Proceedings First International Symposium on Aquatic Biodiversity of the North Eastern Region

26-27 October 2021

Ministry of Environment, Forest & Climate Change

Implemented by giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of the Federal Republic of Germany

Zoological Survey of India

Overview:

GIZ in cooperation with the Ministry of Environment, Forest and Climate Change, Gauhati University and Zoological Survey of India (ZSI) held a two-day symposium on 26-27 October, 2021 called the **First International Symposium on Aquatic Biodiversity of the North Eastern Region of India**.

The North Eastern Region (NER) of India is home to two of the thirty-four biodiversity hotspots in the world. In addition to the abundant species of flora and fauna, the NER is also considered as one of the hot spots of freshwater fish biodiversity in the world, with nearly 430 species of freshwater fishes (35 endemic), 186 mollusc species and 367 different dragonfly species, among others. However, despite ongoing research efforts and surveys, there is still many blank spots on the biodiversity map with a high number of unknown species. To close some knowledge gaps and to get an understanding about the status of research on aquatic biodiversity in NER, the Indo German Bilateral Cooperation project "Protection and Sustainable Management of Aquatic Resources in the North Eastern Himalayan Region of India" organized a two-day Symposium on Aquatic Biodiversity in NER with a focus on the partner states Assam, Meghalaya, Nagaland and Manipur.

More than 50 national and international experts joined in the dialogue on conserving NER's aquatic biodiversity in this 2-day event, sharing knowledge gaps, level of community involvement and in particular opportunities for management to tackle threats with a focus on the effects of climate change. The symposium was held online to facilitate the participation of national, international and local (North Eastern States) contributors, enabling a rich forum for ideas and collaborations.

Day 1_26th October, 2021_Inaugural Session:

Dr Indrani Phukan, Technical Advisor-GIZ, began the symposium with an introduction. She stated that the two-day event has been planned based on the inputs from the implementing states which are Assam, Meghalaya, Manipur and Nagaland on the need for research based activities. She further stated that this symposium is an endeavour to understand the kind of research already taking place and carried out in the aquatic resources in the North-Eastern Region and it could lead to formulation of strategies for increasing resilience of communities of NER. She also mentioned that the event was decided to be an online one based on the current pandemic scenario. The NERAQ project foresees a second symposium in 2022 where in all efforts will be made to hold an offline even where it is envisaged that participants not only have technical sharing and exchange but also meet and greet in person.

Finally, she introduced event partner, Vertiver to the team and welcomed Farhad Vania as next speaker and moderator of the inaugural session.

Mr. Farhad Vania, Country Office-GIZ served as the Moderator of Inaugural Session. He discussed the various projects GIZ is working on like health, environment, economic and skill development and mentioned about a 'Climate Change Adaptation in the North Eastern Region' project, which he, Dr. Uwe Scholz and some others from the symposium were a part of, a decade ago. It led to the development of new projects. He mentioned that the use of research has to be determined and that GIZ is one of the few organizations that supports and commits resources to interesting, useful and important topics such as the current project on aquatic biodiversity. There is a need to expand our horizon of knowledge and understanding of topic. He stated that it is the need of the hour to make informed decisions that work in the best interest of biodiversity including those whose lives depend on it and emphasised that occasions and projects like this provide a chance to work extensively on aquatic biodiversity.

Professor Pratap Jyoti Handique - Vice Chancellor, Gauhati University described the distinctive features of North-east Region biodiversity as it has complex geomorphology along with floodplains, valleys and varying elevations, freshwater lakes etc. He mentioned that the biodiversity of the region can be discussed focussing on its 3 components mainly, the vegetation diversity, plant and animal biodiversity. However various subcategories have been identified based on specific biological parameters. He spoke extensively about the enormous varieties of species found in the region's biodiversity as it is not fully explored, quantified and estimated to a fuller extent and on a finer scale till date. He also emphasised that the

classification and identification of most of the aquatic species are mainly based on morphological characteristics. He shed light on some of the important areas to look after for further research, i.e. Study on ichthyofaunal biodiversity of aquatic ecosystems using latest tools and techniques, Enumeration of biodiversity of large and small indigenous species of fish of NER of India. He mentioned that the huge diversity of insect community must also be studied. He stated that the fish water cladocera of water fish diversity is an interesting group of organisms and Cladocera serves as an important food for small fish and aquatic insects. He stated that we have to study the amphibian faunal diversity. The decline in amphibian population is a major concern throughout the globe. He concluded by stating that the study of aquatic phytodiversity or plant diversity is another important aspect of study.

Mr. Mohamed El-Khawad - Cluster Coordinator, GIZ India explained BMUV's (German Ministry of Environment, Nature Conservation and Nuclear Safety) role in taking a sectoral approach, their interventions and results as the commissioning party. Dr El Khawad spoke about GIZ as a Government owned agency with an unusual setup where it sends employees to numerous countries of the world including India to implement projects where there is not only technical cooperation part but also cultural exchange, getting to know and repo
rting on the ground situations. GIZ has a total of 22,000 staff out of which 15000 are employed in different countries. He elaborated on the fact how GIZ is a vehicle for the German government, society and the taxpayer to bring back information, knowledge and experience to share also in Germany. GIZ has three main sectors of cooperation which is

- Energy
- Sustainable Urban development
- Climate and Environment

He also mentioned that the GIZ office follows German public law in all countries wherever located. He stated GIZ is working on 36 programs across sectors including public health, capacity building, advice on suitable techniques and technologies, cooperation on development of financial instruments and most important co-creation of knowledge. He stated that GIZ usually works with policy and institution building, and this project "Protection and Sustainable Management of Aquatic Resources in North Eastern Himalayan Region (NERAQ)" is a unique ground project with major focus on implementation. He informed that the NERAQ project will continue until November 2023.

Dr Uwe Scholz - Project Incharge, GIZ NERAQ Project appreciated the unique Mentimeter activity that took place at the beginning of the symposium for introduction of participants along with getting to know the scientific background of the participants attending the Symposium. He spoke about the following things regarding the NERAQ project:

The GIZ started its implementation activity in the North-East in 2011 with the commencement of the Climate Change Adaptation North Eastern Region (CCA NER) Project. The current project's idea evolved in 2016 and it was commissioned last year.
The NERAQ Project is funded by the German Ministry for Environment, Nature Conservation and Nuclear Safety (BMUV) and commissioned for implementation by GIZ. The nodal partner at Union level is Ministry of Environment Forest and Climate Change (MoEFCC). At the implementation level, the state nodal partners are the Departments of Forest, Environment and climate Change of Assam, Meghalaya, Manipur and Nagaland. The Project further requires research support for the inventory on aquatic biodiversity.

The Project also has the following technical partners (some more under discussion currently to be added to this list below at a later stage):

- Institute of Inland Fisheries, Potsdam (IfB)
- Zoological Survey of India
- Gauhati University, Assam
- Meghalaya State Fisheries and Training Institute
- Kohima Science College, Nagaland

Dr Scholz emphasized about the upcoming promising project as it will be a true exchange of knowledge between India and Germany, an extensive collaboration with local communities and will contribute to the knowledge base of the unique biodiversity of NER which he considers as a "journey into the unknown" as there is still much to discover in the Bramaputra and Barak River systems. He also mentioned current threats to ecosystems like pollution or

waste disposal. The latter should not be a problem, as solutions like waste to energy or construction of sanitary landfills can easily be funded by the Central or local Governments as long as political will persists. On the other hand, GIZ is supporting many projects on waste management and circular economy on the mainland. Technology and best practices could be easily applied in NER, however, request have to be forwarded by the states.

Prof. Dandadhar Sarma - Gauhati University, offered his heartfelt gratitude to all presenters and guests and for organising such an insightful symposium. He thanked the MoEFCC, Ministry of Development of North Eastern Region and Dr. Uwe Scholz for introducing and elaborating the objective of the project. He also congratulated and expressed deep appreciation for all active members from GIZ for their tireless efforts and making the event a grand success.

These proceedings have been prepared by Vertiver Private Limited, the communications partner to this event.

Presentations

Session 1: Inventory/Knowledge Basis of Aquatic Biodiversity in the North Eastern Himalayan Region

Presenter 1: A. M. Ahmed

Study Title: Assessment of Ichthyofaunal Biodiversity of Diyung River of North Eastern Himalayan Region, Assam

Authors: A.M. Ahmed, R. Dutta, S.K. Bhagabati, H. Pokhrel, L.P. Mudoi, D. Nath & R. Sarmah

Abstract:

The Diyung river, which originates in the Barail range and flows for 240 kilometres until joining the Kopili, a tributary of the mighty river Brahmaputra at Dayangmuk in Kabi Anglong district, is the major river in Dima Hasao District. The current study was undertaken at eight distinct stations from January, 2019 to March, 2021 to document the diversity of fish species, their conservation status, and anthropogenic stress on the river. The Diyung River is home to 81 different fish species, with *Opsarius bendelisis*, *Psilorhynchus balitora*, *Devario aequipinnatus*, *Pethia conchonius*, *Pethia ticto*, *Garra lissorhynchus*, and *Garra annandalei* being the most common (>1.5%). The order Cypriniformes was found to be the most prominent, accounting for 42 (51.85%) of the total fish species found in the river, followed by Siluriformes (17.98%) and Perciformes (17.98%). One Endangered (EN), one Vulnerable (VU), seven Near Threatened (NT), four Not evaluated (NE), two Data Deficit (DD), and the remainder species were classified as Least Concerned (LC) by the IUCN.

The fish diversity at Dehangi bazar point was the highest among all the stations. The average water quality parameters are found to be congenial for fishes. Anthropogenic issues such as land use intensification, sewage disposal, habitat degradation, and sand mining have been recognized as the most serious risks to the river's fish diversity. The development of a conservation plan for the river's fish fauna will focus on declaring sanctuaries in specific portions of the river, mesh size regulation, and raising community knowledge about habitat degradation and economic relevance of the species.

Keywords: Ichthyofauna, Habitat, Dima Hasao, Protected Area, Diversity

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: ASSESSMENT OF ICHTHYOFAUNAL BIODIVERSITY OF DIYUNG RIVER OF NORTH EASTERN HIMALAYAN REGION, ASSAM

Presenter: Ph.D. Scholar, Abdul Malik Ahmed

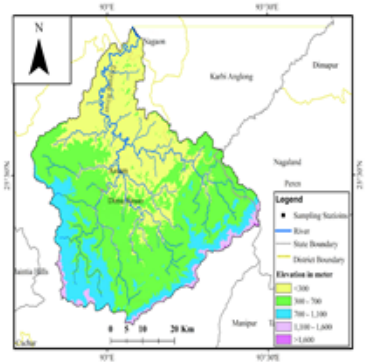
Institute: **College of Fisheries, Assam Agricultural University, Raha**

Research Overview

Study Objective:

1. To study and record Ichthyofaunal diversity of river Diyung, Assam
2. To assess conservation status of fish species of the river based on field surveys

- Study Timeline: January' 2019 to February' 2021
- Geographic scope: Regional



Research Overview Contd...

Study Methodology:

✔The river was thoroughly surveyed and eventually split into eight distinct sampling stations spanning the river's upstream, midstream and downstream stretches

✔Sampling sites were chosen so that they represented the general habitat conditions within the area, could be regularly accessed

✔Total of 8 sampling station was chosen based on preliminary survey

Station	Name	Latitude & Longitude	Elevation (m MSL)
1	Syamagaon	25°08'12"N 93°01'42"E	388
2	Lower Haflong Bridge	25°11'58"N 93°01'21"E	340
3	Samparidisha Village	25°14'12"N 93°00'35"E	298
4	Dihingi Bazar Point	25°25'24"N 92°59'34"E	148
5	Thaijawari Village	25°32'21"N 92°59'06"E	126
6	Purana Kungkuwari Village	25°34'58"N 92°56'38"E	117
7	Digandu PT-II	25°34'34"N 92°57'44"E	80
8	Diyungmukh	25°48'27"N92°55' 44"E,	70

Study Methodology

✔ Fish specimens were collected using gill net, cast net and traditional gears from selected sampling sites at monthly intervals with the help of skilled fishermen

✔ Fish species were identified using standard keys (Jayaram 1981&1999; Talwar & Jhingran, 1991; Kottelat, 2013 & Vishwanath, 2014)

✔ Conservation status of each fish was given based on IUCN Red list of threatened Species (IUCN 2016)

✔ For molecular characterization genomic DNA isolation was done using **Phenol Chloroform Extraction method** with slight modification. PCR amplification were carried at optimize condition using standard Cytochrome Oxidase Subunit (COI) oligos, Fish Fl (TCAACCAACCACAAAGACATTGGCAC) and Fish Rl (TAGACTTCTGGGTGGCCAAAGAATCA) (**Ward *et al.* 2005**) and sequencing was done at Eurofin, scientific based laboratory at Bangalore.

Key Threats and Opportunities

Threats	Opportunities
Constant removal of Sand, gravel and boulders	Socio Economic upliftment through recreational fishery
Constant dumping of Solid waste like polythene bags, paper waste and domestic sewage	Development of Cold water ornamental fish species
Practices of destructive fishing methods	conservation of threatened species
Habitat degradation	

Key Observations/Findings

- Total of 81 fish species was recorded

Belonging to

- 8 orders,
- 24 families
- 52 genera

Endangered (EN) - *Tor putitora*
Vulnerable (VU) - *Botia rostrata, Opsarius ngawa*
Near threatened (NT) - *Neolissochilus hexagonolepis, N hexastichus, Notopterus chitala, Wallago attu, Bagarius bagarius, Labeo pangusia,* Anguilla bengalensis
Data deficit (DD) - *Tor tor, Badis assamensis*

- ✔ Family Cyprinidae contributed 33 (40.79%) species
- ✔ *Tor putitora*, an endangered species, has been collected in significant numbers, indicating that rivers host a lot of cold-water species
- ✔ For the first time Cytochrome Oxidase subunit I (COI) of mitochondrial gene sequences of Forty two (42) fish species was generated and successfully submitted to NCBI gene database from the said study area.

Key Recommendations

- ✔ Prohibiting sand mining along the river side and river beds
- ✔ Prohibiting illegal methods of fishing through mass awareness campaigns among the rural people against poisoning and dynamiting
- ✔ Creation of protected areas in selected stretches of the river for in-situ conservation.
- ✔ Strict enforcement of existing fisheries legislation by empowering Fishery Officers

Acknowledgement

I would like to acknowledge National Mission on Himalayan Studies (NMHS), Nodal institute GBPNIHESD, Ministry of Environment Forest and Climate Change (MoEFCC), Govt. of India, for financial assistance under Project ID: GBPNI/ NMHS-2017-18/HSF-04/600). I also offer my heartfelt obliged and sincere gratefulness to Authority of Assam Agricultural University, Dean College of Fisheries, AAU, Raha, Dr. S. K. Bhagabati and Dr. R. Dutta, PI, Himalayan Research Fellowship Programme for their kind support and guidance.

Presenter 2: Adity Deka

Study Title: A Study on the Diversity of Small Indigenous Species (SIS) of Fish of Jia Bharali River in Sonitpur District of Assam, India

Authors: Adity Deka and Priyam Nath

Abstract:

North Eastern Himalayan Region is highly diverse and harbours wide variety of endemic fish species. The diversity within the region is also of great regional importance in terms of livelihood of the people living around it. The North Eastern Himalayan Region, mainly the North East, forms a part of two of the 34 Biodiversity Hotspots, the Himalayas and Indo-Burma resulting in a diversity of ecosystems. Aquatic biodiversity of the region has immeasurable economic and aesthetic value. It is mainly responsible for enabling and bearing the overall health of the environment. Humans also depend on aquatic foods, medicine as well as for some commercial purposes like fishing and tourism. However, aquatic fauna faces a high risk of threats towards extinction due to some serious anthropogenic factors. The current study discusses the major threats to aquatic life which is leading the fishes towards extinction at an alarming rate in the North East. This study mainly focuses on five major factors that pose a threat to aquatic fauna, including introduction of exotic or 'alien' invasive species, overfishing, pollution, and climate change and habitat loss. It is believed that exotic species are one of the greatest threats to native fish communities. Introduction of Tilapia causes habitat destruction, introduction of disease and parasites and competition with another native species. Another threat to fish diversity for which there is a major decline in the population is due to overfishing. In the North Eastern region, due to excessive food demands and market pressure, people use some destructive fishing gears for their needs which are causing serious harm to some endemic fishes. However environmental pollution is also considered as a major threat to aquatic biodiversity, as the outcome of pollution on freshwater often causes elimination of fish species. In some North Eastern states like Meghalaya, due to coal and limestone mining deterioration of water quality like ph., colour, turbidity etc. of river takes place and these effects lowers the aquatic diversity. Climate change is another important factor which brings down the level of fishes. Climate change causes an increase of sea surface temperature and also changes the water level, river flow and ocean acidification for which fish cannot control their body temperature. Therefore, increasing or decreasing temperature due to climate change causes extinction of fishes. Habitat loss and degradation can also be a major factor for which declining fish fauna are seen. Construction of dams on rivers disrupt the normal route of fishes that swim upstream to spawn and also displacing population from their spawning ground and separating them into small populations. Deforestation also decreases catchment area and degradation due to soil erosion for which siltation and sedimentation occurs. As a result, gill clogging of small fishes occurs. During this study all the major threats are discussed in detail, together with their long-term impact along with suitable examples of occurrences in the whole of the North Eastern Himalayan Region. This study will further help researchers in developing innovative tools to tackle the threats posed to the aquatic faunal habitat such that the endangered fish fauna has a mere chance of survival in the near future.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

A STUDY ON THE DIVERSITY OF SMALL INDIGENOUS SPECIES (SIS) OF FISH OF JIA BHARALI RIVER IN SONITPUR DISTRICT OF ASSAM, INDIA

Presenter: Adity Deka, Msc (zoology)
Institute: Gauhati University

Research Overview

Study Objective:

- To study the total species of fishes in four pre decided sampling site of Jia Bharali river.
- To study the similarity in composition of SIS fish across four sampling site using Jaccard index.
- To relate the diversification of the whole stretch of the river.
- To identify and find out those species of fish that are facing high risk of extinction in the selected stretch of the river.
- Study Timeline: May,2020 -April,2021.

