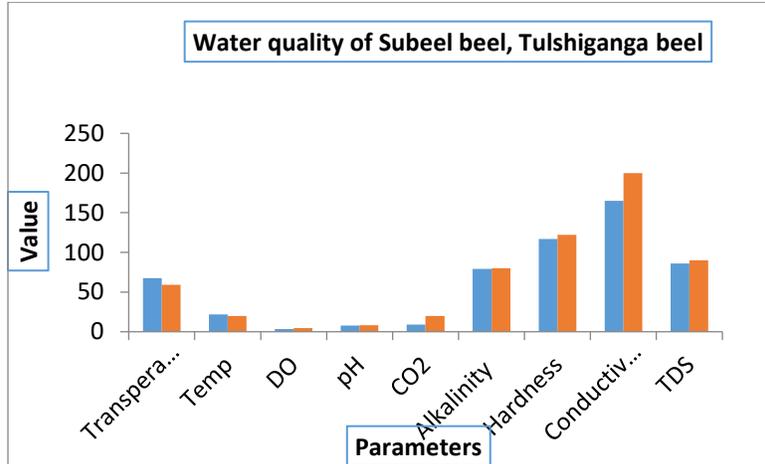


Figure 05: Water qualyty parameters of Subeel, Tulshigonga beel at Naogaon.

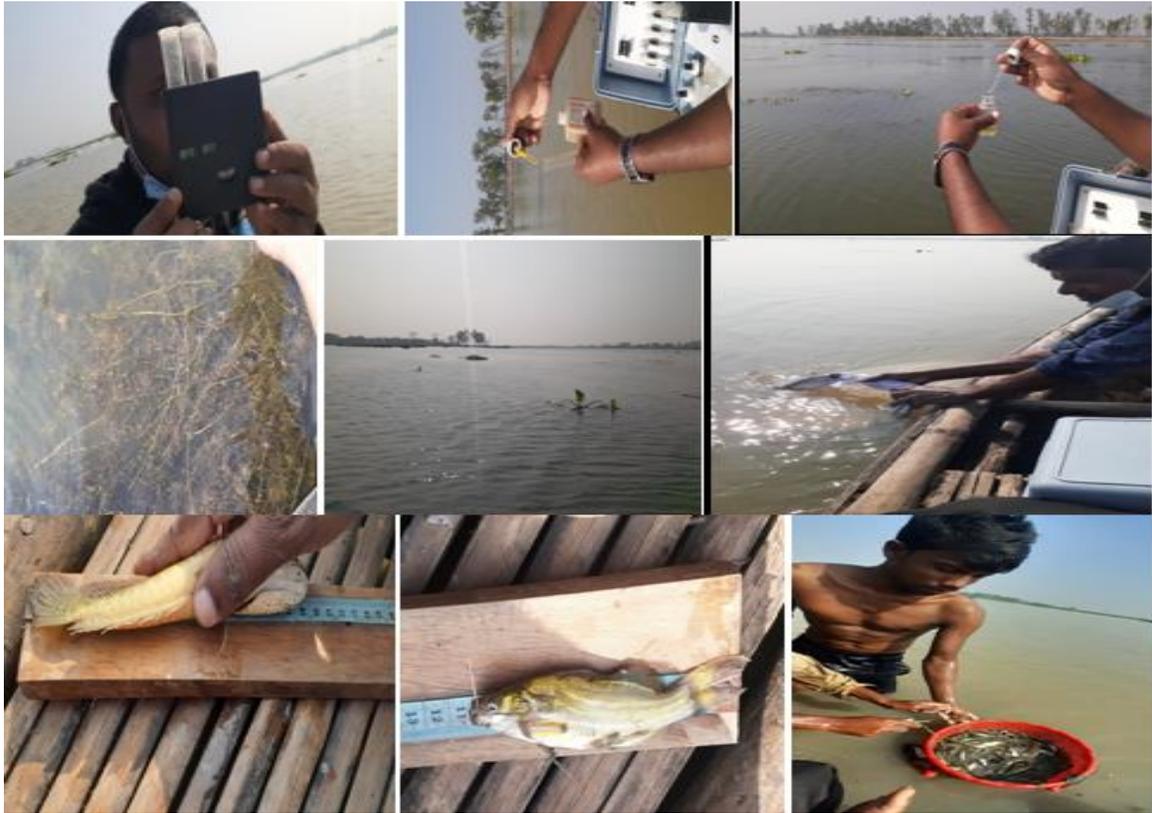


Figure 06: Water quality parameters observation in six different beel.

Plankton identification:

A total of 15 genera of phytoplankton and 5 genera of zooplankton were identified of which Chlorophyceae in phytoplankton population and Crustacea in zooplankton population were dominant.

Table1: Location wise list of different plankton of beels

Location	Beel	Phytoplankton	Zooplankton
Bogura, Naogaon, Natore	Roktodaho	<i>Melosira, Tetraedon, Closterium, Gonatogygon, Spirulina, Navicula, Chlorella, Euglena, Spirogyra, etc</i>	<i>Brachionus Keratella Nauplius</i>
	Hasaigari	<i>Tetraedon, Closterium, Gonatogygon, cyclotella, Cosmoreium, Spirulina, Myrocystes, Navicula, Ulothrix, Spirogyra, Volvoxetc</i>	<i>Nauplius, Brachionus, Daphnia</i>
	Chalan	<i>Cyclotella, Nitzesia, volvox, Melosira, Gonatogygon, Spirulina, Navicula, Spirogyra, etc</i>	<i>Nauplius, Ulotheke Keratella</i>
	Erulia	<i>Chlorella, Oscillatoria, Uroguna, Nitzesis, Euglena, Scenedesmus, Cosmorim, spirulina, spirogyra</i>	<i>Nauplius, Brachionus, Keratella</i>
	Subeel	<i>Uroguna, Nitzesis, Chlorella, Tetradon, Oscillatoria, Mycosistis, Euglena, Scenedesmus, Cosmorim, spirulina, spirogyra</i>	<i>Daphnia Nauplius, Keratella</i>
	Tulshiganga	<i>Tetraedon, Closterium, Gonatogygon, Spirulina, Navicula, Chlorella, Ulothrix, Actinastum, Euglena, Spirogyra, etc</i>	<i>Testudinella Keratella Nauplius</i>

Study 2: Field data collection for estimating population ecology of commercially significant Beel Resident fishes**Length weight range:**

Length weight range of different fish species was described under the following table according to the Fishing gear/ trap operated in different beel. Length range of catch of different gear was 4.5 cm to 33.6 cm and weight range of catch of different gear was 0.6 gm to 557 gm. This length range will be varied according to seasonal fluctuations.

Table 2: Fash Jal

	Tengra	Kholisha	Shing	Veda	Koi	Rui
Length (cm)	8.0-10	8.2-9.5	14-16	5.1-7.5	11.0-17.0	28-32
Weight (g)	7.7-13.1	8.1-14.1	26-27	9.1-20.2	25-80	236-557

	Foli	Gajar	Taki	Tengra	Tilapia	Kalibasu
Length (cm)	17.5-31	30-32.6	14-16	7.5-9	25-30	26.0-30.5
Weight (g)	31-229	210-244	38-41	4.0-6.0	300-356	201-302

Table 3: Gura Jal

	Kankila	Gutum	Baila	Baim	Bajuri
Length (cm)	17.6-20	7.5-10.2	7.6-7.7	11-14.5	4.8-6
Weight (g)	10.0-20.0	3.0-8.0	3-3.3	6.0-12	1.5-1.8

Table 4: Fish Trap/ Unta

	Tit puti	Boicha	Darkina	Bajuri	Baim
Length (cm)	4.5-5.0	3.0-5.0	5.3	5.2	9.5-11
Weight (g)	0.9-1.4	0.3-2.1	0.8	1.2	2.7-4.5

	Echa	Napit koi	C. boicha	Chanda
Length (cm)	4-5.6	4.0-5.0	3.8-4.0	3.5-5.0
Weight (g)	0.4-1.3	0.8-1.5	0.35-0.4	0.5-1.8

Gear study:

Major gear used in those beel: Various types of fishing gear/ trap used in this study area. Type of gear used according to the fisherman output. Seine net, Cast net, Gill net and Fish trap of different mesh size are operated daily.

Table 5: Location wise net list

Location	Net name and type
Roktodaho	Ber jal (Seine net), Fashjal (Gill net), Current jal,(Gill net), Jhakijal (Cast net), Unta (Fish trap), Gurajal (Others)
Hasaigari	
Chalan	Ber jal (Seine net), Jhakijal (Cast net) Fashjal (Gill net), Current jal, (Gill net), Birti/ Poran, Dori, Bosni, (Fish trap), Taki Jal, Harroh Jal, Push Net Etc
Erulia	
Subeel	Ber jal(Seine net), Ricksha net, Push net, Fashjal (Gill net), Current jal (Gill net), Jhakijal (Cast net), Unta/Bana (Fish trap), Ichar Chai, Kati,
Tulshiganga	

Study 3: Assessment of stock or biomass of commercially significant inland beel water fishes**CPUE of different type of fishing gear:**

Use of different fishing gear and traps can also serve as a rough indicator of the availability of different fish species. Some gear is species selective such as gill nets, traps, hook and lines and long line. We observe that gill net used widely during the sampling period in those study areas

and followed by fish trap. CPUE of different type of fishing gear is presented in the following table according to Location.

Table 6: Gear wise* CPUE of various beels

Name of Beel	SN (2 h)	CN (3h)	G/FN (12h)	U/FT (12h)	CRN (12h)	GN (4h)	HN (2h)	KT
Roktodaho	14	2	2	0.5	0.5	0.5		
Hasaigari	7	1	1	0.5	0.5	0.5		
Chalan	20	0.5	1	0.25	1		0.25	
Erulia	8	0.5	1	0.25	0.7		0.4	
Subeel	15	10	10	10				2
Tulshiganga	11	12	12	8				2

*SN=Seine Net, CN= Cast Net, G/FN=Gill/Fash Net, U/FT=Unta / Fish Trap, CRN=Current Net, GN=Gura Net, HN=HaarohNet, KT=Katia

Net based individual CPUE of Different fish species:

Several kinds of small individual species (SIS) was available throughout the study period. Indian Major carps (IMC) was also present during the sampling period (winter) in this study areas. Total catch was dominant by SIS then followed by IMC. Other species was also present in less extent. Net based individual CPUE of different fish species is described in the following graph below. (Figure 6-11).

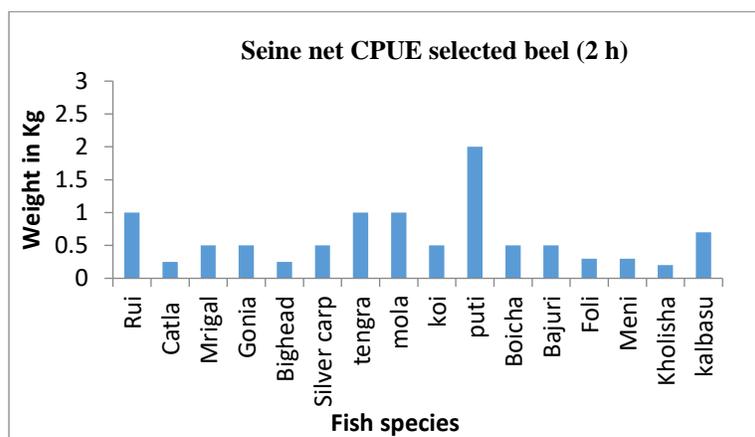


Figure 07:CPUE of Seine net at Selectedbeel

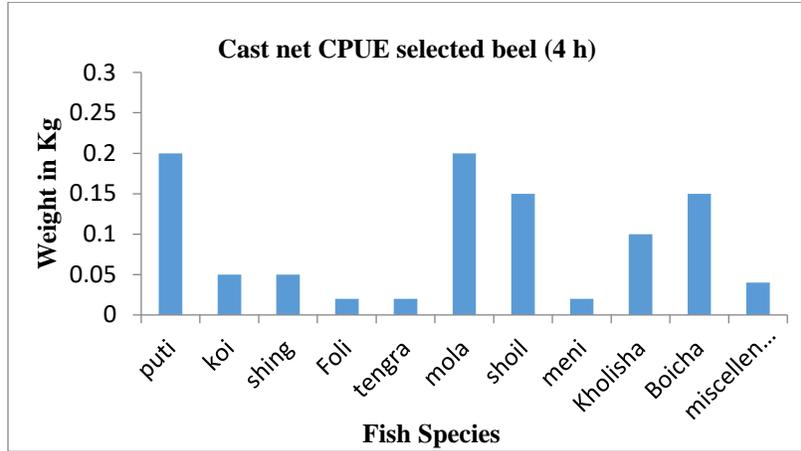


Figure08: CPUE of Cast net at selected beel

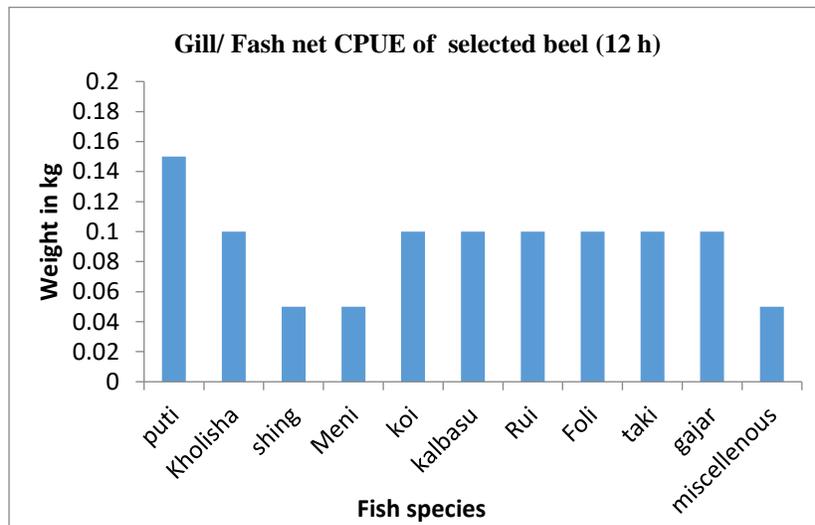


Figure09: CPUE of Gill/Fash net at selected beel

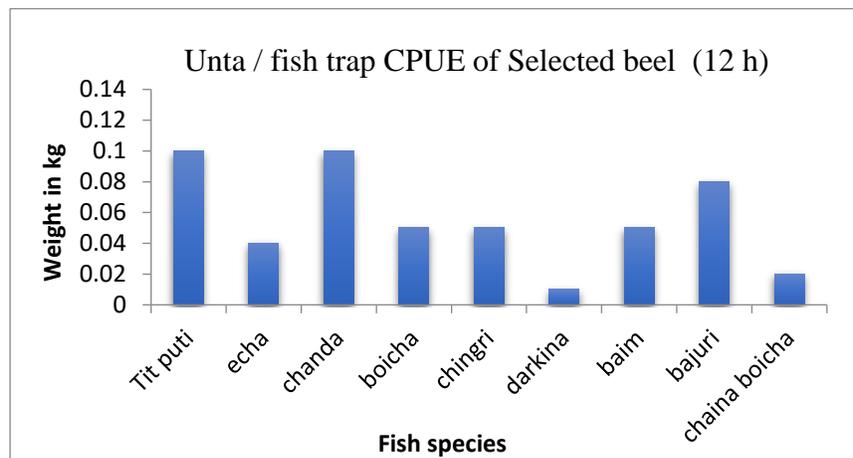


Figure10: CPUE of Unta/Fish Trap at selected beel

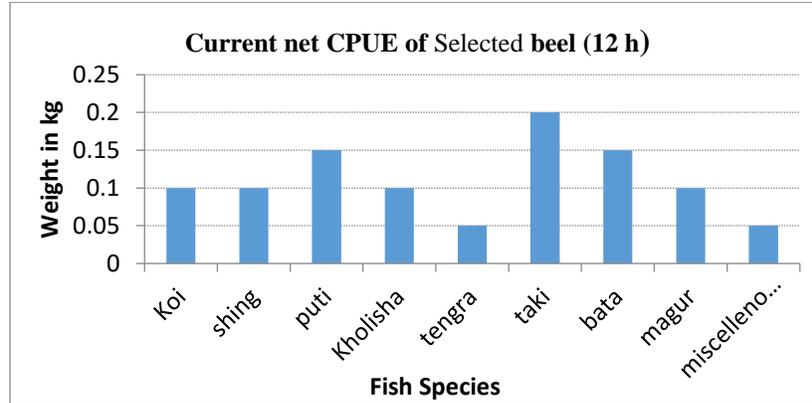


Figure11: CPUE of Current Net at selected beel

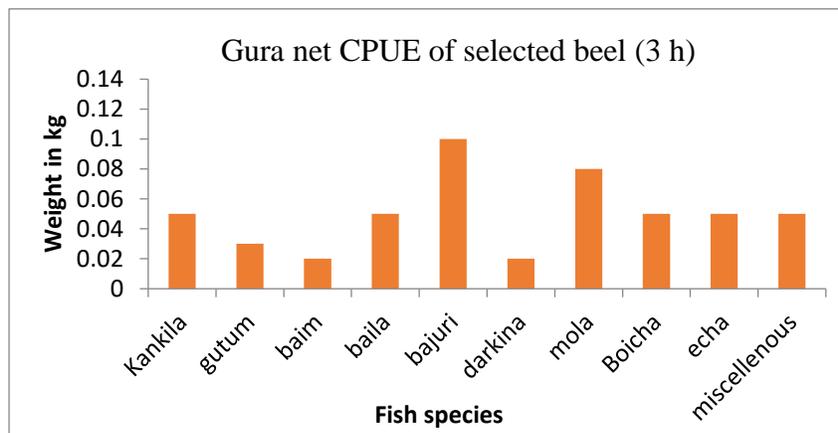


Figure12: CPUE of Gura Net at selected beel

Development and Dissemination of Nursery and Culture Techniques of Cuchia, *Monopterus cuchia* (Comp. B. FSS)

Reserchers

Maliha khanom, Scientific Officer & PI
 Dr. David Rintu Das, Principal Scientific Officer
 Md. Moniruzzaman, Scientific Officer

Objectives

- To develop nursery technique of Cuchia, *Monopterus cuchia*.
- To develop grow-out technique of Cuchia, *M.cuchia*.
- To analyze the cost-benefit ratio Cuchia, *M.cuchia*.

Achievement

Expt.1. Effects of different types of stocking densities on growth and survival rate of *Monopterus cuchia* culture in earthen pond (on Farm)

Study area

An experiment of culture of Cuchia (*Monopterus cuchia*) was carried out in three upazilla (Kahalu, Raninagar and Atrai) during July 2020 to June 2021 in 9 earthen ponds for six months. The above study was undertaken to observed effects of different types of feedson growth, survival, production and the cost-benefit ratio of freshwater mud eel in earthen ponds.

Pond selection and preparation

Nine rectangular ponds each of 5 to 8 decimal were selected for grow-out culture of *M. cuchia*. For the preparation of pond, at least two feet bottom soil were removed from all ponds and then filter net was placed in the bottom due to avoid the burrowing habit of Cuchia. Considering the burrowing habit of Cuchia, a layer of clay soil of about 50 cm deep were provided at the bottom of each pond. Ground water were supplied to the pond up to 25 cm depth. After dewatering, each of the pond were treated with lime (CaO) at the rate of 250 kg/ha. After then, ponds will be filled with underground water up to 70 cm depth. Water of the ponds will be treated with 2.0 ppm rotenone to eradicate Cuchia (if any) hiding into the soil. After that, water of the ponds will be fertilized with Urea and TSP at the rate of 25 ppm and 30 ppm to enhance the production of plankton. Water hyacinth will be provided to the ponds for suitable and safe shelter of Cuchia (Fig. 1)



Fig. 1: Pond preparation activities for cuchia culture

Fish stocking and management:

Live specimens of Cuchia (28.6 g) were collected from local fisherman. The collected baby eels were stocked 17 February/2021 at as following experimental design. The experiment was conducted to know the effects of different types of stocking densities on growth and survival rate of *Monopterus cuchia* culture in earthen pond with following (Treatment-1), (Treatment-2) and (Treatment-3). Feeding rate was adjusted at the rate of 20-5% B.Wt. twice a day.

Monopterusuchia will be reared up to six months. Each treatment was replicate thrice. Sampling was done at an interval of one month to measuring weight of fish and to observe the health condition of fish



Fig. 2 : Stocking of cuchia fry

Experimental design:

The experiment was set up with three treatments namely T₁(Fish paste, Live fish spawn), T₂ (Vermi compost, Live fish spawn), and T₃ (Vermi, fish paste) were included for the study each having three replications. The experiment was continued for 180 days. Initial mean length (23.5cm) and weight (28.6g) for each treatment were recorded individually before fry eel released. Data on growth and water quality parameters were recorded in 30 days intervals.

Table 1: Effects of different feeds on growth and survival of *M. cuchia* in different treatments

Treatments	Replications	Stocking density (nos /m ²)	Size of the ponds (Dec.)	Feed	Culture Period (month)
T ₁ (Kahalu)	3	10	5-8	Fish paste, Live fish spawn	6
T ₂ (Raninagor)				Vermi compost, Live fish spawn	
T ₃ (Atrai)				Vermi, fish paste	

Table 2. Water quality parameters recorded monthly interval from the Cuchia ponds with different treatments

Months	Parameters			
	Temperature ($^{\circ}$ C)	Dissolved oxygen (mg/L)	pH	Alkalinity (mg/L)
February	19.5	4.7	7.3	54
March	28.3	5.6	7.7	62
April	28.7	5.0	7.5	56
May	29.5	5.5	7.6	55
June	30.4	5.6	7.8	61
July	31.5	5.5	7.7	63
August	32.8	6.3	7.8	64

Water quality parameters

Water quality parameters such as water temperature, pH, dissolved oxygen (DO) concentration of water and total hardness measured regularly at 30 days interval throughout the experimental period, were found almost identical in all treatments in every sampling date without showing significant difference among the treatments (Table 2).

Growth and production performance of Cuchia

At the end of the experiment, ponds were been dried and all Cuchia were harvested manually. Final weight and survivability were been recorded (Fig. 3). Growth and production of Cuchia were varied from treatment to treatment. Gross and net production of Cuchia (169.87 ± 3.64 kg and 58.56 ± 1.30 kg / dec. respectively) was significantly higher in Treatment T₂. The survival rate of Cuchia in the present study was also significantly higher in Treatment T₂. The growth performances data of Cuchia in all treatments are presented in Table 3.

Table 3. Growth parameters recorded monthly interval from the Cuchia ponds with different treatments

Months (Sampling)	Growth Parameters (g)		
	T ₁	T ₂	T ₃
February (Initial wt.)	28.6 ± 2.50	28.6 ± 2.50	28.6 ± 2.50
March (1 st)	39.1 ± 1.3	41.9 ± 2.88	38.3 ± 3.1
April (2 nd)	48.32 ± 1.51	45.10 ± 0.50	57.63 ± 2.35
May (3 rd)	61.51 ± 1.34	57.53 ± 1.34	71.62 ± 1.78
June (4 th)	97.32 ± 1.37	108.54 ± 1.2	82.72 ± 1.85
July (5 th)	121.54 ± 1.85	112.32 ± 2.6	132.32 ± 3.21

August (6 th)	135.23±2.32	169.87±3.64	146.45±3.44
Survival (%)	66	73	67
Gross Production (Kg/Dec.)	42.83±0.32	50.96±0.41	42.56±1.30
Net Production (Kg/Dec.)	25.09±0.12	20.40±0.23	28.53±0.12

Expt-2: Effects of different types of feeds on growth and survival rate of *M.cuchia* nursing in cisterns

Preparation of cisterns:

Nine oblong cemented cisterns each of 2.47m x 1.5m x 0.75 m with three replications were used for nursing 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 (Fig. 4). Ground water was supplied to the cisterns up to 25 cm depth. After preparing, each of the cisterns was treated with lime. After then, cisterns were filled with underground water up to 20 cm depth. Water of the cisterns were treated with 2.0 ppm rotenone to kill insect (if any) hiding into the soil. After that, water of the cisterns was fertilized with Urea and TSP properly to enhance the production of plankton. Water hyacinth were provided to the ponds for suitable and safe shelter of *Cuchia* spawn. Treatments with three replications.



Fig. 4. Cuchia nursing in cistern

Experimental design and Methodology:

The experiment was conducted in cistern for a period of two months. The experiment was conducted in following design with 15 days old spawn to evaluate the effects of different types of feeds on growth and survival of *M. cuchia* nursing. Stocking density was kept at 200/m² for all the three treatments with three replications and the design of experiment are shown in Table 4.

Table 4: Design of the experiment

Treatment	Replication	Density	Feed	Culture period
T ₁	3	200/m ²	Vermi/Earthworm pest	60 days
T ₂			Zooplankton	
T ₃			Fish pest	

Table 5. Water quality parameters recorded during nursing period from the cistern

Months	Parameters			
	Temperature (° C)	dissolved oxygen (mg/L)	pH	Alkalinity (mg/L)
May	30.5	5.7	7.5	57
June	31.3	5.9	7.8	60

The experiment was conducted to know the efficacy of feeds on growth and survival rate of *M. cuchian* nursing in three treatments with Earthworm pest/ Vermi (Treatment-1), Zooplankton (Treatment-2), Fish pest (Treatment-3). Feeding rate was adjusted @ 20-5% B.Wt. two times in a day. The study was conducted for 2 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. Water quality parameters were almost similar and suitable for all experimental cisterns are shown in Table 5.

Table 6. Effects of different types of feeds on growth and survival rate of *M. Cuchia* nursing in Cisterns

Growth parameters	T ₁	T ₂	T ₃
Initial Ln. (cm)	8.6 ± 0.32	8.6 ± 0.32	8.6 ± 0.32
Initial Wt. (g)	1.87 ± 0.10	1.87 ± 0.10	1.87 ± 0.10
Final Ln. (cm)	23.91 ± 0.21	19.62 ± 0.26	17.51 ± 0.23
Final Wt. (g)	16.87 ± 0.48	13.76 ± 0.45	11.85 ± 0.49
Survival rate (%)	79	74	56

After 2 months of nursing, the final length and weight of *M. cuchia* were 23.91 ± 0.21 cm and weight 16.87 ± 0.48 gm for T₁, 19.62 ± 0.45 cm and 13.76 ± 0.45 gm for T₂, 17.51 ± 0.23 cm and 11.85 ± 0.49 gm for T₃ respectively. The result indicated that T₁ showed higher growth in weight (g) and survival rate among the three treatments (Table 6).

Development of induced breeding and fry production techniques of Gangetic endangered fish species

Researchers Dr. David Rintu Das, Principal Scientific Officer & PI
 Md. Moniruzzaman, Scientific Officer
 Maliha khanom, Scientific Officer

Objectives

- To domesticate and brood development of Kajuli, Batashi and Pialy in captive condition
- To study the reproductive biology of Kajuli (*Ailia coila*), Batashi (*Neotropius atherinoides*) and Pialy (*Aspidoparia jaya*)
- To determine the reproduction response to different doses of natural and synthetic hormones of Kajuli, Batashi and Pialy in captive condition
- To develop the larvae rearing of Kajuli, Batashi and Pialy in captive condition
- To develop culture technique for Kajuli, Batashi and Pially
- **Achievements**

Expt. 1: Domestication of Gangetic endangered fish species for brood development in captive conditioning

The experiment was conducted at Bangladesh Fisheries Research Institute (BFRI), Floodplain sub-station, Santahar, Bogura during July 2020 to June 2021. The reproductive biological parameters viz; gonadosomatic index (GSI), fecundity, egg diameter and sex ratio of Kajuli, Batashi and Pialy was studied with the following methods:

Gonadosomatic index (GSI)

The study was conducted for a period of 12 months to estimate the monthly gonad value. The total length and body weight of fishes were measured. Gonads of fishes were dissected out and gonad length was measured and then excess moisture was removed from the gonad before taking the weight of gonads. Gonadosomatic index (GSI) of the male and female was calculated separately by using the following formula.

$$\text{GSI} = \frac{\text{Gonad weight}}{\text{Total body weight of fish}} \times 100$$

Fecundity estimating:

A total of 100 gravid females of Kajuli, Batashi and Pialy was collected from the Floodplain and river and studied for fecundity estimation. Fecundity was estimated by gravimetric method. The fecundity was calculated using the following formula:

$$F = \frac{N \times \text{Gonad weight}}{\text{Sample weight}}$$

Where, F is the fecundity and N is the number of eggs in the sample.

Pond preparation and experimental design

The experiment was conducted at Bangladesh Fisheries Research Institute (BFRI), Floodplain Sub Station, Santahar, Bogura for a period of 12 months during July 2020 to June 2021. The experiment was concerned with the observation of the growth, gonadal maturation, and secondary sexual characteristics and also yield performance of pond culture system in the captive condition. One pond was selected for this experiment. The pond was 40 decimals in size. The water depth was maintained at 1.5 meter. After that, water of the ponds were fertilized with Urea and TSP @ 25 ppm and 30 ppm to enhance the production of plankton. Fingerlings and sub-adults of these small endangered indigenous fish species was collected from the adjacent river and floodplain area and stocked in the experimental pond of BFRI, Floodplain Sub Station, Santahar, Bogura. PVC pipes having different length and diameter was used to the pond for creating hole like environment for suitable and safe shelter of fish.

Table. 1. Stocking of Kajuli, Batashi and Pialy fish species in pond for brood rearing

Pond Size (dec)	Stocking density (nos./ha)	Combination of fish species
40	10,000	Kajuli (30%), Batashi (30%) and Pialy (40%)

Fish stocking and management

Live specimens of small endangered indigenous fish species were collected from the adjacent river and floodplain area. The collected fishes were acclimatized for 2 days in a cemented cistern. After acclimatization collected fishes were stocked in last week of October/2020 at as following experimental design. The experiment was conducted to know the domestication and reproductive biology of Gangetic endangered fish species for brood development in captive.

Feeding rate was adjusted at the rate of 20-5% B.Wt. twice a day. Sampling was done at an interval of one month to measuring weight of fish and to observe the health condition of fish.

Determination of Water quality parameters

Water quality parameters such as water temperature, pH, dissolved oxygen and alkalinity were recorded monthly throughout the study period. The results of the water quality parameters are shown in Table 2. The water quality parameters are important for growth, survival and production of fish culture. The water quality parameters were found within the suitable range, however, no significant variation was observed in the pond.

Table 2. Water quality parameters recorded monthly from the culture pond

Months	Parameters			
	Temperature ($^{\circ}$ C)	dissolved oxygen (mg/L)	pH	Alkalinity (mg/L)
November	21.7	4.60	7.52	50
December	22.3	4.75	7.45	49
January	18.5	5.0	7.50	53
February	19.4	5.4	7.6	55
March	26.5	5.5	7.5	60

Total length, body weight, GSI, SGR (%) of Kajuli, Batashi and Pialy

During the study period the mean total length, body weight, GSI, SGR (%) of Kajuli, Batashi and Pialy as shown in Table 3. The term Gonadosomatic Index (GSI) has been using as an indicator of gonadal development. In the pre-spawning period a gradual increase of the GSI, reaching a peak during the spawning period has been reported.

Table 3: Mean (\pm SE) of total length, body weight, GSI, SGR (%) of Kajuli, Batashi and Pialy during the brood development period

Name of the fish	Stockig date	Initial (November)		Final (July)		GSI	SGR (%)	Feed used
		Av.Ln (cm)	Av. Wt (g)	Av. Ln (cm)	Av.Wt (g)			
Batashi (<i>Neotropiusat herinoides</i>)	11.11.20	7.1	1.87	10.2	8.5	2.80	2.76	Tiger brand feed (28-30%) protein
Kajoli (<i>Ailia coila</i>)	15.12.20	7.2	3.2	15.4	10.12	1.7	2.09	
Pialy (<i>Aspidoparia jaya</i>)	15.12.20	3.2	2.8	8..5	7.8	0.90	1.86	

Experiment 2: Development of induced techniques of the Batashi and Pialy

After collection of Batashi, Kajuli, and Pialy from Jamuna, Atrai river & Local beel they were transported to the station and stocked in two ponds which were prepared previously with following the Good Aquaculture Practice (GAP) pond preparation manual. The number of above-mentioned stocked fish was 40,000, 15,000, 20,000 and average initial weight were 1.87 g, 3.2 g, 2.8 g respectively. Different types of commercial feed as Tiger brand (28-30) % protein, Flour, Lysovit etc. were used. After 7 months of rearing period the average body weight and length of the fishes were (8.5, 10.12, 7.8) g and (10.2, 15.4, 8.5) cm respectively.

After that induced breeding technique was applied to breed the above endangered fish species. In case of breeding of Batashi (*Neotropius atherinoides*) during the month of May 20 pairs male and female where average body weight was (3.4, 5.2) g respectively were selected and after conditioning PG (8mg/ kg body weight) was applied as single dose. After 12-15 hours later 16 pairs fishes released eggs. Hatching was come out after 23-26 hours of ovulation.

In case of Pialy (*Aspidoparia jaya*) during the month of June 10 pairs male and female where average body weight was (5.4, 6) g respectively were selected and after conditioning PG (6mg/ kg body weight) was applied as single dose. After 6-8 hours later 07 pairs fishes released eggs. Hatching was come out after 20-22 hours of ovulation. The rate of ovulation fecundity, fertilization, hatching and GSI (Gonado somatic index) are given in the following (Table-4).

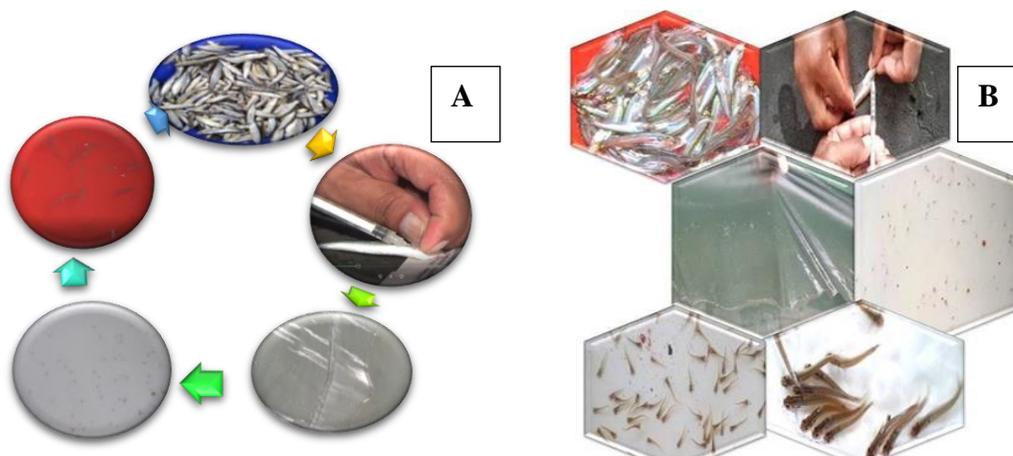


Figure 01(A, B): Induced breeding technique of Pialy (A) and Batashi (B).