Geographic scope: Ichthyodiversity of the Jia Bharali River in Assam contains a total of 56 species belonging to 19 families under 8 orders. This place provides an excellent spot for sport fishing and rafting (Das and Sarmah, 2014). More regions in the major stretch remain unexplored and may provide the existence of threatened endemic fish species.

Geographic area:

- Area of study: *'Sonitpur'* district of Assam (26°3'0"N 92°16'59.88"E – 27°1'59.99"N 93°46'59.88"E).
- 4 sampling stations(upstream to downstream):
  S_1 Nameri (26°59'37.74"N 92°40'40.45"E)
  S_2 Chariduar (26°52'35.13"N 92°48'13.51"E)
  S_3 Jamugurihaat (26°43'27.25"N 92°55'28.59"E)
  S_4 Panch mile (26°39'54.26"N 92°51'46.15"E).

Study methodology

Data collection:

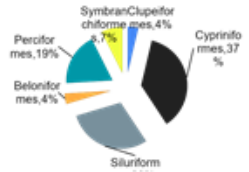
- Fishes were surveyed with the help of local fisherman in the morning and evening hours for three times during a season.
- Secondary data was also collected by interaction with local people of embankment areas and from fishermen.

Photography:

- Fishes were collected in live condition and photographs were taken with the help of camera.
- Fishes collected from sampling station were identified in the field and remaining were brought in to lab in 70% formalin and identified later by following literature of Jhingran and Jayaram.
- Fishes were identified based on www.fishbase.org and checked the conservation status on www.iucnredlist.org.in (version2020-1).

Key Observations:

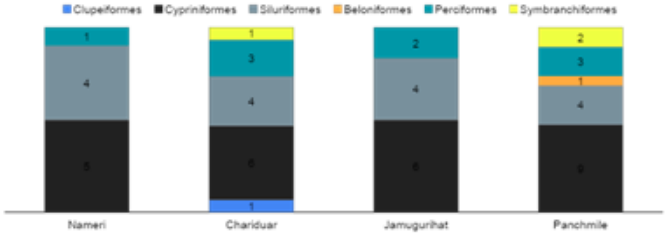
- A total of 27 species belonging to 23 genera, 13 families and 6 orders have been recorded from the four sampling stations of Jia Bharali River.
- Cypriniformes was the most dominant Order.



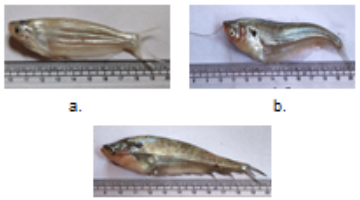
Order	no of species	Contribution(in %)
Cypriniformes	10	37.03%
Siluriformes	8	29.63%
Perciformes	5	18.52%
Synbranchiformes	2	7.4%
Clupeiformes	1	3.70%
Beloniformes	1	3.70%

Species covered

- Following order of species was recorded during the study



- This study recorded the presence of three Near Threatened (NT) SIS species viz. *Ailia coila(a), Ompok pabda(b), Ompok bimaculatus(c)* and the remaining twenty four species found to be least concern (LC).



Major fishes reported during the survey:

Similarities in composition using Jaccard index:

- Similarities in species composition among the study sites were analysed using the Jaccard index (JI) for calculating the extent of similarity between pairs of data sets .
- The JI value between sites S_3 and S_4 was found to be highest while it was lowest between sites S_2 and S_3 .

Sampling stations	S1	S2	S3	S4
S1	1			
S2	0.389	1		
S3	0.217	0.173	1	
S4	0.380	0.360	0.409	1

Conclusion:

- More number of species were reported in the downstream region in comparison to the upstream region.
- Chariduar(S4) was the most even site as recorded during the study period.
- Similarities in species composition between sites S_3 and S_4 was found to be highest while it was lowest between sites S_2 and S_3.
- The study was successful as a good number of SIS fish was reported alluring attention in terms of food value, market value and research purpose.
- Since local people are unaware of the value of indigenous fish species, management programmes must be undertaken to guide the local people such that they value the importance of small indigenous fish species both in terms relating to food and commercial purpose.
- Due to lack of proper knowledge the Small Indigenous Species of fish are deprived of their ornamental value and are prone to some major threats leading to loss of fishes, so an awareness program is necessary for the local people.

Presenter 3: Pranay Punj Pankaj

Study Title: Ichthyofaunal Diversity and Conservation Status Assessment of Dikhu River, Nagaland, India
Authors: Metevinu Kechu and Pranay Punj Pankaj

Abstract:

Nagaland, located in the north eastern state of India, is one of the important freshwater biodiversity hotspots. The state is drained by the Brahmaputra and the Chindwin river systems, which harbour potentially valuable freshwater fish resources. The Dikhu River constitutes one of the major rivers of Nagaland, India, draining the Mokokchung and Zunheboto district of Nagaland. It originates from the Naruto hill, Zunheboto and confluences towards the Brahmaputra river system.

The present study attempts to investigate the ichthyofaunal diversity and conservation assessment of freshwater fishes found in the Dikhu river, Nagaland, from April 2017 to March 2019. A total of 27 different species belonging to 20 genera, 6 orders, 14 Families and 7 sub families were recorded during the reporting period where majority constituted of Cypriniformes order with 18 species then Siluriformes with 4 species followed by Perciformes with 2 species while Beloniformes, Synbranchiformes and Anguilliform orders each having only one species.

The IUCN red list of threatened species shows that 67% Least Concern (LC), 7% Near Threatened (NT), 4% Vulnerable (VU), 4% Endanger (EN), 11% Not Accessed (NA) and 7% Data Deficient (DD) status have been granted by those species.

As per IUCN, the population of fish species trends also show that 56% are unknown, 11% stable, 11% not accessed, and 22% have decreasing population trends in status.

Hill stream modifications such as thoracic labial folds, adhesive apparatus, proboscis, and mental disc in Garra, Glyptothorax, and Psilorhynchus have all been examined. The majority of these indigenous species have ornamental, edible and medicinal properties. Anthropogenic pressure on the Dikhu River has resulted in habitat modification and fragmentation, posing a hazard to fish species diversity. As a result, the study is significant not just for academic purposes but also for providing a more thorough exploration and conservation strategy for making better use of ichthyofaunal resources in the area. Specified freshwater fish species require urgent scientific management and conservation strategies to ensure their long-term viability.

Keywords: Nagaland, Freshwater biodiversity, Dikhu River, Threatened species, anthropogenic pressure, habitat modification and fragmentation

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Ichthyofaunal diversity and conservation status assessment of Dikhu river, Nagaland, India

Presenter: Assistant Professor, Pranay Punj Pankaj

Institute: Nagaland University, Headquarters: Lumami, Nagaland 798627, India

Research Overview

Study Objective:

1. To study the geomorphology, and inventorisation of ichthyofauna of selected regions of Dikhu river of Nagaland.
2. To study the practicing of fishing methods and to develop conservation measures.
3. Ornamental status of fish species and assessment of conservation status from river Dikhu, Nagaland.

Study Timeline: From 01.04.2017 to 31.03.2019

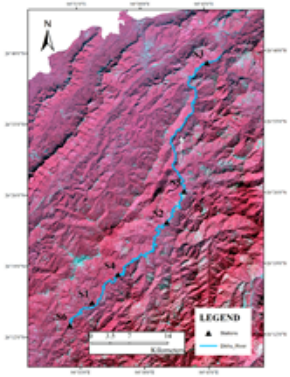
Research Overview Contd...

Geographic scope:

Total Station: 12
Mokokchung: 06
Zunheboto : 05
Tuensang: 01

Species covered:

Species: 27
Genera: 20
Orders: 6
Families: 14
Sub families: 7



Study Methodology

- The geomorphological studies were carried out following the works of Dikshit (1990), Kumar et al (1990), Borah and Goswami (2006) and Prasad and Biswas (2011).
- Preservation and identification of Fish were carried out as described by Ayyappan and Satyamurthi (1960), Day (1978), Menon (1987), Talwar and Jhingran (1991), Jayaram (2010), Vishwanath (2007) and latest nomenclature was based in accordance with catalog of fishes (Fricke et al. 2021).
- The IUCN red list of threatened categories (Version 2021-2) were compiled for the fish conservation status assessment (IUCN, 2021).
- A survey was conducted to collect information on the knowledge of gears and activities in fishing from 01.04.2017 to 31.03.2019. Data regarding various indigenous fishing craft, gear and fishing methods was obtained from both primary sources (Direct observations from extensive field works, personal interviews) and secondary sources (Literature and Reports).

Key Threats and Opportunities

Threats

(1) Overfishing (2) Water pollution (3) Use of agrochemicals (4) Cottage coal mining/open cast mines (5) Habitat loss / Habitat destruction (6) Climate change (7) Damming, deforestation, shifting cultivation, diversion and withdrawal of river water for irrigation, urban consumption (8) Use of destructive and/or unsustainable fishing gear and practices/ Explosives and poisonous substances for fishing (9) Illegal, Unregulated and Unreported fishing (10) Introduction of exotic aquatic species for aquaculture in Nagaland

Opportunities

(1) Encouraging and promoting Community participation in Ecotourism and Sustainable Tourism Development (2) Promotion and regulation of Nagaland State Angling Competition / Catch-and-release fishing / Recreational fishing/ Community fishing (3) Opportunities for enhance livelihood, food security and employment generation and sustainability

Key Observations/Findings

A total of 27 different species belonging to 20 genera, 6 orders, 14 Families and 7 sub families were recorded during the reporting period.

Majority were constituted of Cypriniformes order with 18 species then Siluriformes with 4 species followed by Perciformes with 2 species while Beloniformes, Synbranchiformes and Anguilliform orders each having only one species.

The IUCN red list of threatened species shows that 67% Least Concern (LC), 7% Near Threatened (NT), 4% Vulnerable (VU), 4% Endanger (EN), 11% Not Accessed (NA) and 7% Data Deficient (DD) status have been granted by those species.

As per IUCN, the population of fish species trends also show that 56% are unknown, 11% stable, 11% not accessed, and 22% have decreasing population trends in status.

First record of *Garra birostris*, Nebeshwar & Vishwanath, 2013 (Cypriniformes: Cyprinidae) from Dikhu river, Nagaland (under revision)

Key Recommendations

(i) Creation of awareness among the local masses to conserve the natural fish stock for which the scientific organization, academic institution, policy makers, planners and fish farmers should join hands together.

(ii) Legal banning on the indiscriminate catch of brood and juveniles is important. However, provision should be made to sell endangered ornamental fish species, which are "farm-raised".

(iii) Proper planning is needed for their captive breeding and farming for sustainable supply of indigenous ornamental fishes while reducing the pressure on volume of wild catch in the long run and for their conservation.

(iv) Export should be allowed based on the conservation status of gene pool of the indigenous ornamental fishes.

(v) Identification and protection of natural breeding grounds of native ornamental fish and ensuring less disturbance to fishes during monsoon season to facilitate the natural spawning process.

(vi) An improved information system and accurate reporting is crucial for fish that are caught from the wild and marketed, as well as for farm-raised fish.

(vii) Prevention of anthropogenic threats such as pollution, river embankments, sand digging to avoid destruction of habitat and breeding ground of the fishes.

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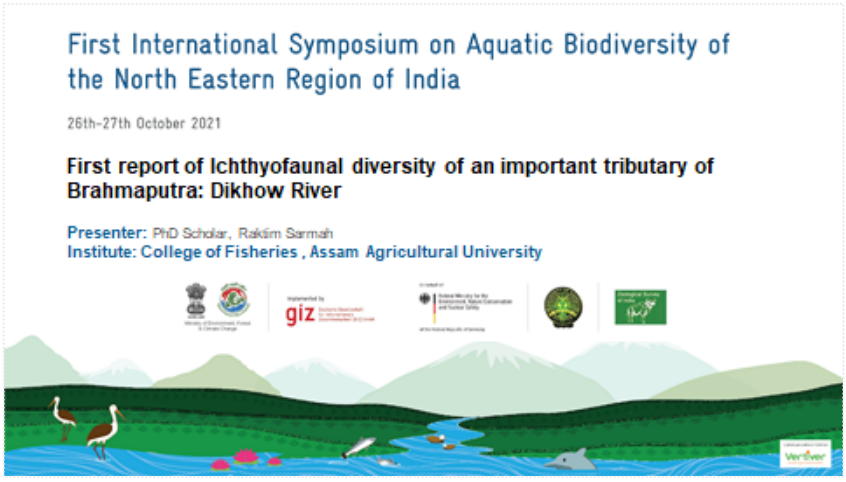
Presenter 4: Raktim Sarmah

Study Title: First Report of Ichthyofaunal Diversity of an Important Tributary of Brahmaputra: Dikhow River
Authors: Raktim Sarmah, Rajdeep Dutta and Sarada Kanta Bhagabati

Abstract:

The Dikhow River, which originates in Yezami village near Zunheboto town in Nagaland, is one of the biggest tributaries of the Brahmaputra river basin. It flows into the Brahmaputra River near Dikhowmukh in the Sivasagar district of Assam, spanning 255.8 kilometres and producing 0.7 percent discharge. The Dikhow catchment covers roughly 3100 km^2, comprising 85 % of Nagaland, 10% of Assam, and 5% of Arunachal Pradesh. The whole river section was split into six study sites, with elevations ranging from 90.83 msl to 669.9 msl (3 in Nagaland and 3 in Assam). These stations were selected to study the fish diversity of the entire river stretch; from January 2019 to February 2021.There are 62 fish species of 7 Orders recorded during the entire study period. Out of these fish species 33 species belong to the order Cypriniformes, 17 to Siluriformes, 2 to Perciformes,2 to Anabantiformes, 1 to Clupeiformes, 1 to Cichliformes and 1 to Gobiformes. The IUCN conservation statuses of the fish species are 41 belong to Least Concern, 1 Endangered, 6 belong to Near Threatened, 1 Vulnerable and the rest are Data Deficit. The fish diversity data generated during the study periods will help develop policies for conservation purposes.

Presentation



Research Overview

- Study Objective:
- **To develop a baseline database of ichthyofaunal diversity of Dikhow river in Nagaland and Assam**
- **To assess the threats to the fish biodiversity**
- Study Timeline:
- **From January 2019 to February 2021**

Research Overview Contd…

- Geographic scope: Nagaland and Assam (Entire stretch of River Dikhow)
- Species covered (if any): 62 fish species covered
- Study Methodology: 6 station were selected in the entire river stretch of Dikhow. **Fish species were identified using standard keys** (Jayaram 1981&1999; Talwar & Jhingran, 1991; Kottelat, 2013 & Vishwanath, 2014)

Study Methodology

The present study comprises of 6 sampling stations divided into 2 sectors hill and plain with 3 station in the hills of Nagaland 3station in the plains of Assam. The details of the stations are as follows-

Station 1-Longsa	*26°15'17.95"N 94°31'42.63"E*	*Elevation – 667m msl.*
Station 2-Longkong Village	*26°17'46.33"N 94°35'29.09"E*	*Elevation-559 m msl*
Station 3-Changtongya	*26°29'51.62"N 94°41'38.78"E*	*Elevation-322 m msl*
Station 4-Nazira	*26°55'31.64"N 94°45'21.98"E*	*Elevation-98 m msl.*
Station 5-Sivsagar Town	*26°58'33.08."N 94°37'50.78"E*	*Elevation-96 m msl.*
Station 6-Dikhow Mukh	*27°00'00.40"N 94°28'06.03"E*	*Elevation- 90 m msl.*

Fish specimens were collected using gill net, cast net, traditional gears from selected sampling sites. The fish collected have been described by following the description keys of Mishra (1962), Menon (1974), Jayaram (1981), Munshi and Srivastava (1988), Talwar and Jhingran (1991). The specimens were collected by means of netting and local markets

Key Threats and Opportunities

Threats

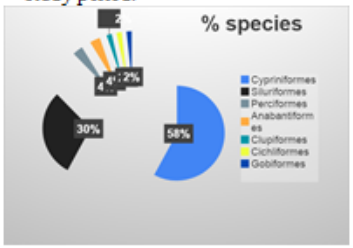
Erosion due to deforestation
River Mining
Unethical Fishing Practises
Discharge of urban waste

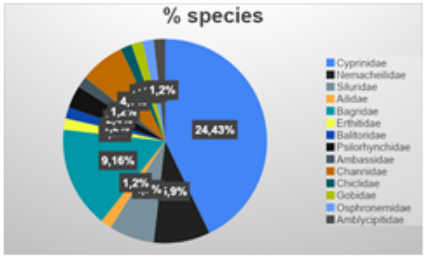
Opportunities

Indegenous ornamental fisheries.
Ecotourism for socio-economic upliftment of fisher-folks.

Key Observations/Findings

There are 62 fish species belong to 7 Orders and 15 families recorded during the entire study period.





The IUCN conservation status of the fish species are 41 belong to Least Concern ,1 Endangered, 6 belong to Near Threatened, 1 Vulnerable and the rest are Data Deficit.

Key Recommendations

More emphasis on community based fish conservation
Awareness of Aquacultural Practises
Strict regulations of Fisheries laws
Development of breeding protocols and Ranching of threatened species

Acknowledgement

I would like to acknowledge National Mission on Himalayan Studies (NMHS) (Project ID: GBPNI/ NMHS-2017-18/HSF-04/600), Ministry of Environment Forest and Climate Change (MoEFCC) and Nodal institute GBPNIHESD, Kosi-Katarmal, Almora, for the financial support provided to carry out the present study under the Himalayan Research Fellowship Programme.

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Presenter 5: Sanborlang Byrsat

Study Title: Diversity and Distribution of Freshwater Fishes in two Important Rivers of Nongstoin, Meghalaya, North-East India

Author: Sanborlang Byrsat

Abstract:

Among aquatic organisms, fish are the most well-known species and they also serve as a sign of a healthy aquatic ecosystem. The present study was conducted to investigate the distribution and diversity of freshwater fishes on the two very important rivers i.e., the Nondein and the Nanbah rivers passing through the town of Nongstoin, West Khasi Hills district (Lat: 25°31'1.34" N, Long: 91°15'53.42" E) which is located in Meghalaya, North-East India. This study was carried out during the months of February-March, 2019 and July-August, 2019 each representing the non-rainy (Pre-monsoon) and the rainy (Monsoon) seasons at Nongstoin, respectively. A total of five study sites were selected along the stretches of these two rivers. These sites were selected on the basis of their location, topography of the rivers and areas of human settlement. Sites 1 and 2 are located midstream of the rivers with maximum human settlement, sites 4 and 5 are on the upstream with less human settlement and site 3 which is the confluence of both the rivers is located downstream with no human settlement and running through the forest area. The collection and capturing of fishes was done by using various fishing techniques. During the course of study, a total of 12 species of freshwater fishes were collected and identified. Detailed analysis revealed that maximum number and diversity of fishes were observed during the rainy season as compared to the non-rainy season (Shannon Diversity index: Rainy season=2.153, Non-rainy season=2.04). Among all the study sites, site 3 harbours maximum number of fishes during both the rainy and non-rainy seasons, whereas site 4 bears the least. Highest species richness was recorded during the rainy season for most species, the highest being *Devario aequipinnatus* (474). However, the Simpson diversity index (D) for dominance species was found to be 0.18 during the non-rainy season and 0.13 during the rainy season. Important freshwater fishes such as *Neolissochilus* sp., *Garra* sp., *Schistura* sp., and Pseudecheneis sp., were found to present abundantly at site 3, possibly due to the clean water running through this area with no human intervention. Thus, the study clearly indicates that rapid urbanization, sewage disposal and other human interventions affect the distribution and diversity of fishes, especially those fishes that reside only in clear river systems.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: Diversity and distribution of freshwater fishes in two important rivers of Nongstoin, Meghalaya, North-East India

Presenter: Assistant Professor, Dr. Sanborlang Byrsat, M.Sc., Ph.D
Institute: Department of Zoology, Shillong College, Shillong, Meghalaya

Research Overview

- **Study Objective**: To investigate the diversity of fishes and their distribution in the rivers Nondein and Nanbah of Nongstoin, Meghalaya.
- **Study Timeline**: The study was carried out during the month of February-March, 2019 and July-August, 2019 each representing the non-rainy (Pre-monsoon) and the rainy (Monsoon) seasons at Nongstoin, respectively.
- **Geographic scope**: Altitude: 1,409m asl; Lat: 25°31'1.34"N, Long: 91°15'53.42"E.

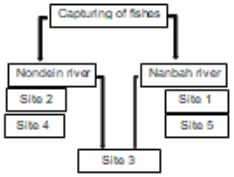
Research Overview Contd...

- **Study Methodology:**

A total of five study sites were selected along the stretches of these two rivers. These sites were selected on the basis of their location, habitat type of the rivers and areas of human settlement. Sites 1 and 2 are located midstream of the rivers with maximum human settlement, sites 4 and 5 are upstream with less human settlement and site 3 which is the confluence of both the rivers is located downstream with no human settlement and running through the forest area. The collection and capturing of fishes was done by using various fishing techniques.

Fig.1: Location of Nondein and Nanbah rivers in Nongstoin

Study Methodology contd.



(Confluence of both the rivers)

Table: Location, descriptions and habitat types of different study sites.

Sampling site	Stream segments	Site Descriptio n	Fishing methods	Habitat types
Site 1	Midstream of Nanbah river	Maximum human settlement, market area, high exposure to waste disposal	Legal	Mostly rocky, only some partia sandy, wider and deeper than Nondein river, slow flowing, less shrub on river side.
Site 2	Midstream of Nondein river	Maximum human settlement, market area, high exposure to waste disposal	Legal	Sandy, muddy, narrow as going upstream, slow flowing, less shrub on river side.
Site 3	Downstream (Confluence of both the rivers)	No human settlement, forest area, river is clean.	Legal	Rocky, forest cover on both sides of the river, fast flowing.
Site 4	Upstream of Nondein river	Less human settlement, less waste disposal	Legal	Sandy, muddy, narrow and shallow, agricultural land and paddy field on river side, some trees and shrubs are also found on its side, slow flowing.
Site 5	Upstream of Nanbah river	Less human settlement, less waste disposal	Legal	Rocky, shrub are found along the river side, fast flowing.

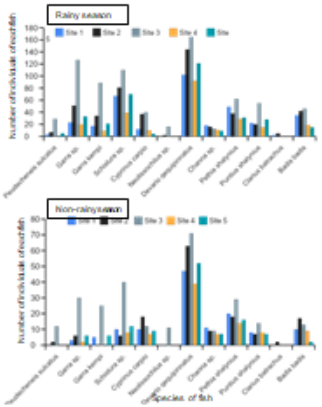
Key Threats

- Rapid urbanization
- Direct disposal of wastes into the rivers
- Constructional activities along the river sides
- Climate change
- Using of chemicals to kill/capture (Illegal means)

Opportunities

- Fish as ecological indicators
- Aquatic ecosystem sustainability
- Understanding fish-river relationship
- Scientific studies
- Etc.,

Key Observations/Findings



Key Recommendations

- Conservation programmes
- Developing integrated management plan
- Establishment of fish sanctuary
- Strengthening studies on fishes (life history, breeding behaviours, habitat selection, etc.)

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Presenter 6: Hrishikesh Choudhary

Study Title: Integrative Taxonomy Reveals Extended Distribution of *Schistura Fasciata* (Teleostei: Nemacheilidae) in the Brahmaputra Drainage, Northeast India
Authors: H. Choudhury, A. Dey, D.K.B. Mukhim, D. Sarma and K.K. Lal

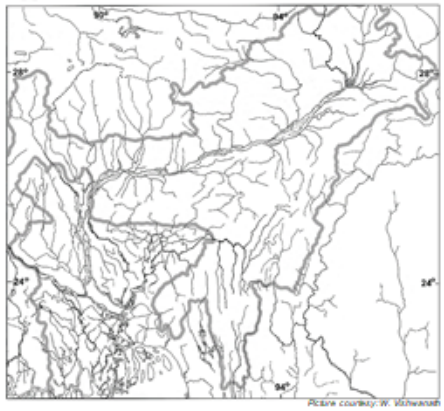
Abstract:

Schistura fasciata Lokeshwor & Vishwanath was described from the Barak River drainage at the western side of Maram Hills in Senapati District, Manipur, India. Apart from its type locality, no additional records of S. fasciata from the Barak-Surma or neighbouring drainages are available. Exploratory surveys of the Khri River, a south bank tributary of the Brahmaputra drainage, in 2018 included four individuals of a species of *Schistura* from the Assam-Meghalaya border. Following an integrated taxonomic approach, viz., analyses based on morphological characters and COX1 sequences, the species was confirmed as *Schistura fasciata*. This is the first record of the species from the Brahmaputra drainage. Specific characters of *S. fasciata* are reviewed and discussed for better identification of the species in future. The Khri River originates from the West Khasi Hills district on the northern side of the Meghalaya Plateau. It flows north-westwards through dense tropical deciduous forests of Meghalaya and is joined by several streams and rivulets before emptying to the Brahmaputra drainage in Assam. Therefore, inferences from the present study will help to have a better understanding of the distribution and taxonomy of nemacheilid loaches of the Eastern Himalayan region.

Presentation

Research Overview

- **Study Objective:**
  To explore and evaluate the distribution of fishes of the genus *Schistura* in the Brahmaputra River drainage, Northeast India
- **Study Timeline:**
  January, 2018 to March, 2020
- **Geographic scope:**
  The Brahmaputra valley, northeast India



Picture courtesy: W. Vishwanath

Research OverviewContd...

Species covered:

- *Schistura fasciata* Lokeshwor & Vishwanath 2011
- **Type Locality**
  Barak River at the western side of Maram Hill, Senapati District (25°23'24.66" N; 94°04'09.25" E), Manipur, India

Collection locality:

- Khri River, Patharkhmah (25°51'27" N, 91°35'38" E), Ri-Bhoi District, Meghalaya, India

Khri River:

- South-bank tributary of the Brahmaputra drainage
- Originates near Mairang (West Khasi Hills District, Meghalaya) at around 1800 m a.s.l.
- Flows north-westwards in Meghalaya, enters the Assam state as the **Kulsi River** to finally join the Brahmaputra.

Schistura fasciata

Map of Khri River showing collection locality of *S. fasciata*

Study Methodology

- Fishes caught with the help of local fishermen using caste nets (mesh size: 1–1.5 cm)
- Specimens sedated with clove oil, fixed in 10% formalin, then transferred to 70% ethanol for permanent preservation
- Specimens deposited at the Gauhati University Museum of Fishes (GUMF), Assam and ICAR-National Bureau of Fish Genetic Resources (NBFGR), Lucknow
- **Counts and measurements** follow **Kottelat (1990)** and **Kottelat & Freyhof (2007)**. Measurements expressed as percentages of standard length (SL) and measurements of the head as percentages of lateral head length (HL)
- **Species identity** confirmed following **Lokeshwor & Vishwanath (2011)**
- **For molecular analyses**, DNA isolated from fin-clips preserved in 95% ethanol using QIAamp® DNA mini kit (Qiagen, Germany) following manufacturer's protocol. PCR amplification carried out using primer pairs Fish F1-Fish R1 (Ward *et al.*, 2005) for mitochondrial COXI gene, & amplified PCR products outsourced to AgriGenome Labs Pvt. Ltd. (Kerala, India)
- Generated sequences deposited to the NCBI-GenBank database
- **BLAST searches** for sequences with closest similarities (similarity > 98%; query cover > 94%) in GenBank
- **Genetic distance** measured using MEGA 7 (Version 7.0.26)

Key Findings

Figure *Schistura fasciata*, 59.9 mm SL (a,b,c - preserved; d - live)

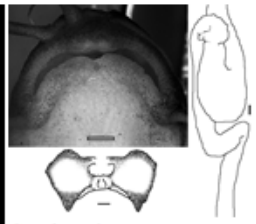


Figure *Schistura fasciata* - lips, air bladder, alimentary canal

Dorsal-fin rays	**iv, 8½**
Anal-fin rays	**iii, 5½**
Pectoral-fin rays	**i, 9-11**
Pelvic-fin rays	**i, 7**
Caudal-fin rays	**9+8**
Lateral-line	**c/inc**
Sensory pores on head	
Supraorbital	**7**
Infraorbital	**4+11**
Supratemporal	**3**
Preoperculomandibular	**9**
Bars	**16**

Table summarizing meristic data of *S. fasciata*

MT269753.1	***Schistura fasciata* (GUMF SF L1)**								
MT260375.1	***Schistura fasciata* (GUMF SF M1)**	0.000							
KJ936799.1	*Schistura fasciata* (Barak, Mizoram)	0.008	0.008						
KX399157.1	*Schistura fasciata* (Locality: Unknown)	0.008	0.008	0.000					
KJ909378.1	*Schistura khugee* (Chindwin, Manipur)	0.008	0.008	0.007	0.007				
KJ909375.1	*Schistura khugee* (Chindwin, Manipur)	0.008	0.008	0.007	0.007	0.000			
KT896738.1	*Schistura* sp. (Barak, Manipur)	0.010	0.010	0.008	0.008	0.008	0.008		
KF318336.1	*Schistura* cf. *fasciata* (Barak, Mizoram)	0.008	0.008	0.000	0.000	0.007	0.007	0.008	
KX951823.1	*Schistura fasciata* (Locality: Unknown)	0.016	0.016	0.015	0.015	0.011	0.011	0.013	0.015

Table showing the genetic (p) distances for MT-COX1 sequences of specimens of *S. fasciata*

Key Findings continued...

Table comparing morphometric data of *S. fasciata*

In % SL	Present study	Data from Lokeshwor & Vishwanath (2011)
Head length (dorsal) (DHL)	23.6-26.7	18.6-22.7
Head length (lateral) (LHL)	25.2-28.4	21.2-25.4
Predorsal length	51.2-53.0	49.7-63.7
Prepelvic length	56.2-57.9	51.1-54.9
Pre-anus length	74.2-75.8	72.2-80.3
Pre-anal length	77.9-81.0	76.5-80.9
Head depth at eye	10.9-13.4	8.9-10.8
Body depth at dorsal-fin origin	12.8-14.5	12.7-16.4
Depth of caudal peduncle	11.0-12.4	11.1-13.5
Length of caudal peduncle	13.0-14.5	12.3-15.2
Head width	15.1-17.2	12.6-14.8
Body width at dorsal-fin origin	10.1-12.9	10.5-13.6
Length of dorsal-fin	14.0-16.3	12.1-15.6
Length of anal-fin	17.2-19.4	12.7-16.1
Length of pelvic-fin	16.7-18.3	13.6-17.7
Length of pectoral-fin	18.1-20.8	14.7-19.4

Figure Map showing the distribution of *S. fasciata* (courtesy: W. Vishwanath)

Key Remarks

- Studies on distribution of Nemacheilids in river drainages of Northeast India is infancy and demanding
- Applying concepts of river morphodynamics, topography, satellite imaging, morphotectonic investigations, etc will enhance the concepts of fish species distribution
- Integrative taxonomic approaches will put up a proper framework to justify the characterization of species of the family Nemacheilidae
- Ambiguities and Errors to identification of Nemacheilids still remain
- Molecular data cannot be the sole representation of Nemacheilid species identity

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Presenter 7: Debolina Dey

Study Title: Notes on Some Interesting Riparian Plants of Assam

Authors: Debolina Dey and Nilakshee Devi

Abstract:

The river and drainage system of Assam is greatly divided into two valleys namely, the Brahmaputra Valley and the Barak Valley. Both the valleys are bestowed with a large number of Forest Rivers and streams that are seasonal and rainfed. Such rivers and streams foam up annually during the monsoon season causing heavy deposition of forest products on both sides of its bank that enhances the species richness and diversity of the existing riparian vegetation. Irrespective of such abundance and variation in aquatic flora, only a handful of exploration and assessment studies have been conducted so far in Assam most of which are restricted to the hydrophytic flora of some urban and roadside wetlands only.