Table-4: Reproductive Biological Parameters of Batashi and Pialy

Parameters	Batashi (<i>Neotropius atherinoides</i>)	Pialy (<i>Aspidoparia jaya</i>)
Fecundity (g /B. Wt)	356	361
Ovulation rate	65%	78%
Fertilization rate	62 %	76 %
Hatching rate	80%	72%
G.S.I.	4.52	7.88

Experiment3: Development of nursing techniques of Batashiand Pialy

After breeding the five days old spawn stocking were reared with special attention for development of nursing techniques of Batashiand Pialy with different types of commercial feed and regular sampling was done to collect data on growth, FCR, etc.

Stocking of spawn

After five days of hatching, the spawn was transferred to the nursery ponds. The nursing period was 55 days. The stocking was done preferably during morning hours by acclimatizing them to the new environment. Here, the area of nursing ponds was 20 decimals in each. About 400 g spawn were stocked in the nursery ponds. The feeding schedule during the experimental period was shown in Table 5.



Figure 02 (A, B). Stocking of Spawn (A) after acclimatization (B).

Table 5. Feeding schedule

Days	Feed ingredients
1-5	Chicken egg yolk (20egg/day), V-plex (15ml)
6-10	Milk flour, Mega feed (fine powder), Panvit-aqua
11-20	Floating Nursery feed (0.5micrometer)
21-30	Crumble (sinking) nursery feed
31-40	Starter 1 Nursery feed (sinking)
41-55	Crumble (sinking) nursery feed

Sampling:

The stocked spawn were sampling four times at 10 days interval throughout the nursing period by netting to check development and physical conditions.

Growth performance:

After 55 days of nursing period the growth performance of both Batashi and Pialy was observed. In case of Batashi the average length and weight of fry were 3.1cm and 2.3 g respectively, while in case of Pialy it was 1.8cm and 1.9g respectively.



Figure 03 (A, B, C, D, E, F). Growth performance (length and weight) at the end of the nursing period (A. Batashi; B. Pialy; C, D. Length and weight of Batashi; E, F. Length and weight of Pialy).

Domestication and Conservation of Some Important Threatened Stream Fishes in Northern Part of Bangladesh

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Objectives

- To collect the fry/semi-adult/adult of the selected fishes from wild sources;
- To study the food and feeding habit and reproductive biology viz; gonadosomatic index (GSI) fecundity, egg diameter, sex ratio of the fishes;
- To domesticate and brood development of the fishes in captive condition;
- To determine the reproduction response of the selected fishes to different doses of natural and synthetic hormones in captive condition; and
- To develop the larvae and nursery rearing techniques of the selected fishes in captive condition.

Achievements

Collection of fry/fingerling/sub-adult/adult of the selected fish species

A total of 500 sub-adults of *Chagunius chagunio* and 40 sub-adults of *Labeo dero* were collected from the wild sources for domestication in ponds at the Freshwater Sub-Station, Saidpur.

Studies of reproductive parameters of *C. chagunio*

Sex ratio and gonadosomatic index (GSI):

The sex ratio and GSI of *C. chagunio* are being studied from July 2020 to June 2021 know the spawning season of this fish. For these reasons about of 20 fishes were studied monthly. The results are presented in Table 1.

Table 1. Sex ratio and GSI values of *C. chagunio*

Month	No. of fish	♂	♀	♂:♀	GSI% (♀)
July 2020	22	09	13	1.0:1.44	0.62±0.12
August	23	08	15	1.0:1.87	2.18±0.23
September	26	10	16	1.0:1.60	3.65±0.37
October	22	09	13	1:1.44	3.95±0.30
November	19	07	12	1:1.71	4.15±0.24
December	19	09	10	1:1.11	5.24±0.20
January 2021	NA	NA	NA	NA	NA

February	25	11	14	1:1.27	6.03±0.26
March	17	7	10	1:1.42	3.80±0.20
April	19	07	12	1:1.71	0.95±0.40
May	20	08	12	1:1.50	0.60±0.26
June	15	07	08	1:1.14	0.56±0.20
Total/Average	227	92	135	1.0:1.46	2.87±0.26

Fecundity estimation:

A total of 50 gravid females of *C. chagunio* were collected from Atrai River for studies of fecundity. The fecundity was estimated by gravimetric method. The method was described by Blay (1981). The fecundity was calculated using the following formula and the results are presented in Table 2.

$$F = \frac{N \times \text{Gonad weight}}{\text{Sample weight}}, \text{ Where, F is the fecundity and N is the number of eggs in sample}$$

Table 2. Fecundity of *C. chagunio* based on length group

Class interval (cm)	TL (cm)	BW (g)	GL (cm)	GW (g)	Fecundity
15.1-18.0	17.1±1.04	67.74±24.85	4.48±0.82	2.61±1.5	3463±2639
18.1-21.0	19.8±0.75	101.95±25.11	5.18±0.81	4.35±2.67	5586±2727
21.1-24.0	22.1±0.87	132.09±22.96	5.79±0.60	5.03±1.42	6628±2487
24. -Above	29.4±2.66	352.67±106.53	8.0±1.41	14.88±7.42	19186±4226
Mean±SD	20.6±2.85	118.13±64.55	5.39±1.06	4.76±3.34	8715±4068

Domestication and brood development of *C. chagunio* with carp in captive condition

Pond preparation and stocking

The experiment was conducted at the Bangladesh Fisheries Research Institute (BFRI), Freshwater Sub-Station (FSS), Saidpur for a period of 12 months from December 2020 to November 2021 to observe the growth, gonadal maturation and also yield performance of *C. chagunio* in the captive condition. For this experiment the ponds were selected 15-25 decimal in size. The water depth maintained at 1.5 meter. The ponds were prepared by dewatering, liming (01 kg dec⁻¹) and fertilization (Urea 100 g and TSP 50 g decimal⁻¹). The fishes were stocked as per experimental design. The experimental design is presented in Table 3.

Table 3. Experimental design

Treatment	Stock. dens. (Indi. ha ⁻¹)		Stock. dens. (3,000 ha ⁻¹)		
	<i>C. chagunio</i>	Catla	Silver	Rohu	Rajpunti
T ₁	3,000				
T ₂	4,000	25% (750)	20% (600)	30% (900)	25% (750)
T ₃	5,000				

Growth performance of *C. chagunio* and water quality parameters

After 180 days, the growth performances of *C. chagunio* and physico-chemical parameters of the experimental ponds are presented in Tables 4 and 5 respectively.

Table 4. Growth performance of *C. chagunio* under different stocking densities

Parameters	Treatments		
	T ₁	T ₂	T ₃
Initial weight (g)	20.3±1.0	21.2±1.3	20.5±1.2
12 th sampling weight (g)	130±2.60	124.5±3.15	115±3.60
Weight gain (g)	109.7±2.60	103.3±3.15	94.5±3.60
SGR (% day ⁻¹)	1.03±0.6	0.98±0.065	0.96±0.07
ADG (g day ⁻¹)	0.61±0.02	0.57±0.04	0.52±0.05
HC (g cm ⁻¹)	5.53±0.4	5.46±0.5	5.13±0.7

Table 5. Physico-chemical parameters in three treatments

parameters	T ₁	T ₂	T ₃
Water Temperature (°C)	26±1.0	25.67±.50	27.2±1.2
Water pH	7.50±.02	7.8±0.6	7.9±0.25
DO (mg l ⁻¹)	6.2±0.10	5.9±0.2	5.3±0.24
NH ₃ (mg ⁻¹ l)	0.03±.0.01	0.04±.02	0.05±.02

Determine the reproduction response of selected fishes in captive condition:

Reproduction response of *L. angra* to different doses of synthetic and natural hormone in captive condition

The experiment were conducted at the hatchery of BFRI, FSS, Saidpur during May 2021 to July 2021 to determine the reproductive response of *L. angra* using natural and synthetic hormone. The breeding results are presented in Tables 6 and 7.

Table 6. Spawning response of *L. angra* to synthetic hormone under natural method

Treatment	Ovuhom (ml kg ⁻¹)	Latency period (hrs)	Incubation temperature (°C)	% of egg release	% of fertilization	% of hatching	Remarks
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	M	F							
T ₁	0.5	0.6	9-10	25.0-28.0	88.0	70	10	Better amount of fertilization and hatching in T ₄ but less amount of hatching observed in other treatments.	
T ₂	0.5	0.66	8-9	25.0-27.0	85.0	80	20		
T ₃	0.5	0.7	8-9	25.0-27.0	80.0	83	65		
T ₄	0.7	0.9	9-10	25.0-27.0	80.0	85	75		

Table 7. Spawning response of *L. angra* to PG under natural method

Treatments	PG (mg kg ⁻¹)		Latency period (hrs)	Incub. Temp. (°C)	% of egg release	% of fertilization	% of hatching	Remarks
	M	F						
T ₁	5	10	8-10	26-28	60	70	60	Comparatively better amount of fertilization and hatching in T ₃
T ₂	6	12	8-10	26-28	80	75	65	
T ₃	7.5	15	8-9	25-26	90	88	80	

Reproduction response of *C. chagunio* to different doses of natural and synthetic hormone in captive condition

The experiment was conducted at the hatchery of BFRI, FSS, Saidpur to determine the reproductive response of *C. chagunio* using different types of hormones. The results are presented in Tables 8 and 9.

Table 8. Spawning response of *C. chagunio* to PG under natural method

Treatments	PG (mg kg ⁻¹)		Latency period (hrs)	Incubation temperature (°C)	% of egg release	% of fertilization	% of hatching	Remarks
	M	F						
T ₁	3	6.0	-	25.73±0.23	-	-	-	No fertilization, ovulation and spawning
T ₂	4	8.0	-	26.86±0.20	-	-	-	
T ₃	5	10	-	24.97±0.28	-	-	-	

Table 9. Spawning response of *C. chagunio* to synthetic hormone under stripping method

Treatment	Ovuhom (ml kg ⁻¹)		Latency period (hrs)	Incub. Temp. (°C)	% of egg release	% of fertilization	% of hatching	Remarks
	M	F						
T ₁	0.2	0.5	-	18.0-24.0	-	-	-	No fertilization, ovulation and spawning

Reproduction response of *L. dero* to synthetic and natural hormone in captive condition

The experiment was conducted at the hatchery of BFRI, FSS, Saidpur to determine the reproductive response of *L. dero* using different types of hormones. The results are presented in Tables 10 and 11.

Table 10. Spawning response of *L. dero* to synthetic hormone under natural method

Treatment	Ovuhom (ml kg ⁻¹)		Latency period (hrs)	Incub. temp. (°C)	% of egg release	% of fertilization	% of hatching	Remarks
	M	F						
T ₁	0.3	0.5	9-10	27-28	90	85	78	Good amount of hatching

Table 11. Spawning response of *L. dero* to PG under natural method

Treatments	PG (mg kg ⁻¹)		Latency period (hrs)	Incub. Temp. (°C)	% of egg release	% of fertilization	% of hatching	Remarks
	M	F						
T ₁	5	10	10-12	26-27	70	60	40	Less amount of hatching

Effects of stocking density on the growth and survival of larvae rearing of *Barila* in nursery pond.

The experiment was conducted in the mini nursery ponds of BFRI, FSS, Saidpur for a period of two months (March-April 2021) to observe the growth, and survival of *B. barila* under different stocking density. After culture tenure, the growth performances of *B. barila* in nursery ponds are presented in Table 12.

Table 12. Growth and survival of the larvae rearing of *B. barila* in three treatments

Parameters	Treatments		
	T ₁	T ₂	T ₃
Stock. dens. (g dec. ⁻¹)	10	12	14
Initial weight (g)	0.0017±0.0	0.0017±0.0	0.0017±0.0
Final weight (g)	1.28 ±0.1	1.20 ±0.2	0.79±0.2
Weight gain (g)	1.278 ±1.0	1.198±1.2	0.788±1.2
SGR (% day ⁻¹)	11.03±0.03	10.93 ±0.04	10.23 ±0.03
ADG (g day ⁻¹)	0.021 ±0.02	0.019±0.01	0.0131±0.01
HC (g cm ⁻¹)	0.25 ±0.12	0.24±0.20	0.17±0.24
Survival (%)	85±5.0	78±7.0	72±8.0

Culture Potential of *Mystus vittatus* under Polyculture in Farmers Pond of Northern Region of Bangladesh

Researchers

Mr. Md. Istiaque Haider, Senior Scientific Officer & PI
 Dr. Khondaker Rashidul Hasan, Principal Scientific Officer
 Mr. Saokat Ahamed, Senior Scientific Officer

Objectives

- To evaluate the culture potential of tengra, *Mystus vittatus* with short-cycle species in the seasonal water bodies of farmer's field;
- To assess the water quality parameters of cultural water bodies;
- To assess the BCR of culture technologies and
- To disseminate polyculture techniques of tengra in different aqua-ecological zones in the northern part of Bangladesh.

Achievements

Dissemination of tengra polyculture patterns in different part of northern region of Bangladesh

Experimental design and methodology

Multi location testing (MLT) program

Multi location testing program were conducted in different Upazilas of northern region of Bangladesh to verify the research results of previously tested tengra polyculture patterns and exchanged views among the researcher, extension people (DoF) and farmers. A total of 06 (six) seasonal ponds were selected in 06 (six) different Upazilas of Rangpur region (Table 1). The ponds were selected with the concern of relevant Senior Upazila Fisheries Officer/Upazila Fisheries Officer (SUFO/UFO). The six ponds (one pond in one upazila) were divided into two groups *viz*: group-I (Trail-1) and group-II (Trail-2) and each pond (upazila) was considered as one replication. The areas of ponds ranged between 10 and 15 decimals. The experimental design is presented in Table1.

Table 1. Experimental design

Culture pattern	Replication (One pond/Upazila)	Species combination	Stock. density (indi. dec ⁻¹)
Trial-1	Domar, Nilphamari+Aditmari, Lalmonirhat+Parbotipur, Dinajpur	Tengra+Pabda+Magur +Rajpunti+GIFT	600+100+50+25+10
Trial-2	Debiganj, Panchagarh+Chirirbondor, Dinajpur+Rangpur Sadar	Tengra+Shing+Magur +Rajpunti+GIFT	600+100+50+25+10

Pond preparation: The selected ponds were prepared by dewatering, liming and fertilizing.

Culture period: 05 months (May-September).

Stocking of fingerlings: Average 7-10 cm of fingerlings was stocked as per experimental design (Table 1).

Feeding: Fish were fed @ 10-5% (30-35% protein) of body weight twice daily.

Sampling: Length-weight data and water quality parameters such as temperature, water pH, dissolve oxygen (DO) and NH₃ were collected fortnightly.

12.7 Growth performance of tengra and water quality parameters in two trails

After 120 days, the growth performances of tengra and physico-chemical parameters of the experimental ponds are presented in Tables 2 and 3 respectively.

Table 2. Growth performance of tengra under polyculture in two trails.

Parameters	Trails	
	Trail-1	Trail-2
Stock. dens of Tengra (indi. dec ⁻¹)	600	600
Culture period (days)	120	120
Initial weight (g)	1.2±0.2	1.2±0.2
8 th sampling weight (g)	17.6±1.20	16.8± 1.0
Weight gain (g)	16.4±1.30	15.6±1.40
% weight gain	1366.7±15.04	1300±20.35
SGR (% day ⁻¹)	2.23 ±0.13	2.2±0.20
ADG (g day ⁻¹)	0.08±0.01	0.07±0.01
HC (g cm ⁻¹)	0.52±0.01	0.49±0.01

Table 3. Physico-chemical parameters of the experimental ponds in two trails

Water quality parameters	Trail-1	Trail-2
Water Temperature (°C)	34.0±2.2	33.2±2.0
Water pH	7.4±0.20	7.5±0.24
DO (mg l ⁻¹)	6.0±0.5	5.5±0.2
NH ₃ (mg l ⁻¹)	0.01±.01	0.01±.01

Culture of Indigenous Small Fishes in Biofloc Aquaculture System (Component-B)

Researchers Mrs. Maliha Hossain Mou, Senior Scientific Officer & PI
Dr. Khondaker Rashidul Hasan, Principal Scientific Officer
Mr. Saokat Ahamed, Senior Scientific Officer

Objectives

- To observe growth and survival of short cycle catfishes *viz*; Shing, Magur, Pabda, Tengra under Biofloc aquaculture system;
- To determine water quality parameters under Biofloc aquaculture system;
- To analysis the economic benefits of Biofloc system; and
- To disseminate the suitable culture trials of short cycle catfishes under Biofloc aquaculture system in the northern part of Bangladesh.

Achievements

Growth and yield performance of magur with different stocking densities under biofloc system

Experimental design and methodology:

- The study was conducted at the Bangladesh Fisheries Research Institute (BFRI), Freshwater Sub-Station (FSS), Saidpur to observe the growth and yield performance of magur, *C. batracus* in biofloc aquaculture system.
- For this experiment, three plastic circular tanks were selected with 5 tons water holding capacity of each.
- Establishment of basement for setting of plastic circular tanks was completed and the plastic circular tanks were set with a frame made of SS pipe and the tanks were covered with thermal sheets.
- The plastic circular tanks were filled with water and then initiated the biofloc environment by adding lime (50 g 1000 l⁻¹), raw salt (1 kg 1000 l⁻¹), molasses (200 ml 1000 l⁻¹) and probiotic (20 g 1000 l⁻¹) with continuous aeration.
- The experimental design is described in table 1.
- The fingerlings of magur were stocked as per experimental design during 17 August, 2020.
- Culture period: 5 months (mid-August to mid-January).
- Feeding: Fish were fed @ 5-2% BW twice daily (commercial feed containing 30-35% protein).

- Data: Length-weight data were collected fortnightly and water quality parameters *viz*; air temperature, water temperature, dissolved oxygen (DO), pH, ammonia and total dissolved solids (TDS) were collected once daily.
- Observation: Weight gain, SGR (% day⁻¹), survival, total production and BCR.

Table 1. The experimental design in the plastic circular tank ecosystem

Treatment	Species	Stock. dens. (indi. m ⁻³)	Stocking size
T ₁	Magur	250	8-10 cm
T ₂		350	
T ₃		450	

Growth performances of magur in the plastic circular tanks:

After the culture tenure, the growth parameters of magur and water quality parameters in the plastic circular tanks are presented in tables 2 and 3 respectively.

Table 2. Growth parameters of magur in the plastic circular tanks

Growth parameters	Tanks		
	T ₁	T ₂	T ₃
Initial weight (g)	2.2±0.1	2.2±0.1	2.2±0.1
Final weight (g)	60.4±2.7	59.1±2.2	57.7±1.7
SGR (% day ⁻¹)	2.21±0.02	2.19±0.02	2.18±0.02
ADG (g day ⁻¹)	0.39±0.01	0.38±0.04	0.37±0.02
HC (g cm ⁻¹)	3.26±0.03	3.28±0.02	3.26±0.02
Survival (%)	92%	88%	84%
Production (kg m ⁻³)	13.74	17.55	21.29

Table 3. Water quality parameters in the plastic circular tanks

Water Quality parameters	Tanks		
	T ₁	T ₂	T ₃
Air temperature (°C)	21.4±0.5	21.4±0.5	21.4±0.5
Water temperature (°C)	23.9±0.9	22.0±1.1	20.4±0.5
Water pH	7.8±0.1	7.6±0.1	7.5±0.1
DO (mg l ⁻¹)	5.8±0.4	5.5±0.3	5.2±0.3
Ammonia (mg l ⁻¹)	0.04±0.01	0.05±0.02	0.05±0.01
TDS (mg l ⁻¹)	860±57.0	720±28.0	680±36.0
Floc density (ml l ⁻¹)	25.2±0.9	23.5±0.6	22.3±0.5
C/N Ratio	15:1	15:1	15:1

Economic analysis for magur in tanks:

Operational cost

Sl No.	Description of Items	Quantity	Total price (Tk)
1	Magur Fish Fry	5250 pc × 3.5/-	18,375/-
2	Fish Feed	400 kg × 65/-	26,000/-
3	Raw salt, Lime, Molasses, Probiotics etc.	-	5,000/-

4	Electricity cost (120 Unit×5 Months)	600 Unit (including vat)	2,505/-
5	Contingency (Test kits, Scoop net, Drum for store feed, Bucket etc.)	-	10,000/-
Total		-	61,880/-

Gross return

Sl No.	Description of Items	Quantity	Total price (Tk)
1	Survived magur 4620 pc (58 g each)	268 kg ×350/-	93,800/-
2	Cost	-	61,880/-
3	Benefit (gross return)	-	31,920/-

Growth and yield performance of Tengra with different stocking densities under biofloc system (2020-21)

Experimental design and methodology:

- The study was conducted at the BFRI, FSS, Saidpur to observe the growth and yield performance of tengra, *M. vittatus* in biofloc aquaculture system..
- The size of tanks and the experimental methodology were performed as previously described. The experimental design is described in Table 4.
- The fingerlings of tengra were stocked as per experimental design during 25 April, 2021.
- Culture period: 5 months (late April to late September).
- Feeding measurement, data collection and observation were also been performed as previously described.

Table 4. The experimental design in the plastic circular tank ecosystem

Treatment	Species	Stock. dens. (indi. m ⁻³)	Stocking size
T ₁	Tengra	600	5-6 cm
T ₂		800	
T ₃		1000	

Growth performances of tengra in the plastic circular tanks:

After 120 days, the growth parameters of tengra and water quality parameters in the plastic circular tanks are presented in tables 5 and 6 respectively.

Table 5. Growth parameters of tengra in the plastic circular tanks

Growth parameters	Tanks		
	T ₁	T ₂	T ₃
Initial weight (g)	1.2±0.1	1.2±0.1	1.2±0.1
8 th sampling weight (g)	14.4±0.2	12.3±0.4	11.2±0.5
ADG (g day ⁻¹)	0.1±0.02	0.1±0.01	0.08±0.01
SGR (% day ⁻¹)	2.1±0.02	1.9±0.02	1.8±0.02
HC (g cm ⁻¹)	1.14±0.02	1.07±0.03	1.02±0.04

Table 6. Water quality parameters in the plastic circular tanks

Water Quality parameters	Tanks		
	T ₁	T ₂	T ₃
Air temperature (°C)	25.5±0.3	25.5±0.3	25.5±0.3
Water temperature (°C)	24.2±0.6	24.4±0.5	24.6±0.4
Water pH	7.9±0.1	7.8±0.1	7.8±0.1
DO (mg l ⁻¹)	6.1±0.5	5.7±0.5	5.4±0.4
Ammonia (mg l ⁻¹)	0.01±0.01	0.03±0.01	0.05±0.01
TDS (mg l ⁻¹)	910±42.0	840±30.0	810±26.0
Floc density (ml l ⁻¹)	19.5±0.8	18.4±0.7	15.7±0.4
C/N Ratio	15:1	15:1	15:1

Riverine Station, Chandpur

Ecological assessment of inland open water fisheries population with bio-physicochemical properties to frame EBFM approach (Comp-D)

Researchers: Md. Mozzammel Hoque, Senior Scientific Officer
Md. Mehedi Hasan Pramanik, Senior Scientific Officer
Rumana Yasmin, Senior Scientific Officer
Md. Monjurul Hasan, Scientific Officer

Objectives:

1. To estimate population ecology and diet composition of some commercially significant inland open water fishes (especially haor and beel resident fishes)
2. To assess bio-physicochemical properties of some selected inland water bodies (haors and beels) including seasonal variation and impact assessment of agro-chemicals level
3. To assess stock and biomass of some important ecological fish groups i.e., Planktivores/Herbivores, Detrivores, Carnivores & Omnivores based on catch and CPUE data
4. To formulate ecosystem-based management approach of some major inland open water bodies (especially haors and beels) with emphasizing to increase productivity, stock enhancement and conservation of the fisheries resources

(Objectives of this study comply with the sustainable development goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development)

Achievement

Study Areas

Haors:

- Hail haor,
- Hakaluki haor of Moulovibazar

Beels:

- Vailadhora beel of B. Baria

Study 1: Sampling of Bio-Physicochemical properties of inland open waters

Collection of hydrological data

Water quality parameter such as Transparency, Temperature, Dissolved Oxygen, pH, CO₂, Alkalinity, Hardness, Ammonia, Conductivity and TDS of sampling site was recorded monthly.

Water quality of Vailadhora Beel

Water quality parameters of a large number of samples were analyzed in this study to observe any appreciable changes that might have occurred in response to different sampling spot. Various physical, chemical and biological parameters of three sampling spot namely Hospital Ghat, Ruposhdi, and Boro beel were collected monthly from Vailadhora beel, Bancharampur, B-Baria. Water quality parameters of Transparency, Temperature, pH, CO₂, Dissolved oxygen, Alkalinity, Hardness, TDS, and Conductivity were measured. Almost all water quality parameter were acceptable range for fish growth. Some exception was observed in case of Transparency among the sampling spot.(Fig 1-3)

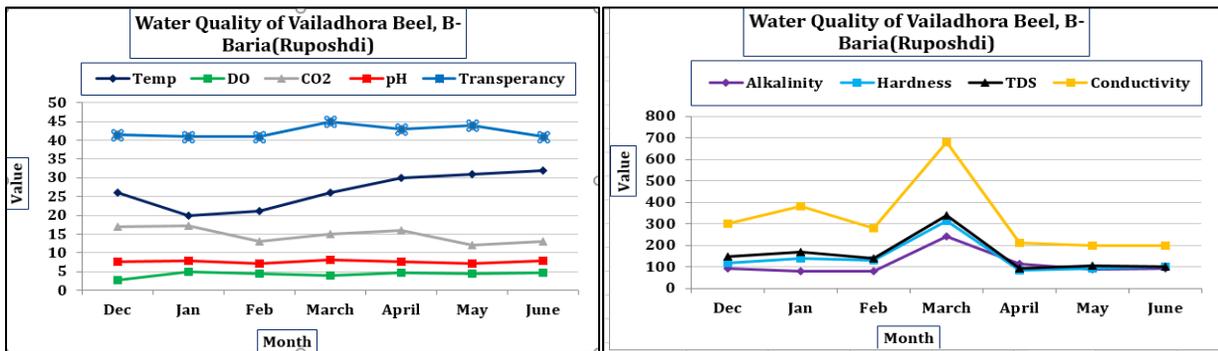


Fig 1: Water quality parameters of Ruposhdi, Vailadhora beel at B-Baria

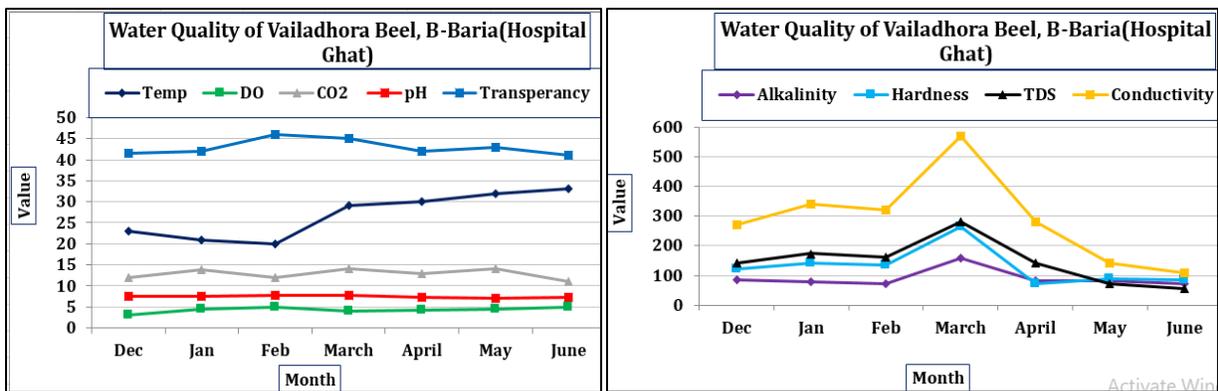


Fig 2: Water quality parameters of Hospital Ghat, Vailadhora beel at B-Baria

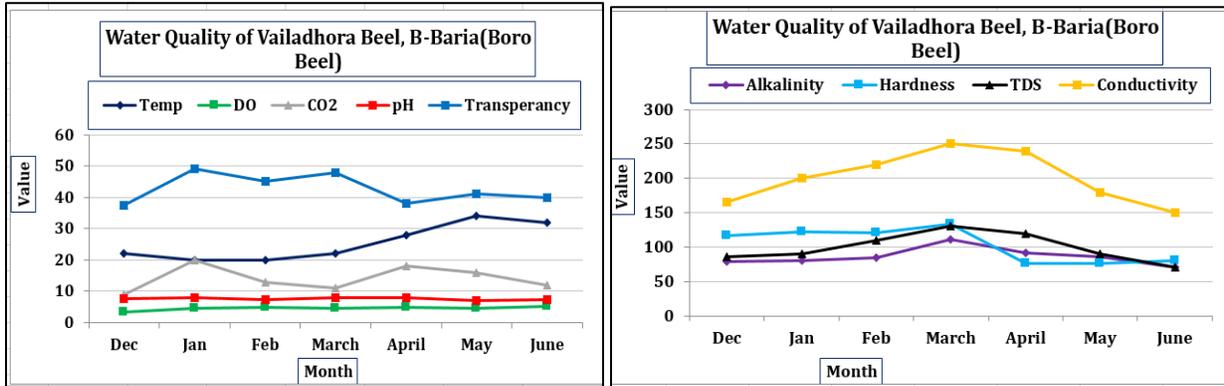


Fig 3: Water quality parameters of Boro beel, Vailadhora beel at B-Baria

Water quality of Hail and Hakaluki Haor

Water quality parameters were also collected monthly from different sampling spot of Hail and HakalukiHaor. Water quality parameters of Transparency, Temperature, pH, CO₂, Dissolved oxygen, Alkalinity, Hardness, TDS, and Conductivity were measured. Almost all water quality parameter were acceptable range for fish growth. Some exception was observed in case of Alkalinity and Hardness among the sampling spot. Highest value of Alkalinity was 38mg/L and the highest value of Hardness was 28. Lower values of alkalinity and hardness among the haor water body indicating beel water to be less nutrient enriched. Data was collected from three Beel of Hakaluki Haor (ZalarBeel, DudaiBeel and Chatla Beel) and same procedure was followed for three beel of Hail Haor which was BallaBeel, Chiruadobi Beel and Gopla River. Water quality parameter was more or less same for three sampling spot of Hail and Hakaluki haor. Physico-chemical parameters of different sampling spot for Hail (BallaBeel) and Hakaluki Haor were represented in graph (Figure4-9).