The present study involves an extensive floristic survey of some selected forest bound streams, rivers and freshwater ponds most of which are located inside the Reserve Forests (RF) of Lakhimpur, Dhemaji, Golaghat, Dima Hasao Autonomous Council (DHAC) and Cachar district. All of these aquatic bodies have originated either from the foothills of Arunachal Pradesh in the northern part, Karbi Anglong in the central part and North Cachar Hills in the southern part of Assam.

As a result of this study, a total of around 40 species of riparian plants were documented out of which only 10 most significant ones have been presented here which are extremely rare, unique and lesser-known to botanical science. Few of them are rediscoveries, recollections and new reports to India and Assam, some even more than a century. Each plant has been supported by photographic illustrations, enumeration plates, interesting facts, and habitat analysis and population status. Their ecological adaptations, co-existence and relationships with other organisms found in the same habitat have also been studied and demonstrated. Based on this, some preliminary methodologies and probable ideas for their conservation and ways of mitigating the anthropogenic factors that are greatly threatening their survival have also been discussed.

Keywords: Aquatic, Wetlands, Riparian, Freshwater, Assam

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: NOTES ON SOME INTERESTING RIPARIAN PLANTS OF ASSAM

Presenter: Programme Coordinator-2 (Biodiversity Conservation), Debolina-Dey
Institute: NMHS Him-Nature Learning Centre, Assam

Research Overview

- **Study Objective**: To study the lesser known riparian plants of some selected reserve forests of Assam.
- **Study Timeline**: From 2019 to present.
- **Geographic scope**: The study was conducted on various aquatic bodies of some selected reserve forests (RFs) of Lakhimpur, Dhemaji, Golaghat, Dima Hasao Autonomous Council and Cachar districts of Assam. Following are some glimpses of the study sites:

Key Threats and Opportunities

Key Threats :-

- Lack of awareness amongst the fringe villagers regarding the rare and endangered aquatic flora of their areas.
- Unsustainable fishing and collection of other aquatic resources from the forest aquatic bodies.
- Pollution of aquatic bodies due to anthropogenic activities like dumping of picnic and other recreational wastes.
- Deforestation leading to soil erosion from the banks of the aquatic bodies causing sediment deposition and loss of biological life.

Key Opportunities :-

ADMINISTRATIVE LEVELS -

- Conduction of mass-awareness programmes on the rare and endemic aquatic flora occurring in and around the reserve forests of Assam.
- Development of various publications, documentaries, declaration of biodiversity heritage sites (BHS) etc.
- Establishment of various capacity building programmes amongst the local people on the artificial propagation of these plants leading to its conservation.

SCIENTIFIC LEVELS -

- Establishment of various scientific studies, assessment projects, surveys etc. by trained taxonomists and field biologists to collect and document new data on native and rare aquatic plants of Assam.
- Understanding the extent and impact of various invasive aquatic plants (like *Eichhornia*, *Monochoria* etc.)
- "Investments to investigate" the economic and commercial benefits out of any potential aquatic NTFPs.

Study Methodology

The following steps were followed during the study:-

1. Preliminary surveys.
2. Documentation of flora growing on and/or in nearby areas of the aquatic bodies (Riparian Flora).
3. Thorough analysis and preparation of taxonomic illustrations of the plant specimens photographed and collected from the various locations.
4. Preparation of herbarium sheets.
5. Consultation with the existing literatures and herbarium sheets present at the regional and national herbaria.
6. Correct Identification.
7. Correct Nomenclature.
8. Preparation of a checklist of the different plants including other data.
9. Revisit to the sites and collection of further data.
10. Publications.

Key Observations/Findings

***Aponogeton lakhonensis* A. Camus** : Long lost aquatic plant of India - rediscovered from Dhemaji, Assam - long gap of 123 years by the presenter - Only in Assam - Only 7-8 individuals - Recommended for immediate nation-wide attention, awareness and conservation.

***Ceropegia lucida* Wall.** : Considered to be extinct in wild - recollected from Golaghat district, Assam after a gap of 145 years by the presenter - Only 5-6 individuals – Insectivorous - Recommended for artificial propagation and conservation.

***Sterculia striariflora* Mast.** : A new addition to the flora of Assam – reported from Lakhimpur district, Assam by the presenter – second collection from India – third collected in the world after the type – Recommended for further population and conservation studies.

***Syzygium cyanophyllum* (P.C. Kanjilal & Das) Raizada** : An endemic myrtle species of Assam – Rheophyte - collected from Panimur, DHAC by the presenter – Restricted to Central Assam - Only 9-10 individuals – Threatened plant species - Recommended for immediate conservation and mass propagation.

***Murdannia assamica* Nampy & A. Aucy** : A lesser known dayflower species native only to Assam – collected from Lakhimpur, Assam by the presenter – recently described as a novel species – Recommended for further study, collection and conservation.

***Gymnostachyum venustum* (Nees) T. Anderson** : A rare riparian herbaceous plant of Assam – Lithophyte – Endemic to N. E. India – collected from Cachar, Assam by the presenter – Recommended for further research and conservation.

Key Recommendations

Large scale activities :-

- Scientific explorations and taxonomic inventorization of the forest riparian flora in Assam.
- Documentation of the native and invasive aquatic flora.
- Documentation, conservation and mass propagation of the native/endemic/RET riparian plant species of the forests in Assam.
- Wide publicity and mass awareness for their conservation.
- Ethnobotanical Surveys, Associated Traditional Knowledge, Associated Folklore Surveys etc.
- Population studies and allotting IUCN criteria.

Small scale activities :-

- Habitat Analysis of the mentioned species.
- Ecosystem and Ecology Monitoring of the mentioned species.
- Morphological Adaptations to their environments.

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Presenter 8: Devanshu Gupta

Study Title: Estimating Water Beetle Diversity in Northeast Region of India (Insecta: Coleoptera)

Authors: Devanshu Gupta, Sujit Kumar Ghosh, Joyjit Ghosh and Priyanka Das

Abstract:

The Northeast region in India is the transition zone between Indo-Malayan and Indo-Chinese geographical realms, and the Himalayan Mountains and Peninsular India receive the highest rainfall globally. The states of Assam, Meghalaya, Nagaland, Manipur, Mizoram and Tripura form the region. Brahmaputra and Barak rivers and their tributaries surpassing the landmass form the region's freshwater sources. Loktak Lake (Manipur), Deepor Beel (Assam) and Rudrasagar Lake (Tripura) are the Ramsar Wetland sites in the area. This paper has estimated the diversity and distribution of water beetles (Insecta: Coleoptera) in freshwater ecosystems of the Northeast region.

Over 776 species of water beetles in 137 genera, and 17 families under three suborders are reported from India, out of 12,600 species globally. Based on the extensive literature review and collection data available with the Zoological Survey of India, it is estimated that the Northeast region has 209 species belonging to 70 genera and 12 families. The majority of the water beetles (203 species) have been reported from Northeast Hills, and 70 species are reported from Brahmaputra Valley. Dytiscidae is the prominent family (93 species, 21 genera), followed by Hydrophilidae (47, 19), Gyrinidae (22, 6), Scirtidae (12, 5), Psephenidae (9, 5), Noteridae (7, 3), Hydraenidae (5, 5), Hydroscaphidae (3, 1), Dryopidae (2, 2), Haliplidae, Helophoridae (1, 1), and Epimetopidae (1, 1). With regards to the water beetle distribution, Manipur represents the maximum number of species (84), followed by Meghalaya (83), Assam (74), Tripura (37), Nagaland (4), and Mizoram (1).

The data thus compiled reveals that the states such as Mizoram, Nagaland, and Tripura have lesser faunal representation of water beetles than Assam, Meghalaya, and Manipur. Mizoram, Nagaland, and Tripura may be less explored, and the collections housed national and international museums are not yet taxonomically identified. Therefore, there is an urgent need to study by applying standardised methods of data collection techniques and taxa thus collected need to be identified and reported.

Keywords: Biogeographic Zone, Checklist, Distribution, Gap Areas, Taxonomy.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Estimating water beetle diversity in Northeast region of India (Insecta: Coleoptera)

Devanshu Gupta, Sujit Kumar Ghosh, Joyjit Ghosh, and Priyanka Das

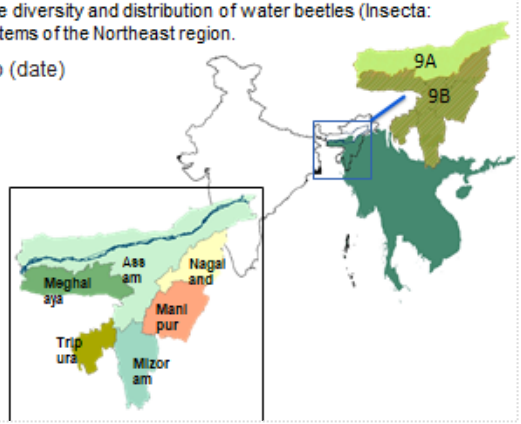
Presenter: Scientist "C"; O/C Coleoptera Section, Dr. Devanshu Gupta
Institute: Zoological Survey of India

Research Overview

- Study Objective: To estimate the diversity and distribution of water beetles (Insecta: Coleoptera) in freshwater ecosystems of the Northeast region.
- Study Timeline: From (date) to (date)
- Geographic scope:

✔ The Northeast region: Transition zone between Indo-Malayan and Indo-Chinese geographical realms, and the Himalayan Mountains and Peninsular India.

✔ The states include: Assam, Meghalaya, Nagaland, Manipur, Mizoram and Tripura form the region.



Key Threats

✔ Climate change; alteration of weather for long period of time can affect the fresh water storage due to shift in rainfall which may effect on species diversity.
✔ Utilisation and burning of phytomass forests for agriculture and farming
✔ Mainly Dytiscids are killed as they eat up fish fry
✔ Habitat degradation, like pollution, eutrophication, water level or management alteration.

Opportunities

✔ Indicator species of lentic freshwater system as multitude of factors, like geomorphology, hydrology, anthropogenic impacts and climate change can be monitored by Long-term monitoring.
✔ Despite of their contribution to freshwater and associated ecosystem, they are less studied. Many families need taxonomic work. Globally 25 families are recognized, of which 17 are reported from India.
✔ Northeast harbours primitive river basin system in India. is the transition zone between Indo-Malayan and Indo-Chinese geographical realms, and the Himalayan Mountains and Peninsular India, definitely a detailed systematic study may reveal tremendous information of this group.

Study Methodology

- Literature related to taxa comprising in freshwater ecosystems was extensively reviewed to constitute the aquatic beetles species diversity from Northeast region.
- Beetles specimens collected during many previous surveys fetched good volume of beetles samples. Being a global repository the samples were preserved in National Collection of Zoological Survey of India, in dry or wet state.
- Freshwater ecosystems dwelling were sorted according to their families and were further studied.
- The characters of the specimens were studied under microscope and species level authentication was maintained by using male genitalia dissection method.
- Entire specimen along with male genitalia was illustrated by using high definition camera.

- Freshwater sources: (main)

  ✔ River:
  Brahmaputra and Barak rivers and their tributaries.

  ✔ Lakes/Wetlands:
  Loktak Lake (Manipur), Deepor Beel (Assam) and Rudrasagar Lake (Tripura) are the Ramsar Wetland sites in the area. This paper has estimated the diversity and distribution of water beetles (Insecta: Coleoptera) in freshwater ecosystems of the Northeast region.


Loktak Lake

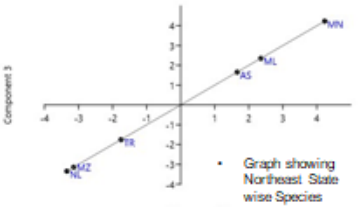
- Species covered (if any):

  water beetles Families: Dytiscidae, Hydrophilidae, Gyrinidae, Scirtidae, Psephenidae, Noteridae, Hydraenidae, Hydroscaphidae, Dryopidae, Haliplidae, Helophoridae and Epimetopidae.

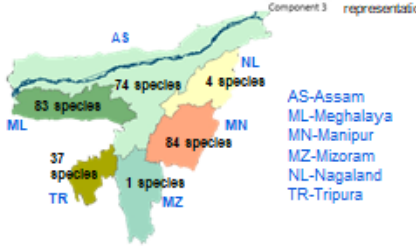
Key Observations/Findings

- Genera/Genus and Species representation from India and Northeast

NAME OF THE FAMILIES	INDIA		NORTHEAST	
	Genus / Genera	Species	Genus/ Genera	Species
Gyrinidae	5	73	6	22
Haliplidae	1	10	1	1
Noteridae	4	16	3	7
Dytiscidae	36	254	21	93
Hydroscaphidae	1	5	1	3
Dryopidae	6	10	2	2
Psephenidae	9	24	5	9
Scirtidae	8	75	5	12
Hydrophilidae	41	212	19	47
Helophoridae	1	7	1	1
Epimetopidae	1	4	1	1
Hydraenidae	8	45	5	5
	137	778	70	203



- Graph showing Northeast State wise Species representation



Key Recommendations

✔ Detailed taxonomic studies of each families.
✔ Ecological studies; mainly habitat analysis, foraging behaviour
✔ Long-term monitoring plot planning as their diversity depends upon multitude of factors, like geomorphology, hydrology, anthropogenic impacts and climate change

Contact Details

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Presenter 9: Abhinit Dey

Study Title: A New Species of the Genus Garra (Teleostei: Cyprinidae) from the Brahmaputra Drainage, Northeast India

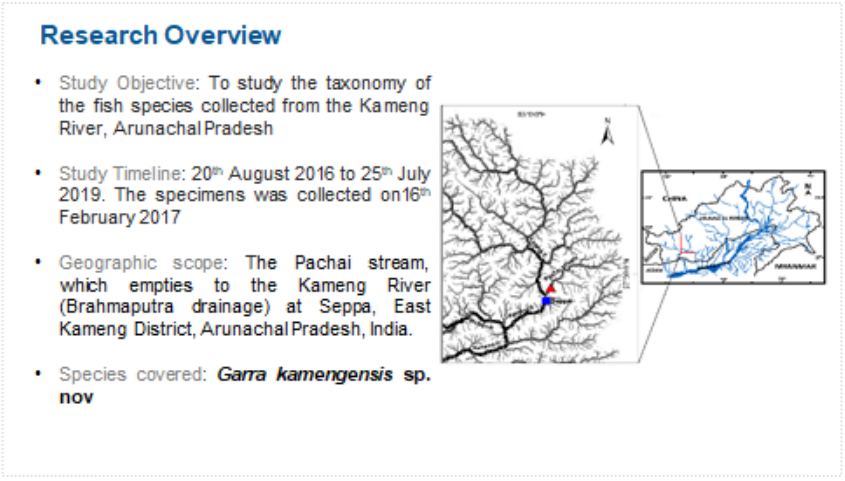
Authors: Abhinit Dey, H. Choudhury, R. C. Bharali and D. Sarma

Abstract:

Garra kamengensis, a new species, is described from the Kameng River of Brahmaputra drainage in Arunachal Pradesh, India. It has a prominent unilobed, quadrate proboscis, and is distinguished from all its congeners of the Brahmaputra and adjacent river drainages in having 7–8 small to medium-sized unicuspid and 2 large tetracuspid tubercles on the anterior marginal aspect of the proboscis; a prominent transverse lobe with 20–25 small to medium-sized unicuspid tubercles; a deep, concave and creased depressed rostral surface, an anus positioned slightly closer to the anal-fin origin (distance from anus to anal fin 44.2–45.1% of the pelvic-anal distance); 36–37 lateral-line scales; and 12 circumpeduncular scales.

Keywords: taxonomy, morphology, new Labeonini, freshwater fish, Arunachal Pradesh

Presentation



Research Overview Contd…

Study Methodology:

- Measurement expressed in proportions of standard length (SL) and head length (HL)
- Counts, measurements, snout & oromandibular terminologies follow Kottelat (2020) and Nebeshwar & Vishwanath (2013).
- Counts were made under a Leica S8APO stereo-zoom microscope. Dorsal and anal-fin ray counts follow Kottelat (2001).
- Vertebral counts were made from X-radiographs. Abdominal vertebrae include the Weberian complex, assumed as four.

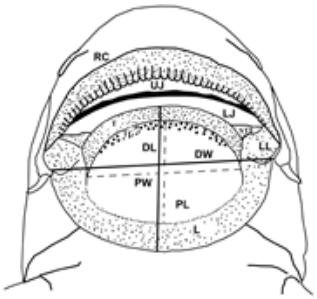


FIGURE. Schematic illustration of oromandibular structure of *Garra* sp. RC, Rostral cap; UJ, Upper jaw; LJ, Lower jaw; T, Torus; STF, Subtoral fold; TG, Toral groove; LL, Labellum; DL, Disc length; DW, Disc width; PW, Pulvinus width; PL, Pulvinus length; L, Labrum

Key Observations/Findings

FIGURE. *Garra kamengensis*, 144 mm SL; **a**, lateral, and **b**, ventral views; **c**, unilobed quadrate proboscis; **d**, gular disc.