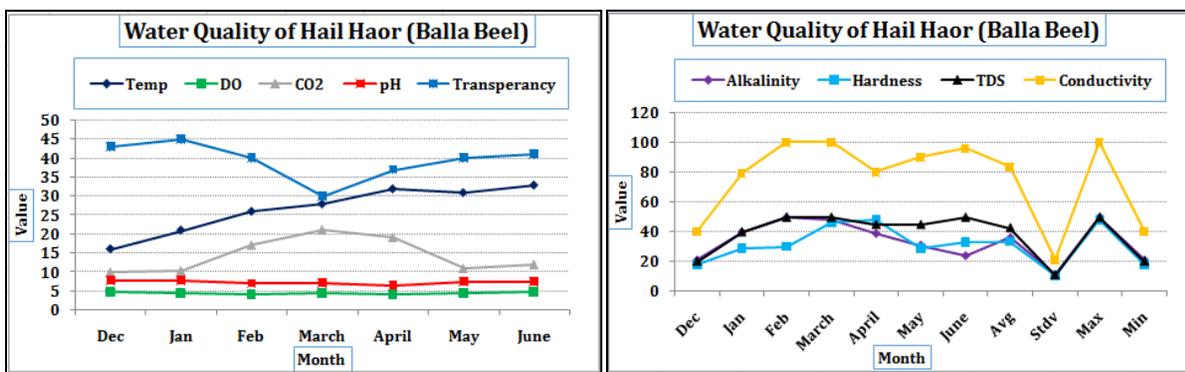


Fig4: Water quality parameters of Balla Beel, Hail Haor at Moulvibazar

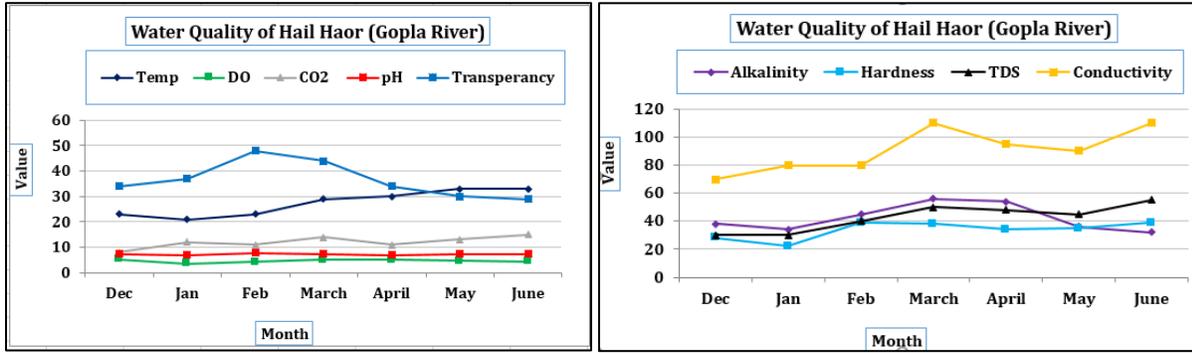


Fig 5: Water quality parameters of Gopla river, Hail Haor at Moulvibazar

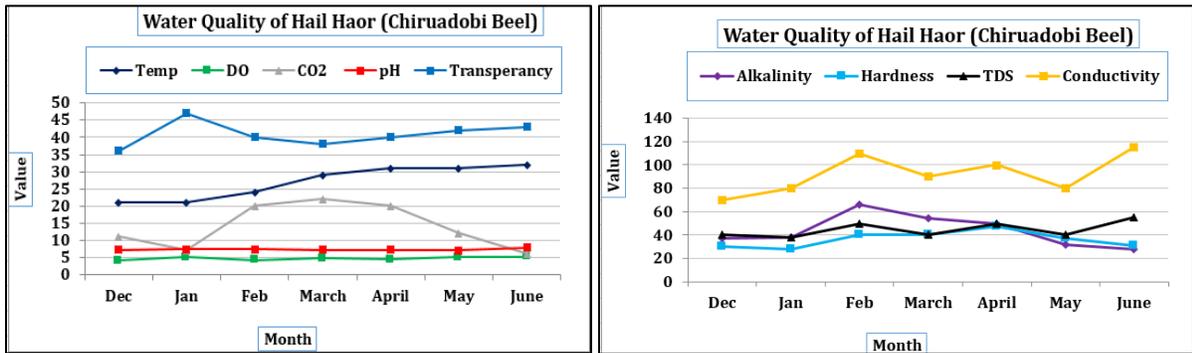


Fig 6: Water quality parameters of Chirudobi beel, Hail Haor at Moulvibazar

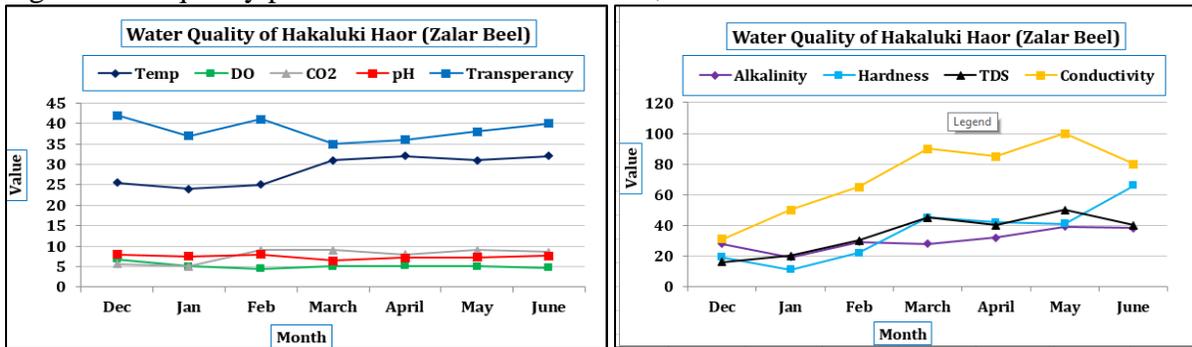


Fig7: Water quyality parameters of Zalar Beel, Hakaluki Haor at Moulvibazar

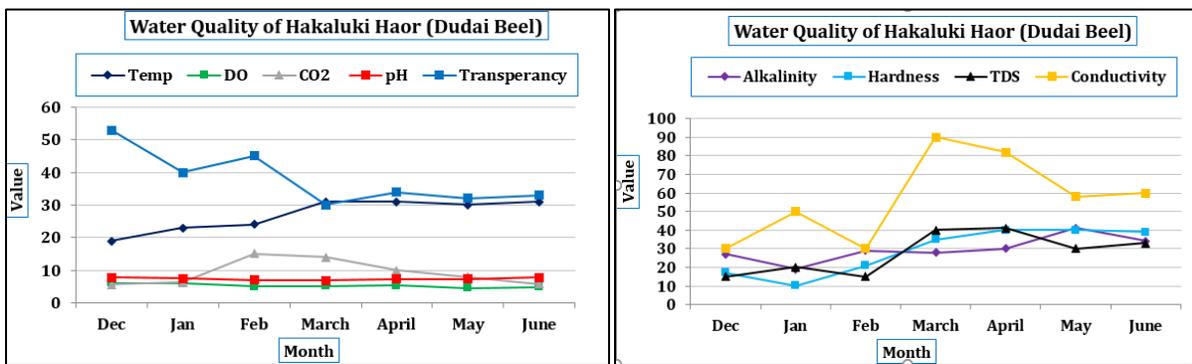


Fig 8: Water quyality parameters of Dudai Beel, Hakaluki Haor at Moulvibazar

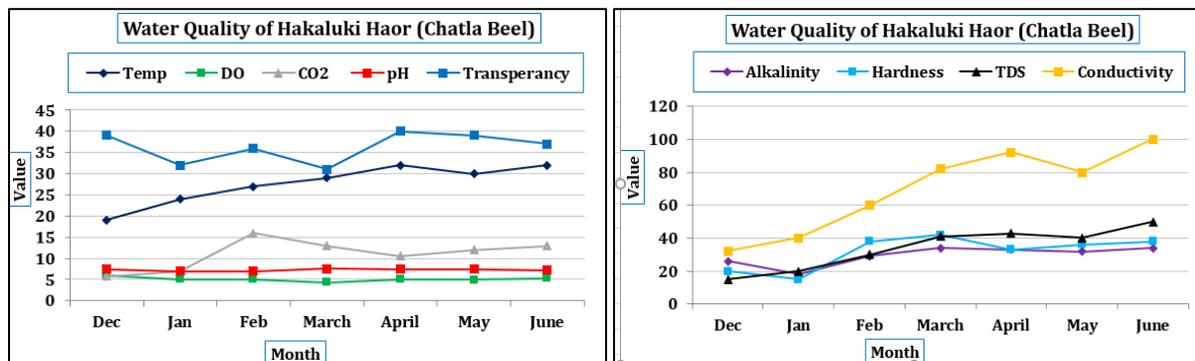


Fig 9: Water quality parameters of Chatla Beel, Hakaluki Haor at Moulvibazar

Water Quality Standard

Almost all water quality parameters were acceptable range for fish according to Bangladesh standard. Which is suitable for the fish and other aquatic animals. (Table: 1)

Table 1: Water quality standard

Sl. No.	Parameter	BD Standard	Source
1	Air Temperature	30.5	DoE, 2001
2	Water Temperature	30	EQs, 1997
3	Dissolved Oxygen	6.5	DoE, 2001
4	Carbondioxide	23	EPAUS, 1976
5	pH	8.5	EQs, 1997
6	Transperancy	45	Hossain, 2011
7	Alkalinity	100-200	Boyd & Tucker, 1998
8	Hardness	500	DoE, 1997

Plankton identification

A total of 26 genera of phytoplankton and 9 genera of zooplankton were identified during the study period from those study area of which Chlorophyceae in phytoplankton population and Crustacea in zooplankton population were dominant. Groupwise list of different plankton of three samplingsite has given on Table: 2-4.

Table 2: Groupwise list of different plankton of Vailadhora beel

Plankton Type	Plankton Groups	Genus
Phytoplankton	Bacillariophyceae	<i>Melosira sp. Cyclotella sp. Navicula sp.</i>
	Cyanophyceae	<i>Spirulina sp.</i>
	Chlorophyceae	<i>Closterium sp. Spirogyra sp. Tetraedron sp. Volvox sp.</i>
Zooplankton	Copepoda	<i>Nauplius sp.</i>
	Rotifera	<i>Keratella sp.</i>
	Cladocera	<i>Brachionus sp.</i>

Table 3: Group wise list of different plankton of HakalukiHaor

Plankton Type	Plankton Groups	Genus
Phytoplankton	Bacillariophyceae	<i>Melosira</i> sp. <i>Asterionella</i> sp. <i>Coscinodiscus</i> sp. <i>Navicula</i> sp. <i>Nitzsehia</i> sp. <i>Synedra</i> sp.
	Dinophyceae	<i>Ceratium</i> sp.
	Euglenophyceae	<i>Euglena</i> sp. <i>Phacus</i> sp. <i>Trachelomonas</i> sp.
	Chlorophyceae	<i>Pediastrum</i> sp. <i>Closterium</i> sp. <i>Tetraedron</i> sp. <i>Staurodesmus</i> sp.
Zooplankton	Copepoda	<i>Cyclops</i> sp. <i>Nauplius</i> sp.
	Rotifera	<i>Lecane</i> sp.
	Cladocera	<i>Brachionus</i> sp.
	Protozoa	<i>Arcella</i> sp.

Table 4: Group wise list of different plankton of Hail Haor

Plankton Type	Plankton Groups	Genus
Phytoplankton	Bacillariophyceae	<i>Melosira</i> sp., <i>Asterionella</i> sp., <i>Cyclotella</i> sp., <i>Navicula</i> sp., <i>Synedra</i> sp.
	Cyanophyceae	<i>Spirulina</i> sp., <i>Microcystis</i> sp., <i>Nostoc</i> sp.
	Dinophyceae	<i>Ulothrix</i> sp.,
	Euglenophyceae	<i>Euglena</i> sp. <i>Phacus</i> sp.
	Chlorophyceae	<i>Ankistrodesmus</i> sp., <i>Chlorella</i> sp., <i>Closterium</i> sp., <i>Pediastrum</i> sp., <i>Scenedesmus</i> sp. <i>Spirogyra</i> sp, <i>Volvex</i> sp
Zooplankton	Copepoda	<i>Cyclops</i> sp., <i>Nauplius</i> sp., <i>Diaptomus</i> sp.
	Rotifera	<i>Keratella</i> sp.
	Cladocera	<i>Brachionus</i> sp., <i>Daphnia</i> sp., <i>Bosmina</i> sp.

Study 2: Field data collection for estimating population ecology of commercially significant Haor and Beel resident fishes

Length weight range

Length weight range of different fish species was described under the following table according to the Fishing gear/ trap operated in study area (Winter). Length range of catch of different gear was described under the following table. This length range will be varied according to seasonal fluctuations.

Table 5: Length weight range of different fish species at Vailadhora Beel

	Punti	Kholish a	Shing	Veda	Koi	Rui	Napit koi	C. boicha	Boich a
Length (cm)	9.0-10	8.1-9.2	15-16	4.1-5.5	11.0-17.0	28-32	4.0-5.0	3.8-4.0	3.0-5.0

Weight (g)	7.7-13.1	8.1-14.1	25-26	0.8-2.2	25-80	231-447	0.8-1.5	0.35-0.4	0.3-2.1	
	Chanda	Napit koi	Echa	Gutum	Baila	Baim	Bajuri	Tit puti	Darkina	Echa
Length (cm)	3.5-5.0	4.0-5.0	4-5.6	7.5-10.2	7.6-7.7	11-14.5	4.8-6	4.5-5.0	5-5.3	4-5.6
Weight (g)	0.5-1.8	0.8-1.5	0.4-1.3	3.0-8.0	3-3.3	6.0-12	1.5-1.8	0.9-1.4	0.5-0.8	0.4-1.3

Table 6: Length weight range of different fish species at Hakaluki Haor

	Ayre	Catla	Kalibasu	Mrigal	Rui	Gonia	Boal	Foli	Shorputi	Shol	Chapila
Length (cm)	28-47	68-69	22.5-25.8	45-60	54-65	32-41	41-56	27-34	27-30.5	27-42	2.8-2.9
Weight (g)	148-189	4500-5000	135-194	850-2540	1990-2500	345-956	289-687	144-314	421-470	420-589	6.5-6.6

	Gajar	Pabda	Chapila	Chanda	Punti	Gulsha	Tengra	Icha	Rani	Meni	Pabda	Dhela
Length (cm)	28-41	16-20	9.0-14.0	3.9-5.2	6-9.1	9.5-13.6	6.4-7.5	3.6-4.6	5.5-10	8.4-8.5	16-17	8.1-8.2
Weight (g)	415-578	19-44	7.0 -28	0.8-2.5	3.1-8.6	5.6-15.4	2.2-3.5	0.3-0.6	1.9-10	8.8-8.9	25-26	5.5-5.6

Table 7: Length weight range of different fish species at Hail Haor

	Punti	Chanda	Boicha	Tengra	Kholisha	Mola	Gutum	Pabda	Darkina	Icha	Gonia	Ayre	Boal
Length (cm)	6.5-9	4.8-7.2	3-5.3	4-9.2	7-12.2	5-7.1	8.5-11	10-25.6	6.3-7.5	2.4-10	22.4-38.1	27.5-52.2	41-55.6
Weight (g)	3.2-12.3	1.5-5.3	0.4-2.4	1-9.6	7-15	1-3.1	3-11	6-129	2.1-4	0.2-8	402-612	138-1145	281-690

	Baim	Bajuri	Chanda	Taki	Koi	Meni	Tengra	Shing	Kankila	Foli	Rui	Kalbasu	Mrigal
Length (cm)	12-34	4.5-6	2.4-6.6	11-21	6-15.1	6-11	6-15.1	11.5-15.6	15.3-16.6	11-31	27-56.5	26-46	45-60
Weight (g)	8-155	1-1.8	0.3-4.3	13-92	7-53	7-22	2.4-6	6.3-17	7-7.1	13-229	236-468	201-1143	850-2500

Gear study

Major gear used in those beel: Various types of fishing gear/ trap used in this study area. Type of gear used according to the fisherman benefit. Seine net, Cast net, Gill net and Fish trap of different mesh size are common in all study area.

Table8: Location wise net list

Sl. No.	Location		Name and types of net
1	Vailadhora Beel	Ruposhdi	Berjal (Seine net), Fashjal (Gill net), Current jal (Gill net), Jhakijal (Cast net), Unta (Fish trap), Gurajal (Others)
		Hospital ghat	
		Borobeel	
2	Hail Haor	Bilash river	Berjal (Seine net), Jhakijal (Cast net) Fashjal (Gill net), Current jal (Gill net), Birti/ Poran(Fish trap), Dori(Fish trap), Bosni, (Fish trap), Taki Jal, Harroh Jal, Push Net, Fine Jal Etc
		Gopla river	
		BallaBeel	
3	Hakaluki Haor	Zalarbeel	Berjal(Seine net), Ricksha net, Push net, Fashjal (Gill net), Current jal (Gill net), Jhakijal (Cast net), Unta/Bana (Fish trap), Ichar Chai, Kati, Etc.
		Chatla Beel	
		Gutaora Haor Beel	

Study 3: Assessment of stock or biomass of commercially significant inland open water fishes as well as water bodies

CPUE of different type of fishing gear

Use of different fishing gear and traps can also serve as a rough indicator of the availability of different fish species. Some gear is species selective such as gill nets, traps, hook and lines and long line. We observe that gill net used widely during the sampling period in those study areas and followed by fish trap. CPUE of Seine net was the highest in VailadhoraBeel. The CPUE was 3.45 kg in December and 5.43 kg in June. The CPUE in April, May and June at Taki Net in Hail Haor was 3.5 kg and the rest was 4 kg.

The CPUE in the Seine net at HakalukiHaor was higher at the massive level. It was 118 kg in December and 6 kg in February. There was not enough water in Haor during the period from March to June. VailadhoraBeel, Hail and HakalukiHaor also have more or less use of fish trap. CPUE of different type of fishing gear is presented in the following table according to Mmonthly basis. (Table 9-11).

Table 9: Gearwise Average CPUE (Kg/100m net/hour)of Vailadhora Beel

Net Name	Dec	Jan	Feb	Mar	Apr	May	June
Seine net	3.45	3.68	3.58	4.65	4.4	4.71	5.43
Cast Net	0.21	0.35	0.39	0.38	0.50	0.5	0.44
Gill Net (Fash net)	0.10	0.14	0.11	0.14	0.17	0.19	0.26
Unta (fish trap)	0.08	0.073	0.07	0.12	0.08	0.08	0.19

Table 10: Gearwise Average CPUE (Kg/100m net/hour) of Hail Haor

Net Name	Dec	Jan	Feb	Mar	Apr	May	June
Dori (Fish trap)	0.02	0.02	0.01	0.02	0.03	0.03	0.03
Bosni (Fish trap)	0.09	0.06	0.08	0.11	0.13	0.16	0.17

Poran (Fish trap)	0.06	0.06	0.08	0.08	0.09	0.10	0.10
Tengra Chai (Trap)	0.004	0.004	0.004	0.004	0.004	0.004	0.004
TakiJal	4	4	4	4	3.5	3.2	3.7
Seine net	1.8	1.73	1.68	1.77	1.73	1.97	1.98
Fine Jal	1.5	1.5	1.1				
Gill/ Fash net	1	1	1	1.14	1	1.2	1.2

Table 11: Gear wise Average CPUE (Kg/100m net/hour) of Hakaluki Haor

Net Name	Dec	Jan	Feb
Seine net	116.5	91.5	88.17
Cast net	3.34	3.34	4.84
Push net	2.82	2.78	2.46
Ricksha net	3.12	2.5	2.75
Kati (fish trap)	3.55	3.3	2.9

Trial on Semi-natural Breeding and Early Larval Rearing of Hilsa for Its Stock Enhancement in the Meghna River Estuary.

Researchers Dr. Md. Anisur Rahman, Chief Scientific Officer
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Md. Abul Bashar, Senior Scientific Officer
Md. Mehedi Hasan Pramanik, Senior Scientific Officer
Md. Monjurul Hasan, Scientific Officer

Objectives

1. Breeding trial and early larval rearing of Hilsa in the semi-natural condition
2. Reassess the previously identified spawning and nursery grounds and
3. Identification of Breeding grounds of Hilsa.

Objective 2: Reassess the previously identified spawning and nursery grounds

Both vessel and field trips were conducted for the reassessment of previously identified spawning and nursery grounds of Hilsa.

Percentage of spent rate

In the year 2020, 51.2% spent Hilsa fishes were recorded which is higher than the previous year 2019 (48.92%).

Percentage comparison of spent Hilsa in the Meghna River (2019 and 2020)

Spent rate of Hilsa in Monpura was recorded 61% in 2020 which was 55% in 2019. In Chandpur region it was 41% in 2020 and 52% in the previous year (2019).

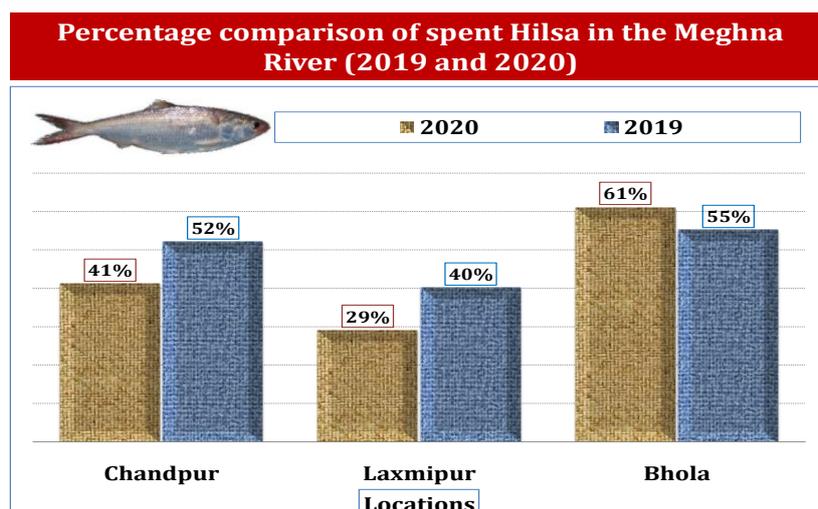


Fig. Percentage comparison of spent Hilsa in the Meghna River (2019 and 2020)

Abundance Percentage (%) of Hilsa larvae during High & Low Tides (2020)

Abundance of Hilsa larvae was recorded higher during low tide (51%) than high tide (33%). Larvae of other fishes contributed 67% and 49% during high and low tide respectively.

CPUE of *Tenualosa ilisha* Larvae at Hilsa Breeding Ground (Monpura-2019 and 2020)

CPUE of Hilsa Larvae in Monpura was found higher in 2020 during both high and low tide (1505 and 1264 g/BFRI net/hr) than in 2019 (466 and 434 g/BFRI net/hr).

Length Frequency Percentage (%) of Jatka 1st (100 km) Hilsa Sanctuary (2019-2021)

Jatka, 14 cm in length was found to be the most common size in 2019 and 2021 whereas it was 12 cm in 2020 followed by 13 cm. The lowest percentage of Jatka (1%) was recorded as 9 cm in 2019 and 2021 and 10 cm (2%) in 2020.

Length Frequency Percentage (%) of Jatka at 5th (20 km) Hilsa Sanctuary (2019-2021)

Jatka, 13 cm in length was found to be the most common size followed by 14 cm in 2019 whereas it was 12 cm in 2020 followed by 14 cm. The lowest percentage of Jatka (0.4%) was recorded as 17 and 23 cm in 2019 and 17 and 18 cm (2%) in 2020.

CPUE of Jatka at 1st (100 km Meghna River) and 5th (20 km Lower Padma River) Hilsa Sanctuary (2019-2020-2021)

CPUE of Jatka in 1st Sanctuary was determined as 6.3, 6.6 and 6.7 kg/100 m net/hr. in 2019, 2020 and 2021 respectively. In 5th sanctuary, CPUE of Jatka was determined as 4.2 and 4.5 kg/100 m net/hr. in 2019 and 2020.

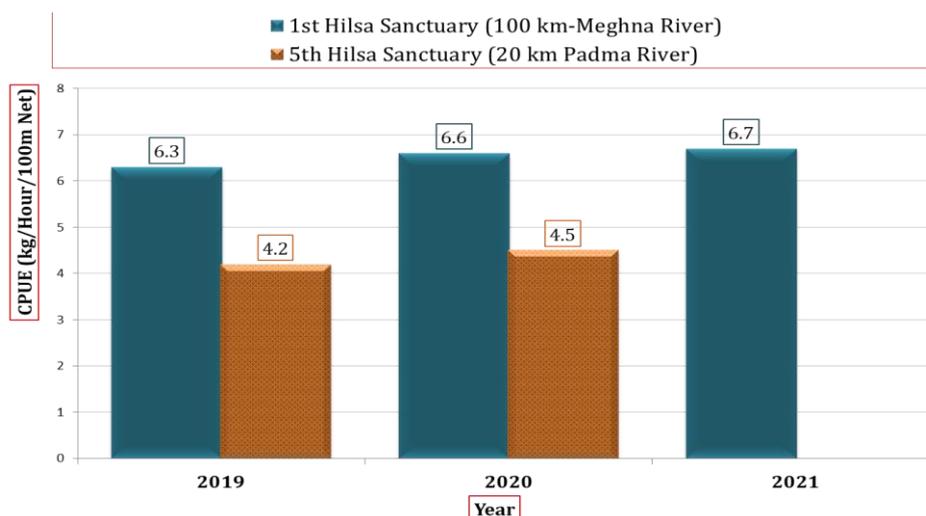


Fig. CPUE (kg/hour/100m net) of Jatka at 1st (100 km Meghna River) and 5th (20 km Lower Padma River) Hilsa Sanctuary (2019-2020-2021)

Physico-Chemical Parameters of Water of 1st (100 km) and 5th (20 km) Hilsa Sanctuary (2020-2021)

All the physico-chemical parameters were found congenial in range in all sampling locations except Char Alexandar (salinity: 3-10 ppt) and Shatnol (Ammonia: 0.1 ppm).

Length Frequency Percentage (%) of Brood and Larvae Hilsa at Breeding Ground (2020)

Larvae, 2 cm in length was found to be the most common size (67%) followed by 3 cm (29%). 7 cm size contributed the lowest (0.25%). Brood Hilsa ranged 42 and 46 cm in length have higher percentages (10%) and 54, 55 and 56 cm have lower percentage (0.2%).

Plankton composition of 1st (100 km) Hilsa Sanctuary

Bacillariophyceae was found the most dominant group among the identified phytoplankton followed by Cyanophyceae, Dinophyceae, Euglenophyceae, Chlorophyceae and Myxophyceae. Branchiopoda were recorded to be the most dominant group among the identified zooplankton followed by Copepoda and Rotifera.

Plankton composition of 5th (20 km Lower Padma River) Hilsa Sanctuary

Bacillariophyceae was found the most dominant group among the identified phytoplankton groups. followed by Dinophyceae, Euglenophyceae, Chlorophyceae and Myxophyceae. In case of zooplankton, Copepoda and Branchiopoda shared highest percentage followed by Rotifera.

Plankton composition of major breeding ground-Monpura (Ramnewaz, Hazirhat, Janata Bazar and Sakuchia)

Bacillariophyceae contributed highest percentage followed by Chlorophyceae, Cyanophyceae, Coscinodiscophyceae, Mediophyceae and Myxophyceae among the identified

phytoplankton groups and Copepoda followed by Branchiopoda followed by Rotifera, Ostracoda, Melacostraca were recorded to be the most dominant group among the identified zooplankton groups.

Summary of Spawning ground and nursery ground reassessment

Percentage of spent rate, length frequency, larvae and jatka abundance, CPUE of larvae, plankton composition and physico-chemical parameters of water were found satisfactory in Monpura, Bhola during the peak spawning period. Same conditions were also observed in two (1st and 5th) Hilsa sanctuaries.

Objective 3: Identification of Breeding ground of Hilsa

Sampling site and Study Time

The field visits were conducted for the identification of new breeding ground of Hilsa in Baleswar River during pre-ban, ban and post-ban period.

Length Frequency percentage (%) of Brood and Larvae Hilsa at Baleswar River (2020)

Larvae, 2 cm size in length was found to be the most common size (36%) and 27 cm sized brood Hilsa shared higher percentage (9.5%). The lowest percentage of larvae length size was recorded at 7, 8 and 10 cm. In case of brood Hilsa, the lowest sizes were 47, 50, 51, 53 and 54 cm.

Physico-Chemical Parameters of water

All the physico-chemical parameters were found congenial in range in all sampling locations of Baleswar river.

Plankton composition of Baleswar River

Bacillariophyceae contributed highest percentage followed by Chlorophyceae, Cyanophyceae, Euglenophyceae, Mediophyceae and Myxophyceae among the identified phytoplankton groups and Rotifera was recorded to be the most dominant group among the identified zooplankton groups followed by Protozoa, Copepoda, Ostracoda and Ciliophora.

Hilsa Spent Rate (%) of Baleswar River and Baleswar River Estuary

Spent rate of Hilsa was determined as 50% in 2020 and 49% in 2019 in Baleswar river and in Baleswar river estuary it was 55%.

CPUE of Hilsa Catch (chandi net) at Baleswar River (October 2020-March 2021)

CPUE of Hilsa Catch (chandi net) was found to be higher from the upstream (Charkhali) to the downstream (Supati) of Baleswar river. CPUE were found 4.5 to 15 kg during pre ban period, 1.5 to 7 kg during post ban period and 2.5 to 6.2 kg on average in the following three months.

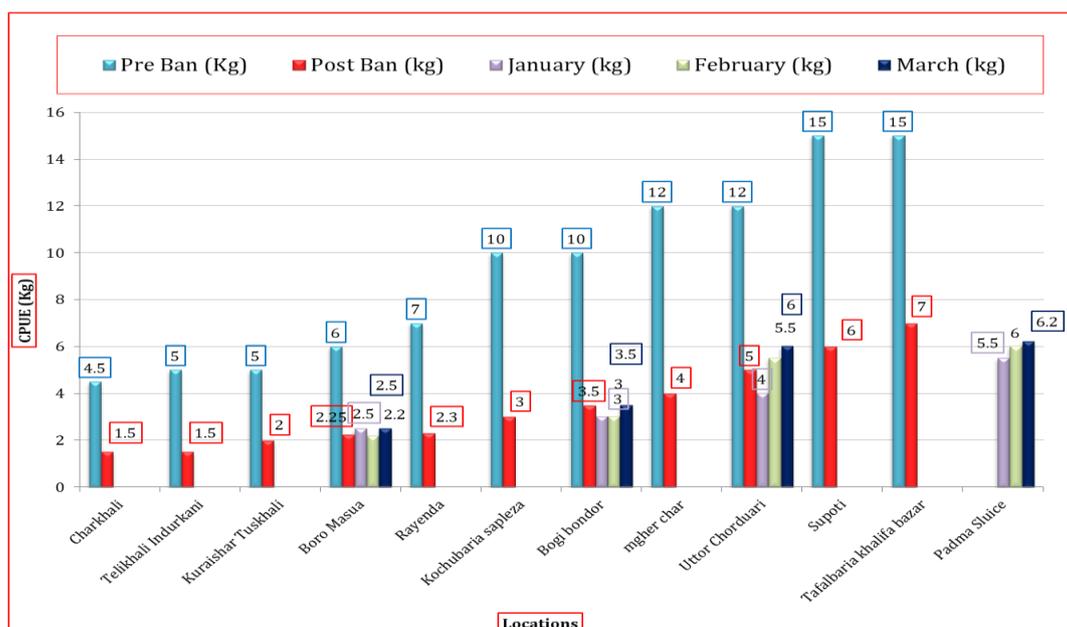


Fig. CPUE of Hilsa Catch (chandi net) at Baleswar River (October 2020-March 2021)

Percentage of spent rate, length frequency, larvae abundance, CPUE of larvae, plankton composition and physico-chemical parameters of water were found satisfactory in the Baleswar River to be identified as potential breeding ground.

Estimation of nutrient flux and primary productivity in the major nursery grounds of hilsa

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 Flura, Senior Scientific Officer
 Md. Abul Bashar, Senior Scientific Officer
 Md. Moniruzzaman, Scientific Officer

Objectives

- To assess the primary productivity of nursery grounds of hilsa
- To study the factors affecting primary productivity of nursery grounds of hilsa
- To assess the carrying capacity of nursery grounds of hilsa

Achievements

In order to address the aforesaid objectives of the project, monthly data from two sampling locations (Shatnol, Chandpur-Alexander, Laxmipur 100 km, Lower Meghna and Tarabunia, Shariotpur 20 km, Lower Padma) were collected and analyzed. The results of the analysis are furnished below:

Primary productivity (GC/m³/Day) of nursery grounds of hilsa in the study areas

To determine the primary production, representative water samples were collected at the onset of sunrise from the mid-euphotic level with the help of a water sampler. Thereafter,

both light and dark bottles were hanged in duplicate in the water at the same depth and incubated for half the period of the day length. The data were analyzed using standard protocols. The result showed that the average GPP was found higher in the month of April at Katakali point ($1.02 \pm 0.027 \text{gC/m}^3/\text{Day}$) and Padma Meghna-confluence ($1.09 \pm 0.023 \text{gC/m}^3/\text{Day}$) under the Sanctuaries of Shatnol, Chandpur-Alexander, Laxmipur 100 km, Lower Meghna compared to the other sampling sites in the same month. The result also showed that the average GPP of Char monipur ($1.02 \pm 0.027 \text{gC/m}^3/\text{Day}$) was also found higher in the month of May compared to the other sampling sites. Higher sunlight diffusion in the month of April and May could be attributed this higher values (Figure 1). This result also establishes a coherence between the higher abundance of jatka (CPUE) in the month of April and average GPP at Katakali point (Figure 2).

According to bray-curtis similarity index, three distinct clusters were found where Katakali and Padma-Meghna confluence were found more similar (96%) in consideration of jatka abundance than other two sites. Tarabunia formed a totally different cluster (Figure 3 & 4)

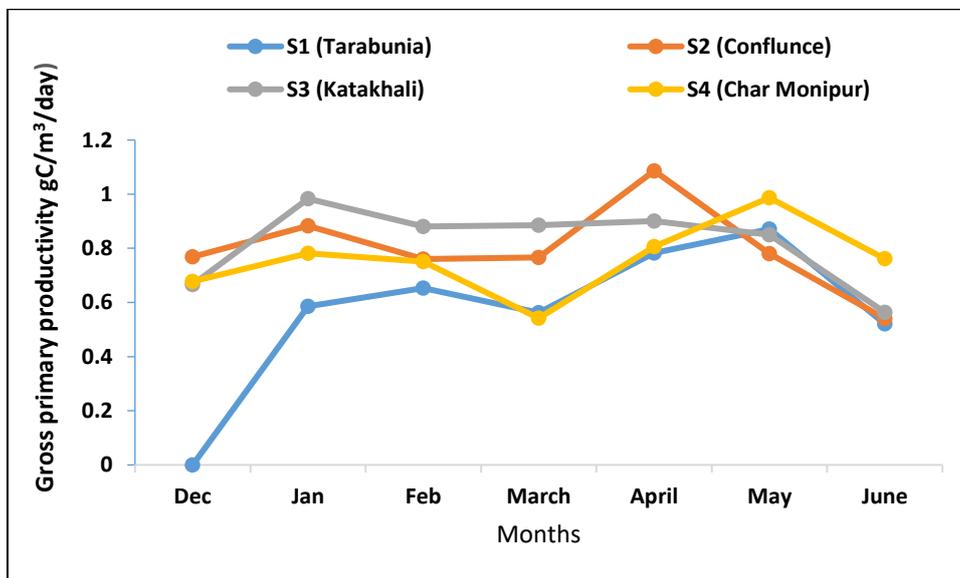


Figure 1. Gross primary productivity (gC/m³/day) of different months at sampling sites

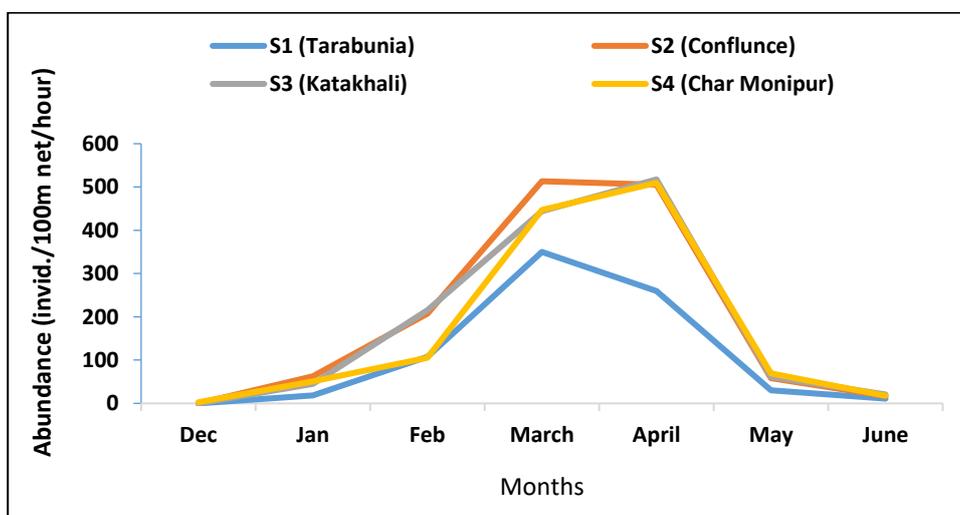


Figure 2. Abundance (indiv./100 m net/hour) of hilsa juveniles at different months

Abundance of fish larvae

For hilsa larvae collection, *Bongonet* was mainly used. *Bongonet* was set into the selected sampling locations for 30 minutes and all larvae were collected in plastic bottle and immediately preserved in ethanol (10%). Thereafter, the larvae of different fish species alongside with hilsa were identified with microscopic observation. The percentage of hilsa larvae was 76.36 % and other fish's larvae were 23.64 % at Katakhal under the Sanctuaries of Shatnol, Chandpur-Alexander, Laxmipur 100 km, Lower Meghna whereas the percentage of hilsa larvae was 36 % and other fish's larvae were 57.7 % at Tarabunia, under the Sanctuaries of Tarabunia, Shariotpur 20 km, Lower Padma respectively (Figure 5).