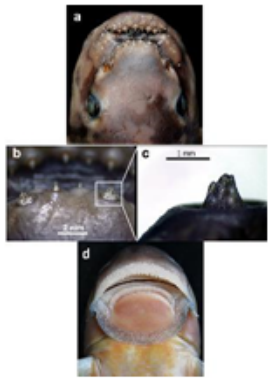


FIGURE. *Garra kamengensis*, 144 mm SL; **a**, **b**, magnified views of the tip of proboscis showing unicuspid and tetracuspid tubercles.

Key Observations/Findings

Measurements	Holotype	Range*	Mean	SD
Standard length (in mm)	144	105–144	–	–
In % SL				
Body depth	19.7	18.1–20.1	19.3	0.9
Head length	24.2	23.2–24.5	23.7	0.8
Head depth at nape	15.6	14.0–15.6	15.0	0.7
Head depth at eye	12.6	11.3–12.8	12.0	0.8
Head width	20.4	18.0–20.4	19.4	1.1
Body width at anal-fin origin	10.4	10.4–11.2	10.8	0.3
Body width at dorsal-fin origin	18.1	17.0–18.1	17.5	0.5
Caudal peduncle length	15.4	15.5–17.1	16.2	0.7
Caudal peduncle depth	13.4	12.5–14.1	13.3	0.6
Dorsal-fin base length	15.6	15.7–17.3	16.4	0.9
Dorsal-fin length	22.8	22.3–22.8	22.5	0.2
Pectoral-fin length	21.4	19.5–21.4	20.4	0.8
Pelvic-fin length	19.9	19.2–20.8	19.9	0.7
Anal-fin base length	8.3	7.1–9.3	8.3	0.9
Anal-fin length	18.8	17.2–19.7	18.6	1.0
Predorsal length	48.1	45.9–51.9	49.2	2.7
Prepectoral length	20.9	20.3–25.3	22.5	2.3
Prepelvic length	52.6	50.9–59.1	53.5	3.8
Pre anus length	65.1	64.4–74.6	67.3	4.8
Preanal length	76.1	75.6–85.4	78.2	4.8
Pelvic anal distance	18.2	17.5–20.4	19.0	1.4
In % of pelvic anal distance				
Distance from anus to anal fin	45.1	44.2–45.1	44.7	0.4
In % of HL				
Snout length	60.1	59.3–63.4	60.6	1.9
Eye diameter	15.2	15.2–17.3	16.7	1.2
Inter-orbital distance	49.1	46.4–49.1	47.7	1.1
Disc width	69.8	68.1–69.8	69.1	0.8
Disc length	44.4	44.4–48.4	46.3	1.8
Pulvinus width	47.5	43.2–47.5	45.0	1.9
Pulvinus length	29.7	29.7–30.3	29.9	0.3

Meristic data	
Dorsal fin	iv, 8½
Pectoral-fin	i, 14
Pelvic fin	i, 8 (3) or 9 (1)
Anal fin	iii, 5½ (4)
Caudal fin	10+9
Lateral line	36 (2) or 37 (2)
Transverse scale	3½ +2½
Circumpeduncular scale	12
Predorsal scales	11
Dorsal-fin base scales	6 (3) or 7 (1)
Vertebrae:	35; 23 (1) or 24 (1) abdominal and 12 (2) caudal

Key Observations/Findings

Differs from other proboscis-bearing congeners:

- having a unilobed, quadrate proboscis, in having two large tetracuspid (vs. unicuspid) tubercles on the anterior margin of the proboscis.
- a deep transverse groove with small- to medium-sized, irregularly-distributed unicuspid tubercles; creased, concave depressed rostral surface;
- bulging lateral surfaces with 6–14 tubercles on each;
- an ellipsoid pulvinus (width 43.2–47.5% HL; length 29.7–30.3% HL);
- the anus slightly closer to anal-fin origin than pelvic-fin origin (distance from anus to anal fin 44.2–45.1% of pelvic-anal distance); and 36–37 lateral line scales.

G. arunachalensis *G. paraxenorhynchus* *G. quadratirostris*

G. gotyla *G. kalpangi* ***G. kamengensis* sp. nov**

Conclusion

Based on the variations in the characters of the snout viz. proboscis shape and size, tubercle number and shape and gular disc position with its nearest congeners, *G. kamengensis* can be distinguished as a new species.

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Presenter 10: Dr Identicia Marwein

Study Title: Aquatic Insect Community Assemblage in two Small Streams of Shillong, Meghalaya, North-East India

Authors: Dr Identicia Marwein and S. Gupta

Abstract:

Stream habitat can sustain valuable and ecologically important biodiversity, and aquatic insect community is one of them. Thus, the study focuses on the diversity and abundance of aquatic insects and their importance as bio-indicator which reflect the health status of an ecosystem depending on their composition in the system. The study was conducted at two small forest streams of Shillong namely, Wahdienglieng and Umrisa. Four sites were selected from each stream - W1 & U1 – upstream, W2 & U2 – upper midstream, W3 & U3 – lower midstream and W4 & U4 – downstream. Aquatic insects were collected in three replicates in four seasons from each site following one-minute kick net and all out search methods during 2014 and 2015. Statistical analyses were done using PAST and CANOCO software. During the study period, 9 orders, 38 families, 74 genera and 75 species were recorded from both the streams. In the first year, 9 orders, 21 families, 35 genera and 35 species were recorded from Wahdienglieng and 9 orders, 27 families, 48 genera and 49 species were recorded from Umrisa. In the second year, 8 orders, 22 families, 42 genera and 42 species were collected from Wahdienglieng and 9 orders, 25 families, 45 genera and 45 species were recorded from Umrisa stream. Shannon (H′) diversity index value was found highest at upstream W1 (1.89) and lower midstream U3 (2.28) in the first year while in the second year, the highest value of Shannon (H′) diversity index was both at upstream W1(2.5) and U1(2.28) of the two streams. The highest density of aquatic insects was at downstream and lower midstream during the first year in Wahdienglieng and Umrisa, respectively while in the second year, it was found to be at upstream and downstream in Wahdienglieng and Umrisa respectively. Number of common species recorded in the two streams was 47.

Six biological indices were computed to determine the water quality of Wahdienglieng and Umrisa streams using aquatic insects. Accordingly, Biological Monitoring Working Party Thailand ($BMWP^{THAI}$) and Singapore score (SingScore) showed poor water quality downstream of Wahdienglieng. The water quality for upstream, upper midstream and lower midstream indicated as clean, good to moderate quality. However, at Umrisa stream, the biological indices indicated clean, excellent, healthy, good to moderate water quality for the four selected sites. The study revealed that the two streams are rich in aquatic insect diversity. This study provided ample information about aquatic insect species diversity of two streams of a region which is data deficient and part of Indo-Burma Biodiversity Hotspot.

Keyword: aquatic insects, diversity, biological indices

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: Aquatic Insect community assemblage in two small streams of Shillong, Meghalaya, North-east India.

Presenter: Dr. Identicia Marwein
Institute: Sankardev College, Shillong

Research Overview

Streams of Shillong has been valuable aquatic ecosystem which provide immeasurable services that we rely upon. Part of the services that involve is the aquatic organism which perform as bio-indicator for the quality of the stream water. Aquatic insects are widely used globally as bio-indicator because of their sensitivity to certain pollution level present at the habitat due to several anthropogenic influence.

Hence, the study focuses on the diversity and abundance of aquatic insect and their important as bio-indicator which reflect the health status of an ecosystem depending on their composition at the system.

The study was conducted for two years, from 2014-2015 to 2015-2016 at two small streams of Shillong namely Wahdienglieng and Umrisa.

Being part of Indo-Burma Biodiversity Hotspot, works done on such region adds up the information for future study.

Research Overview Contd...

During the study period, 9 orders, 38 families, 74 genera and 75 species were recorded from both the streams. In the first year, 9 orders, 21 families, 35 genera and 35 species were recorded from Wahdienglieng and 9 orders, 27 families, 48 genera and 49 species were recorded from Umrisa. In the second year, 8 orders, 22 families, 42 genera and 42 species were collected from Wahdienglieng and 9 orders, 25 families, 45 genera and 45 species were recorded from Umrisa stream

For the study, two small streams were selected from Shillong which are Wahdienglieng and Umrisa. Four sites were then taken from each stream dividing into - W1 & U1 – Upstream, W2 & U2 – Upper midstream, W3 & U3 – Lower midstream, W4 & U4 – Downstream.

Study Methodology

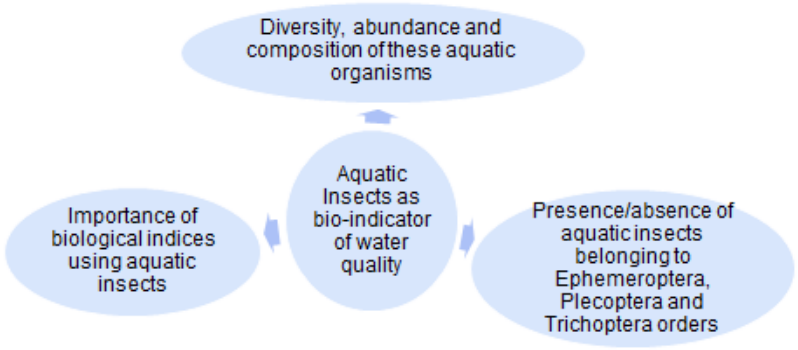
Aquatic Insects were collected seasonally (2014-2015 and 2015-2016)

pre monsoon (PRM) (March-May)	monsoon (MON) (June-Aug	post-monsoon (PSM) (Sept-Nov)	winter (WIN) (Dec-Feb)

Kick net as well as all out search method (Subramanian and Sivaramakrishnan, 2007)

- 4% formaldehyde solution were added and then sorted, counted, identified
- preserved at 70% ethanol
- Literature with standard identification keys (Bal and Basu, 1994a, b; Thirumalai, 2002; ZSI, 2004; Zwick, 2004; Webb and Maccafferty, 2008; Suter and Webb, 2011; Webb and Suter 2011) were used to identify the collected aquatic insect samples up to genus level using an Imported Motic Steroescopic Zoom Trinocular Microscope (SMZ – 168TL0)

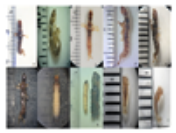
Key Threats and Opportunities



Key Observations/Findings

The presence of 9 orders, 38 families and 75 species of aquatic insects in both the small streams indicates that the systems are rich in aquatic fauna.

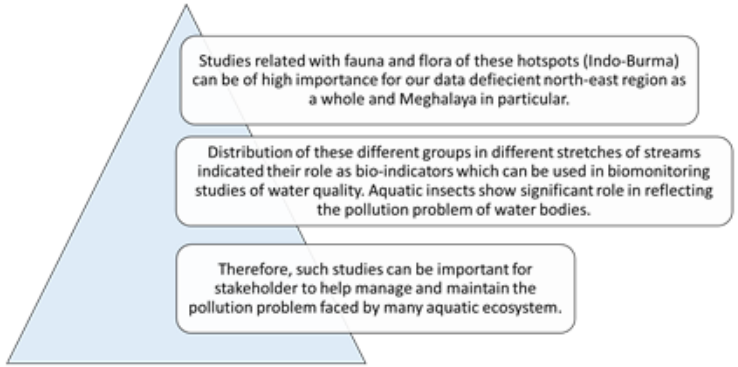
Biological Indices showed that the water quality of these two streams was in good conditions since the taxa inhabiting the streams are giving high numeric expressions except for few sites from both streams.



Offadens sp. (Baetidae) belonging to Ephemeroptera is found to be the most eudominant species at both Wahdienglieng and Umrisa concentrating more on lower stretches than at upper stretches.

As these nymphs are considered moderately pollutant tolerant their presence indicated that there were some anthropogenic activities in these sites.

Key Recommendations



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Presenter 11: Augustni Shongsir

Study Title: Mahseer Fishes-King of Rivers: Diversity and Conservation Status in Manipur

Authors: Augustni Shongsir and Yumnam Rameshori

Abstract:

Mahseer or *King of rivers* comprises the three genera of *Neolissochilus, Tor* and *Nazirator* under the family Cyprinidae. They are distinguished in having large scales and heads. Mahseers are very attractive sport-fish with excellent food value fetching high market price and are potential candidate species for aquaculture as well. A preliminary study on the Mahseers of Manipur revealed the occurrence of two genera viz., *Tor* and *Neolissochilus*. The two genera are represented by eight species *Tor putitora, T. tor, T. mosal*, *T. barakae* and *Neolissochilus stracheyi, N. paucisquamata, N. hexagonolepis*, *N. hexasticus* are found in the two river basins draining the state, the Barak and the Chindwin. However, there has always been an ambiguity between the congeneric Mahseer species and the taxonomy of Mahseer is confusing due to the morphological variations they exhibit. Therefore, there is a need to undergo an Integrative taxonomy approach to study the congeneric species of Mahseer.

On the other hand, despite their economic and cultural importance, the status of Mahseer fishes in water bodies has been declining rapidly and threatened severely due to various form of human impacts such as pollution, habitat loss, overfishing and increasing unregulated release of artificially bred stock of a very limited number of species. As per a recent IUCN report, Mahseer is considered a threatened species and hence needs special attention in terms of conservation. Therefore, a well-balanced and holistic approach should be taken up, with a plea for detailed biological information on the Mahseer of the region so as to enable conservation of these species.

Presentation

Study Methodology

- Collection: Nets, traps and electro-fishing equipments and bought from local fishermen.
- Preservation: Fin and muscle tissues- 95% absolute ethanol. Voucher specimens- 10% formalin.
- Identification: Morphometric and meristic measurements- followed Sen & Jayaram (1982) and Jayaram (1999), Kottelat (2001).
- Molecular techniques: DNA isolation, PCR amplification, Sanger sequencing, PCR amplification of mt gene and submission to database.

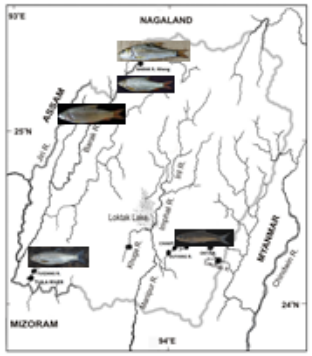
Research Overview

- Study Objective:

- To carry out detailed inventory of mahseer in fresh water bodies in Manipur
- To describe new species and genera (if any)
- To determine taxonomic uncertainties/ambiguities within its genus and species

Study Timeline: From August,2020 to September, 2021

Geographic scope:



- Species covered:

Neolissochilus stracheyi (Day, 1871)

Neolissochilus hexagonolepis (Mc Clelland, 1839)

Tor putitora (Hamilton,1822)

Tor tor (Hamilton, 1822)

Tor barakae (Arun kumar & Basudha, 2003)

Key Threats

- Habitat destruction.
- Over exploitation.
- Destruction of natural habitat by introduction of exotic fish species.
- Pollution

Over fishing at Chahong village, Kamjong Dist. Manipur.

Opportunities

- Sport fish-a means of recreation
- Good for consumption as it has high nutritional value
- High commercial value- boost the economy of the people.
- Plays as pioneer for new researcher
- New species are expected- many hilly areas are yet to discovered.

Form	IMC price per Kg	Mahseer price per Kg
Fresh	Rs.250-300	Rs. 800-900
Dry (Processed)	Rs. 500-600	Rs. 1200-1500

Key Observations/Findings

- There is a great diversity of mahseer in Manipur- 5 species.
- Over fishing of Mahseer in the name of consumption-sustenance fishing
- Habitat inventory is still at its infancy
- Lack of awareness among the villagers
- Some fishes are under "near threatened" and "endangered" as IUCN report

ENDANGERED	NEAR THREATENED
Tor putitora	*Tor tor*

Key Recommendations

- Detailed inventory and exploration needed so as to solve the ambiguity within the genus
- Awareness programme/campaign about the importance of mahseer should be conducted at village and community level
- Introduction of proper legislative policy by the Govt. for mahseer conservation

Mahseer awareness campaign at Bukpi village, Pherzawl.