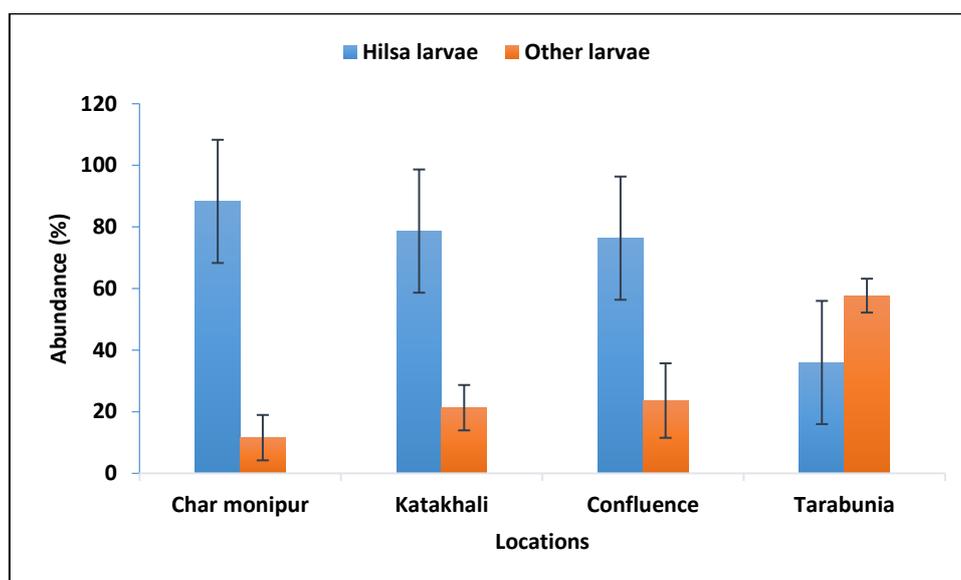


Figure 5. Abundance (%) of hilsa and other fish larvae at different sampling sites

Factors affecting the primary productivity

Physico-chemical parameters of water in the study areas

Water quality parameters of Shatnol Chandpur-Alexander, Laxmipur exhibited considerable fluctuations. The average air and water temperature was found 23 ± 1 °C and 21.5 ± 1.5 °C, respectively. Average dissolved oxygen (mg/L) was found 7.9 ± 0.1 and CO_2 6.5 ± 0.51 , respectively. Total average alkalinity was found 90.0 ± 7.0 mg/l and hardness 93.0 ± 1.0 mg/l, respectively. The average pH was found just slightly above the neutral value 7.7 ± 0.6 among the studied sampling sites. The average conductivity was found 206.0 ± 3.6 ($\mu\text{s}/\text{cm}$) whereas; average TDS was found 105.6 ± 4.2 (mg/l). Nevertheless, the average transparency (cm) was found 63.3 ± 1.5 cm and average turbidity (mg/L) was found 7.31 ± 0.74 (Figure 6). The ranges of all studied water quality parameters were found within the acceptable limits for the growth of fishes.

Water quality parameters of Tarabunia, Shariotpur exhibited similar pattern of fluctuations in its acceptable limits. The average air and water temperature was found 23 ± 1 °C and 22.8 ± 0.7

°C, respectively. Average dissolved oxygen was found 7.9 ± 0.1 and CO_2 7.8 ± 0.5 mg/L. Total average alkalinity was found 88.0 ± 1.0 mg/L and hardness 95.0 ± 2.1 mg/L, respectively. The average pH was found just slightly above the neutral value 7.4 ± 0.3 in Tarabunia region. The average conductivity ($\mu\text{s}/\text{cm}$) was found 217.0 ± 12.1 whereas; average TDS was found 109.0 ± 4.1 (mg/L). Nevertheless, the average transparency was found 64.4 ± 3.1 cm and average turbidity (Mg/L) was found 7.86 ± 0.66 (Figure 7). Hence, the ranges of all studied water quality parameters like previous sites were also found within the acceptable limits.

Water quality parameters of Char monipur exhibited considerable fluctuations in its acceptable limits. The average air and water temperature was found 27 ± 1 °C and 24.6 ± 0.5 °C, respectively. Average dissolved oxygen was found 7.5 ± 0.37 mg/L and CO_2 7.4 ± 1.5 mg/L. Total average alkalinity was found 88.0 ± 22.5 mg/L and hardness 89.330 ± 31.2 mg/L, respectively. The average pH was found just slightly above the neutral value 8.2 ± 0.27 in Char monipur region. The average conductivity ($\mu\text{s}/\text{cm}$) was found 236.0 ± 5.68 ($\mu\text{s}/\text{cm}$) whereas average TDS was found 116.33 ± 6.43 (mg/L). Nevertheless, the average transparency was found 70.6 ± 10.66 cm and average turbidity (mg/L) was found 7.35 ± 0.75 (Figure 8). Therefore, the ranges of all studied water quality parameters like previous sites were also found within the acceptable limits.

Water quality parameters of Padma-Meghna Confluence exhibited similar pattern of fluctuations in its acceptable limits. The average air and water temperature was found 27.5 ± 4.6 °C and 25 ± 3.5 °C, respectively. Average dissolved oxygen (mg/L) was found 6.05 ± 0.5 and CO_2 13.75 ± 2.6 mg/L, respectively. Total average alkalinity was found 103.5 ± 14.9 mg/L and hardness 92.5 ± 17.6 mg/L, respectively. The average pH was found just slightly above the neutral value 8.1 ± 0.5 in Padma-Meghna Confluence region. The average conductivity ($\mu\text{s}/\text{cm}$) was found 179.0 ± 9.5 .Whereas;

average TDS was found 121.50 ± 9.5 (mg/L). Nevertheless, the average transparency was found 80.4 ± 5.6 cm and average turbidity (mg/L) was found 7.14 ± 0.3 (Figure 9). Hence, the ranges of all studied water quality parameters like previous sites were also found within the acceptable limits.

Plankton abundance in the study areas

In Katakali, 20 taxa were identified in which 17 were phytoplankton and 3 were zooplankton. Phytoplankton belonged to the dominant groups: Bacillariophyceae (32%), Chlorophyceae (28%) and Cyanophyceae (30%) while zooplankton included Rotifera (35%), Copepoda (40%) and Cladocera (25%) (Figure 10)

In Tarabunia, 18 taxa were identified in which 15 were phytoplankton and 3 were zooplankton. Phytoplankton belonged to the dominant groups: Bacillariophyceae (28%), Chlorophyceae (32%), Cyanophyceae (28%) while zooplankton including Rotifera (40%), Copepoda (35%) and Cladocera (25%) (Figure 11)

In Chor Monipur, 16 taxa were identified in which 14 were phytoplankton and 3 were zooplankton. Phytoplankton belonged to the dominant groups: Bacillariophyceae (35%), Chlorophyceae (30%) and Cyanophyceae (26%) while zooplankton included Rotifera (40%), Copepoda (40%) and Cladocera (20%) (Figure 12)

In Padma-Meghna confluence, 15 taxa were identified in which 11 were phytoplankton and 4 were zooplankton. Phytoplankton belonged to the dominant groups: Bacillariophyceae (10%), Chlorophyceae (70%) and Euglenophyceae (15%) while zooplankton included Rotifera (70%), Copepoda (20%) and Cladocera (9%) (Figure 13)

Concentration of nitrate and phosphate (mg/l) in sampling site

It was also observed that Nutrient flux (nitrate and phosphate) in the study areas showed that nitrate was higher (7.6 ± 2.5 mg/L) in the Charmonipur area compared to Tarabunia (5.6 ± 1.5 mg/L) and Padma Meghna confluence (5.6 ± 1.34 mg/L). On the other hand, in terms of phosphate concentration Katakali showed higher (2.4 ± 0.12 mg/L) concentration compared to the other areas (Figure 14).

Population Dynamics and Stock Assessment of Hilsa *Tenuulosa ilisha* in Bangladesh

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Flura, Senior Scientific Officer
Md. Mehedi Hasan Pramanik, Senior Scientific Officer

The objectives of this study is harmonic with SDG (Sustainable Development Goal) 15.1. Objectives

- To determine the temporal and spatial variation of hilsa demographics in Bangladesh
- To determine the length-weight relationship (LWRs) and different types of condition factors of hilsa
- To determine the population parameters of hilsa at different regions of Bangladesh
- To estimate the maximum sustainable yield (MSY), biomass and stock of hilsa in Bangladesh.

Achievements

In order to address the aforesaid objectives of the project, monthly length frequency data from twelve sampling locations of Bangladesh were collected and analyzed. The results of the analysis are furnished below:

Spatial and temporal variation of length and weight of hilsa

The length frequency distribution (LFDs) of hilsa exhibited considerable spatio-temporal variations. In terms of spatial variations, the average lengths of the female hilsa were above 35cm in most of the places albeit the lowest average length (32 ± 4.9 cm) was recorded in

Rajshahi and the highest (36.5 ± 3.9 cm) in Chandpur. On the contrary, the average lengths of the male hilsa were around 30 cm and the lowest average length (18.7 ± 14.0 cm) was found in Bhola and highest (32.0 ± 5.4 cm) in Borgona (Fig 1). In terms of temporal variations, the lowest average length (33.7 ± 3.9 cm) of female hilsa was found in December and the highest (37.1 ± 4.1 cm) in June whereas the lowest average length (21.4 ± 8.7 cm) of male hilsa was found in April and the highest (32.8 ± 3.3 cm) in December (Fig 1). The average weights of hilsa also exhibited similar spatio-temporal variations. In terms of spatial variations, the lowest average weight (351 ± 144.8 g) of female hilsa was recorded in Rajshahi and the highest (572.2 ± 194.1 g) in Chandpur whereas the lowest average (101.0 ± 70.1 g) weight of male hilsa was found in Rajshahi and the highest (354.0 ± 196.2 g) in Barishal (Fig 2). On the contrary, in terms of temporal variations, the lowest average weight (448.2 ± 206.8 g) of female hilsa was found in January and the highest (592.9 ± 185.4 g) in October (Fig 2).

Spatial and temporal variation of percent composition of spent and oozing hilsa

The percentage of spent and oozing hilsa also exhibited considerable spatio-temporal variations. In terms of spatial variations, the highest percentage of spent hilsa (13%) was found in Chattagram and the lowest in Borgona (0.1%). On the other hand, the highest percentage of oozing hilsa was found in Laxmipur (6%) and the lowest in Cox's Bazar (1%). In terms of temporal variations, the highest percentage of spent hilsa (47.7%) was found in October and the lowest (1.3%) in August whereas the highest percentage of oozing hilsa (9.1%) was found in June and the lowest in May (0.3%) (Fig 3).

Capture of restricted jatka, premature and mature hilsa (2020-2021)

Length frequency and percentage composition data of male and female of all sampling locations were compiled together to estimate the capture of immature jatka (<25cm), pre-mature (26-32 cm) and mature (>33cm) hilsa and the results showed substantial monthly variations (Fig 4). On average, about 16.8% immature male and 2.4% immature female hilsa were captured whereas 26.7% pre-mature and 71% mature hilsa were captured during the stipulated time. If capture of immature and pre-mature hilsa could be entirely restricted or minimized, current hilsa production could be increased manifold.

Sex ratio and chi-square test

As the percentage composition of male, female, spent and oozing hilsa showed spatio-temporal variations, it is obvious that will be reflected in the sex ratio of male and female hilsa. It was observed as expected and significant variations were found in chi-square (χ^2) test of male and female hilsa sex ratio.

Length-weight relationship and condition factor of male and female hilsa

This study determined the length-weight relationship (LWRs) of pooled data for all months (July 2018-June 2019) and all sampling locations for male and female hilsa as body weight (BW) = 0.0084 total length (TL)^{3.06} with $r^2=0.93$ and $BW = 0.0054$ TL^{3.19} with $r^2 = 0.94$, respectively. The regression parameters and 95% confidence interval for slope (b) of the LWRs, exhibited spatial and temporal variations and the growth pattern ranged from negative to positive allometric. In terms of spatial variations, the average Fulton's condition factor (K)

ranged from 0.92 ± 0.13 to 1.12 ± 0.2 for male and from 0.95 ± 0.13 to 1.13 ± 0.15 for female, whereas in terms of temporal variations, the average Fulton's condition factor (K) ranged from 0.86 ± 0.14 to 1.03 ± 0.2 for male and from 1.02 ± 0.13 to 1.18 ± 0.2 for female hilsa. In general, the conditions of female hilsa were comparatively better than the male hilsa both spatially and temporally.

Population dynamics (2020-2021)

The collected length frequency data were analyzed with FiSATII software and important population dynamics parameters were estimated. The estimated asymptotic length (L_{∞}) and growth co-efficient (K) for hilsa were 60.85 cm and 0.85 yr^{-1} , respectively. Total mortality coefficient (Z) was estimated as 4.53 yr^{-1} using length converted catch curve (Fig. 7). Estimated natural mortality (M) was 1.32 and fishing mortality (F) was 3.21. The estimated exploitation rate (E) was 0.71. The recruitment pattern demonstrated two distinct peaks in a year, once between April-May and another between August-September. However, hilsa breeds more or less all the year round and recruitment takes place accordingly.

The length based virtual population analysis of hilsa was completed. The results showed that relatively higher mortality of male and female hilsa occurred between 26 cm to 44 cm length. The estimated standing stock and maximum sustainable yield (MSY) were 296683.4 (MT) and 609617.3 (MT), respectively. The MSY was estimated using the following formula:

$$\text{MSY} = Z_t * 0.5 * B_t = 609617.3 \text{ MT (Trodec, 1980)}$$

Where Z_t total mortality in year $t = 4.53$

B_t is the standing stock in year $t = 296683.4$

Riverine Sub station, Patuakhali

Development and Dissemination of Nursery and Culture Techniques of Cuchia (*Monopterus cuchia*) Component-E

Researchers: Md. Amirul Islam, Principal Scientific Officer
Aovijite Bosu, Senior Scientific Officer
Abu Bakker Siddique Khan, Scientific Officer

Objectives

- To develop the nursery technology for juvenile of *M. cuchia*
- To develop grow-out technique of *M. cuchia*
- To popularize cuchia culture in Patuakhali region

Achievements

Exp.1. Development of culture technology for *M. cuchia* using different type of feeds

Site selection

Experimental sites were selected from three different Upazillas such as Kalapara (T₁) and Baufal (T₃) Upazilla of Patuakhali and Amtoli (T₂) upazilla of Barguna district.

Table 1. Experimental Design for 2020-21

Study areas	Feed type	Replication
Kalapara (T ₁)	Live fish + SIS (3% BW every 15 days)+ Vermi compost 1.5% BW everyday	3
Amtoli (T ₂)		
Baufal (T ₃)		

Pond Preparation

The experiment was conducted in 09 ponds with water area of 40m² each of pond. Pond bottom was covered with Polythene, knotless nylon net and triple then fill-up with 08-12 inch clay mud. The ponds were protected by fencing with nylon net. The ponds soil was treated with quick lime at rate of 2kg per decimal. Ponds were then filled-up with 0.6-0.8m water and then dolomite @ 15 ppm was applied for strengthening buffer capacity of pond water. After three days, the ponds water were fertilized with Urea, TSP and MoP @ 2.5 ppm, 3.0 ppm 1.0 ppm respectively to accelerate primary productivity. Water hyacinth (*Eichhornia crassipes*) and PVC pipe were provided to the ponds for suitable and safe shelter of cuchia.



Figure 1: Pond preparation

Stocking of cuchia fry

After pond preparation Cuchia fry having initial average weight of 46.85 ± 6.21 g were stocked to the culture pond on 01.04.2021. Stocking density was 10 ind./m².



Figure 2: Stocking of cuchia

Feeding and Sampling

Fingerlings were fed with live fish+SIS (3% BW every 15 days) and Vermi compost 1.5% BW everyday up to satiation level. Feed was supplied by a feeding tray to check waste of feed. Major water quality parameters viz., depth, temperature, pH, dissolved oxygen (DO) and free CO₂ were determined and recorded at fortnightly following standard methods. Growth parameters of cuchia were recorded at monthly basis.

Water quality parameters

During the experiment, physico-chemical parameters such as pH, dissolved oxygen and temperature for different rearing conditions were maintained and recorded fortnightly. Mean levels of physico-chemical parameters of 90 days culture of *M. cuchia* is presented in table 2. The mean water temperatures in treatment T₁, T₂ and T₃ were not statistically significant ($P>0.05$) among different treatments during the study period. The highest pH was recorded in treatment T₂ (7.45 ± 0.45) and pH decreased from T₃ to T₁ but did not differ significantly ($P>0.05$). Highest range of dissolved oxygen was recorded in treatment T₂ (4.27 ± 0.43 ppm) and lowest range of dissolved oxygen was recorded in treatment T₃ (4.05 ± 0.5 ppm) (Table 2). However, there were no significant variations ($P>0.05$) in the value of dissolved oxygen among the treatments.

Table 2: Variation in water quality parameters in experimental ponds during 90 days culture period of *M. cuchia*.

Parameters	Treatments		
	T ₁	T ₂	T ₃
Temperature (°C)	26.09± 3.48	26.39± 3.66	26.09± 3.63
p ^H	7.27± 0.47	7.45± 0.45	7.13± 0.33

Dissolved Oxygen (ppm)	4.07± 0.48	4.27± 0.43	4.05±0.5
Ammonia (ppm)	0.13± 0.16	0.15± 0.12	0.25± 0.17
Total Dissolved Solids (ppm)	206.64± 41.5	202.18±36.6	202.45±36.3

Growth performance and Survivability:

Table 3. Growth performance of *M. cuchia* in different type of feeds

Parameters	T ₁	T ₂	T ₃
Initial Length (cm)	25.30±2.94	24.26±2.38	25.01±1.97
Length (cm) on 01.07.2021	35.54±3.41	33.75±1.98	31.42±2.53
Initial weight (g)	46.85± 6.21	43.55± 5.34	44.76± 5.93
Weight (g) on 01.07.2021	64.73± 5.12	59.76± 6.34	55.95± 5.32

Initially, the length of *cuchia* in T₁ was 25.30±2.94 cm with an average weight 46.85± 6.21 g, in T₂ the length was 24.26±2.38 cm with a mean weight 43.55± 5.34 g and in T₃ the length was 25.01±1.97 cm with an average weight 44.76± 5.93. After 90 days of rearing the length of *cuchia* in T₁ was 35.54±3.41 cm with an average weight 64.73± 5.12 g, in T₂ the length was 33.75±1.98 cm with a mean weight 59.76± 6.34 g and in T₃ the length was 31.42±2.53 cm with an average weight 55.95± 5.32 g.

Identification, Culture and Bio-activity Analysis of Some Commercially Important Seaweed in Mid-Southern Coast of Bangladesh

Researchers Md. Amirul Islam, Principal Scientific Officer & PI
Aovijite Bosu, Senior Scientific Officer
Abu Bakker Siddique Khan, Scientific Officer

Objectives

- To conduct detail survey for identification of natural growing seaweed species at Kuakata coastline and its surrounding areas.
- To find out the potential area for seaweeds in this region.
- To demonstrate culture technique of seaweeds in the Kuakata coastline.
- To investigate bioactive compounds and their activity of certain seaweed.

Expected output and impacts

Commercially important seaweed species will be known in this area. Appropriate culture technique of seaweed will be developed for this area. Bioactive compound will be found which can be used in Pharmaceutical, Food and Cosmetic industry. Medicinal properties of seaweeds will be known that is important to make the species commercially viable.

Achievements

Experiment-1: Feasibility of seaweed *Hypnea musciformis* culture in Kuakata coastline, Bangladesh.

Three experimental sites were selected on sheltered intertidal zones of Kuakata. The experimental variables were three culture sites Midpoint of Gangamati, Gangamati Estuary and 33 Kani in Kuakata coastline. The experiment was conducted for a period of 60 days from January 2021 to March 2021. Young, growing fragments of *Hypnea musciformis* were collected from the net of local fishers in Kuakata beach was used as initial seedlings. Seeding was done by inserting the young fragments of *Hypnea musciformis* in the twists of the kachi ropes (nylon rope used in net) of 70 mm diameter. Initially 0.8 ± 0.01 kg fwm⁻² and average 4 cm length were used for each seedling density. A 4 × 4 m net was used for seedling density.



Figure 1. Preparation of Seaweed culture nets and observing growth of seaweeds in Kuakata

Table1. Water quality parameters (mean±Sd) of seaweed culture sites, Kuakata

Parameters	Midpoint of Gangamati	Gangamati Estuary	33 Kani
Water Transparency (cm)	45.1±1.2	65.5±0.5	63.7±1.2
Salinity (ppt)	18±0.4	20±0.6	19±0.3
Water Temperature (°C)	28.3±0.2	28.2±0.3	28.6±0.1
pH	5.9±0.4	7.63±0.2	7.41±0.1
DO (mg/L)	4.8±0.2	4.9±0.2	5.2±0.1

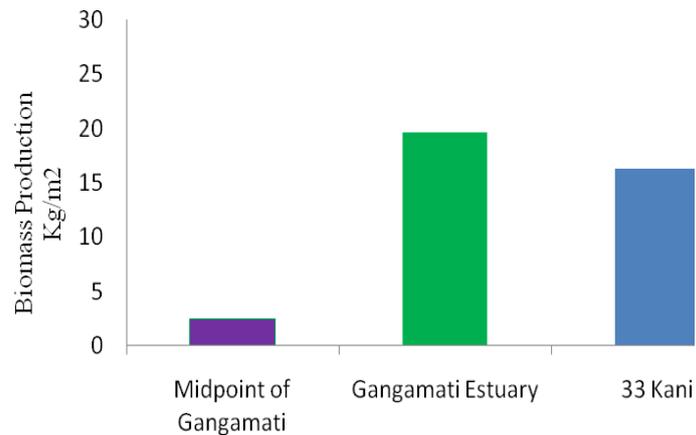


Figure 2. Biomass production (Kg/m²) of *Hypnea musciformis* during 60 days of culture period.

Harvest at the end of 60-day duration of culture period in three sites resulted in the absolute maximum biomass ($19.58 \pm 0.0.60$ kg fresh wt./m²) yielded in Gangamati Estuary and the lowest biomass (2.46 ± 0.25 kg fresh wt./m²) in Midpoint of Gangamati (Fig. 2). Hoq *et al.* (2016) evaluated the feasibility of culture of *Hypnea sp.* in Saint Martin and found maximum biomass (11.05 ± 0.10 kg fresh wt./m²) yield that is more or less similar to the result of present study.

Experiment-2: Culture Feasibility of Different seaweeds (*Ulva conglobata*, *Hypnea musciformes* and *Enteromorpha intestinalis*) in Kuakata coastline, Bangladesh.

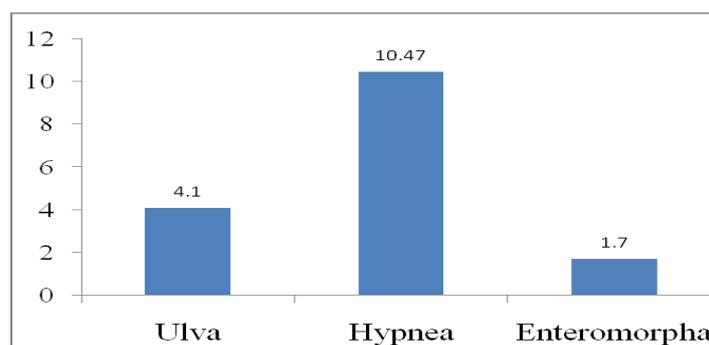
The experiment was conducted for a period of 30 days from March 2021 to April 2021 at Gangamati Estuary in Kuakata. Young, growing fragments of *Ulva conglobata*, *Hypnea musciformes* and *Enteromorpha intestinalis* was collected from Bakkhali, Cox's Bazar. Seeding was done by inserting the young fragments of *Ulva conglobata*, *Hypnea musciformes* and *Enteromorpha intestinalis* the twists of coconut husk of 70 mm diameter.



Figure 3. Collection of seaweeds and preparation of seaweeds for netting.

Table 2. Water quality parameters (mean±Sd) of seaweed culture site, Kuakata

Parameters	Mean±sd
Water Transparency (cm)	60.3±0.5
Salinity (ppt)	18.6±0.6
Water Temperature (°C)	28.7±0.3
pH	7.56±0.2
DO (mg/L)	5.02±0.2

**Figure 4.** Biomass production (Kg/m²) of three different seaweeds in Kuakata coastline

Harvest at the end of 30-days duration of culture period in three sites resulted in the absolute maximum biomass (10.47±0.0.30 kg fresh wt./m²) yielded in *Hypnea* sp. and the lowest biomass (1.70±0.25 kg fresh wt./m²) in *Enteromorpha intestinalis* (Fig. 4). Hoq *et al.* (2016) evaluated the feasibility of culture of *Hypnea* sp. in Saint Martin and found maximum biomass (11.05±0.10 kg fresh wt./m²) yield that is more or less similar to the result of present study.

Riverine Sub station, Rangamati

Diversity of adaptive gear and their impact on Kaptai Lake fisheries

Researchers: B.M. Shahinur Rahman, Senior Scientific Officer & PI
Azhar Ali, Pncipal Scientific Officer
Rabina Akther Lima, Scientific Officer

Objectives

- To identify the gear used in the Kaptai Lake
- To determine the CPUE and catch composition
- Cataloging fish and gear of Kaptai lake
- To analyze cumulative length frequency

Achievement

During Sampling from different sampling site of Kaptai Lake, 11 types of gear, 07 types trap and many Brush shelter were found among these one brush shelter catch data found during the study. Length, width, personnel, fishing efficiency and others information of the fishing gear and traps as well as Catch Per Unit Effort (CPUE), length and weight data of fishes were taken.

Identified Fishing Gear:

01. Kechki Net (Seine Net)

Kechki net mesh size 0.0 cm, length 300-2700 ft., wide 39-75 ft., CPUE 0.7-80 kg, haul time 01-4.5 hour where water depth 12-98.5 ft and 35 species found as the following table-01:

Sl.	Species name	Sl.	Species name
01	Kechki (<i>Corica soborna</i>)	18	Mossambique Tilapia (<i>Oreochromis mossambica</i>)
02	Round chanda (<i>Parambassis ranga</i>)	19	Boirali (<i>Gonialosa manmina</i>)
03	Guchi Baim (<i>Macrognathus pancalus</i>)	20	Kakila (<i>Xenentodon cancilla</i>)
04	White chingri (<i>Macrobrachium lamarrei</i>)	21	Bele (<i>Glossogobius giuris</i>)
05	Techokha/Tinchokha (<i>Aplocheilus panchax</i>)	22	Narikel chela (<i>Salmostoma bacaila</i>)
06	Ek thuta (<i>hyporhamphus limbatus</i>)	23	Shalbaim (<i>Mastacembelus armatus</i>)
07	Gutum (<i>Lepidocephalichthys guntea</i>)	24	Darkina (<i>Esomus danricus</i>)
08	Chapila (<i>Gudusia chapra</i>)	25	Gulsha tengra (<i>Mystus cavasius</i>)
09	Poma/Koitor poa (<i>Johnius coitor</i>)	26	Ghaura (<i>Clupisoma garua</i>)
10	Long Chanda (<i>Nama chanda</i>)	27	Vacha (<i>Eutropiichthys vacha</i>)
11	Tengra (<i>Mystus vittatus</i>)	28	Mrigel (<i>Cirrhinus cirrhosus</i>),
12	Napit koi (<i>Badis badis</i>)	29	Lal Kholisa (<i>Colisa fasciatus</i>)
13	Chela (<i>Chela cachius</i>)	30	Foli (<i>Notopterus notopterus</i>)
14	Tit puti (<i>Puntius ticto</i>)	31	Black chingri (<i>Macrobrachium palaemonidae</i>)
15	Mola (<i>Amblypharyngodon mola</i>)	32	Pabda (<i>Ompok pabda</i>)
16	Kalibaush (<i>Labeo calbasu</i>)	33	Kajoli (<i>Ailia coila</i>)
17	Jat puti (<i>Puntius shophore</i>)	34	Dhela (<i>Osteobrama cotio</i>)
35	Couwa (<i>Gagatia cenia</i>)		

Fisherman found 66.6-95% kechki fish and 5-33.3% others fish by this gear. Smaller size Chapila fish which weight (0.18-5.62 gm), Kalibaush which length 20-22 cm and weight 97-180 gm, Air (4-35 gm), bele fish (0.09-5.24 gm) and Ekthuta fish (0.08-7.7gm). If fisherman release these smaller size fish, it will be helpful for the increase of fish production in Kaptai lake.

02. Current net

Current net also known as chapila net to the fisherman of kaptai lake which mesh size 0.02-3.5 cm, length 192-2880 ft., wide 2.2-7.5 ft., CPUE 0.21-3.35 kg, haul time 38 min-17 hour where water depth 10-70.3 ft and 25 species found as the following table-02:

Sl.	Species name	Sl.	Species name
01	Chapila (<i>Gudusia chapra</i>)	13	Kakila (<i>Xenentodon cancila</i>)
02	Boirali/ bori chapila (<i>Gonialosa manmina</i>)	14	Air (<i>Sperata aor</i>)
03	Long Chanda (<i>Nama chanda</i>)	15	Kajoli (<i>Ailia coila</i>)
04	Round Chanda (<i>Chanda baculis</i>)	16	Tengra (<i>Mystus vittatus</i>)
05	Vacha (<i>Eutropiichthys vacha</i>)	17	Dhela (<i>Osteobrama cotio</i>)
06	Guchi baim (<i>Macrogathus pancalus</i>)	18	Bele (<i>Glossogobius giuris</i>)
07	Poma/Koitor poa (<i>Johnius coitor</i>)	19	Tit puti (<i>Puntius ticto</i>)
08	Shalbaim (<i>Mastacembelus armatus</i>)	20	Jat puti (<i>Puntius sophore</i>)
09	Bata (<i>Labeo bata</i>)	21	Foli (<i>Notopterus notopterus</i>)
10	Gutum (<i>Lepidocephalus guntea</i>)	22	Shol (<i>Channa striata</i>)
11	Mossambique Tilapia (<i>Oreochromis mossambica</i>)	23	khorsula (<i>Rhinomugil corsula</i>)
12	Narikel chela (<i>Salmostoma bacaila</i>)	24	Chela (<i>Chela cachius</i>)
25	Darkina (<i>Esomus danricus</i>)		

Air fish (13.87-74 gm), Bele (0.14-5.70 gm), koitor poa fish (2.16-17.78 gm) and smaller size Vacha fishes are harmful catch by this gear. Among the harvested poma/koitor poa 85-95% were smaller in size.

03. Ber net (One part)

Ber net (One part) mesh size 0.0-4.9 cm, length 150-420 ft., wide 30-75 ft., CPUE 0.67-5 kg where water depth 51.1 ft, haul time 30 min-3.0 hr; fisherman sometimes used flour or atta as lure for fishing and and 16 species found as the following (table-03) where smaller size Kalibaush fish is the Harmful catch by this gear:

Sl.	Species name	Sl.	Species name
01	Chapila (<i>Gudusia chapra</i>)	09	Kechki (<i>Corica soborna</i>)
02	Boirali/ bori chapila (<i>Gonialosa manmina</i>)	10	Kakila (<i>Xenentodon cancila</i>)
03	Ek thota (<i>Hyporhamphus limbatus</i>)	11	Kalibaush (<i>Labeo calbasu</i>)
04	Round Chanda (<i>Chanda baculis</i>)	12	Bata (<i>Labeo bata</i>)
05	Tilapia nilotica (<i>Oreochromis niloticus</i>)	13	Rui (<i>Labeo rohita</i>)
06	Boirali/ bori chapila (<i>Gonialosa manmina</i>)	14	Mrigel (<i>Cirrhinus cirrhosus</i>)
07	Sada chingri (<i>Macrobrachium lamarrei</i>)	15	Chela (<i>Chela cachius</i>)
08	Narikel chela (<i>Salmostoma bacaila</i>)	16	Long Chanda (<i>Nama chanda</i>)

04. Ber net (Two part)

Ber net (Two part) known as Chap jal made by two types net i. e., inner and outer part which mesh size 3.0 and 4.0-6.0 cm; respectively inner and outer part , length 300-600 ft., wide

55.5-90 ft., CPUE 0.36-01 kg where depth 39.9 ft, haul time 30-50 min and 02 species found Air (*Mystus aor*), Gulsha tengra (*Mystus cavasius*).

05. Cotton net (larger mesh size)

Cotton net (larger mesh size) is made by larger mesh size which is used mainly caught for Air and Larger size fish; mesh size 05-10 cm; length 300-2100 ft., wide two types for one type 12. 90 ft where two types 8.6-13 and 8.6-19.5 ft; CPUE 0.0-3.6 kg, haul time 1.0-17 hour where water depth 22.7-51.5 ft. No catch found during the very low temperature especially Fisherman in the month of January/2021; Fisherman used this net at the main navigation route of Bilaichori where the wide of the lake is very narrow. 03 species Found by this gear as the following table-04:

Sl.	Species name	Sl.	Species name
01	Air (<i>Sperata aor</i>)	02	Kalibaush (<i>Labeo calbasu</i>)
03	Mrigel (<i>Cirrhinus cirrhosus</i>)		

Though 27-28.6 cm in Length Air fish which weight 124-138 gm and 23.1-24.6 cm in Length Kalibaush which weight 162-180 gm caught by this gear that's reached more than 23 cm in length but those fishes still smaller in size than standard size in weight.

06. Cotton net (Small mesh size long line net)

Cotton net made by one or two types mesh size i.e., 1.5-2.5 or 1.4-2.5 & 2.0-3.5 cm; respectively., lower to upper portion in case of two types mesh size; length 255-7800 ft., wide 3.5-13 ft., CPUE 1.2-05 kg, haul time 12-17 hour where water depth 22.7-72.1 ft and 20 species found as the following table-05:

Sl.	Species name	Sl.	Species name
01	Air (<i>Sperata aor</i>)	10	Boirali/ Bori chapila (<i>Gonialosa manmina</i>)
02	Chapila (<i>Gudusia chapra</i>)	11	Jat puti (<i>Puntius stigma</i>)
03	Bata (<i>Labeo bata</i>)	12	Tit puti (<i>Puntius ticto</i>)
04	Dhela (<i>Osteobrama cotio</i>)	13	Air (<i>Mystus Aor</i>)
05	Shal baim (<i>Mastacembelus armatus</i>)	14	Poma/Koitor Poa (<i>Johnius coitor</i>)
06	Guchi baim (<i>Macragnathus pancalus</i>)	15	Long Chanda (<i>Chanda nama</i>)
07	Shing (<i>Heteropneustes fossilis</i>)	16	Round Chanda (<i>Chanda baculis</i>)
08	Kajoli (<i>Ailia colia</i>)	17	Tengra (<i>Mystus vittatus</i>)
09	Tilapia mossambic (<i>Oreochromis mossambica</i>)	18	Bele (<i>Glossogobius giuris</i>)

Air fishes reached above 23 cm (23.8-28.2 cm) but yet it's very smaller in size (100-168 gm) than their standard size. Smaller air and Bata which length (cm) \pm Standard deviation and Weight (gm) \pm Standard deviation 11.9 \pm 1.2 and 16.0 \pm 4.4 fishes caught by this gear.

07. Cotton net (larger mesh size long line net)

Cotton net mesh size 3.5-7.0 cm, length 375-900 ft., wide 18-30 ft., CPUE 1.5-3.7 kg, haul time 10.0-15.0 hour and 08 species found among them (table-06). Among the species Kalibaush (*Labeo calbasu*) is harmful catch by this gear.

Sl.	Species name	Sl.	Species name
01	Rui (<i>Labeo rohita</i>)	05	Mrigel (<i>Cirrhinus cirrhosus</i>),
02	GulshaTengra (<i>Mystus cavasius</i>),	06	Kalibaush (<i>Labeo calbasu</i>),
03	Air (<i>Mystus Aor</i>)	07	Foli (<i>Notopterus notopterus</i>),
04	Guchi baim (<i>Mastacembelus pancalus</i>),	08	Catla (<i>Catla Catla</i>)

08. Nylon Cotton net (larger mesh size)

Nylon Cotton net that is made by larger mesh size which is used mainly caught for Air and Larger size fish; mesh size 4-5 cm; length 825 ft., wide 16.5 ft., CPUE 0.0 kg, haul time 16 hour where water depth 43 ft. No fish found by this gear during the study. Catch of this gear depend on the availability of larger size fish at this area and some other criteria of water body of the kaptai lake.

09. Tengra or Kajoli net

Tengra or Kajoli net made by nylon cotton used mainly caught for Kajoli fish. Mesh size One or three types 0.0-1.0 or 1.0-1.2; 0.5 & 0.7 cm respectively; length 45-1500 ft, wide One or two types 6.0-75 or middle 105 and both side 45 ft respectively; CPUE 0.245-0.692 kg, haul time 30 min-08 hour where water depth 21.4-94.5 ft and 13 species found as the following table-07:

Sl.	Species name	Sl.	Species name
01	Kajoli (<i>Ailia coila</i>)	07	Poma/Koitor poa (<i>Johnius coitor</i>)
02	Chapila (<i>Gudusia chapra</i>)	08	White chingri (<i>Macrobrachium lamarrei</i>)
03	Dhela (<i>Osteobrama cotio</i>)	09	Vacha (<i>Eutropiichthys vacha</i>)
04	Bele (<i>Glossogobius giuris</i>)	10	Air (<i>Mystus aor</i>)
05	Darkina (<i>Esomus danricus</i>)	11	Guchi baim (<i>Mastacembelus pancalus</i>)
06	Couwa (<i>Gagatia cenia</i>)	12	Boirali/ bori chapila (<i>Gonialosa manmina</i>)
13	Poma/Koitor Poa (<i>Johnius coitor</i>)		

Smaller size bele fish (1.38-9.39 gm) caught by this gear. Bele fish carnivorous, feed on small insects, crustaceans and small fishes like kechki thus when bele fish searching for food, they caught by this gear. Vacha fish and White chingri caught during passing through the gear. Among the Bele fish about 85% is smaller in size (3.68-5.69 gm) also smaller size koitor poa fish (1.85-4.93 gm) caught by this gear.

Dharmo jal (Square Shaped Ber net)

Dharmo jal made by three to six types mesh size net where smaller mesh size in lower portion and larger mesh size in upper portion. 03 types mesh size net those are 0.6; 6.8; 19 cm; 04 types mesh size net those are 0.6; 7.3; 17.4, 22.6 cm; 05 types mesh size net those are 0.5-07; 4.5-08; 12-16.5; 15-22; 20-28 cm; 06 types mesh size net those are 0.6; 3.6; 8.4; 11.2; 16.8 and 25.2 cm. Length of the gear 300-960ft, Depth of the Net 45-300 ft and CPUE 0.38-2.2 kg. This gear haul time depends on water depth that is 30-50 min; water depth 22-61.4 ft and 15 Species found as the following table-08:

Sl.	Species name	Sl.	Species name
01	Air (<i>Sperata aor</i>)	08	Dhela (<i>Osteobrama cotio</i>)
02	Tilapia nilotica (<i>Oreochromis niloticus</i>)	09	Round Chanda (<i>Chanda baculis</i>)
03	Poma/Koitor poa (<i>Johnius coitor</i>)	10	Bele (<i>Glossogobius giuris</i>)
04	White chingri (<i>Macrobrachium lamarrei</i>)	11	Long Chanda (<i>Nama chanda</i>)
05	Mossambique Tilapia (<i>O. mossambica</i>)	12	Chapila (<i>Gudusia chapra</i>)
06	Gulsha Tengra (<i>Mystus cavasius</i>)	13	Bele (<i>Glossogobius giuris</i>)
07	Kechki (<i>Corica soborna</i>)	14	Kajoli (<i>Ailia coila</i>)
15	Mola (<i>Amblypharyngodon mola</i>)		

Smaller size Air (23-137 gm), koitor poa (2.42-15.55 gm) and Bele fish (0.7-6.08 gm) caught by this gear. Smaller size fish those are live should be released in Kaptai Lake.

Mosquito pelling net known as Chingri net that is triangular shape made by zero mesh size net which length 70 ft., wide 51 ft., CPUE 01 kg where water depth 2.75 ft, haul time 50 min and species found as the following table-09:

Sl.	Species name	Sl.	Species name
01	Sada Chingri (<i>Macrobrachium lamarrei</i>)	05	Taki (<i>Channa punctata</i>)
02	Tin cokha (<i>Aplocheilus panchax</i>)	06	Black Chingri (<i>M. palaemonidae</i>)
03	Guchi Baim (<i>Mastacembelus pancalus</i>)	07	Napit koi (<i>Badis badis</i>)
04	Round Chanda (<i>Chanda baculis</i>)	08	Shing (<i>Heteropneustes fossilis</i>)

Identified Fishing Trap

Single Borshi

Single Borshi length 22-25.5 ft. cotton but used as water level, 02-04 hook; each hook contain 01 Borshi, used bamboo branches or iron made pipe, nylon cotton for catch fish and float used for assumption of fish trap also used atta, rotten rice, puti (*Puntius ticto*) or chapila (*Gudusia chapra*) fish as well as some attractive used as bait. The CPUE of this trap found 0.5-1.3 kg; which haul time 03 hour 40 minute and 04 species found; Kalibaush (*Labeo calbasu*), Mrigel (*Cirrhinus cirrhosus*), Foli (*Notopterus notopterus*), Pabda (*Ompok pabda*).

Borshi or hook line

Borshi or hook line has 12-57 ft length cotton but used as water level, 01-35 hook; each hook contain 02-05 nos Borshi, used bamboo pole, nylon cotton for fishing and float used for assumption of fish trap. Fisherman used lure or bait by mixing of atta, semai, suji, rotten rice, puti (*Puntius ticto*) or chapila (*Gudusia chapra*) fish etc. as well as some attractive used as bait. The CPUE of this trap found 0.28-5.4 kg; which haul time 1.22- 07 hour where water depth 17.67-42 ft and 05 species found as the following table-10:

Sl.	Species name	Sl.	Species name
01	Kalibaush (<i>Labeo calbasu</i>)	03	Rui (<i>Labeo rohita</i>)
02	Mrigel (<i>Cirrhinus cirrhosus</i>)	04	Mossambique Tilapia (<i>O.mossambica</i>)
05	Bata (<i>Labeo bata</i>)		

Rui (*Labeo rohita*), Bata (*Labeo bata*), Mrigel (*Cirrhinus cirrhosus*). Among the species Bata (*Labeo bata*), which length (cm) \pm Standard deviation and Weight (gm) \pm Standard deviation 15.8 \pm 0.0 and 34.0 \pm 0.0; respectively.

Long line Borshi which contain 100-2000 nos borshi by hook with nylon cotton and distance 15-18 ft. between each hook or borshi. Generally used 03-12 ft length nylon cotton into the water from the surface it depends on the water depth of the fishing area; used float for floating of the trap also and used atta/bread, rotten rice, puti or chapila fish as well as some attractive like mussel muscle as bait. This CPUE of this trap 0.8-3.20 kg where water depth 13.10-29.5 ft; which haul time 03-15.5 hour and 06 species found as the following table-11:

Sl.	Species name	Sl.	Species name
01	Kalibaush (<i>Labeo calbasu</i>)	04	Bata (<i>Labeo bata</i>)
02	Rui (<i>Labeo rohita</i>)	05	Shol (<i>Channa striata</i>).
03	Gozar (<i>Channa marulius</i>)	06	Air (<i>Mystus aor</i>)

Among the species Shol (*Channa striata*) and Gozar (*Channa marulius*), which length (cm) \pm Standard deviation and Weight (gm) \pm Standard deviation 20.1 \pm 0.0 and 63.0 \pm 0.0 and 21.7 \pm 0.0 and 77.0 \pm 0.0; respectively smaller size cath of this trap.

Chingri Trap

Chingri Trap t is made by using different types trees branches as trap or shelter for fish which Length 2.0-7.0 ft and wide 2.0-6.0 ft. Fishes harvest by using triangular shape net which mesh size 0.0-0.5 cm., length 5.9-13.4 ft, wide 5.7-12 ft, net depth 7.7-14.5 ft, CPUE 0.09-1.7 kg where water depth 5.7-15.0 ft, haul time 96-360 hour. Fisherman found larger or lower amount of catch; depends on availability of fish and environment of the water body and 25 species found as the following table-12.

Sl.	Species name	Sl.	Species name
01	White chingri (<i>Macrobrachium lamarrei</i>)	13	Cheng (<i>Channa gachua</i>)
02	Black Chingri (<i>M. palaemonidae</i>)	14	Long Chanda (<i>Chanda nama</i>)
03	Bele (<i>Glossogobius giuris</i>)	15	Shing (<i>Heteropneustes fossilis</i>)
04	Shal Baim (<i>Mastacembelus armatus</i>)	16	Lal Chanda (<i>Parambassis lala</i>)
05	Tengra (<i>Mystus vittatus</i>)	17	Kakila (<i>Xenentodon cancila</i>)
06	Napit koi (<i>Badis badis</i>)	18	Kechki (<i>Corica soborna</i>)
07	Kalibaush (<i>Labeo calbasu</i>)	19	Tit puti (<i>Puntius ticto</i>)
08	Round Chanda (<i>Chanda baculis</i>)	20	Sada kholisa (<i>Colisa fasciatus</i>)
09	Guchi Baim (<i>Macrogonathus pancalus</i>)	21	Shing (<i>Heteropneustes fossilis</i>)
10	Foli (<i>Notopterus notopterus</i>)	22	Taki (<i>Channa punctata</i>)
11	Tin cokha (<i>Aplocheilus panchax</i>)	23	Koi (<i>Anabus testudineus</i>)
12	Lal Kholisha (<i>Colisa fasciatus</i>)	24	Couwa (<i>Gagatia cenia</i>)
25	Mola (<i>Amblypharyngodon mola</i>)		

Smaller size Kalibaush (18.05 gm), Bele (0.09-5.90 gm), guchi baim (1.3-2 gm), Foli (12.36 gm), Shol (5.43-10.77 gm) and Kakila fish (0.2 gm) caught by this gear.

Chingri Chai

Fisherman generally used 43-170 chai in a day which made by bamboo slice, nylon cotton, thin hard plastic sheet etc. which mesh size 0.2-0.3 cm, length 31.0-35.5 cm, diameter 11.1-14 cm., CPUE 0.296-6.1 kg where water depth 2.3-37.3 ft, haul time 12-18 hour. Fisherman used atta, soap, puti sutki, rotten rice, methi, collasen, oil cake etc. in the chai for attraction of fish. Sometimes they used crab or crab shell as bait or lure for fish as availability. Chingri chai normally put at low water level beside the dike or hill of the lake kaptai whereas long cotton used for high water level and long line chai where more than one chingri chai used by a cotton. 11 species found as the following table-13:

Sl.	Species name	Sl.	Species name
01	White chingri (<i>Macrobrachium lamarrei</i>)	06	Koi (<i>Anabus testudineus</i>)
02	Black Chingri (<i>M. palaemonidae</i>)	07	Round Chanda (<i>Chanda baculis</i>)
03	Bele (<i>Glossogobius giuris</i>)	08	Kholisa (<i>Colisa fasciatus</i>)
04	Kajoli (<i>Ailia coila</i>)	09	Lal chanda (<i>Parambassis lala</i>)
05	Foli (<i>Notpterus notopterus</i>)	10	Tit puti (<i>Puntius ticto</i>)
11	Guchi Baim (<i>Mastacembelus pancalus</i>)		

01. Tengra Chai

Tengra Chai mesh size 0.6 cm, length 31.2-32 cm, wide 17.3-18 cm, depth 17.2 cm., CPUE 0.056-03 kg where water depth 02-03 ft, haul time 15-17 hour. Fisherman used snail as bait or lure for fish. Tengra chai normally put at low water level beside the dike or hill of the lake kaptai. smaller size Gozar fish (41-43 gm) caught by this gear. 08 species found as the following table-14:

Sl.	Species name	Sl.	Species name
01	Tengra (<i>Mystus vittatus</i>)	05	Gozar (<i>Channa marulius</i>)
02	Shing (<i>Heteropneustes fossilis</i>)	06	Tit Puti (<i>Puntius ticto</i>)
03	Bele (<i>Glossogobius giuris</i>)	07	Darkina (<i>Esomus danricus</i>)
04	Taki (<i>Channa punctata</i>)	08	Foli (<i>Notopterus notopterus</i>)

02. Peti

Peti is popular as Baim Trap among the fisherman of lake kaptai that is three side covered by Slice of wood filled with different types small trees branches for trap or shelter of fish also used soil in peti for the sink of this trap and total fish harvest after a few days. This trap mesh size 0.0 cm, length 2.63-2.67 ft, wide 1.33-1.75 ft, depth 1.83-2.0 ft, CPUE 1.0-2.0 kg where water depth 5.0-6.5 ft, haul time 96-144 hour and 10 species found as the following table-15:

Sl.	Species name	Sl.	Species name
01	Shal Baim (<i>Mastacembelus armatus</i>)	06	Tit puti (<i>Puntius ticto</i>)
02	Bele (<i>Glossogobius giuris</i>)	07	Shing (<i>Heteropneustes fossilis</i>)
03	White chingri (<i>Macrobrachium lamarrei</i>)	08	Tengra (<i>Mystus vittatus</i>)
04	Black Chingri (<i>M. palaemonidae</i>)	09	Gulsha Tengra (<i>Mystus cavasius</i>)
05	Foli (<i>Notopterus notopterus</i>)	10	Kechki (<i>Corica soborna</i>)

Smaller size shal baim (6-21 gm), bele (3.1-8gm) and foli (6-21 gm) caught by this trap.

Brush Shelter:

Brush Shelter those are locally known as Jak in the channel/river of the kaptai Lake those are prepared by different types of tree branches under water and covered by water hyacinth, used different types of lures or bait for fish attraction. Present study found a Brush Shelter that was covered by water hyacinth without tree branches which length one side 93 ft and another side 48 ft; wide one side 58 ft and another side 24 ft, water depth 20.75ft. Zero mesh size gear surrounded the brush shelter for harvesting fish from this Brush shelter which length 150 ft, wide 30 ft; CPUE 13.3 kg and haul time 05 hour. 28 species found as the following table-16:

Sl.	Species name	Sl.	Species name
01	Kalibaush (<i>Labeo calbasu</i>)	15	Tengra (<i>Mystus vittatus</i>)
02	Mola (<i>Amblypharyngodon mola</i>)	16	Air (<i>Sperata aor</i>)
03	Bata (<i>Labeo bata</i>)	17	Kakila (<i>Xenentodon cancila</i>)
04	White chingri (<i>Macrobrachium lamarrei</i>)	18	Tit Puti (<i>Puntius ticto</i>)
05	Black Chingri (<i>M. palaemonidae</i>)	19	Jat puti (<i>Puntius sophore</i>)
06	Rui (<i>Labeo rohita</i>)	20	Shol (<i>Channa striata</i>)
07	Ful Chela (<i>Salmostoma bacaila</i>)	21	Taki (<i>Channa punctata</i>)
08	Kechki (<i>Corica soborna</i>)	22	Gozar (<i>Channa marulius</i>)
09	Gutum (<i>Lepidocephalichthys guntea</i>)	23	Foli (<i>Notopterus notopterus</i>)
10	Round Chanda (<i>Chanda baculis</i>)	24	Shing (<i>Heteropneustes fossilis</i>)
11	Long Chanda (<i>Chanda nama</i>)	25	Lal kholisa (<i>Colisa fasciatus</i>)
12	Lal Chanda (<i>parambassis lala</i>)	26	White kholisa (<i>Colisa lalia</i>)
13	Tin Cokha (<i>Aplocheilichthys panchax</i>)	27	Napit koi (<i>Badis badis</i>)
14	Guchi Baim (<i>Mastacembelus pancalus</i>)	28	Bele (<i>Glossogobius giuris</i>)

Smaller size Kalibaush (70-99 gm), Air (15-63 gm), foli (08-30 gm), bele (0.61-14.76 gm), Shol (157 gm), etc fish caught by this trap.

Development and dissemination of Nursery and Culture Techniques of *cuchia* (*Monopterusuchia*) Component-C

Researchers: Azhar Ali, Principal Scientific Officer & PI
B.M. Shahinur Rahman, Senior Scientific Officer
Rabina Akther Lima, Scientific Officer

Objectives

- To develop the nursery technology for juvenile of *M. cuchia* using different types of feed
- To develop the *M. cuchia* culture technology using different types of feed
- To disseminate and popularize of *cuchia* culture in Chittagong Hill Districts

Achievement

Development of culture technology for *M. cuchia* using different types of feed

Site selection

We have selected Night culture ponds in six upazilas of three hill districts of Chittagong (Rangamati, Khagrachori and Bandarban). To fulfill the objectives of experiment, the following design was followed.

Table-1 Design of the experiment

Study area	Feed type	Stocking density
Rangamati T ₁	Live fish + SIS (3% BW Every 15 day) + Vermicompost (1.5% BW Every day)	10/m ²
Bandarban T ₂		
Khagrachori T ₃		

Pond Preparation

The experiment were conducted in 09 ponds with water area was 40m² each of ponds. Ponds were dug with (30×15×3.5) ft³. Pond bottom were covered by Polythene, knotless nylon net and triple then fill-up with 08-12 inch clay mud. The ponds were protected by fencing with nylon net. The ponds were prepared by treating soil with quick lime at rate of 2kg per decimal. Ponds were filling-up with 0.6-0.8m water and then use of dolomite at the rate of 15 ppm for strengthening buffer capacity of water. After three days, the pond water was fertilized with Urea, TSP and MoPat the rate of 2.5 ppm, 3.0 ppm 1.0 ppm respectively to accelerate primary productivity. Water hyacinth and PVC pipe were used as shelter.

Stocking

After sufficient production of plankton, cuchiafingerling was stocked at a density of 10 nos/m² on March 2021



Stocking of *Monopterusuchia*

Feeding and Sampling

Fingerlings were fed according to design. Feed were supplied twice daily up to satiation level. Feed was supplied by a feeding tray to check waste of feed. Basic water quality variables and growth monitoring viz., depth, temperature, pH, dissolved oxygen (DO) and free CO₂ were determined by monthly basis following standard methods as mentioned in APHA (1992) and Strickland and Parsons (1968). All variables were suitable for cuchia culture.

Harvesting and Data Analysis:

Cuchia were harvested after six months of culture period by dewatering the ponds. The harvested cuchia were counted and recorded. Highest mean weight was recorded in 192.14±5.087g in Khagrachori district and lowest was 168.43±3.92g in Bandarban district. Highest survival was recorded 79.38±2.65 in Dighinala, Khagrachori district and lowest was 67.5±1.06 in Bandarban district. Highest production was recorded in 192.14±5.087g in Khagrachori district and lowest was 168.43±3.92g in Bandarban district.

Shrimp Reserch Station, Bagerhat

Bioaccumulation of Hazardous Organochlorine Pesticides in Shrimp and its Risk Assessment on Human Health

Researchers: Dr. ASM Tanbirul Haque, Senior Scientific Officer & PI
Mollah NS Mamun Siddiky, Senior Scientific Officer

Objectives

- To assess bioaccumulation of pesticides in cultured and wild shrimp/prawn
- To assess the risk of pesticides residues on human health

Achivement:

Experiment-1: Assessment of bioaccumulation of pesticides in cultured shrimp and wild shrimp

A total of 110 samples were collected from the wild and cultured areas of Morelganj, Sarankhola, Mongla and Bagerhat sadar upazilla of Bagerhat district for pesticidal residue analysis. Then the samples were analyzed for detection of DDT, Dieldrin, Endrin and Heptachlore by GC-MS Machine using standard analysis protocol. However, among those groupes Heptachlore was ditedected during months of September, May June at both cultured and wild sources in Bagerhat sadar, Morelganj, Mongla but not cross the acceptable limit. DDT was not found at both wild and cultured sources. In some cases of Bagerhat sadar Endrin, Dieldrin were found at negligible amount (Table: 1). Due to the shrimp and prawn culture pattern, during the month of November to February, most of the gheres were under preparation and the samples were not available or minimum to collect accordingly.

Table 1: Experimental Design

Sampling Area	Morelganj	Sarankhola	Mongla	Bagerhat sadar
No of sampling site for cultured shrimp/prawn	2	2	2	2
No of sampling site for wild shrimp/prawn	1	1	1	1

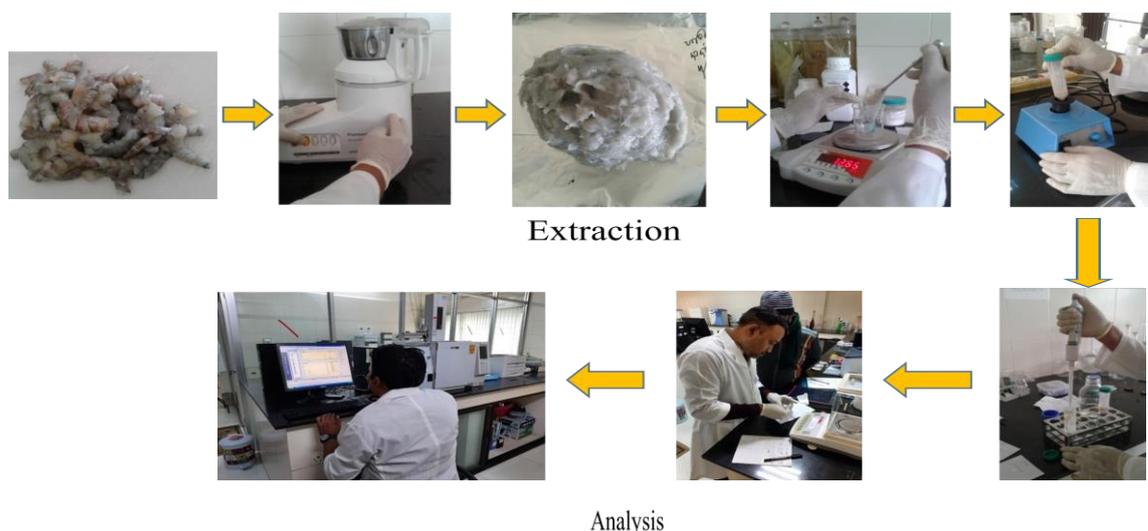


Figure-1: Pictorial view of sample analysis

Table 1: Assessment of hazardous pesticides residue in Prawn/ Shrimp sample

Sampling area / Upazila	No. of Sampling	Month	Sampling site	DDT (ppm)	Heptachlor e (ppm)	Endrin (ppm)	Dieldrin (ppm)
Morelganj	30	July		ND	ND	ND	ND
		August	Cultured	ND	0.005	ND	ND
		September		ND	ND	ND	ND
		October	Cultured	ND	0.002	ND	ND
		November		ND	ND	ND	ND
		December		ND	ND	ND	ND
		January		ND	ND	ND	ND
		February		ND	ND	ND	ND
		March		ND	ND	ND	ND
		April		ND	ND	ND	ND
		May	cultured-1	ND	0.01	ND	ND
			Cultured-2	ND	0.007	ND	ND
			Wild	ND	0.01	ND	ND
		June	cultured-1	ND	0.01	ND	0.001
			Cultured-2	ND	0.012	ND	0.001
Wild	ND		0.009	ND	ND		
Sarankhola	20	July		ND	ND	ND	ND
		August		ND	ND	ND	ND
		September		ND	ND	ND	ND
		October	Wild	ND	0.002	ND	ND
		November		ND	ND	ND	ND
		December		ND	ND	ND	ND
		January		ND	ND	ND	ND
		February		ND	ND	ND	ND
		March		ND	ND	ND	ND
		April		ND	ND	ND	ND
		May	Wild	ND	0.02	ND	ND
		June	Wild	ND	0.016	0.04	ND

		July		ND	ND	ND	ND
		August		ND	ND	ND	ND
		September	cultured-1	ND	0.015	ND	ND
			Cultured-2	ND	0.017	ND	ND
		October	Wild	ND	ND	0.078	ND
		November		ND	ND	ND	ND

Mongla	30	December		ND	ND	ND	ND
		January		ND	ND	ND	ND
		February		ND	ND	ND	ND
		March		ND	ND	ND	ND
		April		ND	ND	ND	ND
		May	cultured-1	ND	0.011	ND	ND
			Cultured-2	ND	0.034	ND	ND
			Wild	ND	0.01	ND	ND
		June	cultured-1	ND	0.01	ND	ND
			Cultured-2	ND	0.009	ND	ND
			Wild	ND	0.013	0.006	ND
Bagerhat sadar	30	July		ND	ND	ND	ND
		August	Cultured-1,	ND	0.029,	ND	ND
			Cultured-2	ND	0.021	ND	ND
			Wild	ND	0.015	ND	ND
		September		ND	ND	ND	ND
		October		ND	ND	ND	ND
		November	Cultured-1	ND	0.003	ND	ND
		December		ND	ND	ND	ND
		January		ND	ND	ND	ND
		February		ND	ND	ND	ND
		March	Cultured-1	ND	0.018	0.009	0.002
		April		ND	ND	ND	ND
		May	Cultured-1	ND	0.015	ND	0.02
			Cultured-2	ND	0.005	ND	ND
			Wild	ND	0.006	ND	ND
		June	Cultured-1	ND	0.016	0.008	0.006
Cultured-2	ND		0.032	ND	ND		
Wild	ND		0.011	0.01	ND		
Total	110		Acceptable Limit	0.05	0.01	0.01	0.02

Development of Mariculture Practice of Seabass (*Lates calcarifer*) in the Southwest Coast of Bangladesh

Researchers: Nilufa Begum, Principal Scientific Officer & PI
 Dr. ASM Tanbirul Haque, Senior Scientific Officer
 Md. Shariful Islam, Senior Scientific Officer

Objectives

- To develop cage culture technique of Seabass in coastal water of Bangladesh
- To develop brood of Seabass in coastal environment.
- To study growth and survival of Seabass in net cage.

Achievement:**Expt. No-01: Culture of Seabass (*Lates calcarifer*) using net cages in tidal river system****Selection of study area:**

Experiment was carried out in Darata river part of Bhairab River, nearby the Shrimp Research Station Bagerhat. The site was located in an area where influence of tidal fluctuation is not pronounced with salinity ranging from 01–14 ppt.

Design and construction of net cages:

9 cages were made by wooden frame and knotless nylon net. The shape of the cages was maintained with the use of concrete weights attached to the corners of the cage bottom. These cages dimensions were easy to change when clogged with fouling organisms. The status of the fixed cages were as follows-

Structure Materials: Wood

Shape: Square

Floating Materials: Concealed Plastic drum

Cage Size: 16 m³ (3.5m × 3m × 1.5m)

Net: 01cm mesh size knotless polythene nylon net.

Rope: Thick nylon rope were used for mooring

Mooring: 4 mooring (up to 50 kg of each) were used for fixing the cages



Figure-1: Progress of cage making

Cage culture management and techniques

In the month of late February (23/02/2021) seabass fry were released. Before stocking of seabass juvenile in cages, fish were acclimatized to the ambient temperature and salinity to prevent the mortality in the cages. Same size (18.7±2.41cm) wild seabass fry were stocked in the early morning when the temperature was cooler. Stocking rates were changed from proposed experimental design due to during stocking month small size fish (5-8cm) were not found in nature and proposed stocking density was too high that's why fish were not capable for free movement . And fish were injured for high density. That's why Stocking rate were rearranged through following design.

Table 01: Experimental design with stocking rate of sea bass

SL No	Treatment Name	Proposed stocking rate (Nos/m ³)	Implemented stocking rate (Nos/m ³)
1	T ₁	10	3
2	T ₂	15	6
3	T ₃	20	9

***All treatments will have 3 replications**



Figure-2: Pictorial view of fry release in cages

Feeds and feeding

Feed is the major constraint confronting the sea bass culture industry. Initially live feed (tilapia fry, silver carp fry etc) and pellet feed were supplied in the overall rate of 10% of total biomass in the first two months of culture to the sea bass. But they did not take any artificial / commercial feed. After 60 days of culture, Chopped trash fish were replaced instead of formulated feed but they totally refuses to take trash fish only live fish they were intake. After that only live fish were supplied according to overall rate of 7% and 5% of total biomass. Food was given only when the fish swim near the surface to eat.

Fish cage management

Cages were regularly monitored. Since fish cages were immersed under water all the time, they were vulnerable to destruction by aquatic animals such as crabs, otter, etc. If damaged, they were repaired immediately or replaced with a new one.

In addition to bio-fouling, the net walls of cages were subjected to siltation and clogging. Bio-fouling is unavoidable since the net walls usually represent a convenient surface for attachment by organisms such as amphipod, polychaete, barnacles, molluscan spats, etc. These could lead to clogging and reduce exchange of water and may result in unnecessary stress to the cultured fish due to low oxygen and accumulation of wastes. Feeding and growth would likewise be affected. Mechanical cleaning of fouled nets was done frequently.



Figure-3: Pictorial view of Sampling, feeding and water quality data collection

Water Quality and growth parameters monitoring:

Water quality parameters viz., pH, Dissolve Oxygen, Salinity, Turbidity etc. of different cages were monitored fortnightly. On the other hand, growth of sea bass also monitored fortnightly.

Growth performance of *Lates calcarifer* at 180 days

Compare to three treatments T₁ and T₂ shows good result. Feeding competition was very high. That's why all fishes in same cage not shown equal growth. In case of weight gain standard deviation was found higher that indicate they are highly competitive for feed, as a result they has high size variation. At final harvesting maximum average weight and length was found at T₁ (504.43±89.05g) and 32.41±0.47cm accordingly. After 6 month culture period in cages overall 95% survival rate was found. On the overall, result obtained were high FCR in all treatments and low SGR. Among three treatments relatively T₁ shows lower FCR than others.

Table-2: Growth performance of *Lates calcarifer* at 180 days

Treatment	Stocking density (m⁻³)	Initial length (cm)	Length gain (cm)	Initial weight (g)	Final Weight (g)	FCR	SGR (%)	Survival rate
T ₁	3	18.7±2.41	32.41±0.47	69.45±5.35	504.43±89.05	3.14	1.10	97%
T ₂	6		29.94±0.57		447.72±54.59	3.69	1.03	95%
T ₃	9		26.42±0.68		331.88±74.85	4.39	0.83	93%

Water quality parameter of Vairab River during culture period**Table-3: Water quality parameter of Vairab river during culture period**

Month	Salinity	pH	Turbidity	Oxygen	Temperature
February	7±0.36	7.5±0.77	40±2.36	5±01.32	22±01.27
March	8.2±0.26	8.2±0.56	39.6±2.96	4.3±0.76	28±01.25
April	8±0.63	7.8±0.85	39.6±02.72	5.1±0.95	30±0.89
May	14±0.75	8.1±0.64	34±1.97	6.3±1.42	33±0.94
June	10±0.95	8.6±0.56	30±01.25	5.6±0.76	30±1.97
July	6±0.47	6.5±0.75	31±01.27	4.5±0.85	29±0.63
August	1±0.67	8.5±0.71	30±0.37	5±0.77	28±0.56
September	1±0.77	7.5±0.56	32±0.21	5±0.47	30±0.64

Influencing Haemocytic Defense in Black Tiger Shrimp (*Penaeus monodon*) using Diversified Lipid A-core Oligosaccharide Molecules to Cope with WSSV Infection

Researcher(s): H. M. Rakibul Islam, Senior Scientific Officer & PI
Mst. Subrina Khatun, Senior Scientific Officer
Md. Shariful Islam, Senior Scientific Officer

Objectives:

- To identify suitable gram-negative bacteria as a better immunomodulators
- To develop effective administration methods of LPS to boost immunity

Achievements

Experiment I: Identification of suitable gram-negative bacteria as a better immunomodulators

Achievements

In this year, *Vibrio parahaemolyticus* and *Escherichia coli* has been selected for the experiment. First of all, specific primer for *V. parahaemolyticus* and *V. owensii* has been designed and synthesized (Table 1). *V. parahaemolyticus* has been isolated from the hepatopancreases of affected shrimp through PCR (Figure 1). Pure stock of *E. coli* and *Salmonella sp.* was procured. LPS extraction process was optimized and extracted to see the efficacy.

LPS Extraction Procedure

- Take 500 ml glass beaker
- Weight 10 gm bacterial culture

- Add 2 M 150 ml Calcium Chloride drop by drop and homogenize
- Transfer into a centrifuge tube and centrifuge at 7500g/7000 rpm for 30 min at 4C⁰
- Discard the pellet, take supernatant and add 25% Ethly Alcohol
(Original volume=0, Ethly Alcohol need= x, $0.25(0+.95x) = x$)
- Mix for 30 min using magnetic stirrer in iced condition
- Centrifuge at 7500g/7000 rpm for 30 min at 4C⁰
- Discard the pellet, take supernatant and add 80% Ethly-Alcohol
 $0.8(0+.95x) = x$
- Store at -20 C⁰ for 1 hour
- Centrifuge at 7500g/7000 rpm for 30 min at 4C⁰
- Discard the supernatant, store pellet at -20 C⁰ for further use

Table 1. Specific primer for the target bacteria.

Target species	Sequence	Amplicon size(bp)	Targeting gene
<i>V. parahaemolyticus</i>	F- GCAGCTGATCAAAACGTT GAGT R- ATTATCGATCGTGCCACTCAC	897	flaE
	F- GATTTGGCGAACGAGAAC R- CGTCTCGAACAAGGCG	695	
	R- TGTAGTTTTTCGCTAATTTC F- ACGCTGACATCACCTTC	583	
	R- ATCCGCGCGAAGATCG		
<i>V. owensii</i>	F- TACCTCAACACTTCAGCAAGCG R- TTCATACAGACGCTGAGCCAG	85	topA

Experiment II: Development of effective administration methods of LPS to boost immunity

For this study main challenge was to keep experimental animals (average weight 2 g approx.) alive to certain days in glass aquarium. After taking different strategies, pond reared 2 g sized shrimp transferred into wet lab of SRS and acclimatized for two days in 40 L glass aquarium at a density of 20 individuals/tank (Figure 2). LPS was administrated in two different ways with replication, i) Intramuscular Dose, IM (75ng/ml) and ii) added with commercial feed (5µg/g). IM administration was done only once while feed was continued throughout the observation period of 72 hrs. Control tank maintained with the same commercial feed having no LPS. Hemocyte cells were counted after 24, 48 and 72hrs of post administration. IM showed almost three times more increase in hemocytes followed by LPS provided with feed (Figure 3,4). Further experiment is ongoing to assess the boost in hemocytes at different feeding schedule.