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Presenter 12: Ngaihte Thangliankhai L

Study Title: Diversity of Cyprinidae Fishes in Barak and Chindwin River of North East

Authors: Ngaihte Thangliankhai L and Yumnam Rameshori

Abstract:

Northeast India falls under the Eastern Himalaya Freshwater Biodiversity Hotspot and has rich ichthyofaunal diversity which are endemic to the region. The Barak and the Chindwin are two important river drainages of the region. The Barak River originates in Senapati district of Manipur and flows along the state of Assam and into Sylhet district of Bangladesh. The Chindwin River rises in the broad Hukawng valley of Kachin state of Myanmar and flows into the mighty Irrawady near Mandalay. In this paper, the diversity of Cyprinidae fishes of the Barak and Chindwin drainage in northeast India is presented. The preliminary study reveals the occurrence of 85 Cyprinid fishes belonging to 30 genera and six subfamilies viz., Barbinae, Cyprinidae, Labeoninae, Rasborinae, Squaliobarbinae and Xenocyprinae. Of these, the subfamily Labeoninae exhibits the highest diversity with as many as 28 species. There are 34 species of Cyprinid fishes in Barak while 65 species in the Chindwin and out of these 14 species are common to both the drainage.
Labeo with six species is the most dominant Cyprinid in the Barak while *Garra* with 13 species in Chindwin being the most dominant.

Many Cyprinid fishes are structurally modified for hill stream mode of life. Among them, the members of the subfamily Labeoninae show the highest hill stream adaptation.

The Cyprinids are highly valued fishes in terms of food value and ornamental aspects. Large sized Cyprinids like *Labeo, Osteobrama, Neolissochilus, Tor* etc. are good food fishes while small sized ones like *Barilius, Chela, Devario, Esomus, Garra, Pethia, Puntius, Rasbora* etc. are ornamental. So far, 25 species have been categorised under the IUCN threat category of which two are endangered, 17 vulnerable and six near threatened. Population growth and related development activities has resulted in the dwindling of a number of species at a very fast pace. There exists taxonomic ambiguity among some genera and needs to be resolved. Due to inaccessibility of the interior parts of the region, many areas have never been visited by ichthyologists. Many new species await discovery. There is an urgent need for extensive surveys of the fauna and evaluating their status

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Diversity of Cyprinidae fishes in Barak and Chindwin River of Northeast India

PhD Scholar, Ngaihte Thangliankhai L
Department of Life Sciences (Zoology), Manipur University, Canchipur- 795003

Research Overview

- **Study Objective:**

  1) To study the diversity of Cyprinidae fishes in Barak and Chindwin River basin of Northeast India
  2) To describe new taxa (many new species & taxa are expected)
  3) To assess the threat status of Cyprinidae fishes of Barak and Chindwin River basin

- **Study Timeline:** May 2020 to September 2021

- **Geographic scope:** Northeast Indian States of Arunachal Pradesh, Assam, Manipur, Mizoram & Nagaland.

Northeast India : Barak and Chindwin river basin

- **Species covered:** Cyprinid fishes found in Barak and Chindwin basin

Garra naganensis Hora | *Puntius sophore* (Hamilton) | *Laubuka laubuka* (Hamilton)

Barilius bendelisis Hamilton | *Opsarius ngawa* Vishwanath & Manojkumar | *Neolissochilus stracheyi* (Day)

Devario aequipinnatus McClelland | *Pethia ornata* (Vishwanath & Juliana) | *Hypsibarbus myitkyinae* (Prasad & Mukerji)

Study Methodology

i) Collection

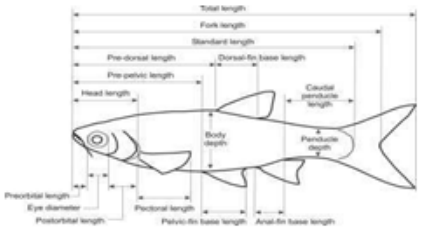
- Nets, traps, electrofishing machine
- From local fisherman and local fish market

ii) Preservation

- 10% formalin (Walsh & Meador 1998)
- Deposited in MUMF

iii) Identification

- General measurements and counts followed Hubbs & Lagler (1947) and Kottelat (2001)
- For *Garra*, *Pethia* and *Tor*, the methods respectively of Kullander & Fang (2008), Kullander (2008) and Jayaram (1999) were followed



Schematic illustration of a Cyprinid fish (Rainboth, 1996)

Key Threats

- Habitat loss
- Degradation of water quality
- Construction of dams
- Flow modification
- Introduction of invasive species
- Over exploitation
- Pollution

a) b)

Drying up of Lanva river, Churachandpur district in a) May 2020 and b) May 2021 due to pollution

Opportunities

- Explore the rich diversity of Cyprinidae fishes of Manipur
- Beneficial for study as they have good food value
- High potential source of income
- Species like *Tor* and *Neolissochilus* provides recreational means as a sport fishes
- Manipur have the potential of leading in fish production and exportation

Freshly caught fishes

Key Observations/Findings

- Diversity of Cyprinids fishes in Barak and Chindwin basin is very high
- 85 Cyprinids species belonging to 30 genera and six subfamilies viz. Barbinae, Cyprinidae, Labeoninae, Rasborinae, Squaliobarbinae and Xenocyprinae
- 20 new species have been discovered from Barak and Chindwin basins of Manipur in the past 30 years by Vishwanath and co-workers
- New fishes being discovered till date, but with lesser rate
- Huge areas, especially that of the interior hills are left unexplored
- Many fishes awaits discovery
- Taxonomic ambiguity occurs in many species
- 25 species categorised under IUCN threat category – five from Barak, 21 from Chindwin
- *Tor putitora* and *Pethia manipurensis* are endangered, six species are near threatened and 17 are vulnerable.

Key Recommendations

- Awareness to local level about the value of fish conservation
- Environment Impact Assessment (EIA) should be properly done before constructing dams
- More exploratory and inventory work
- Standardization of protocols for captive rearing and breeding of high value indigenous fish species
- Urgent Conservation practices
- Introduction of proper legislative policy
- Vehement steps should be taken to conserve the native species which are threatened in their natural system.

Fishes conservation and awareness campaign at Bukpi village, Churachandpur

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Presenter 13: Bhaskar Saikia

Study Title: Diversity of Aquatic Frogs of North-East India: Scopes and Opportunities
Authors: Bhaskar Saikia and Bikramjit Sinha

Abstract:

The life cycle of amphibians, with a few exceptions, are characterised by the use of both land and water as their habitats. As such, they are sensitive to their environment, primarily due to their dependency on aquatic habitats, which are prone to rapid environmental deterioration. With rapid climate change and environmental degradations, this makes amphibians a taxon in peril. However, to understand the conservation needs, a proper understanding of their natural history is essential, which begins with the compilation of an inventory, and their distribution records.

Among the three living orders of amphibians, the anurans are the most diverse group, both in terms of diversity and their adaptability to varied habitats. Globally, out of 8,380 species of amphibians, 7,401 species belong to the anurans. In India, among the 447 species of amphibians recorded so far, 406 species belong to the order anura, while in Northeast India, the amphibians are represented by 163 species of which 150 species belong to anurans.

The adult anurans are known to occur in ponds, rivers, lakes, streams, trickles, crop fields, marshes, cascades, in burrows, forest leaf litters, bushes, tree canopies, homesteads, etc. This has resulted in slight morphological adaptations from a typical anuran body plan, according to the habitat or ecological niche required. Among the aquatic frogs this change is characterised by eyes and nostrils projected upwards and toes almost fully webbed that aid in swimming.

Based on published literature and available museum vouchers in the collection of the Zoological Survey of India, Shillong, we are reporting 16 species of aquatic frogs from the four Northeast India states of Assam, Nagaland, Manipur and Meghalaya, including two vulnerable species. These 16 species are under seven genera and two families. With recent phylogenetic studies, the range of *Euphlyctis cyanophlyctis* and *Limnonectes kuhlii* may be revised in the near future. *Euphlyctis ghoshi, Minervarya sengupti* and *Nanorana mokokchungensis* are known from their respective type locality of Manipur, Meghalaya and Nagaland. Not much data is available on another frog described from Meghalaya, *Limnonectes mawlyndipi. Ingerana borealis* is not a typical aquatic frog; however, the report of a viable population of this species from the Lymput cave of Meghalaya where they were reported to remain in water holes on the cave floor is an interesting find.

Other than the bush frogs and phytotelm-breeding frogs, all the anurans spent some of their life cycle in aquatic habitats as tadpoles. So, to conserve the species diversity, conservation of the aquatic habitats is essential. Another thrust area *vis-à-vis* the amphibian research should include a thorough exploration of diverse aquatic habitats of the region using integrative taxonomy, particularly molecular phylogeny, for cryptic groups like *Euphlyctis, Minervarya*, etc., which may result in better documentation of the diversity of aquatic frogs from these states.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: Diversity of Aquatic Frogs of North-East India: Scopes & Opportunities

Presenter: Bhaskar Saikia, Senior Zoological Assistant
Institute: Zoological Survey of India, North Eastern Regional Centre, Shillong

Research Overview

- **Study Objective:** Inventory of the current known diversity of aquatic frogs of four Northeast India states of Assam, Nagaland, Manipur and Meghalaya (NERAQ project area), and its scopes and opportunities.
- **Study Timeline**: This is a review work based on published literature and vouchers collection available at ZSI, Shillong. As such, this study was undertaken in September, 2021 post the announcement of this symposium.
- **Geographic scope:** Aquatic frog diversity of four Northeastern States of Assam, Nagaland, Manipur and Meghalaya are included in this study.
- **Species covered** (if any): 16 species of aquatic frogs under seven genera and two families (details in later slides) are covered.

Study Methodology

- The documentation of the aquatic frog diversity of the four Northeastern States of India *viz*. Assam, Nagaland, Manipur and Meghalaya (NERAQ project area) were done based on review of published literature and the vouchers deposited in the National Zoological Collections of the Zoological Survey of India, Shillong (ZSIS).
- The state-wise distribution and the IUCN threat status of the species are also included in this study.
- Remarks on the probable distributional errors and threats are also highlighted.
- A few recommendations were made based on the needs of shortfalls highlighted based on present-day knowledge.

Species List

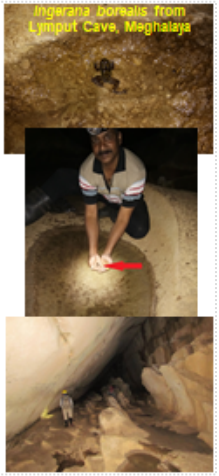
Aquatic Frogs of NERAQ Project States

AS-Assam, NL-Nagaland, MN-Manipur, ML-Meghalaya, #-endemic, *- special cases, VU-Vulnerable, LC-Least Concern, DD-Data Deficient, NE-Not Evaluated

SN	Species	Distribution	IUCN status	SN	Species	Distribution	IUCN status
1	*Euphlyctis* cf. *cyanophlyctis* (Schneider, 1799)	AS, NL, MN, ML	LC	9	*Hoplobatrachus crassus* (Jerdon, 1853)	AS, NL, MN	LC
2	***Euphlyctis ghoshi* (Chanda, 1991) #**	MN	DD	10	*Hoplobatrachus tigerinus* (Daudin, 1802)	AS, NL, MN, ML	LC
3	*Euphlyctis kalasgramensis* Howlader et al., 2015	AS	NE	11	*Ingerana borealis* (Annandale, 1912)*	NL, MN, ML	VU
4	*Minervarya asmati* (Howlader, 2011)	AS, MN	NE	12	*Limnonectes khasianus* (Anderson, 1871)	AS, ML	DD
5	*Minervarya nepalensis* (Dubois, 1975)	AS, NL, MN, ML	LC	13	*Limnonectes* cf. *kuhlii* (Tschudi, 1838)	AS, ML	LC
6	*Minervarya pierrei* (Dubois, 1975)	AS, NL, MN, ML	LC	14	*Limnonectes mawlyndipi* (Chanda, 1990)	ML	DD
7	***Minervarya sengupti* (Purkayastha & Matsui, 2012)#**	ML	NE	15	***Nanorana mokokchungensis* (Das & Chanda, 2000) #**	NL	DD
8	*Minervarya teralensis* (Dubois, 1975)	AS, NL, MN, ML	LC	16	*Pterorana khare* Kiyasetuo & Khare, 1986	AS, NL, MN, ML	VU

Key Observations/Findings

1. **AQUATIC FROG SPECIES INVENTORY**: We are reporting 16 species of aquatic frogs from the study area, including two vulnerable species. These 16 species are under seven genera and two families (Dicroglossidae – 15 spp. & Ranidae – 1sp.).
1. **DOUBTFUL SPECIES**: With recent phylogenetic studies (Dinesh et al., 2021; Frost, 2021), the range of *Euphlyctis cyanophlyctis* and *Limnonectes kuhlii* may be revised in the near future.
1. **ENDEMIC SPECIES**: *Euphlyctis ghoshi*, *Minervarya sengupti* and *Nanorana mokokchungensis* are known from their respective type locality of Manipur, Meghalaya and Nagaland only.
1. **SPECIAL MENTION**: Not much data is available on another frog described from Meghalaya, *Limnonectes mawlyndipi*.
1. **SPECIAL CASE**: *Ingerana borealis* is not a typical aquatic frog; however, the report of a viable population of this species (since 2006) from Lymput Cave of Meghalaya where they were reported to remain in water holes/pools on the cave floor is an interesting find (Saikia and Saikia, 2020).
1. **STATE WISE DISTRIBUTION**: Assam has 11 species, Nagaland has 8 species, Manipur has 10 species and Meghalaya has 11 species of aquatic frogs known currently.



Key Threats and Opportunities

The **key threats** observed are:

1. **Unsustainable urbanization** where aquatic habitats are destroyed either due to pollution or filled-up for infrastructure development. E.g. Silsako Lake/Sachal wetland of Eastern Guwahati, Wah Umkhrah of Shillong.
2. **Unsustainable harvesting** of aquatic frogs as food. Species like ***Hoplobatrachus tigerinus*** is a delicacy. ***Pterorana khare,*** a vulnerable species under IUCN Red list is harvested as food in Nagaland.

The major **opportunities**/scopes are:

1. **Comprehensive documentation:** Newer records and species
2. **Integrative Taxonomic Approach:** Eg. Molecular taxonomy
3. **Re-Discovery of Lost Amphibians:** Eg. *E. ghoshi* or *L. mawlyndipi*
4. **Lack of natural history information on most species:** Eg. Yellow frogs news
5. **Assessment of threat category of aquatic frogs:** Eg. DD/NE of IUCN

Key Recommendations

1. **Extensive surveys of less explored areas** like Nagaland & hill areas of Manipur and also covering different habitats and ecosystems to unearth the hidden diversity of aquatic frogs.
1. Use of **integrative taxonomic approach** like molecular, bioacoustics, etc. for cryptic species.
1. **Studies on the natural history**, especially breeding biology.
1. Town planners must consider **preserving the wetlands while urbanizing** an area.
1. Inclusion of frogs in ***ex-situ* aqua-culture** for the species harvested from the wild as food source. **Proper certification** also needed to ensure the produce is from *ex-situ* source.
1. **Assessment of threat categories** of frog species which were not evaluated by IUCN. **Revision of amphibian species list** under WL(P)A, 1972; CITES, etc.
1. Conservation of highly localized **Endemic Species** in the form of CRs, CCAs, etc.

References:

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Presenter 14: Prabina Salam
Study Title: Diversity of Labeonine (Labeoninae: Cyprinidae) Fishes of Manipur, India
Authors: Prabina Salam and Yumnam Rameshori

Abstract:

Manipur comes under the geographical scope of the Eastern Himalaya Freshwater Biodiversity Hotspot. The region being drained by the Barak–Surma–Meghna and Chindwin drainages harbours potentially significant freshwater fish resources. Most of the members belonging to the subfamily Labeoninae are adapted to hill-stream mode of life. In the present preliminary study, the diversity of the Labeonine fishes is studied based on snout morphology, anus position, colouration pattern, and various structural modifications such as oral and gular morphology, tuberculation pattern on the snout, etc., The study found the occurrence of thirty-one (31) Labeonine fishes under five genera in Manipur viz., *Bangana, Cirrhinus, Garra, Labeo,* and *Tariqilabeo*, represented by two *Bangana,* two *Cirrhinus,* eighteen *Garra,* seven *Labeo,* and two *Tarqiilabeo,* genus *Garra* exhibits the maximum diversity among the subfamily. Three new species of Garra with proboscis are expected from the present study and may await discovery. As such detailed exploration and proper documentation of the subfamily needs to be undertaken. Possible threats, IUCN status, and conservation measures are broadly discussed. Since the region harbours numerous endemic species and blooming potential threats, immediate conservation measures should be taken up.