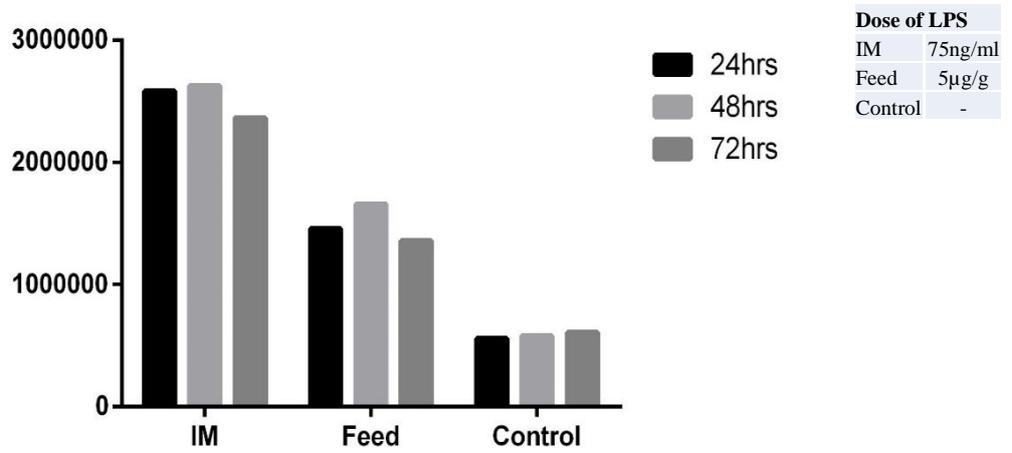
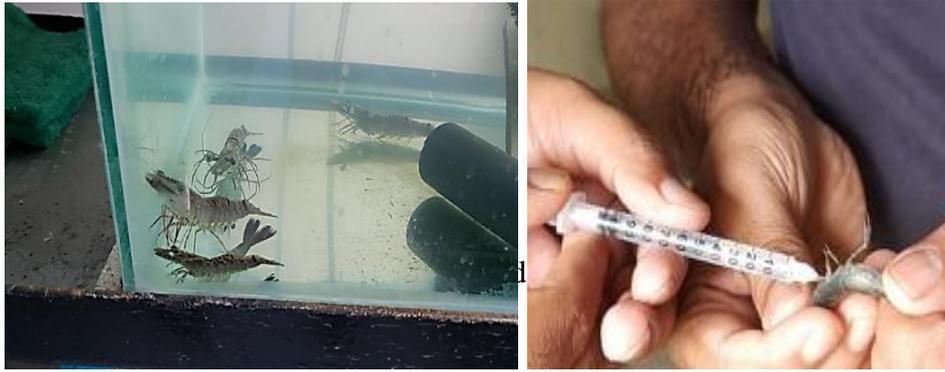


Figure 3. Number of hemocytes per ml at different mode of LPS administration

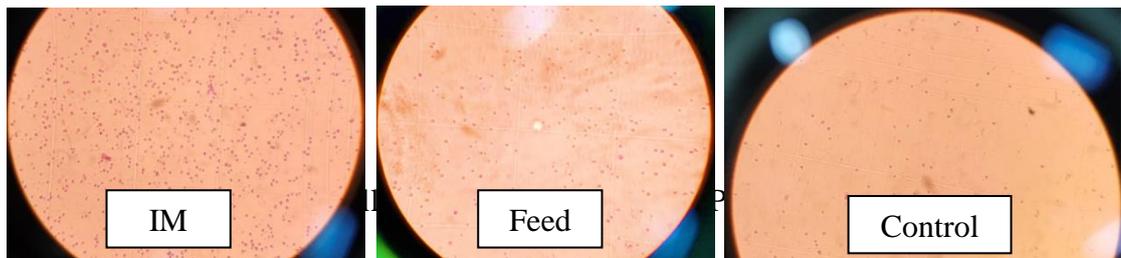


Figure 4. Hemocytes cells at different method of LPS administration

Marine Fisheries and Technology Station, Cox's Bazar

Development of culture technique for live feed isolation from the Bay of Bengal

Researchers: Jakia Hasan, Senior Scientific Officer & PI
 Ahmad Fazely Rabby, Senior Scientific Officer
 Mohammad Khairul Alam Sobuj, Scientific Officer
 Md. Golam Mostofa, Scientific Officer

Objectives

- To identify the commercially important microalgae from the Bay of Bengal
- To isolate the commercially important live feed species
- To investigate the nutritional status of identified microalgae
- To utilize the isolated microalgae as a live feed supplement for fish/shellfish larvae in culture system

Achivements

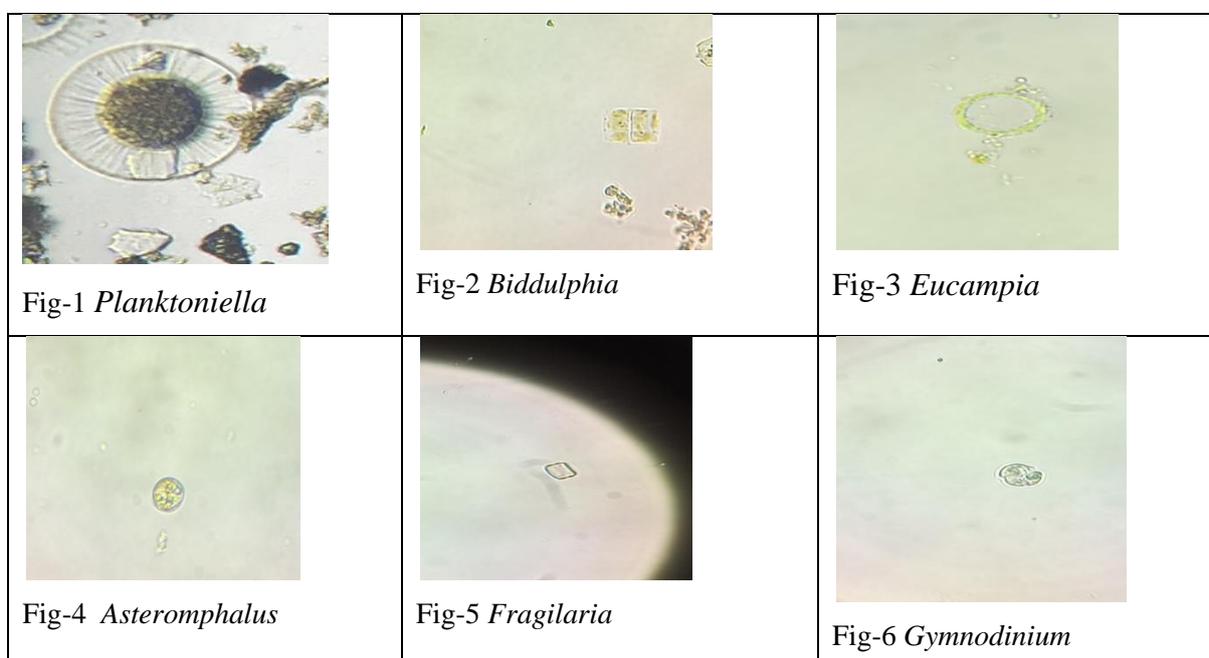
Study 1. Identification of available marine algae species

Firstly, plankton samples were collected in monthly intervals at 10.30 am on each sampling date using 20 µm plankton net. Samples were collected from pelagic waters of the open sea estuary and river. Sixty litres of pelagic water were passed through the plankton net with the help of a plastic bucket of 10-liter capacity from 6 different areas (300-meter interval). The water was passed through the net and the plankton accumulated at the lower end of the plankton net. After that, the accumulated plankton sample was collected into a sampling bottle. After collection, the sample was transported in Styrofoam box with ice to maintain 20-25°C temperature. Then the plankton samples were carried out to the Marine Fisheries and Technology Station lab for further analysis. Collected sample was divided into two parts. One part was preserved by 5% formalin for identification and other part was enriched with two media one is Gillard and Ryther's Modified f/2 medium and other is Conway/Walne's medium. Samples were cultured with suitable lab condition (Aeration and Light) for isolation. For the identification, the samples were examined by electric light microscope (Leica DM1000) at 10X, 20X and 40X. Desirable species were identified based on pigmentation, morphology (coccolid, filamentous), size, the presence or absence of flagella and other distinctive features. During the examination, 6 genus of Bacillariophyceae, 2 genera of Dinophyceae, 3 genera of Mediophyceae, 1 genus of Chlorophyceae and 1 genus of Cosinodiscophyceae were identified.

Table 1: Identified genus of different microalgae

Class	Order	Family	Genus	Species
Bacillariophyceae	Bacillariales	Bacillariaceae	<i>Cylindrotheca</i>	<i>Cylindrotheca closterium</i>
	Rhopalodiales	Rhopalodiaceae	<i>Epithemia</i>	<i>Epithemia sp.</i>
	Naviculales	Pleurosigmataceae	<i>Gyrosigma</i>	<i>Gyrosigmabalticum</i>
	Surirellales	Surirellaceae	<i>Surirella</i>	<i>Surirellalinearisis</i>
	Thalassiophysales	Catenulaceae	<i>Amphora</i>	<i>Amphora sp.</i>
	Fragilariales	Fragilariaceae	<i>Fragilaria</i>	<i>Fragilariasp.</i>
Mediophyceae	Thalassiosirales	Thalassiosiraceae	<i>Planktoniella</i>	<i>Planktoniellasp.</i>
	Biddulphiales	Biddulphiaceae	<i>Biddulphia</i>	<i>Biddulphiasp.</i>
			<i>Eucampia</i>	<i>Eucampiasp.</i>
Dinophyceae	Gymnodiniales	Gymnodiniaceae	<i>Gymnodinium</i>	<i>Gymnodiniumsp.</i>
	Gonyaulacales	Ceratiaceae	<i>Ceratium</i>	<i>Ceratiumfurca</i>
Coscinodiscophyceae	Asteromlamprales	Asteromlampraceae	<i>Asteromphalus</i>	<i>Asteromphalussp.</i>
Chlorophyceae	Chlorellales	Chlorellaceae	<i>Chlorella</i>	<i>Chlorellasp.</i>

The microscopic view of the identified microalgae are given below:



 <p>Fig-7 <i>Cylandrotheca closterium</i></p>	 <p>Fig-8 <i>Epithemia sp.</i></p>	 <p>Fig-9 <i>Gyrosigma balticum</i></p>
 <p>Fig-10 <i>Surirellalinearior</i></p>	 <p>Fig-11 <i>Amphora sp.</i></p>	 <p>Fig-12 <i>Ceratiumfurca</i></p>
 <p>Fig-13 <i>Chlorella sp.</i></p>		

Study 2. Isolation of microalgae

Isolation of microalgae could be done through a variety of techniques including traditional and automated/advanced processes. Traditional methods included single-cell isolation using micropipette, isolation using agar media, dilution techniques and gravity separation using centrifugation. Among them, the following technique was applied: -

Consecutive serial dilution method:

One ml microalgae sample from crude mixed culture was taken by sterilized micropipette and added to marked 1st serial dilution test tube where 9 ml autoclaved seawater was taken and f/2 media (20 μ l) used as enhancer which was expressed as 10^{-1} . Aseptically, 1 ml from this test tube (10^{-1}) was taken and added to the next tube (10^{-2}) and then mixed gently. This procedure was repeated for the remaining tubes (10^{-3} – 10^{-21}). Test tubes were incubated under room temperature and light conditions. The incubation was kept in light with a photoperiod of 24 hours. All test tubes were gently shaken twice in daily at morning and afternoon. The cultures were examined microscopically after every week withdrawing by micropipette in a small volume (10 μ l) aseptically from each dilution tube whether unialgal had been growth or not.

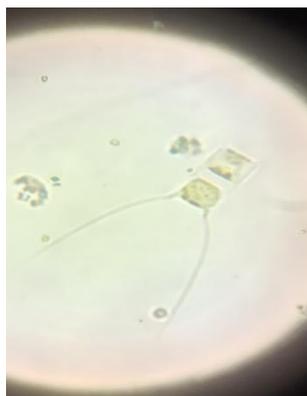


Fig-14 *Chaetoceros gracilis*(40x)



Fig-15 *Tetraselmis suecica*(40x)

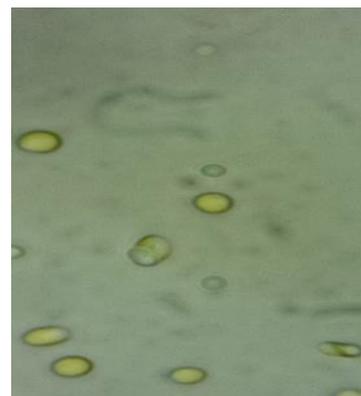


Fig-16 *Isocrysis galvana*(40x)



- Temperature: 26±2 °C
- Light intensity: 2000-5000 lux
- pH: 7.2
- Salinity: 30, 35, 40 and 45 ppt

Figure 17: Isolation of marine microalgae by consecutive serial dilution (10^{-1} - 10^{-21}) where salinity was 25, 30, 35, 40 and 45 ppt.

Pure culture development from isolated micro algae

For the pure culture development in 50 ml, firstly 10 ml sample of serial dilution test tube (10^{-8}) was mixed with 40 ml autoclaved sea water in sterilized 50 ml conical flask. In this time several samples were prepared for pure culture. Then added 100 μ l of F/2 media for one sample and Conway/ Walne's medium for another. The culture was kept in light with a photoperiod of 24 hours and gently shaken twice in daily at morning and afternoon in fixed time. This process was carried on up to 3 days and cell density was observed after every day with sterilized micropipette through microscope. Controlled culture parameters has been tabulated bellow

Table 2: Pure culture development parameters of isolated microalgae in 50 ml

Temperature (°C)	Salinity (ppt)	Light (Lux)	P ^H
25±1	32	2000-5000	7.2

Cells concentration increased gradually day after day and turned light brown color at 4th day and 8th day for *Chaetoceros gracilis* and *Isocrysis galvana* and light green at 5th day for *Tetraselmis suecica*.

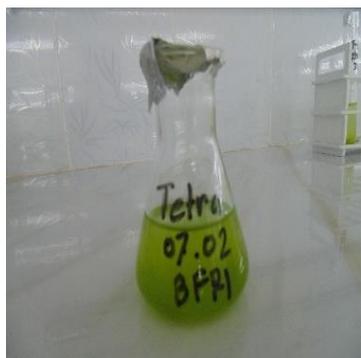


Figure- 18: Pure culture of different microalgae



Figure- 19: Conway medium solution

Study 3: Preparation for nutritional analysis of isolated microalgae

Scale up was done of the identified microalgae for nutritional analysis. Table 3 shows the scale up process:

Table 3: Highest density and Biomass after the scale up of isolated microalgae

Species name	Cell size	Isolation method	Diluted Test tube	Salinity during isolation	Highest density (cell/ml)	Biomass (gm / L)
<i>Chaetoceros gracilis</i>	5-8 μm	Serial dilution	10^{-12}	35ppt	4.61×10^6 at 9th day	0.88
<i>Isocrysis galvana</i>	3-5 μm	do	10^{-21}	28ppt	6.12×10^6 at 9th day	0.92
<i>Tetraselmis suecica</i>	10-14 μm	Serial dilution	10^{-5}	45ppt	3.98×10^6 at 6th day	1.01
<i>Skeletonema costatum</i>	15-42 μm	Serial dilution	10^{-7}	32 ppt	4.85×10^6 at 6th day	1.23

Preparation for nutritional analysis of microalgae:

For the nutritional analysis micro algae sample were prepared by centrifuging method. About 1.5 ml cultured microalgae was taken in a test tube. Then the taken sample of cultured microalgae were concentrated by centrifuging at 4,000rpm for 5 minutes and the super-latent was discarded. After that concentrated microalgae were collected and kept it in a vial.



Figure-13: Preparation for nutritional analysis

Table 4: Results of Proximate Composition analysis of microalgae (%Moisture basis)

Name of item	% Moisture	% Crude lipid	% Crude Protein	% Ash	% Crude fiber	% Carbohydrate
<i>S. costatum</i>	16.58	2.62	7.65	57.67	5.50	9.98
<i>I. galvana</i>	14.61	4.40	7.73	59.21	6.38	7.67
<i>N. culata</i> (BOB)	12.19	6.32	13.84	45.98	4.80	16.87
<i>N. culata</i> (Thailand)	12.44	5.60	9.94	51.05	5.59	15.38
<i>C. gracilis</i>	16.19	4.73	9.51	56.69	6.20	6.68
<i>T. suecica</i>	12.70	3.88	14.78	44.54	5.78	18.32

Study4: Utilizing the isolated microalgae as a live feed supplement for fish/shellfish larvae in culture system

In this experiment, performance of live feed was evaluated on the growth of bivalve in glass aquarium. 4 treatments will be assigned with 2 replicates. Treatment 1 consists of the combination of 4 isolated phytoplankton species, treatment 2 with 3 species, treatment 3 with 2 species and treatment 4 with 1 species. Stocking of oyster was performed on 05 February 2021. About 20% of water was exchanged weekly. Live phytoplankton (250 ml with 5×10^6 cell/ml) was applied as a feed from the live feed laboratory. Water quality parameter was measured fortnightly.

Table 4: Experimental treatments

Treatment	Feeding (isolated microalgae)	Replication	
		R1	R2
T 1	Four phytoplankton species (<i>Nannochloropsis oculata</i> , <i>Cheatoceros gracilis</i> , <i>Tetraselmis suecica</i> and <i>Isocrysis galvana</i>)	40 oyster/liter	40 oyster/liter
T 2	Three phytoplankton species (<i>Cheatoceros gracilis</i> , <i>Tetraselmis suecica</i> and <i>Isocrysis galvana</i>)	40 oyster/liter	40 oyster/liter
T 3	Two phytoplankton species (<i>Tetraselmis suecica</i> . And <i>Isocrysis galvana</i>)	40 oyster/liter	40 oyster/liter
T 4	Only one phytoplankton species (<i>Isocrysis galvana</i>)	40 oyster/liter	40 oyster/liter

Table 5: Growth performance of Oyster in different culture treatments

Culture method	Initial Parameters (Mean±SD)			Final Parameters (Mean±SD)			Survival rate
	Weight (gm)	Length (cm)	Body depth (cm)	Weight (gm)	Length (cm)	Body depth (cm)	
T 1	35.5±0.5	5.9±0.4	4.3±0.2	48.9±0.3	7.9±0.6	4.5±0.5	92%
T 2	35.5±0.6	5.9±0.5	4.3±0.3	47.1±0.2	7.6±0.5	4.3±0.4	90%
T 3	35.5±0.8	5.9±0.3	4.3±0.2	45.4±0.5	6.7±0.3	4.8±0.2	95%
T 4	35.5±0.7	5.9±0.6	4.3±0.4	42.13±0.6	6.4±0.4	4.1±0.2	90%

Breeding and Seed Production of Mud Crab (*Scylla olivacea*)

Researchers: Dr. Shafiqur Rahman, Principal Scientific Officer
Ahmad Fazley Rabby, Senior Scientific Officer & PI
Jakia Hasan, Senior Scientific Officer
Md. Golam Mostofa, Scientific Officer

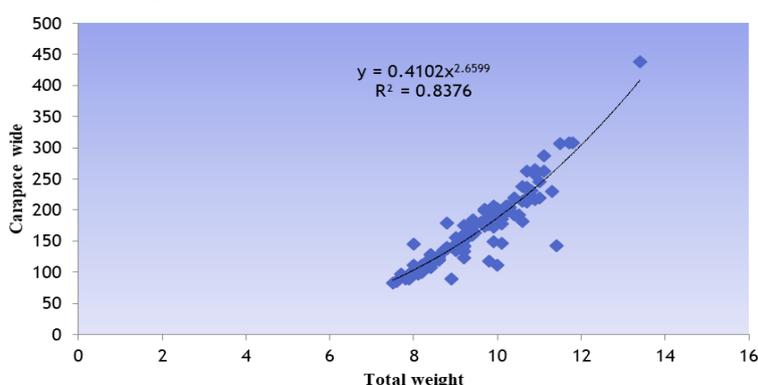
Objectives

- To domesticate the mud crab (*Scylla olivacea*) broodstock under captive/ hatchery conditions
- To develop breeding technology of mud crab (*Scylla olivacea*) in captivity
- To develop larval rearing technique
- To develop nursery management technique of mud crab (*Scylla olivacea*)

Achivements

The experimental site was at hatchery of Marine Fisheries & Technology Station, BFRI at Cox's Bazar. Wild female crabs were collected from crab dealers of Moheskhai, Chakaria, Eid gah's crab market under Cox's Bazar district. The taxonomic identification of mud crab

was followed by Keenan *et al.* (1998). Total 56 gravid brood crabs were sorted and collected from market for rearing in MFTS hatchery. Among them, 40 crabs were finally survived. The crabs were examined for ovarian maturity by looking through the transparent membrane between the junction of the first abdominal segment and carapace. Mature ovaries were dark orange. De-chlorinated sea water was used for this experiment that was transported from Modina hatchery. During the experiment, collected crabs were subjected to a bath treatment of 100 μ L/L of a 40% formalin solution for disinfection. After the formalin bath, brood crabs were transfer into cemented tank which bottom was filled with 2-3 inch sand for conditioning. Water temperature was maintained to 25-27 $^{\circ}$ C, water salinity was 30 ppt, and daily feeding ratio was @ 10-15% of body weight of fresh marine squid, bivalve (Oyster) or fish meat (Tilapia, leaf fish) alternatively. Broods were stocked in sand filled cemented cistern tank for conditioning. The brood crabs were in good condition and mortality was 5%. The length weight relationship of brood crabs is given below.



After few days of conditioning, eyestalk ablation was applied for selected 32 broods for early maturation by a blunt scissor. After eyestalk ablation, gravid crabs were again treated in 100 μ L/L formalin bath for 24 minutes. After formalin bath, eyestalk ablated crabs were reared under 3 different systems for making them berried.

Treatment 1 (Individual bucket):

- Each bucket contains one brood crab.
- Brushing of gravid crabs of whole body was done on regular basis but formalin bath treatment was continued (in an alternate day) up to develop berried.
- Water exchange was done every day.

In this process total 10 brood crabs were used.

Treatment 2 (Cistern cemented tank):

- Gravid crab reared into 3000 L rectangular cemented tank that was filled with 2-3-inch-thick sand
- No need to brush the gravid crabs in this system.
- Water exchange was done 20 days interval.
- Each tank contained 8 brood crabs.
- Water re-circulatory filtration unit was present.
- A daily management schedule was maintained for siphoning out of waste material from the tank bottom.

In this process total 16 brood crabs were used.

Treatment 3 (Fibre tank):

- Gravid crab reared into a 500 L fibre tank that was filled with 2-3-inch-thick sand.
- No need to brush the gravid crabs in this system
- Water exchange was done 10 days interval.
- Each tank contained one brood crab.
- Water re-circulatory filtration unit was present.
- A daily management schedule was maintained for siphoning out of waste material from the tank bottom.

In this process total 6 brood crabs were used.

In every technique water temperature was maintained to 25-30° C, water salinity was 30 ppt with continuous aeration and daily feeding ratio was @ 10-15% of body weight of fresh marine squid, bivalve (Oyster) or fish meat (Tilapia, leaf fish) alternately. The result of three techniques is tabulated below.

Table: Comparison of three techniques

Key point	Treatment 1 (Bucket 25L water)	Treatment 2 (Cemented 3000L Tank)	Treatment 3 (Fiber Tank 500L)
Duration of Berried formation	Need 12-19 days	Need 8-10 days	15-18 days required.
Physical damage	No Physical damage	Pleopod distortion occurred in 2-3 gravid crabs due to fight.	No Physical damage
Filtration unit	Absent	Present	Present
No. of berried formation	2	11	3

Total 16 berried female crabs are identified from three treatments when water levels are reduced. Berried females are then transferred individually to 100-liter or 300-liter tank with aerated sea water at 30 ppt salinity. Hatching occurs 7-14 days after spawning at temperatures of 26.5-31°C. Each brood crabs of *S. olivacea* were found to produce 0.4-2.7 million zoeae.

Larvae management:

Zoeae were stocked at a density of 30 individuals per liter in circular concrete tanks contain 500 L seawater and fed with the rotifer *Brachionus rotundiformis* at a density of 10-15 rotifers/ml. The microalga *Nannochloropsis sp.* was maintained in the rearing tanks at 50,000 cells/ml as food for the *B. rotundiformis*. Brine shrimp *Artemia* nauplii were also given at 0.5-3/ml to zoea 3 stage and larger larvae. The zoeae were reared at a salinity of 28-30 ppt and water temperature of 26-30.5°C and a natural photoperiod of 11-13 hours light and 11-13 hours dark. Water temperature maintained by thermostat and monitored by thermometer. The rearing water was replaced at a daily rate of 30% starting on day 3 and increasing upto 80%

as larvae grow bigger or when disease-causing luminescent bacteria are detected in the water and larvae.

Nursery management

Megalopa were nursed in circular concrete tanks. To prevent or reduce cannibalism, the stocking density of 3-5 day old megalopa in nursery tanks were reduced to 300-400inds/400litre of water. Black nets were placed at the bottom as substrates and some were suspended in the water column. Food consists of newly hatched and adult *Artemia*. As soon as the megalopa molt to crab stage, they were fed with minced trash fish, mussel, oyster or small shrimp *Acetes* twice daily ad libitum. About 30-50% of the volume of the rearing water (26-30 ppt) was replaced daily during the first 5 days and every two days thereafter.

Using several hatchery tanks to rear megalopa up to juveniles at low density was not cost-effective because these were better used for rearing the zoea, which had a faster turnover. Megalopa was transferred to net cages at 200-300/liter. They were stocked at 30/m² and fed adult *Artemia* on the first day in net cages. Food was then changed to minced trash fish and mussel placed in feeding trays. Water depth was maintained at 60-80 cm. About 30% of the water was replaced 3-4 times a month.

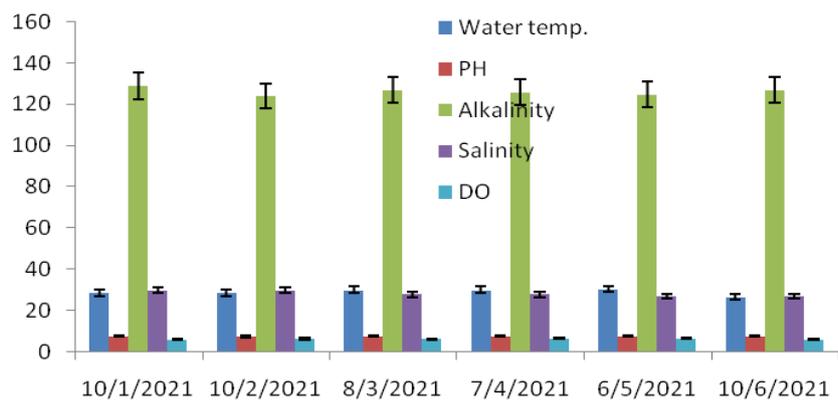


Fig 1: Water quality analysis during rearing of zoeae, Megalopa and crablet in Circular concrete tank

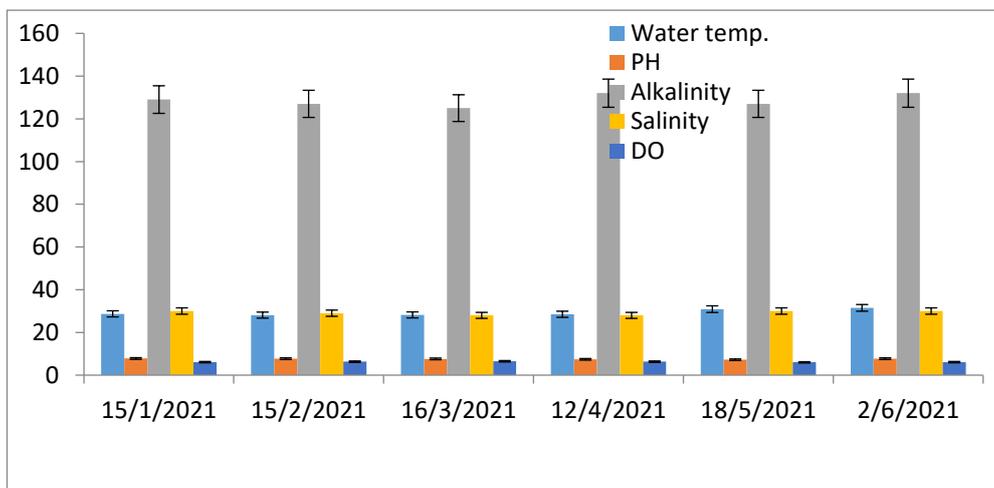


Fig 2: Water quality analysis of Brood Crabs during Domesticating in cistern tank.

Water quality parameters were monitored daily following standard methods. The water temperature, pH, Alkalinity, salinity and dissolved oxygen was <0.05 & was statistically significant.

The survival rate from Zoea 1 to 4 days old Megalopa was less than 5%. The survival from Megalopa to juveniles (1-3 g bodyweight) after 30 days in hatchery tanks was 2%. A considerable number of crabs for grow-out can be produced if the Megalopa are nursed in net cages in ponds. Crabs are about 1 g and 2 cm in carapace width can be stocked directly in grow-out ponds.

Breeding and Culture of Potential Marine Oyster in the Bay of Bengal Bangladesh Coast

Reseachers: Dr. Shafiqur Rahman, Principal Scientific Officer & PI
 Jakia Hasan, Senior Scientific Officer
 Ahmad Fazley Rabby, Senior Scientific Officer
 Mohammad Khairul Alam Sobuj, Scientific Officer
 Md. Golam mostafa, Scientific Officer

Objectives

- To develop culture techniques of oyster in Cox's Bazar and other suitable areas.
- To develop breeding techniques of oyster in captivity.
- To develop larval rearing techniques of oyster.

Achivements

Study-1 Development of culture technique of oyster

Considering the depth, nature of substratum, tide, wave action, salinity and productivity of the water at Bakkhali and khorushkul, Cox's Bazar area were selected as a suitable site for the raft culture of oyster.

Raft- tray method

This method was conducted for wild oyster culture using bamboo raft with an area of 30 meter square. Experimental cage, made of nylon net (0.8 inch mesh size) with plastic ring attached with GI pipe (Volume 8.8 feet³) were suspended at 1m in depth (3 m surface-bottom in low tide), hanging them from the raft with a rope (Figure 1). Three experimental density treatments were established with ten replicates: 20, 40 and 60 oysters/cage where their initial averages weight were 80.3 gm and the species was *Saccostrea cucullata*. Growth parameters of cultured oyster are showed in table 1. The physico-chemical parameter, temperature: 28-32°C and salinity: 33-30 ppt was observed.



Fig 1.Bamboo raft setup, raft-tray set-up and sampling at Choufaldandi

Table1: Growth parameter of cultured oyster reared in cages at Choufaldandi

Culture method	Initial Parameter (Mean±SD)			Final Parameter (Mean±SD)			Survival rate
	Weight (gm)	Length (cm)	Body depth (cm)	Weight (gm)	Length (cm)	Body depth (cm)	
20oysters/cage	80.3±0.8	6.2±0.3	4.3±0.4	119.6±0.9	9.2±0.6	6.8±0.4	95%
40oysters/cage	80.3±0.9	6.2±0.5	4.3±0.4	128.4±0.6	9.6±0.3	6.9±0.6	95%
60oysters/cage	80.3±1.2	6.2±0.4	4.3±0.2	102.8±0.9	8.2±0.6	6.1±0.3	90%

Raft-string

method:

80 pairs of live oysters were hanged in a length of 1.5 m roof each with three pairs of oysters maintaining 12-15 cm gap from the water level. In this system survival rate was 88% but growthrate is better than raft- tray method that was 112.4 gm (average) individuals.



Fig 2.Raft-string culture system at Choufaldandi

Indoor culture: In hatchery three 100L tank were used for the rearing of oyster spat. Moderate growth of oyster was measured in indoor condition.

Spat collection from wild by using different clutch materials

For the collection of spat 3 clutch materials such as oyster shell, kortal and tiles were used. Twelve numbers of cultch materials (such as oyster shell, earthen pot, kortal) were placed

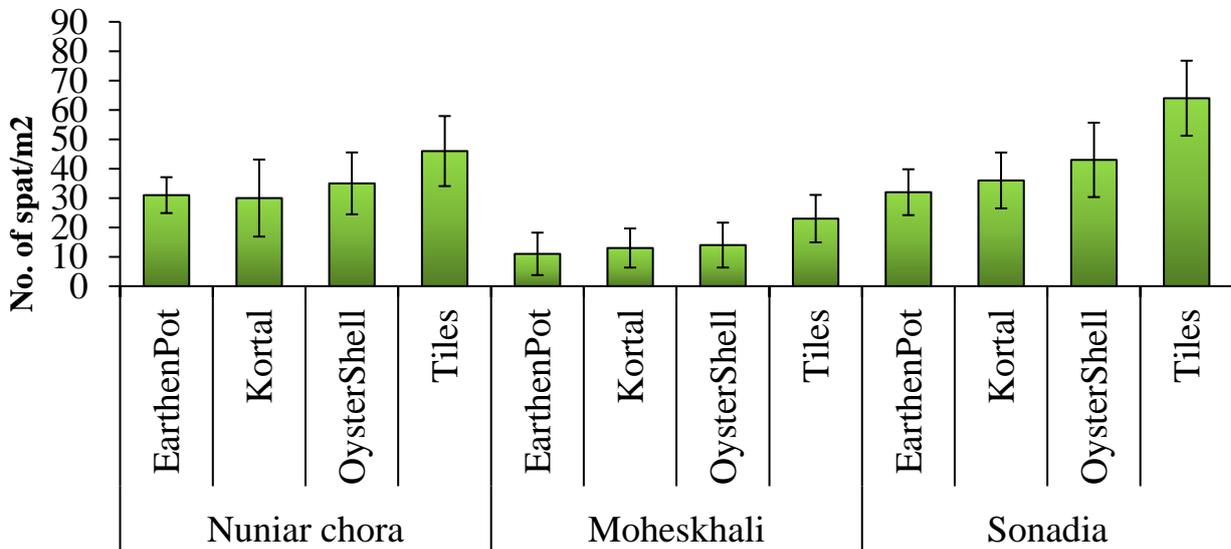
(each with 10-12 cm gap) into 1.5 m length roof. Three sets for each sets (oyster shell, kortal and tiles) were hanged the Choufaldandi. After the settlement of Clutch materials, a regular monitoring was done for every 15 days interval and Water quality data also recorded.