Presentation

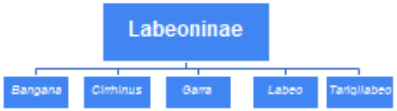
Research Overview

- **Objectives**:

➢ Detailed survey of fish species of the subfamily Labeoninae in Manipur
➢ To determine the threat status
➢ To describe new taxa and catalogue them

- **Study Timeline**: From April 2019 to 2021
- **Geographic scope**: **Manipur**: Barak & Chindwin River drainage
- **Present study covered**: 5 genera (31 species)

Fig: Drainage map of Manipur indicating Barak River drainage and Chindwin River drainage



- *Bangana*: blunt, pendulous and inferior; lower jaw cornified
- *Cirrhinus*: mouth inferior, rostral cap thick, smooth or slightly fimbriated
- *Garra*: mouth inferior, lower lip is modified into gular disc
- *Labeo*: snout inferior thick, smooth rostral cap, post labial groove continuous
- *Tariqilabeo*: snout inferior with well developed lip, upper lip thin or absent, lower lip modified into papillated labial plate

Cirrhinus reba(Hamilton,1822)

Garra sp.

Fig: *Tariqilabeo burmanicus (Hora, 1936)*

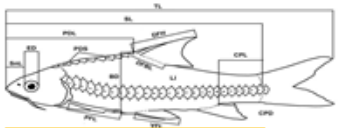
Study Methodology

Collection:
➢ Electrofishing equipment, nets, hiring local fishermen and local market
➢ Details of the collection site; date & time of collection (GPS reading)

Preservation:
➢ Formalin preservation is done at 10%

General Counts & Measurements:
➢ Hubbs & Lagler (1946), Kottelat 2001
➢ *Garra*: Nebeshwar & Vishwanath (2013), Kottelat (2020)
➢ *Bangana*: Zhang & Chen (2006)
➢ *Cirrhinus*: Roberts (1997)
➢ *Labeo*: Jayaram & Das (2000)
➢ *Tariqilabeo*: Ciccotto & Page (2016)

Dna Barcoding
➢ White muscles tissues or fins are preserved at 95% Ethanol
➢ DNA isolation was done following Sambrook et al.(2001) with some minor modifications
➢ For PCR, amplification was done using universal primer F1 and R1, Ward et al. (2005)
➢ Sequencing by Sanger sequencing method



Schematic illustration of Labeonine fish

Threats and Opportunities

Major threats :
- Habitat destruction, (dam: migration)
- Overexploitation
- Pollution
- Invasive species
- Climate change

Opportunities:
- Provide an opportunity to explore and study the diversity of Labeonine fishes of Manipur
- Many area remained unassessed so new species is expected so further exploration is needed
- The threat status of endemic species
- Conservation by captive breeding and
- Sustainable fishing methods can boost the state economy as they serve as main food fish in the state

Observations/Findings

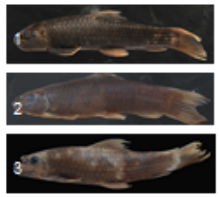
Total Labeoninae: 31 species belonging to 5 genera

Highest diversity in genus *Garra* : Chindwin River drainage

- In the last 2 decades, Vishwanath and co-workers discovered 13 new species of *Garra* from Manipur ; and also 3 new species from Manipur are expected from the study
- DNA Barcode : 6 species of *Garra*

Genus	Barak	Chindwin	Total	IUCN status data
Bangana	1	1	2	LC
Cirrhinus			2	LC
Garra	4	14	18	>70% are either vulnerable or NE
Labeo			7	LC
Tariqilabeo	1	1	2	LC: T. latius/ DD: T. burmanicus

Species	Diagnostic characters
Garra sp. 1	a prominent transverse lobe, depressed rostral surface with or without ridges and unilobed proboscis, 31–32 lateral line scales and 3½ or 4½ transverse scale row above lateral line.
Garra sp. 2	unilobed proboscis, two acanthoid, unicuspid tubercles at the anterolateral margin of the proboscis and a small unicuspid tubercle in between, 33–34 lateral line scales and anteriorly positioned anus position 44.4%–48.4%
Garra sp. 3	a protruding unilobed proboscis, not reaching the transverse lobe, with 18–29 small to medium-sized uni- or tetracuspid tubercles on the transverse lobe, 31–33 lateral line scales and more posteriorly positioned anus 23.7–30.7%



Recommendations:

- Manipur has high diversity of Labeonine fishes therefore needs further exploration and inventory
- Proper documentation of the species
- Planning and conservation status of the species should be taken up
- Detailed biology of the species
- High production of fish resources by captive breeding
- Improving public awareness to the local people about the diversity and value of endemic Labeonine fishes

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Presenter 15: Bikramjit Sinha

Study Title: Present Knowledge of Freshwater Cladocera Diversity in North East
Author: Bikramjit Sinha

Abstract:

Biotic interactions in ecosystems are the most important factor which determines species selection and structure of biological communities. This is more appropriate in aquatic ecosystems where interactions are more intense and severe due to relatively low support offered by the environment. Most of the efforts and resources on aquatic biodiversity studies have been directed and focused on select larger groups particularly Pisces, amphibians, reptiles, molluscs, crabs and other larger insects like bugs and beetles. But we fail to appreciate the role played by other smaller organisms like zooplankton in maintaining the good health of an ecosystem and thus avoid our interest and attention.

Cladocera, commonly known as 'water fleas' is the most important group among zooplanktonic organisms in freshwater ecosystems with regard to their interaction along different trophic levels and ensuring smooth energy transfer in the food chain. Though most Cladocera are filter feeders, they also feed on detritus, algae and diatoms, thus keeping a check on eutrophication for which this group is also widely used as good indicators of ecosystem health. At the same time Cladocera is the favourite food prey of many invertebrates like midges, aquatic insects, other zooplankton and many vertebrates like larval fishes, small fishes and amphibian tadpoles. The jerky movements of Cladocera make them easily visible to the predators and that is why most fish larvae were found to prefer Cladocera over other prey. Most importantly, both their preying as well as predation is species specific, thus acting as a determiner for diversity of other organisms. For instance, out of a mixture of green algae, *Daphnia carinata* prefers larger *Scenedesmus obliquus* over other food whereas *D. lumholtzi* and *Ceridaphnia quadrangula* chooses smaller size of *Ankistrodesmus falcatus*.

Out of nearly 700 species of Cladocera occurring globally, only 131 species are known from India. Of the Indian Cladocera, about 75-80 species are known to occur in the North Eastern Region of the country. This appears to be a representation of the Cladocera diversity of the country given the diversity of habitats and ecosystems prevailing in the country and also home to four of the global biodiversity hotspots. Out of the four NERAQ project states, virtually nothing is known about the Cladocera diversity of Nagaland. The present study appraises the existing knowledge of Cladocera diversity in the North Eastern region and advocates thorough exploration of the vast and diverse aquatic ecosystems of the region to ascertain the true diversity of one of the critical elements of aquatic ecosystems.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: Present knowledge of diversity of freshwater Cladocera in North East India and future opportunities and challenges

Presenter: Bikramjit Sinha, Scientist-E
Institute: Zoological Survey of India, North Eastern Regional Centre, Shillong

Research Overview

Study Objective:
- To elicit the status of diversity & distribution of Cladocera in N E India.

Study Timeline: Till date.

Geographic scope:
- North East India w.s.r. to Assam, Manipur, Meghalaya & Nagaland.

Taxon covered (if any): (Crustacea: Cladocera).

- One of the most important group of microscopic organisms
  - ensuring smooth energy transfer in the food chain.
- Though mostly filter feeders, also feed on detritus, algae and diatoms,
  - check eutrophication, widely used as good indicators of ecosystem health.
- Characteristic jerky movements make them easily visible to predators
  - favourite prey of many invertebrates & vertebrates
- Both their preying as well as predation is species specific,
  - acts as a determiner for diversity of aquatic ecosystems

Study Methodology

Extensive survey of existing literature, both print as well as electronic

- No. of species recorded from the project states
- Current taxonomic validation carried out
- Distribution in the different basins, drainages, wetlands
- Distribution in the different Protected Areas of the project areas
- Altitudinal distribution in the project areas

Ecosystem Diversity

- In Assam, 58 species from Deepar Beel-a Ramsar site, 55 species from Majuli wetlands
- In Manipur, 51 species from Loktak Lake-a Ramsar site
- In Meghalaya, 31 species from rice-fields
- Virtually no basin-wise, drainage-wise information

Protected Areas

Assam – 20 PAs, none

Manipur – 8 PAs, none

Meghalaya – 6 PAs

- Nokrek Biosphere Reserve (34 spp.), Baghmara Reserve Forest (21 spp.)

Nagaland – 4 PAs, none

No data on altitudinal distribution of Cladocera in NERAQ project areas

Key Threats and Opportunities

Threats

- **Habitat Destruction**, e.g. Deepar beel, Sone beel, Loktak Lake, Silsako Lake/Sachal wetland, Wah Umkrhah
- **Loss of habitats**, e.g. ponds, pools, ditches,
- **Inadequate voucher materials** for verification.
- **Lack of expertise**, low interest, non-lucrative

Opportunities

- Development of trained manpower especially from the region
- Modernization of research infrastructure
- Use of integrated taxonomy for resolving cryptic taxa
- Study of food habits of predators, e.g. larval fishes, tadpoles

Key Observations/Findings

- About 700 species of Cladocera are known globally (Kotov, 2015),
- Studies on Indian Cladocera was initiated by Baird (1860) describing *Daphnia newporti* from Nagpur and surrounding areas.
- About 131 species are recorded from India (Sharma & Sharma, 2017)
- Studies on Cladocera of N E India began with the report of *Simocephalus vetuloides* from Changchang Pani in Nagaland by Brehm (1950) **almost after a century after the initiation of studies on Indian Cladocera**.
- With about 80 species recorded so far, the cladocera fauna of the North East is the best known within India,
- 75 species are known from Assam, 58 species from Meghalaya, 56 species from Manipur, 1 species from Nagaland reported by Brehm is not included in all subsequent reports.

Key Recommendations

- Launching of a project for documentation of aquatic invertebrate diversity w.s.r. to lesser known groups, of NE India
- Emphasis on less explored areas like Nagaland, HAWs
- Ecosystem diversity like ponds, beels, lakes, rice-fields
- Generation of basin-wise diversity like, Brahmaputra, Barak, Chindwin
- Documentation of diversity in Protected Areas
- Diversity of Cladocera along the altitudinal gradient.

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Presenter 16: Sanjenbam Bidyasagar Singh

Study Title: Conservation of Endemic Fish Genetic Resource of Manipur, Northeast India

Authors: Sanjenbam Bidyasagar Singh, Yumnam Bedajit & Rameswori Yumnam

Abstract:

Manipur is located in the north eastern part of India. The state lies at latitudes of 23°83'N and 25°68'N and longitudes of 93°03'E and 94°78'E. The total area covered by the state is 22,347 square km. Its boundary hills constitute 92% area with various altitudes ranging from 2,000 to 3,000 meters above the mean sea level. The capital lies in an oval-shaped valley of approximately 700 square miles (2,000 km^2) surrounded by blue mountains and is at an elevation of 786 meters above the sea level. Manipur has diversified water bodies with 56,461.05 ha suitable for fish farming. The total Fish diversity of Manipur accounts for 218 species. Many more species are likely to be discovered following extensive surveys because many areas remain still unexplored. Various indigenous/endemic fishes such as *Osteobrama belangeri, Bangana devdevi, Mystus sp., Clariasmagur, Ompok sp., Lepidocephalichthys berdmorei, Anabas testudineus, Channa sp., Trichogaster sp., Puntius sp., Pethia sp., Synchrossus berdmorei etc.* are the potential candidate species for aquaculture which required standardisation of culture and breeding protocol. There is vast scope for exporting ornamental fishes by enhancing the revenue of the state. However, it can be taken up with proper conservation measures viz. standardization of breeding technologies, in situ conservation etc. Wild fish genetic resources (FiGR) represent the majority of the genetic diversity that is available for the further domestication and genetic improvement of farmed fish.

Many wild FiGR are threatened with genetic change or extinction. These wild relatives of farmed and potentially farmable aquatic species must be valued and protected in order to ensure their future availability for use in aquaculture. With adequate recognition of the value of wild FiGR and sharing of the costs and benefits of their conservation, there is still time and opportunity for aquaculture to avoid losses of wild genetic resources to the extent that have been experienced in the livestock and crop sectors. In situ conservation of wild FiGR should be recognized as part of the nature conservation sector, and should be pursued through intersectoral action and cooperation. Ex situ conservation of wild FiGR to complement in situ efforts for aquaculture is an important option and captive breeding can assist conservation of some endangered fish. For all aspects of the management of wild FiGR, accurate and up to date information is of paramount importance. Conservation of wild FiGR should be accorded adequate importance in funding allocations and in the sharing of natural resources with other sectors. Therefore, it is important first to recognize that wild FiGR are vital for the future sustainability and profitability of aquaculture and, second, to invest adequately in their characterization and conservation, so as to ensure their continued availability.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study:

CONSERVATION OF ENDEMIC FISH GENETIC RESOURCE OF MANIPUR, NORTH EAST INDIA

Presenter: Sanjenbam Bidyasagar Singh

Institut

RESEARCH OVERVIEW

- **Study Objective:**
  To conserved the endemic fishes resources of Manipur with the development of live Genebank.
- **Study Timeline**: From 1st February, 2018 to till date
- **Geographic scope**: Chindwin basin in Manipur and Barak rivers system of Manipur
- **Species covered (if any):** *Bangana devdevi, Osteobrama belangiri, Neolissochilus*

Hypsibarbus myitkyinae *Bangana devdevi* *Ompok bimaculatus* *Neolissochilus stracheyi*

Clarias magur. *Osteobrama belangiri*

RESEARCH OVERVIEW CONTD...

Study Methodology:

- Samples were collected from different river stretch of **Barak** and **Chindwin** river system
- Fish are brought to CAU, Central farm for maintaining **LIVE GENEBANK** after **ACCLIMATIZATION**
- Reproductive biology of some selected species are being done
- GSI,
- Breeding protocol of some of the species are being done

STUDY METHODOLOGY

Details:

1. Collection of specimen from different river system

River name	Geo-coordinates
Sanalok River, Kanjeng District	(24°52'N/94°39'E msl
Imphal river, Chanoubung, Kangpokpi District	(25°10'N/93°58'E) 1884 msl
Barak river, Karong, Senapati District	25°18'N/94°82'E, 966 msl
Khuga river, Churachandpur District	24°27' N /93°67'E
Khordak, Bishnupur District	24°48' N /93°86'E
Iril river, Imphal East District	24°46' N /93°85'E, 794msl
Thoubal river, Thoubal District	24°70' N, 93°85'E, 790 msl

2. Estimation of **in-situ environmental data**

Parameter	Sanalok River, Kanjeng District	Imphal river, at Chanoubung, T Khullen, Kangpokpi District	Barak river, Karong ,Senapati District	Khuga river, Churachandpur District	Khordak, Bishnupur District	Iril river, Imphal East District	Thoubal river, Thoubal District
DO	8-15	7-14	8-15	8-12	5-13	8-14	5-13
Alkalinity	50-90	50-80	50-100	50-120	40-120	50-120	50-80
Hardness	50-90	50-100	40-80	50-100	50-110	50-100	50-80
Temperature	15-26	14-33	12-28	14-34	18-33	17-33	10-33
pH	7.5-8.3	7.2-8.8	7-8.5	7.4-8.2	8.6-8	7.5-8.8	7.5-8.7

3. Identification of specimen with the use of taxonomic key from the sub-sample.

4. Stocking of fish into **live gene bank at CAU central farm** and

Parameters	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
DO	5.7-8	6-8	6-8	5.5-8	6-8
ALKALINITY	40-60	80-100	40-80	60-80	40-70
HARDNESS	95-120	80-100	85-125	60-85	85-75
TEMPERATURE	18-33	18-33	18-33	18-33	18-33
pH	7-8.8	8.6-8.5	7-8.5	8.6-8.5	7-8.6

5. Optimization of breeding technique of ***Bangana devdevi*** and ***Hypsibarbus myikyinae***

KEY THREATS AND OPPORTUNITIES

THREATS: Some of the species are becoming **very rare** in the wild, it may be due to

- leaching of **fertilizers, pesticides** and **insecticides** from the subsequent agricultural filed in the river course.
- **Pollution**
- **Mining** of sand and stones from river.
- Obstruction of **migratory rout** for hill stream fishes
- Use of **destructive fishing**.

OPPORTUNITIES:

- There is a good scope for **uncovering** fish genetic resources in Manipur with the intensive exploitation
- There is a scope of addition of more **candidate species** in aquaculture for augmentation of fish production in the state.
- There is more scope of conducting research on **biology, stress response** and **breeding of fish**

KEY OBSERVATIONS/FINDINGS

- Fishes are successfully reared in the **CAU Central farm**, with **zero** mortality
- Breeding techniques of ***Bangana devdevi*** and ***Hypsibarbus myikyinae*** are standardized
- Additionally, breeding of ***Ananbas testudenus***, ***Ompok bimaculatus***, ***Clarias magur*** are being done.