Fig 3. Settlement of Spat on clutch materials

Table 1. Water quality data of the culture sites

Parameter	Choufaldandi	Bakkhali
Water temperature	26-32°C	25-33°C
Salinity	25-30 ‰	27-30 ‰
pH	7.4-8.7	7.5-8.3
Dissolved oxygen	4.4-4.7 mg/l	5.2-5.9 mg/l



Locations and collectors

Figure 1: Mean density of oyster spat at different collectors and locations in the coast of Bangladesh

Study-2 Development of breeding techniques of oyster in captivity:

Brood oysters were collected from Sonadiabridge, Cox'sbazar and Kutubdia. A total number of 120 oyster broods namely *Crassostrea sp* were bought into Marine fisheries and technology station, BFRI. For feeding, live feed were used at the rate of 2-3 L with cell concentration of 1.5-2 million cells/ml daily. Mixed algae such as *Skeletonema costatum*, *Isochrysis galbana*, *Chaetoceros gracilis*, *Tetraselmis sp.*, *Nanochloropsis culata* were provide as feed where *Nanochloropsis sp.* was predominant. A regular checkup of Water quality parameter was done and water exchange was done weekly. Survival rate was 85%. Gonadal development is being monitor regularly for taking necessary step for breeding purpose. But the development of maturation was very poor. It means that we should collect brood from the wild before the breeding trial.

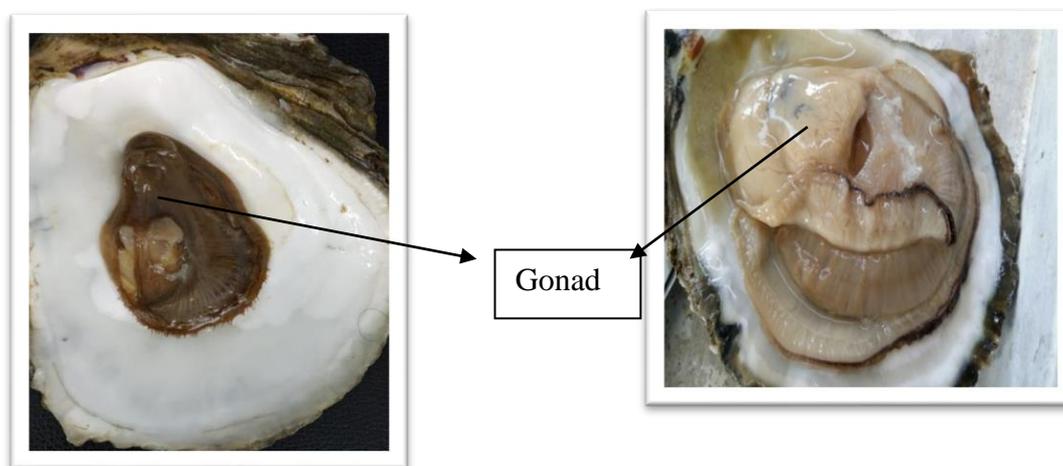


Fig.6 Poor maturation of oyster rearing in hatchery
wild

Fig. 7Matured oyster (Gonad) from wild

Study-3 Development of larval rearing techniques of oyster:

Larval rearing tank was setup and all facilities were setup. After sacrificing of male and female oysterthe larvae will transfer to the Larval rearing tank (LRT).

Investigation on the spawning season of commercially Important marine fishes of the Bay of Bengal, Bangladesh coast**Researchers**

Dr. Shafiqur Rahman, Principal Scientific Officer & PI
Ahmad Fazley Rabby, Senior Scientific Officer
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Mohammad Khairul Alam Sobuj, Scientific Officer
Md. Golam Mostofa, Scientific Officer

Objectives

- To estimate the spawning & peak spawning season and size at sexual maturity of commercially important marine fishes and shellfish;
- To measure the egg diameter, total egg in gonad and Spawning Stock Biomass (SSB) of commercially important marine fishes;
- To assess Spawning Potential Ratio (SPR) and total spent marine fishes after imposing banned period;
- To analyze hard part (otolith) for age estimation of commercially important marine fishes of Bangladesh;
- To justify the existing imposed banning period for commercially important marine fishes and shellfish in the Bay of Bengal.

Achivements

Estimation of Spawning- and peak-spawning season, relationship between total length and monthly variations of length at first sexual maturity of 9 species such as *Congresox talabon* (Kamila), *Dussumieri acuta* (Nailla), *Ilisha filigera* (Dhela), *Acanthoepgrus berda* (Datina), *Coilia dussumieri* (Alua), *Scomberoides commersonianus* (Surma), *Sardinella fimbriata* (Takia) *Arius arius* (Gujja), *Peneaus monodon* (Bagda) were estimated. The observed results are presented in Table 1.

Table 1. Relationship between total length and Lm

Name of the fish	Relation between Total Length and GSI% graphically	Size at sexual maturity
Bagda (tiger Shrimp) <i>Peneaus monodon</i>	The GSI rose sharply at the length of 16.5 cm total length (TL) with a GSI (%) ≥ 2.0 , which indicates its size at sexual maturity	16.5 cm
Datina (Goldsilk sea bream) <i>Acanthoepgrus berda</i>	The GSI rose sharply at the length of 12.4 cm total length (TL) with a GSI (%) > 2.0	12.4 cm
Kamila (Yellow pike conger) <i>Congresox talabon</i>	The GSI rose sharply at the length of 54.87 cm total length (TL) with a GSI (%) > 2.0	54.87 cm
Nailla (Rainbow sardine) <i>Dussumieri acuta</i>	The GSI rose sharply at the length of 10.72 cm total length (TL) with a GSI (%) > 1.0	10.72 cm
Dhela/ faissa (Coromandel ilisha) <i>Ilisha filigera</i>	The GSI rose sharply at the length of 44.13 cm total length (TL) with a GSI (%) > 2.0	44.13 cm
Alua (Goldspotted grenadieranchovy) <i>Coilia dussumieri</i>	The GSI rose sharply at the length of 12.90 cm total length (TL) with a GSI (%) > 1.0 .	12.90 cm

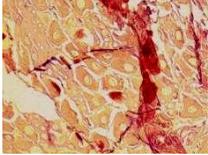
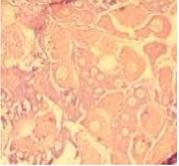
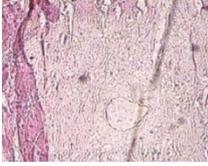
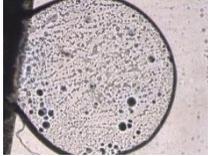
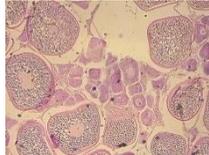
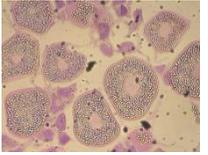
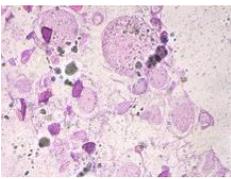
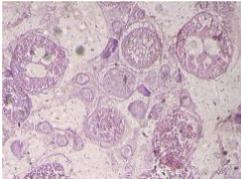
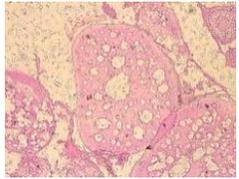
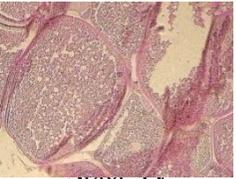
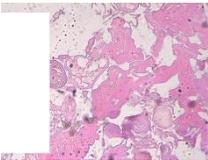
Surma (Needle scaled queen fish) <i>Scomberoides commersonianus</i>	The GSI rose sharply at the length of 22.70cm Total length (TL) with a GSI (%) > 3.	22.70 cm
Takia (Fringescalesardinella) <i>Sardinella fimbriata</i>	The GSI rose sharply at the length of 13.22 cm Total length (TL) with a GSI(%) > 2.0	13.22 cm
Gujja (Threadfin sea catfish) <i>Arius arius</i>	GSI rose sharply at the length of 25.8 cm Total length (TL) with a GSI (%) > 2	25.8 cm

About total 98 (male=10 and female=88) individuals of *Penaeus monodon* were examined. Estimated size at sexual maturity was at the length of 16.5 cm (Total Length; TL). Total 85 (male= 20 and female=65) individuals of *Acanthopogon berda* were examined. Estimated size at sexual maturity was at the length of 12.4 cm (TL). Total 87 (male=17 and female=70) individuals of *Congresox talabon* were examined. Estimated size at sexual maturity was at the length of 54.87 cm (TL). Sum of 85 (male=20 and female=65) individuals of *Arius arius* were examined. Estimated size at sexual maturity was at the length of 25.8 cm. About 98 (male=18 and female=80) individuals of *Coilia dussumieri* were examined. Estimated size at sexual maturity was at the length of 12.90 cm (Total Length; TL). About 83 (male=21 and female=62) individuals of *Dussumieri acuta* were examined. Estimated size at sexual maturity was at the length of 10.72 cm (TL). About 86 (male=15 and female=71) individuals of *Ilisha filigera* were examined. Estimated size at sexual maturity was at the length of 44.13 cm (TL). About 54 (male=11 and female=43) individuals of *Scomberoides commersonianus* were examined. Estimated size at sexual maturity was at the length of 22.70. About 86 individuals of *Sardinella fimbriata* were examined, where 18 were male and rest of were female. Calculated size at sexual maturity was at the length of 13.22 (Table 1).

Table 1: Descriptive statistics and assessed parameters of length–weight relationships ($BW = a \times TL^b$) for eight commercially important fishes and shrimp in Bay of Bengal, Bangladesh during July 2020 to June 2021.

Species	NO.	Total length (TL)			Body weight (g)			Regression parameter		95% CL of a	95% CL of b	r^2	t_s
		Min	Max	Mean±SD	Min	Max	Mean±SD	a	b				
<i>Penaeus monodon</i> (Fabricius, 1798)	98	4	7.5	5.932±1.101	48	239	123±45.23	2.079	2.249	1.89-2.18	2.094-2.482	0.767	-5.93
<i>Acanthopogon berda</i> (Valenciennes, 1830)	85	17	20.4	18.85±1.07	71	131	98.1±17.62	0.013	3.108	0.0106-0.0141	2.98-3.21	0.87	0.58
<i>Congresox talabon</i> (Cuvier, 1829)	87	61	107	77.97±15.25	257	1946	753.18±93.19	0.001	2.94	0.0009-0.0012	2.760-3.23	0.87	-1.519
<i>Arius arius</i> (Hamilton, 1822)	85	38	47	48.05±19.74	1110	2264	1820.1±346.27	0.001	3.09	0.0009-0.0014	3.01-3.12	0.96	4.58
<i>Coilia dussumieri</i> (Valenciennes, 1848)	98	18.5	22	20.12±1.23	24	36	30.93±3.59	0.0087	2.57	0.0056-0.0112	2.34-2.95	0.967	-0.65
<i>Dussumieri acuta</i> (Valenciennes, 1848)	83	15	18	16.87±0.82	40	58	47.82±5.54	0.011	2.81	0.0074-0.0113	2.91-3.033	0.86	-0.92
<i>Ilisha filigera</i> (Valenciennes, 1848)	86	28.4	37	31.12±1.83	191	342	241±39.33	0.0037	3.13	0.0021-0.0067	2.960-3.303	0.89	1.519
<i>Scomberoides commersonianus</i> (Cuvier, 1832)	54	30	40.8	34.88±3.062	206	406	274.75±57.11	0.012	2.854	0.0068-0.0123	2.61-2.97	0.89	-0.32
<i>Sardinella fimbriata</i> (Valenciennes, 1848)	86	8.37	15.7	15.2±2.65	17	26	25±2.98	0.0097	2.87	0.0078-0.011	2.78-2.97	0.78	-0.23

Histological study of Marine species during January –May 2021:

Species	January	February	March	April	May
<i>(Penaeus monodon)</i> Bagda (Fabricius, 1798)	 Stage I	 Stage I	 Stage II	 Stage II	 Stage V
<i>Acanthopogon berda</i> (Valenciennes, 1830)	 Stage II	 Stage III	 Stage III	 Stage III	 Stage IV
<i>Congresox talabon</i> (Cuvier, 1829)	 Stage II	 Stage III	 Stage III	 Stage IV	 Stage IV
<i>Dussumieri acuta</i> (Valenciennes, 1848)	 Stage II	 Stage III	 Stage III	 Stage III	 Stage III

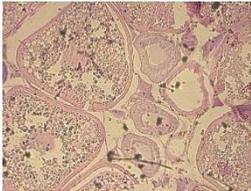
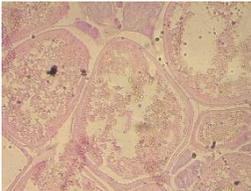
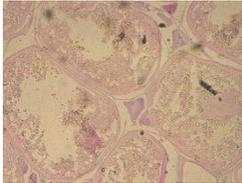
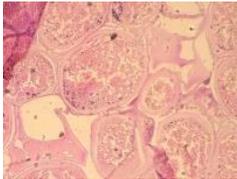
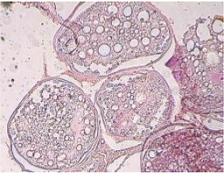
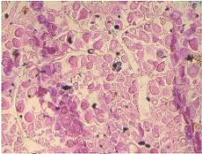
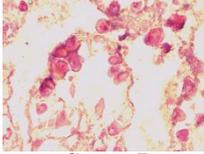
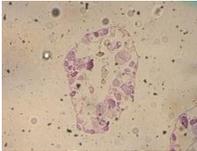
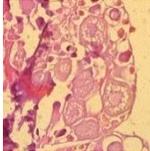
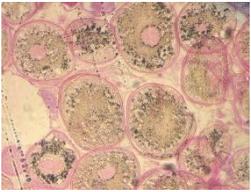
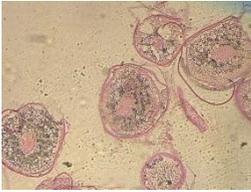
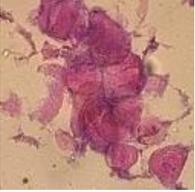
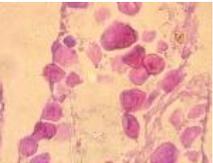
Species	January	February	March	April	May
<i>Ilisha filigera</i> (Valenciennes, 1848)	 Stage III	 Stage IV	 Stage V	 Stage III	 Stage III
<i>Scomberoides commersonianus</i> (Cuvier, 1832)	 Stage I	 Stage I	 Stage I	 Stage II	 Stage V
<i>Coilia dussumieri</i> (Valenciennes, 1848)	 Stage III	 Stage III	 Stage I	 Stage I	Not done yet Still working

Fig. 2 GSI values of commercially important of marine fishes in monthly basis

Egg diameter of Marine fishes:

The egg diameter of Marine fishes illustrates that, fishes were not reached at Ovulate stage. They need more time to develop their eggs. The egg diameter of some species were given below

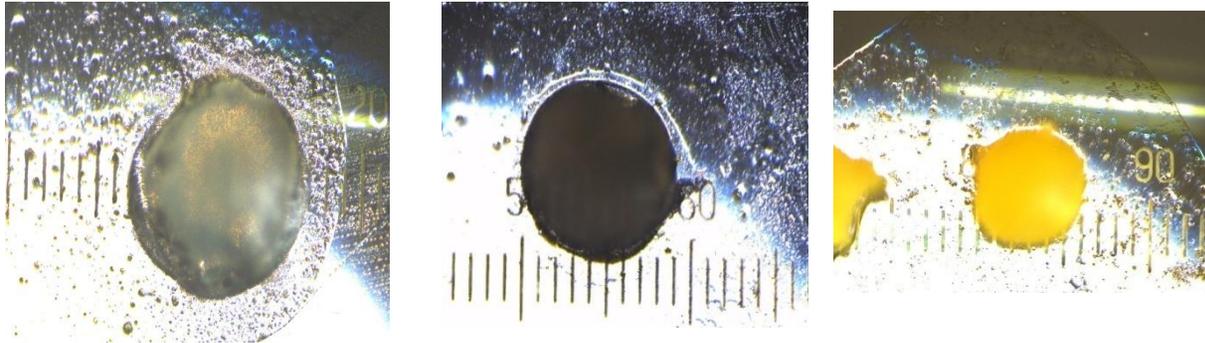


Figure: Egg diameter of *Congresox talabon*, *Acanthopegrus berda* & *Ilisha filigera*

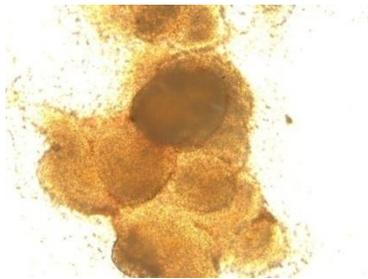


Figure: Microscopic gonad cell observation of *Penaeus monodon*



Figure: Eggs of *Arius arius* in petridish

Development of Mariculture Practices of Some Important fin fishes (Seabass, Mullet) in the South-East Coast of Bangladesh

Researchers: Ahmad Fazley Rabby, Senior Scientific Officer & PI
 Mohammad Khairul Alam Sobuj, Scientific Officer
 Golam Mustafa, Scientific Officer

Objectives

- To develop a proper nursery and grow-out management protocols for cage culture suitable species (Mulletts, Seabass)

- To optimize stocking density, analyze growth, mortality and production in the period of cage rearing
- To develop proper cage culture technique and piloting mariculture practices with co-management

Achievements

Study 1: Preparation of nursery ponds and development of proper nursery and grow-out management protocols for cage culture suitable species i.e mullets and seabass.

Pre-stocking cage culture activities were executed by two ways-

i) Nursery pond management for fingerlings of Seabass and Mullet

Nursing is so much important stage for the growth and development of any fishes and it lies between 1-3 months which varies from species to species. In case of saline water or euryhaline fishes it is utmost important for growth and acclimatization. Because wild fingerlings need to be domesticated in low or less saline condition in the nursery pond of MFTS, Cox's Bazar and those will further re-stock in the sea-cages. For this reason, two on-station ponds were selected and prepared for nursing in where first one dedicated for Seabass fingerlings and other belonged to Mullet fingerlings. But still now, mullet was not survived in pond due to rough handling of fries during releasing. In addition, at the same time another two were also selected and prepared for grow-out unit in where collected juveniles or sub-adults were stocked for domestication.

The collection of wild fingerlings of Seabass (size ranged 8-10cm, 15-20gm) was started from July, 2020 and continuing to till date from the nearby seashore, estuarine areas and channels i.e. Rejukhal, Cox's Bazar, Maheshkhali channels, Naf estuarine areas etc. After collection, live fishes were transported to the MFTS pond complex by using oxygenated polybags for nursing and acclimatization. For nursing purposes, two (10 decimal sized) nursery ponds-equal in depth, configuration and pattern having well-equipped water supply facilities also well-organized inlet and outlet system to maintain saline water level were used. The water depth was maintained at a maximum of 1.2 m. Before stocking, both ponds were prepared by maintaining the following protocols-

At a glance nursing activity -

- Ponds were re-excavated i.e., removal of bottom clay, dyke repaired, removal of trash fish and aquatic weeds etc.
- Liming with 500g agricultural lime and inorganic fertilization e.g., Urea (100g) & TSP (50g) applied before stocking
- Tried to maintain salinity at least 5ppt in each treatment pond
- Source of water: Transported seawater from nearby sea by 1000-liter tank through truck

- Used feed: Floating starter feed (Mega) containing 35% protein with supplementing some trash fish (e.g. tilapia fry and fingerlings) for Seabass and 0.5% Vitamin- Mineral premix.
- Sampling : Every 15 days interval (growth and health monitoring).
- Water quality data : Collected periodically (15 days interval).



Figure: Monthly sampling of Seabass (*Lates calcarifer*) and *Mugil cephalus* in MFTS pond Complex

Periodically monitoring of water quality factors (water temperature, salinity, dissolved oxygen, free carbon dioxide, alkalinity, pH and ammonia) and fish's health status (appearance, length and body weight) were monitored.

Table 03: Monitored water quality parameters of nursing units in last six months are as follows--

Species/ N. Ponds	Factors	Jan./21	Feb./21	March/21	April/21	May/21	June/21
Seabass (N. Pond 1)	Avg. Water depth (cm)	112.5	110.1	109.6	107.5	110.1	112.6
	Temp. (°C)	19.4-22.1	18.8-21.9	20.7-25.5	22.8-26.2	24.9-30.5	26.7-30.9
	Transparency (cm)	41.6-43.7	39.4-41.3	38.8-40.5	38.8-39.5	35.8-38.6	36.4-37.5
	pH	7.9-8.6	8.1-8.4	7.9-8.5	7.6-8.9	7.5-8.2	7.1-8.5
	DO (mg/l)	4.7-5.8	5.2-6.3	5.4-6.1	4.7-5.8	5.2-6.3	5.4-6.1
	CO ₂ (mg/l)	3.4-3.8	3.3-3.7	3.2-3.6	3.5-3.9	3.4-3.8	3.1-3.9
	Ammonia	nil	nil	nil	nil	nil	nil
Seabass (N. Pond 2)	Avg. Water depth (cm)	111.5	110.9	108.4	109.5	110.7	114.9
	Temp. (°C)	19.4-22.7	18.8-21.1	20.9-26.1	23.1-26.8	25.1-30.9	27.1-31.4
	Transparency (cm)	41.1-42.4	39.3-40.5	38.7-39.8	37.8-41.4	34.3-37.5	32.7-36.8
	pH	7.6-8.1	8.0-8.5	7.7-8.1	7.3-8.6	7.9-8.5	7.7-8.8
	DO (mg/l)	5.8-6.1	5.3-5.8	5.1-5.6	5.2-6.1	4.9-5.9	5.1-5.7
	CO ₂ (mg/l)	3.2-3.9	3.5-4.1	3.9-4.2	3.0-3.5	3.1-3.8	3.3-3.9
	Ammonia	nil	nil	nil	nil	nil	nil

ii) Grow-out pond management for juveniles and sub-adults of Seabass

Transfer of any live eury-haline fishes from wild source to off-shore cages is the key part especially for brackish water environment which require satisfactory adjustment of fishes. Grow-out pond management for juveniles and sub-adults rearing is another important step for growth and adaptation of fishes which will further re-stock in the sea cages and it lies several months that varies from species to species. Because wild juveniles need to be domesticated in low or less saline condition in the on-station nursing unit and those will further re-stock in the sea-cages. For this reason, two on-station grow-out ponds were prepared for initial stocking of juveniles and sub-adults in where first one dedicated to Sea-bass and other belonged to Mulletts.

Sea –cage settling activities are as follows:

The over-all cage settling activities were started from the month of May, 2020 and initially three cages were prepared at the selected point of Maheshkhali Channel. In late January, fishes were transferred in the net cages of Maheshkhali channel. The status of the fixed cage was as follows-

- **Shape:** Round
- **Inner Diameter:** 6 meters
- **Outer Diameter:** 7 meters
- **Depth:** 1 meter
- **Frame:** 110 mm HDPE Pipe were used
- **Body Net:** Nylon net 40 mm Mesh size were used
- **Cover Net:** Nylon net 20mm Mesh Size were used
- **Float:** Concealed Plastic Drum-Length 990 mm were used
- **Rope:** Green fabricated Nylon 1.5inch diameter thick rope used for mooring
- **Mooring:** 4 nos. of 50 kg weighted mooring were used for fixing the cage

Cage culture activities:

The seabass (*Lates calcarifer*) and Mulletts (*Mugil cephalus*) were stocked at 20-25 January 2021 and till date the stocked fishes were in good condition.

Table 1: Growth performance and survival of Sea-bass and Mullet after 78 days reared in net cages

Parameter	Cage 1 60 Seabass / Cage	Cage 2 46 Mullet / cage	Cage 3 40 Mullet / cage
Initial length (cm)	20.4±4.40	30.4±4.79	30.4±4.98
Final length (cm)	24.8±1.039	35.43±3.606	35.75±0.5
Net length gain (cm)	4.4	5.03	5.35
Initial weight (g)	176±4.12	556±32.57	567±24.24
Final weight (g)	417.6±14.6	802.44±41.50	856.4±37.01

Net weight gain(g)	241.6	246.44	289.4
Feeding	Chopped tilapia	Natural feed	Natural feed
Survival rate (%)	68	76	85

The growth performances of seabass (*Lates calcarifer*) and Mulletts (*Mugil cephalus*) in different stocking densities have been depicted in the Table 1. This result specifies higher growth in weight (g) at circular cage with lower stocking densities and the growth rate progressively decreased with increasing densities.

Table 2. Water quality data of the culture sites (Cages)

Factors	February/21	March/21	April/21
Temp. (°C)	26.4—27.1	26.8—28.9	28.7—29.5
Transparency (cm)	41.6-43.7	39.4-41.3	38.8-40.5
pH	7.9-8.6	8.1-8.4	8.0-8.5
DO (mg/l)	5.7-6.8	5.2-6.3	5.4-6.6
CO ₂ (mg/l)	3.4-3.8	3.3-3.7	3.2-3.6
Ammonia (mg/l)	nil	nil	nil

Brackishwater Station, Paikgacha, Khulna

Enhancement of brood stock development and culture of mud crab (*Scylla olivacea*)

Researchers Dr. Md. Latiful Islam, Principal Scientific Officer & PI
Md. Motiur Rahman, Senior Scientific Officer
Shawon Ahmmed, Scientific Officer

Objectives

- To develop gonad maturation of mud crab, *Scylla olivacea* both in earthen ponds and hatchery conditions,
- To uplift the survival of crab larvae at different larval stages and improvement of crab seed production,
- To enhance culture and fattening of mud crab in coastal areas.

Achievement

Experiment-1: Evaluation of different male-female rations on growth, survival and intactness of sub-adult to adult mud crab (Winter season)

To determine the impact of different male-female rations on growth, survival and intactness of mud crab, experiment was conducted in earthen ponds of Brackishwater station, Paikgacha, Khulna. The experiment was conducted during the commencement of winter (November-2020) and continued for 105 days up to the end of winter season. The experiment was designed with three treatments depending on the variations of male-female ratios viz, M:F= 1:1 (T1); M:F= 1:2 (T2) and M:F= 1:3 (T3). Three replications for each treatment were assigned and stocking density was 2/m². Selected ponds were prepared following drying, removal of bottom sludge, fencing with nylon net and liming. The pond was divided into 9 sub-divisions partitioning with bamboo fence (*Bana*) and nylon net to set adequate replications. The pond was filled with tidal water at a depth of 1 meter. After that, required quantity of crablet (sub-adult) was collected stocked according to the experimental design. The crabs were fed with chopped trash fish and mussel meat @ 4-5% of the biomass twice daily. Growth performance of crabs was monitored weekly basis and feeds were adjusted accordingly. Water quality parameters like, temperature, salinity, pH, dissolved oxygen and ammonia was monitored after every 7days interval following the standard methods. The experiment was conducted for a period of 105 days. Records on growth, survival and intactness were estimated after harvesting.

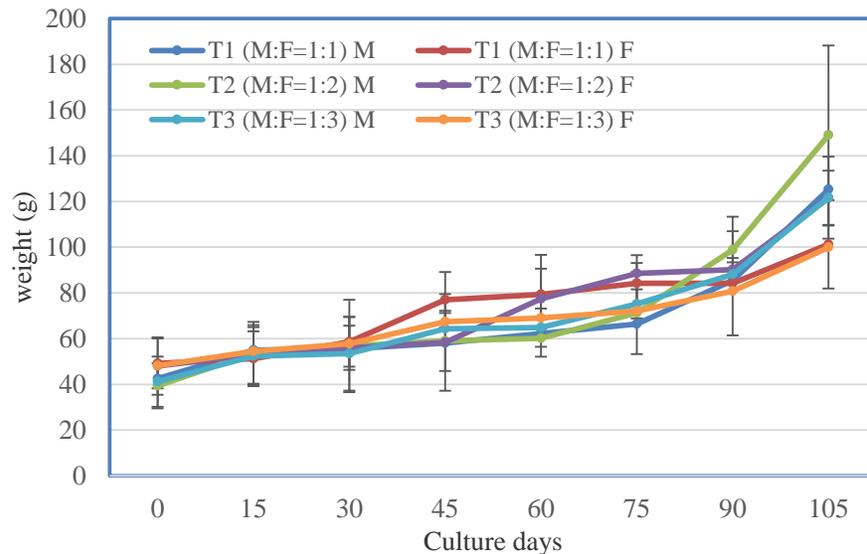


Fig. 1: Growth increment of mud crab under different male-female combinations (Winter season)

Growth increment showed similar size at stocking, the growth increment was uniform up to 30 days and started to be varied between treatments and between sexes. However, highest growth increment was noticed in case of male in T2 (M:F=1:2) followed by T1 and T3 for the same

sexes. Females had slower growth increment in comparison to that of the male in all the treatments (Fig. 1).

Table 1: Water quality variables of experimental ponds for different male-female ratio of mud crab (Winter season)

Treatments (Male:Female)	Replication	Temperature (°C)	pH	Salinity (ppt)	DO (mg/l)	Alkalinity (mg/l)
T1 (1:1)	T1R1	17.0-26.5	7.8-8.6	4.0-6.0	4.5-6.5	175-220
	T1R2	17.0-26.8	7.8-8.7	4.0-6.0	4.6-6.8	180-210
T2 (1:2)	T2R1	17.0-26.6	7.8-8.4	4.0-6.0	4.5-6.5	180-220
	T2R2	17.0-27.0	7.8-8.6	4.0-6.0	4.7-6.6	170-220
T3 (1:3)	T3R1	17.0-26.5	7.8-8.5	4.0-6.0	4.4-6.7	170-210
	T3R2	17.0-27.0	7.7-8.6	4.0-6.0	4.5-6.8	180-220

The experiment was initiated in November 2020 at existing low temperature (17-27 °C) and low salinity (4.0-6.0 ppt) in all the treatments (Table 1). Other water quality variables seemed congenial for crustacean culture like mud crab.

Table 2: Growth, survival and intactness of mud crab under different male-female ratios (Winter season)

Treatment	Initial weight (g)	Survival (%)	Intactness (%)	Final Weight (g)
T1 (M:F=1:1)	45.83±4.35	38±8.0	78±6.0	113.8±3.86
T2 (M:F=1:2)	43.67±1.92	46±6.0	72±9.0	135.22±19.25
T3 (M:F=1:3)	44.67±1.48	42±10.0	70±8.0	110.77±4.34

As presented in Table 2, final body weight (135.22±19.25 g) was highest in T2 (M:F=1:2) followed by T1 (113.8±3.86 g) and T3 (110.77±4.34 g). Likelihood to the growth, survival was also highest (46±6.0 %) in T2 followed by T3 (42±10.0 %) and T1 (38±8.0 %). Meanwhile, highest (78±6.0 %) proportion of intactness was observed in T1 followed by T2 and T3. Overall result of the experiment indicated that 1:2 male-female ratios provided better survival and body weight gain. The experiment was conducted during extremely low temperature and low salinity period. However, the experiment needed to be repeated during other (Summer and wet) seasons to achieve a refined scenario on grow out of mud crab under different male-female ratios.

12.2 Experiment-2: Evaluation of different male-female ratios on growth, survival and intactness of sub-adult to adult mud crab (Dry/summer season)

The previous experiment was repeated during the dry/summer season. Overall pond preparation was similar to that of the 1st experiment. Stocking was done in March 2021 with juvenile crabs having initial weight of 43.33 g, 43.33 g and 44.50 g in T1, T2 and T3, respectively. Feeding was done with chopped trash fish and mussel meat @ 4-5% of the biomass twice daily. Growth performance of crabs was monitored fortnightly basis and feeds were adjusted accordingly. Water quality parameters like, temperature, salinity, pH, dissolved oxygen, total alkalinity and ammonia was monitored after every 15 days' interval following the standard methods. After 105 days of rearing, crabs were harvested by pond drying and records on growth, survival and intactness were estimated.

Table 3: Water quality variables of experimental ponds for different male-female ratio of mud crab (Dry/summer season)

Treatment	Temperature (°C)	Salinity (ppt)	pH	Depth (cm)	Alkalinity (ppm)	DO (ppm)	Ammonia (ppm)
T1	28.4-37.5	10-17	8.5-8.8	85	98-110	5.3-8.2	0.0
T2	28.1-37.4	10-17	8.7-8.9	88	109-112	5.6-8.4	0.0
T3	28.4-37.6	10-18	8.6-8.8	85	98-112	5.6-8.1	0.0

Initially water temperature in all the treatment was very congenial level (28.1 to 28.4 °C). However, water temperature gradually increased and reached to extremely high level (37.4 to 37.6 °C) at middle of culture period (Table 3). Other water quality variables were within the acceptable ranges of crustacean culture like mud crab.

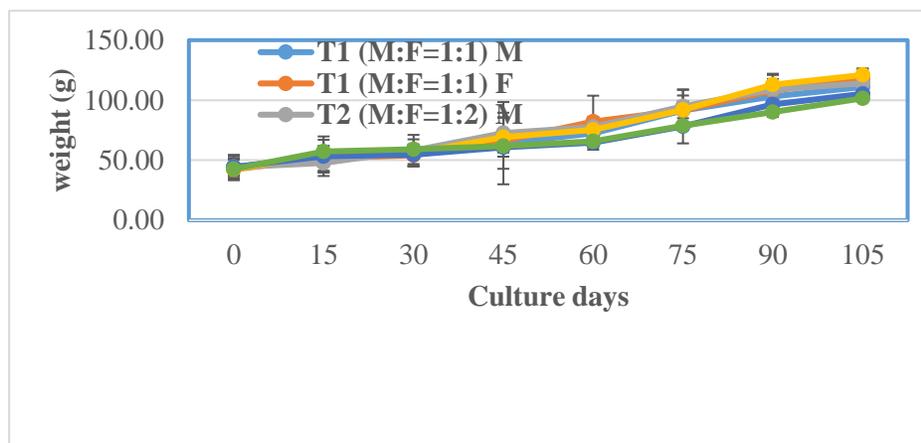


Fig. 2: Growth increment of mud crab under different male-female combinations (Dry/summer season)

Growth pattern of crabs has been illustrated in Fig. 2, both the sexes showed continuous growth in all the treatments. However, females of T3 showed the lowest growth and that of in T2 showed the highest growth. Males in all treatments exhibited moderate growth for entire culture period (Fig. 2).

Table 4: Growth, survival and intactness of mud crab under different male-female ratios (Dry/summer season)

Treatment	Initial weight (g)	Survival (%)	Intactness (%)	Final Weight (g)
T1 (M:F=1:1)	43.33±3.37	21±6.0	68±6.0	114.29±1.57
T2 (M:F=1:2)	43.33±1.96	22±5.0	70±8.0	117.50±1.95
T3 (M:F=1:3)	44.50±1.37	18±7.0	70±9.0	103.43±2.32

As summarized in Table 4, final body weight (117.50±1.95 g) was highest in T2 (M:F=1:2) followed by T1 (114.29±1.57 g) and T3 (103.43±2.32 g). Likelihood to the growth, survival was also highest (22±5.0 %) in T2 followed by T1 (21±6.0 %) and T3 (18±7.0 %). Meanwhile, highest (70 %) proportion of intactness was observed in T2 and T3, respectively. Survival in this repeated trial was remarkably lower than the previous. Gradual mortality was observed in all the treatments and the mortality reached to the critical level as the weather temperature exceeded 34 °C due to prolonged draught. Despite the crucial temperature level during the experiment, survival, intactness and body weight gain was higher in T2, and coincided the findings of the previous trial. However, the experiment is aimed to be repeated during the rainy/and wet season with similar protocols.

12.3 Experiment-3: Evaluation of different male-female ratios on growth, survival and intactness of sub-adult to adult mud crab (Rainy/wet season)

The 1st experiment was further repeated with same protocol as earlier for the rainy/wet season from July onwards to achieve through information on grow out culture of mud crab and to have the environmental effects on culture practice irrespective of stocking at different male-female ratios.

Table 5: Growth of mud crab under different male-female ratios during the rainy/wet seasons

Treatments	Male-Female Ratio	Replication	Initial weight Mean + SD		Final Weight Mean + SD	Final Weight Mean + SD
			Male (gm)	Female (gm)	Male (gm)	Female (gm)
T1	1:1	T1R1	12.3±10.21	18.48±7.13	129.33. ±20.22	149.33±10.99
		T1R2	12.3±10.21	18.48±7.13	140.11±13.50	145.66±8.34

T2	1:2	T2R1	14.5±9.54	20.24±4.83	82.11±9.31	115.27±20.55
		T2R2	14.5±9.54	20.24±4.83	52.11±21.20	70.33±15.99
T3	1:3	T3R1	13.6±8.16	17.39±5.95	109.66±16.10	98.66±22.43
		T3R2	13.6±8.16	17.39±5.95	129.12±26.10	111.37±28.22

Stocking was done with smaller crabs collected from nearby river. Stocked crabs has average weight of 12.3 to 14.5 g for the male and 17.39-20.24 g for the female (Table 5). Crabs attained an average weight of 52.11 g to 140.11 g for male and 70.33 to 149.33 g for the females (Table 5). Though the water salinity was around 16 ppt at stocking, but gradually dropped to 5 ppt due to seasonal rain (Table 6). The experiment is in ongoing condition and harvesting will be done at the end of October, 2021. Data will be analyzed for all three seasons and a clear scenario will be found out for grow out culture of mud crabs with different male-female ratios.

Table 6: Water quality variables of experimental ponds for different male-female ratio of mud crab (Rainy/wet seasons)

Treatments (Male:Female)	Replication	Temperature (°C)	Water pH	Salinity (ppt)	Alkalinity (mg/l)
T1 (1:1)	T1R1	28.3-30.5	7.8-8.4	16-5	92-118
	T1R2	28.1-30.5	7.8-8.5	16-5	96-118
T2 (1:2)	T2R1	27.9-30.5	7.8-8.6	16-5	90-110
	T2R1	28.0-30.5	7.8-8.4	16-5	94-110
T3 (1:3)	T3R1	28.2-30.5	7.8-8.6	16-5	90-130
	T3R2	28.3-30.5	7.7-8.4	16-5	98-130

Experiment-4: Effect of introducing of juvenile crabs in rice field on growth, survival and production

To observe the feasibility of crablet nursery and grow out in rice field an experiment is being conducted in rice field conditions during this *Aman* paddy season. Rice fields and related farmers have been selected from different locations of Paikgacha region. The experiment has been designed with 3 treatments depending on stocking densities, viz, 50 crab/decimal (T1); 75 crab/decimal (T2) and 100 crab/decimal (T3). Each of the treatment has five replications. An area of 8 decimals was selected from each rice field. The selected area was encircled accordingly with bamboo split (bana) fencing along with nylon net to prevent the crabs from escaping through burrowing. Total area of each farm was equally subdivided into three parts and encircled with bana and nylon net to ensure sufficient replicates. Each of the farm contains a peripheral canal of 2-3 meter-width and with a depth of 0.5 meter below the rice field level. Half of the crab culture area of each plot contains rice, meanwhile the rest was canal. Rice field was prepared accordingly and rice seedlings was planted prior to 15 days of crab stocking.

Juvenile crabs weight (BW) ranged from 23.40 to 40.13 g and carapace width (CW) ranged from 4.4 to 5.8 cm were collected from the supplier. Collected juveniles were acclimatized to the rice field conditions and were randomly stocked to each replicated plots to minimize initial size variation among the treatments. Feeding has been done with chopped tilapia @4-5% bw in each alternate days. Partial water (30-50%) has been exchanged with tidal water from nearby Sibsha river. After 15 days of culture, crab attained an average weight of 37.40, 38.56 and 36.95 g in T1 (SD=50/dec), T2 (SD=75/dec) and T3 (SD=100/dec), respectively (Fig. 3). Water quality variables of the rice field has been illustrated in Table 7. The culture duration will be 90-120 days or up to harvesting of rice. A complete scenario will be available on growth, survival, biometric parameters and effect on rice at the end of the trial.

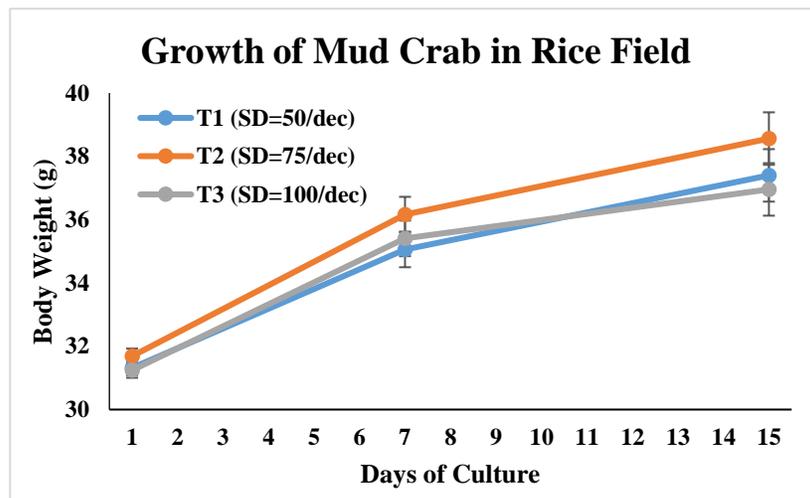


Fig. 3: Growth increment of juvenile crab in rice field under different densities

Table 7: Water quality variables of rice field for different male-female ratio of mud crab culture

Farm No.	Temperature (°C)	Salinity (ppt)	pH	Depth (cm)	Alkalinity (ppm)	DO (ppm)	Color	Ammonia (ppm)
T1	28.4	2.0	8.6	33	90	8.5	turbid	0.0
T2	28.1	2.0	8.7	38	109	8.4	turbid	0.0
T3	28.4	2.0	8.7	38	96	8.0	turbid	0.0

Discussion and conclusion

Mud crab aquaculture in Bangladesh is mainly practiced by fattening of grade failed immature gonad contained female crabs or hardening of less meaty male crabs which are not accepted for

export. All these activities are still dependent on natural source of crabs. However, very recent interventions in mud crab aquaculture is soft shell shedding and grow out of crabs.

Grow out of crab happens through molting and molting is regarded as crucial as rebirth. Predation by hunters and cannibalism by agnate subsequently reduce the biodiversity of crab population in natural resources. Moreover, for cannibalistic animals stocking density, presence of sufficient shelter and male-female ratios are regarded as major concern. During pubertal molting males guards the females up to end of successful matting. Thus, maintaining the proper male-female ratios might provide better survival and intactness. In addition, environmental factors such as water temperature and salinity plays vital role for any type of aquaculture ventures, especially for crustacean. Extremely high or low level might cause sudden death as well as mass mortality. Finding from successive trials focused that 1:2 male-female ratio provided better survival and intactness. Though, environmental parameters like extremely low and high temperature severely affected the survival rate. Sudden change of salinity and dropping of temperature due to heavy rainfall is therefore observed as another crucial factor of low survival. However, still experiments are in ongoing conditions, a comprehensive scenario will be available on growth, survival, biometric parameters and adequate male-female stocking ratios to promote the grow out aquaculture of mud crab considering the environmental parameter in coastal areas.

Photo gallery:



Fig. 1: Stocking in grow out ponds with different male-female ratios



Fig. 2: Collection of crabs from different male-female ratios for sampling



Fig. 3: Samples crabs under different male-female ratios



Fig. 4: Prepared rice field for crab nursery (site-1)



Fig. 5: Prepared rice field for crab nursery (site-2)



Fig. 6: Measurement of crabs before stocking in rice field



Fig. 7: Acclimatization and disinfection before stocking in rice field



Fig. 8: Stocking of juvenile crabs in rice field

Improvement of soft-shell mud crab (*Scylla olivacea*) culture technique of in south-west coastal region of Bangladesh

Researchers

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Objectives

- To observe the effect of environmental conditions (salinity variations and aeration) on molting efficiency of mud crab.
- To observe the effect of physical stress (limb trimming) on molting of mud crab.
- To compare the performance of soft-shell shedding between hatchery produced and natural crablets.

Achievements

Experiment 1: Effect of different salinity levels on soft-shell shedding of mud crab

The experiment was entirely conducted and repeated at old hatchery complex and earthen ponds of Brackishwater Station (BS) in Paikgacha, Khulna. Six cemented cisterns (Each Cistern 7 m²) were prepared for this experiment. The experiment was conducted with 3 treatments depending on salinity variations, viz., Treatment 1 (T1, 5 ppt), Treatment 2 (T2, 10 ppt) and Treatment 3 (T3, 15 ppt). There was a control treatment Treatment 4 (T4) in the earthen ponds under existing salinity levels. Crabs were purchased from local market and stocked according to the design as 60 crabs (1 crab/1 box) were stocked for each treatment. Chopped tilapias @5-10% bw were used as feed at every 2 days interval and 30% of tank water was exchanged in every week. Generally, crabs were monitored in every 6 hour interval for observing soft-shell shedding. Growth of crabs was monitored by naked eyes and recorded the data. Water quality parameter such as salinity, temperature, pH, dissolved oxygen, alkalinity, and ammonia were monitored regularly and recorded accordingly.

The recorded physico-chemical parameters, namely salinity, temperature, pH, dissolved oxygen, total ammonia and alkalinity of water during the culture period in this research were presented in Table 1. Generally, all the parameters of the experimental ponds and cisterns were within the acceptable ranges for brackishwater aquaculture like crab. Temperature is one of the key physical factors that affects the growth, energy flow and biological effects in marine organisms. There were found very little temperature fluctuations in experimental ponds and cisterns. The temperature of the experimental ponds ranges between 25 °C and 31°C. Salinity is considered as one of the most fundamental factors for mud crab culture. The salinity level in different experimental cisterns and ponds were observed between 5 ppt and 15 ppt according to the objective of the study in different treatments. The recorded pH of this study ranged from 6.0 to 8.0. Ammonia, dissolved oxygen, and total alkalinity levels of the experimental cisterns and ponds ranged from 0-1.5 ppm, 5-8.0 ppm, and 80-150 ppm, respectively.

Table 1. Water quality parameters of different treatments

Treatments	T1 (5ppt)	T2 (10ppt)	T3 (15ppt)	T4 (Control)
Salinity (ppt)	5	10	15	3-9
Temperature (°C)	25-28	25-28	25-28	27-31
pH	7-7.8	6.5-8.0	6.0-8.0	6.5-8.0
Ammonia (ppm)	0.0-1.5	0.0-1.0	0.0-1.5	0-0.5
Dissolved oxygen (ppm)	6.0-7.2	6.0-8.0	5.0-6.5	5.2-7.0
Total alkalinity (ppm)	90-120	100-125	80-120	80-150

As a result, salinity shortened molting duration depending on the variation of salinity level of mud crabs (Figure 1). In this experiment, it was observed that treatment 1 (5ppt) could not shorten the molting duration in indoor trials. As compared to treatment 1, treatment 3 (15ppt) shortened average molting duration by 13 days in indoor condition. In the outdoor trial (Treatment 4) took higher duration than the treatment 2 (indoor trial) by about 3 days. Besides, treatment 2 took higher shedding duration than the treatment 3.

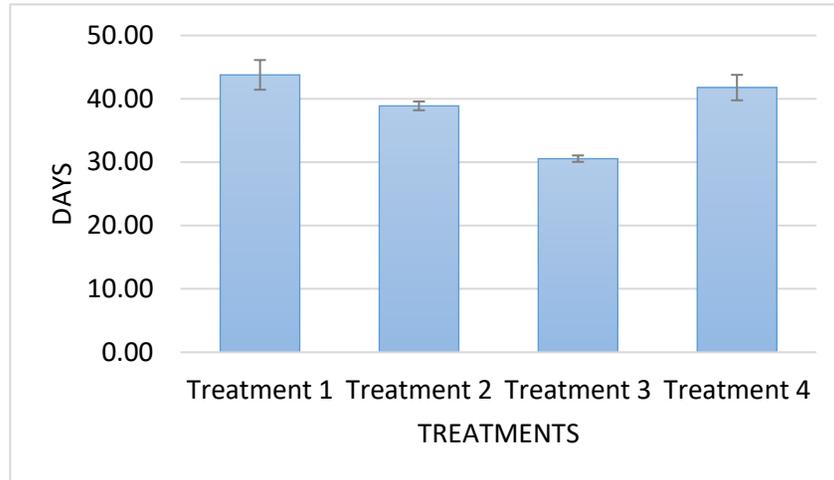


Figure 1. Showing salinity effect on the length/duration of molting period.

Effects salinity on the growth performances of soft-shell mud crabs were firstly evaluated in terms of weight increments during shedding (Figure 2). In general, salinity stress in crabs resulted in fluctuating body weights in different treatment groups. In the experiment, treatment 3 (15ppt) showed better performance in gaining body weight than other treatments. Body weight increment of crabs were found the lowest in treatment 1. The average weight gain in treatment 1, treatment 2, treatment 3 and treatment 4 were found as $37.60 \pm 0.28\%$, $45.84 \pm 0.47\%$, $55.92 \pm 2.46\%$, and $40.17 \pm 1.55\%$, accordingly (Figure 2)

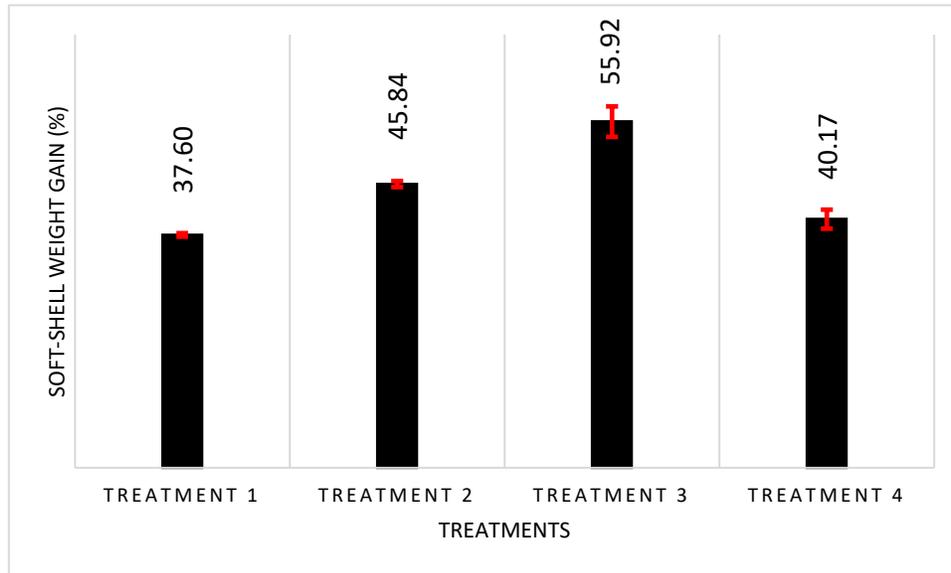


Figure 2. Effect of salinity on the weight gain of molted crabs

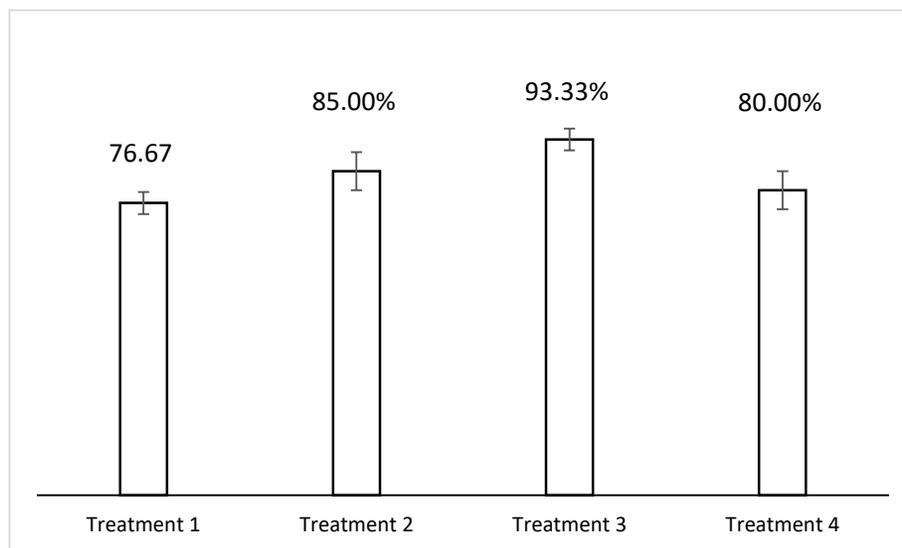


Figure 3. Effect of salinity on survival rate during the soft-shell shedding

The overall survival rate of mud crab in each treatment during soft-shell farming is presented in Figure 3. Considering salinity variations, the overall survival rate (%) of soft-shell mud crab was 76.67 ± 2.89 , 85.50 ± 5.00 , 93.33 ± 2.89 and 80.00 ± 5.00 in T1, T2, T3 and T4, respectively. The survival rate in T2 and T3 was higher than T1 and T4. The highest survival rate was identified in Treatment 3, whereas, the lowest survival rate was computed in treatment 1. High salinity level seemed suitable for the farming of soft-shell mud crab. Here, 15 ppt salinity performed well than other salinity levels among the treatments.

12.2 Experiment 2: Effect of limb removal on soft shell shedding performance of mud crab

The Experiment 2 was repeated again and fully carried out at the old hatchery complex of the Brackishwater Station in Paikgacha, Khulna. According to design, effect of limb trimming on soft shell shedding of mud crab was investigated. Six cemented cisterns (Each Cistern 7 m²) were prepared for this experiment. A constant level water salinity (15 ppt) was maintained in all cisterns as this salinity level provided better performance. The experiment was conducted with 3 treatments viz., no limb trimmed (T1), one side limb trimmed (T2) and both side limb trimmed (T3). Immature crabs were purchased and acclimated in hatchery conditions. In cisterns, 60 crabs were stocked for each treatment, while 20 individual crabs were regarded as each replication. Limbs (walking legs) of crabs were trimmed and stocked in floated boxes (one crab/box) according to the design. Almost 30% water were exchanged in every week and crabs were fed with chopped tilapia at every 2 days interval 5-10% bw. Crabs were monitored in every 6 hours interval for soft-shell shedding. Growth of crab were monitored by naked eyes and recorded the data. Water quality parameter such as salinity, temperature, pH, dissolved oxygen, alkalinity, and ammonia were monitored regularly and recorded accordingly.

Table 2. Water quality parameters of different treatments

Treatments Parameters	Treatment-1 (No limb trimming)	Treatment-2 (Single side limb trimming)	Treatment-3 (Both side limb trimming)
Salinity (ppt)	15	15	15
Temperature (°C)	26-31	26-31	26.5-30
pH	5.8-8.4	6.2-8.3	5.8-8.48
Ammonia (ppm)	0.0-1.0	0.0-1.0	0.0-1.0
Dissolved oxygen (ppm)	6.5-8.6	6-8.8	5.8-8.7
Total alkalinity (ppm)	110-160	115-150	110-180

To begin with, the recorded physico-chemical parameters, namely salinity, temperature, pH, dissolved oxygen, total ammonia and alkalinity of water during the culture period in this study were presented in Table 2. Generally, all the parameters of the cisterns were within the acceptable ranges for brackishwater aquaculture of crab in the old hatchery complex. Temperature is one of the key physical factors that affects the growth, energy flow and biological effects in marine organisms. There were found little bit temperature fluctuations in this experiment. The temperature of the experimental ponds ranges between 26°C and 31°C. Salinity is considered as one of the most fundamental factors for mud crab culture. The salinity level was kept at 15 ppt in all cisterns according to the objective of the study. The recorded pH of this study ranged from 5.8 to 8.48. Ammonia, dissolved oxygen, and total alkalinity levels of the experimental cisterns within a range of 0-1.5 ppm, 5.8-8.80 ppm, and 110-180 ppm, respectively.

The effect of lunar cycle was displayed in the figure 4. Lunar cycle was divided into four distinct phases such as first quarter - full moon, full moon - third quarter, third quarter - new moon, and new moon - first quarter. The highest molting (46.54%) was happened in the phase of first quarter - full moon. During third quarter – new moon, the percentage of mud crab shedding was 35.85. Thereafter, 12.58% shedding was occurred in the phase of full moon – third quarter. Seemingly, new moon – first quarter period was the poor schedule for shedding of mud crab during the study.

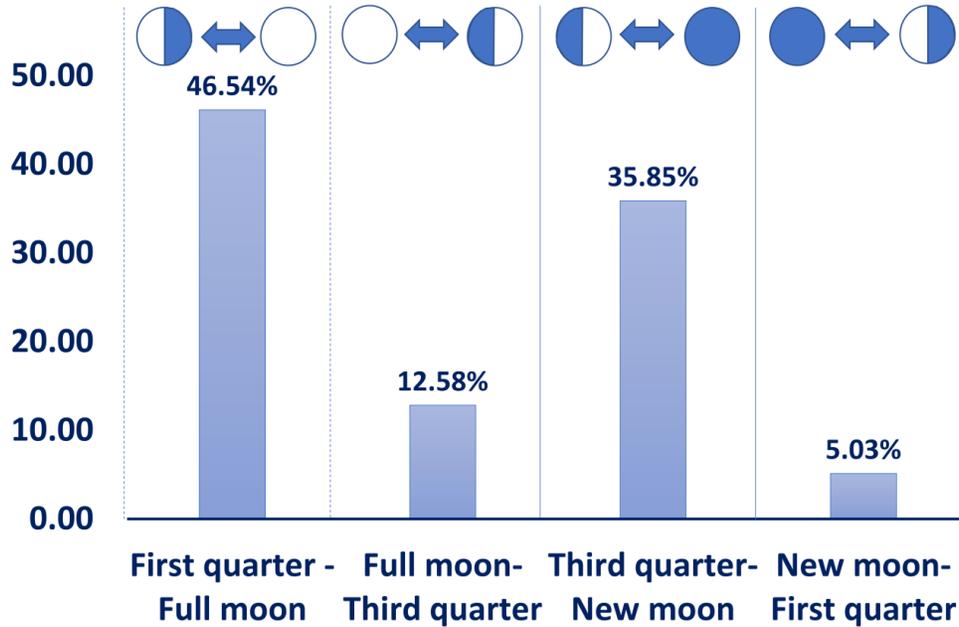


Figure 4. Effect of lunar cycle on crab shedding

Figure 5 reveals the mortality due to temperature of mud crab during shedding performance during soft-shell mud crab culture. Mortality (9.52%) initiated from the ambient water temperature at 28° C. Thereafter, it increases with an increasing trend when the temperature increases in the cemented cisterns. The highest mortality (42.86%) was recorded at 31° C during mud crab soft-shell farming. Apparently, crabs found relaxed and healthy below the temperature 28° C for culturing in the soft-shell cages in the indoor condition. Thus, no mortality was happened at the temperature of 27 ° C and lower.

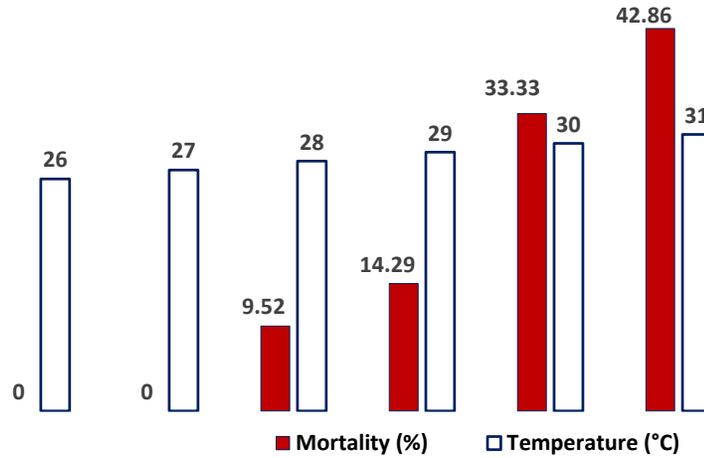


Figure 5. Effect of temperature on crab mortality

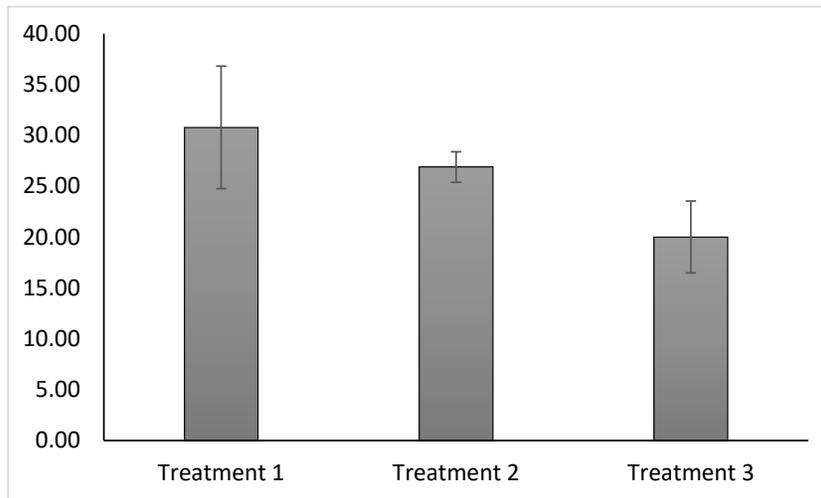


Figure 6. Effect of limb trimming on shortening shedding time in soft-shell farming

Shedding rate in different treatments is showed in the figure 6. Molting rate were quite good in terms of cutting limbs of immature crabs. Treatment 3 (both side limb cut) could have reduced the time of shedding by almost 10 days than Treatment 1. In contrast, Treatment 2 reduced around 3 days in producing soft-shell in comparison with the Treatment 1. No limb trimming (Treatment 1) took more than 30 days in yielding soft-shell crabs at cemented cistern.

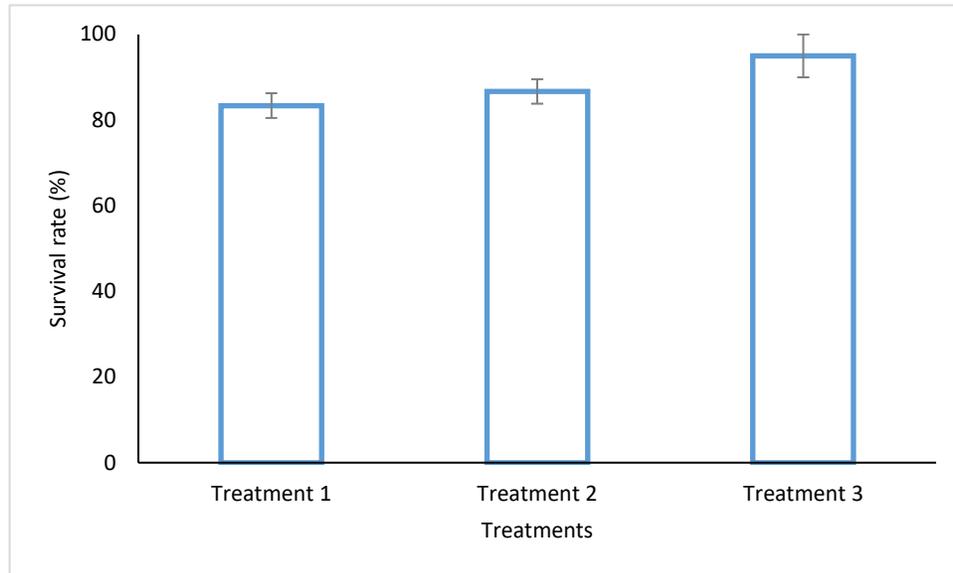


Figure 7. Effect of limb trimming on survival rate in soft-shell farming

Effect of limb trimming on overall survival rate of mud crab in treatments during soft-shell farming is presented in Figure 7. The overall survival rate (%) of soft-shell mud crab of experiment was 83.33 ± 2.88 , 86.67 ± 2.88 , and 95.00 ± 5.00 in T1, T2, and T3, respectively. The survival rate in T1 was the lowest among the all treatments, whereas, the highest survival rate was calculated in treatment 3. Limb trimming showed higher survival rate in the experiment due to reduce the required time for shedding cycle. Here, the survival rate was found close enough between the treatments, however, single or both limb trimming survived well enough among all three treatments in this study.

Experiment 3: Comparison of soft-shell shedding performance between natural and hatchery produced crablets

This experiment was conducted in brackishwater new and old hatchery complex to compare soft-shell shedding efficiency between natural and hatchery produced crablets. Hatchery produced crablets were produced in the new hatchery cottage and reared in different small cemented cisterns. Besides, similar sized crablets were collected from the river for comparing with the hatchery produced crabs. Thereafter, in old hatchery complex, few cemented cisterns (Each Cistern 7 m²) were prepared for the experiment between hatchery produced crablets and naturally procured crablets. A constant level water salinity (15 ppt) was maintained for the cisterns. The experiment was conducted with 2 treatments viz., natural/wild crablets (T1) and hatchery produced crablets (T2). Pre-molted crabs were purchased and acclimated in hatchery conditions and were stocked in T1. Whereas, crablets produced in Brackishwater Station crab hatchery (new) were used for T2. A total 60 crablets having average weight of 0.50 g were selected for each treatment, while 20 crabs were be regarded as each replication among three.

Table 3. Water quality parameters in cemented cistern

Environment Parameters	Cemented Cistern (Both hatchery and natural crabs)
Salinity (ppt)	15
Temperature (°C)	27-28.4
pH	7.56-8.37
Ammonia (ppm)	0.25-0.5
Dissolved oxygen (ppm)	7.0-8.8
Total alkalinity (ppm)	76-85

The performance of hatchery and wild crabs is presented in the Figure 8. Here, survival rate of hatchery produced crabs was higher than the natural crablets in the soft-shell culture. Almost all crabs were live during the culture period in the cemented cistern. In contrast, about four-fifths of the crabs from wild were survived during the culture period in the same environmental condition. Besides, Total shedding was also lower in the wild population than the crabs from hatchery at the brackishwater station within 25 days. However, hatchery produced mud crab was observed more adaptive in the soft-shell farming rather than wild stock. Therefore, this study will be continued and our ultimate aim is to grow them up to broodstock size with intensive monitoring of molting performance, survival and weight gain.

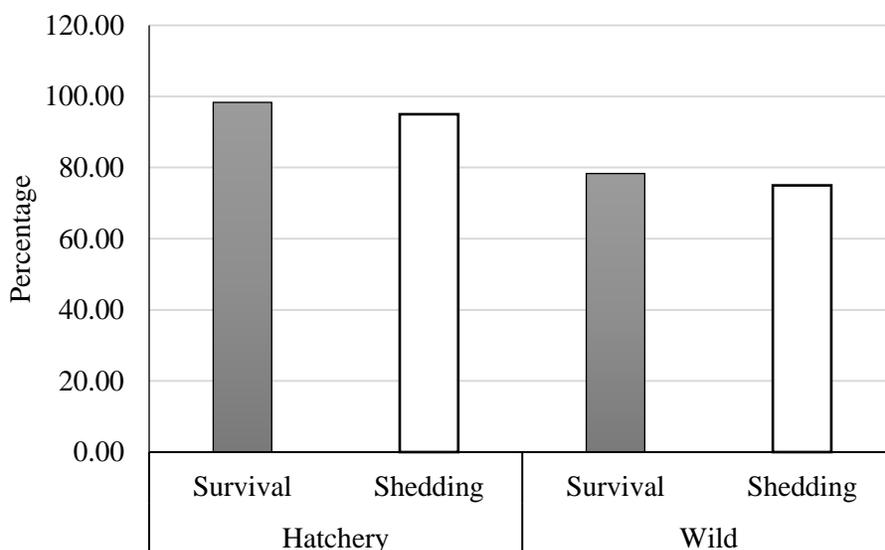


Figure 8. Performance of hatchery and wild crablets

Discussion and conclusion:

Soft-shell Mud crab farming is very new concept in Bangladesh and it is solely dependent on natural seeds and the natural stock from brackishwater environment with a significant variation of salinity. Thus, salinity variation and limb trimming have also some significant effects on quality and quantity of soft-shell. In contrast, by supplying juvenile crabs in soft-shell mud crab aquaculture from hatcheries might reduce intense pressure on natural stocks. Development of soft-shell mud crab farming in controlled condition is the primary challenge in rural farms. Therefore, our study on soft-shell farming considered pond and hatchery (controlled) condition to understand the insights. Besides, hatchery produced crabs and wild crabs were compared to know the performance in soft-shell farming in the long run, without putting extra pressure on wild stock.

In various salinity, crabs showed different responses and performances according to the situations. The highest shortened molting duration was found in the high salinity (15ppt) during the culture period of soft-shell mud crab. Likewise, the percentage of the gained weight for soft-shell mud crab was 55.92 in the same salinity. High salinity level seemed suitable for the farming of soft-shell mud crab. Here, 15 ppt salinity performed well than any other salinity levels in the experiments.

In limb removal conditions, molting rate was quite good in terms of cutting limbs of immature crabs prior stocking. In particular, cutting both side limbs took only 20 days to produce soft-shell during the culture period. Considering lunar cycle, the highest molting (46.54%) was happened in the phase of first quarter - full moon. Similarly, during third quarter – new moon, the percentage of mud crab shedding was 35.85. It means, shedding performance was better just before the full moon and new moon period. Apparently, crabs found relaxed and healthy below the temperature 28° C for culturing in the soft-shell cages in the indoor condition. Limb trimming showed higher survival rate in the experiment. Here, the survival rate was found close enough between the treatments, whereas, no limb trimming (T1) survived lower than all other treatments in the experiment.

In between hatcher and wild, about four-fifths of the crabs from wild were survived during the culture period. Besides, Total shedding was also lower in the wild population than the crabs from hatchery at the brackish water station. In contrast, almost all hatchery produced crabs were alive during the culture period in the cemented cistern. In summary, hatchery produced mud crab were more adaptive in the soft-shell farming rather than wild stock.

Photo gallery:



Plate 1: Soft-shell crab



Plate 2:
Acclimatization



Plate 3: Beginning of
molting



Plate 4: Keeping record



Plate 5: Monitoring
water



Plate 6: Feeding juveniles

Scientific Publications (2017-20)

- Kohinoor, A.H.M and M. M. Rahman. (2018). Production performances of GIFT strain (*O. niloticus*) with Magur (*C. batrachus*) and Gulsha (*M. cavasius*) in semi-intensive culture management. *Bangladesh J. Fish. Res.* 170(1-2):1-11.
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