Parameter	*B. devdevi*	*Hypsibarbus myikyinae*
Peak maturity occurred	Male-August Female-July	Male-June Female-July
Length at first maturity	93mm	78mm
Absolute Fecundity	2,830-22,024 eggs/female	2,240-20,400 eggs/female
GSI	Male- 1.17 Female -2.24	Male- 1.6 Female-2.68
Hormone used	Gonopro FH	Gonopro FH
Dose	0.4ml/kg	0.3ml/kg
Hatching rate in %	75-80	80-85
Survival rate in %		
Spawn to fry	45-50	60-70
Fry to fingerling	65-75	80-85

KEY RECOMMENDATIONS

1. There is a need of research on **discoveries** of endemic fish species with intensive exploitation of wild water bodies

1. Focus should be on identification of **potential candidate species** for **diversified aquaculture.**

1. Endemic fish species can be conserved through establishment of live Genebanks

1. Proper **evaluation** of fish and their categorization in **IUCN status**

Sanjenbam Bidyasagar Singh

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Presenter 17: Prof. Dandadhar Sarma

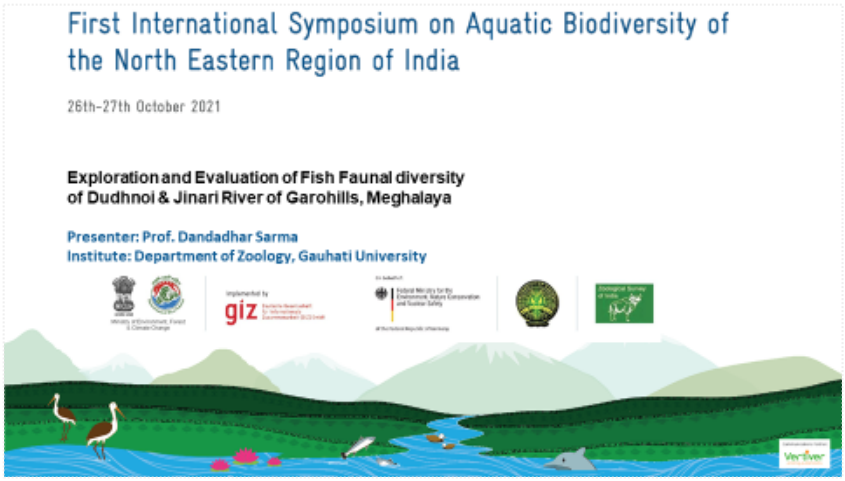
Study Title: Exploration and Evaluation of Fish Faunal Diversity of Dudhnoi and Jinari Rivers of Garo Hills, Meghalaya

Authors: Dandadhar Sarma, H. Choudhury and K.K. Lal

Abstract:

Dudhnoi and Jinari rivers are two rainfed rivers that originate from the northern slope of the Nokrek Biosphere Reserve, Meghalaya and flow northwards to empty into the Brahmaputra drainage in Assam. The Nokrek biosphere reserve is located in the Tura range, a part of the Meghalaya plateau. Literature survey has revealed that no previous studies were carried out on the fish fauna of these two rivers, even though about 30% of the associated village communities are dependent on the fisheries resources of the rivers. The present investigation was carried out from October 2012 to March 2015. Collection of fish specimens, estimation of relative abundance and taxonomic richness followed standard protocols. A total of 36 fish species of 28 genera under 16 families from the Dudhnoi River and 58 fish species of 45 genera under 21 families were collected during the period. The occurrence of fish species like *Parambassis lala*, *Tor putitora*, *Bagarius bagarius*, which fall under the threat categories as per IUCN signifies the importance of these two tributaries of the Brahmaputra in supporting rich ichthyofaunal diversity. Fish species belonging to the threatened criteria thereby require special attention in the form of proper sustainable management approaches. Relative abundance of Cyprinidae was estimated as highest. The course of Dudhnoi and Jinari, both originating from the Garo Hills, Meghalaya, is highly varied and hence, these rivers support immense ichthyofaunal diversity in the form of both torrential and plain water species. Species like *Glyptothorax cavia*, *Opsarius tileo*, *Schistura Savona*, *Batasio batasio*, *Olyra kempi*, etc. were restricted to the upper stretches, these species being specially adapted in the form of structural modifications to sustain the harsh flow of water. A comprehensive biotic assessment program is required for effective protection of freshwater fish resources in both the rivers, with initiatives to be taken from both government and non-government bodies for preservation of these indigenous germplasm of Northeast India.

Presentation

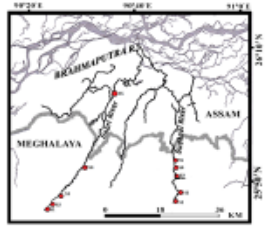


Research Overview

- **Study Objective**: The investigation was carried out to investigate fish faunal diversity, and habitat ecology of River Dudhnoi and Krishnai (both being tributaries of River Brahmaputra).
- **Study Timeline**: 1.10.2012 to 31.03.2015
- **Geographic scope**: **Dudhnoi River,** one of the tributaries of the River Brahmaputra, originates from *Jamge Bisik* (the name of its source) *Mejolgre Chekchongbra* (Garo Village) in East Garo Hills District of Meghalaya. Two streams meets the river very near to the Village Depaon. The streams are known as *Saragma Chiring* in west side of the river and Ampatchi in east side of the river. the river enters in Assam at Dainadubi in the name of Dudhnoi. After crossing Dudhnoi town, it joins the Krishnai River and takes the name of Domoni and finally meets the Brahmaputra River. Total length of the River 130 km

Research Overview

- **Geographic scope**: **Jinari River:** a small tributary of River Brahmaputra originates from Nokrek Peak (about 1400 MSL, now declared as Nokrek Biosphere Reserve). After flowing through certain areas of West Garo Hills and East Garo Hills via Bajengdoba finally it meets plain of Assam at Goalpara District. Before joining with River Brahmaputra at Goalpara, the river routed through a wetland called Urpod Beel. During its journey from Nokrek Biosphere Reserve to River Brahmaputra, several unnamed small rivers or streams joined in it at various point of East and west Garo Hills. The approximate length of the river from its origin to River Brahmaputra is 140 km. The river flows between the altitudes of 1120 m MSL to150 m MSL.



Study Methodology

- Five sampling sites each have been selected in both the River for collection of Fish and water quality assessment.
- For collection of fish samples, an eco friendly electric fishing device had been fabricated to catch the fishes in various sampling sites of the rivers as well as the sites as indicated by the fringe villagers. Also, fishing nets (caste nets, gill nets) were used.
- To examine fish faunal diversity of the rivers, experimental fishing was carried out on a monthly basis with the help of local fishers. Fishes were also collected regularly from local collaborator appointed in all selected sampling site.
- Collected species were preserved in 10% formalin for initial one week and then transferred to 70% alcohol for permanent preservation.

Key Threats and Opportunities:

Dudhnoi River: A total of 36 fish species of 28 genera under 16 families have been collected during the period of investigation. According to IUCN, 2016 (ver. 2016.3) three species (*Parambassis lala*, *Ailia coila* and *Bagarius bagarius*) as Near Threatened, two species (*Eutropichthys vacha* and *Glossogobius gutum*) as Not Evaluated, one species (*Devario assamensis*) as Vulnerable, two species (*Anabas testudineus* and *Badis assamensis*) as Data Deficient, and the rest as Least Concern. Less diversity of fishes from the river might have resulted due to Acid Mine Drainage (AMD) of coal mining being practiced in the bank of the river in its upper stretches.

Jinari River: A total of 58 fish species of 45 genera under 21 families have been collected during the period of investigation. four species (*Parambassis lala*, *Tor tor, Ailia coila* and *Bagarius bagarius*) as Near Threatened, two species (*Glossogobius gutum* and *Oreichthys crenucoides*) as Not Evaluated, one species (*Devario assamensis*) as Vulnerable, two species (*Anabas testudineus* and *Badis assamensis*) as Data Deficient, rest are recorded as Least Concern. One specimen of *Oreichthys crenuchoides* was collected in S_5 in retreating monsoon which has been reported from Sonkosh River (tributary of Brahmaputra) in West Bengal.

Key Observations/Findings:

Glyptothorax cavia

Garra nasuta

Ailia coila

Psilorhynchus balitora

Setipinna brevifilis

Large number of hill stream species with highly localized distributions from different families like Balitoridae, Psilorhynchidae, Cyprinidae and Sisoridae. Fish species like *Oreichthys crenucoides*, *Devario assamensis*, *Channa stewartii*, *Badis assamensis*, etc are restricted to the Brahmaputra basin in Northeast India. This endemicity or restricted distribution along with various threats has been a major problem for the fish fauna of the region. Species like *Glyptothorax cavia*, *Tor tor*, *Opsarius tileo*, *Schistura savona*, *Batasio batasio*, *Olyra kempi*, etc were restricted to the upper stretches, these species being specially adapted in the form of structural modifications to sustain the harsh flow of water.

Key Observation & Recommendations:

Community fishing through herbal poison, electric fishing (and occasionally through dynamiting) in receding season is the significant feature in *Garo* dominated areas. Hand picking is another method being executed by *Garo* tribes in upper reaches of both the rivers. This free hand fish capturing method is done by lifting boulders. A boulder is lifted and striked over the boulder where fishes remain hidden. *Glyptothorax* sp., *Channa* sp., and eels are also caught by this method.

Pterocarpus marsupium

Poligonum hydropiper

Careya arborea

Vanguria spinosa

The findings of the study indicate that the both the tributaries of River Brahmaputra is still very rich in terms of fish species diversity. Though the feeder channels of the rivers are subjected to varied pressures (anthropogenic and natural) they are still rich aquatic ecosystems. Therefore, conservation of these indigenous fish species, various strategies are the need of the hour, which may be halting of siltation, promoting controlled harvest and control of herbal poison or dynamiting.

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Presenter 18: Shanglow L N Konyak

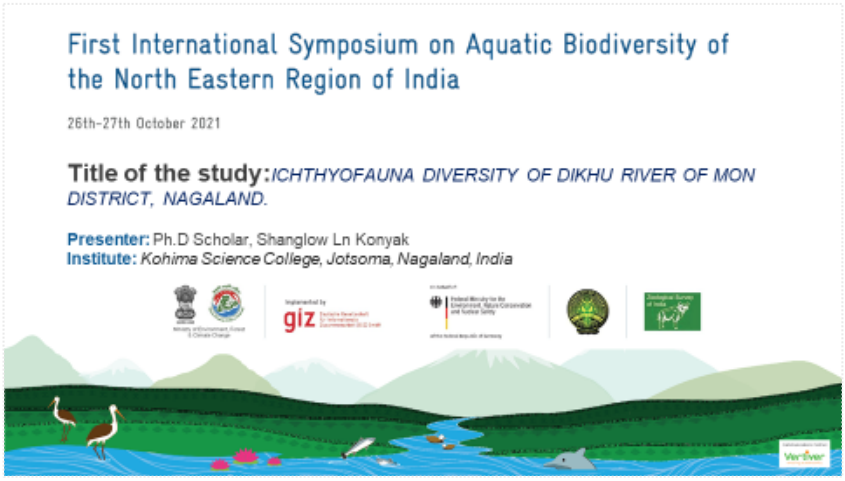
Study Title: Ichthyofauna Diversity of Dikhu River Mon District, Nagaland

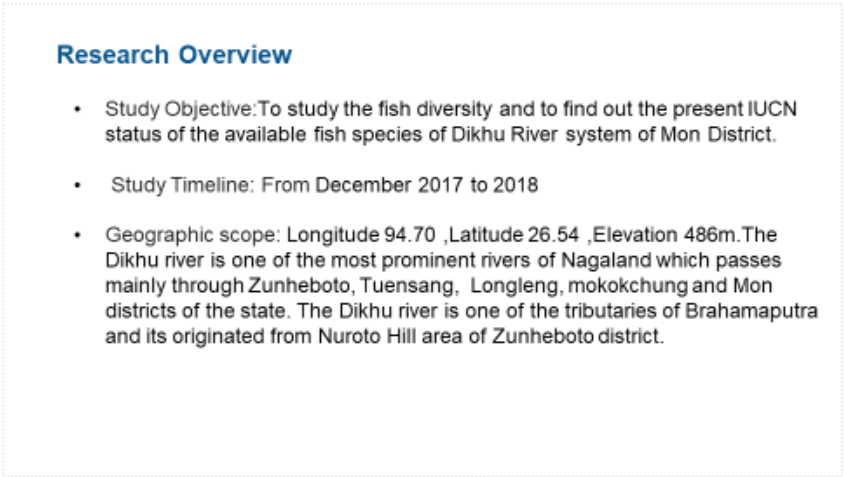
Author: Shanglow L N Konyak

Abstract:

The present study was conducted to document the Ichtyofauna diversity of Dikhu river of Mon district of Nagaland. The study was conducted for a period of one year starting from December 2017 to November 2018, so that species collection can be done covering all the seasons. A total of 21 species belonging to the family Balitoridae, Cyprinidae, Psilorhynchychus, Amblycipitidae, Bagridae, Sisoridae, Channidae, Belonidae, were identified. Out of which 15 species were belonging to Cypriniformes, 4 belonging to Siluriformes and 1 each to Perciformes and Beloniformes. According to IUCN red list and through habitat studies during the different seasons, one species belonging to family Cyprinidae is under IUCN – EN category, two species from family Balitoridae and Sisoridae are under IUCN – NT category, two species belonging to Balitoridae and Cyprinidae under IUCN – VU category and the rest sixteen species were under IUCN – LC and IUCN – LR – nt category

Presentation





Study Methodology

• Fish samples were collected by using cast net, gill nets of various sizes and varies locally adopted technique.
• The documentation and collection of specimens was carried out with the help of local fishermen having more than a decade of experience in fishing technologies.
• The specimens and the sites of area were photographed and all the essential data like place of collection, number of fish caught and body colour , body marking etc were recorded.
• Specimens were identified following Ao s,Dey Sc,Sarmah SK(2008). Fish and Fisheries of Nagaland and Jayaram KC. The Freshwater Fishes of the Indian.

Key Threats and Opportunities

• No immune to further change of existing threat intensity or the new threat arises.
• Threat like overfishing, increasing agriculture development and climate change are likely to invite the challenge in near future
• The effects of which are not predictable.

Opportunities

• Powerful insights research are in need to safeguard and to preserve germplasm of the existing fishes species which are categorized in the IUCN endangered list.
• Research unexplored area.

Key Observations/Findings

• Primary threats to the biodiversity in Dikhu river include climate changes, deforestation, land use change, Agriculture expansion and open-pit mining etc contributes significantly to habitat loss.

• The key challenge to addressing biodiversity impact include the lack of financial, limited data access to protected area and the lack of public participation environmental planning

Key Recommendations

• To design realistic pilot activities that develop concrete solutions to conserved the biodiversity loss.
• To build further awareness of biodiversity issues in the public sector
• To seek support from donor and expert to provide the building capacity of government agencies for the biodiversity conservation.
• International and National environmental initiatives need to be strengthen.
• Local media by using various communication channel to enhancing the knowledge on biodiversity issue and to improve their ability to raise public awareness.

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Presenter 19: Simanku Borah

Study Title: Understanding the Spatio-Temporal Variation in Fish Community Structure of a Large Himalayan River, Siang

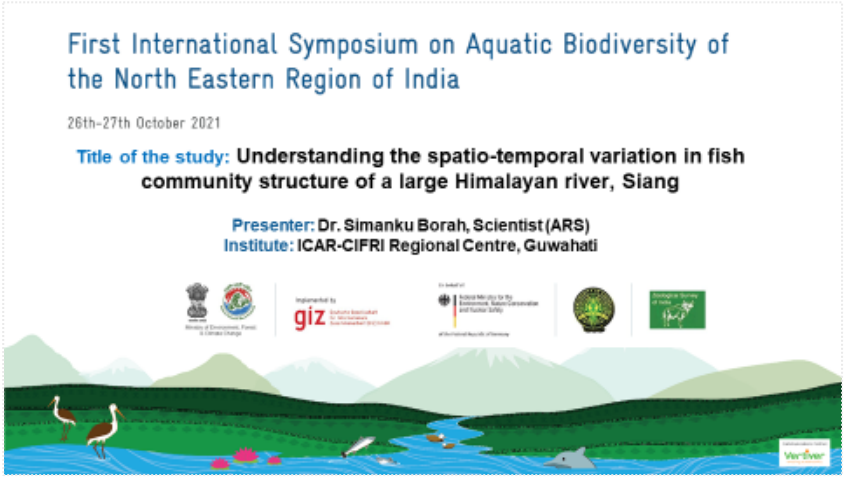
Authors: Simanku Borah, Pranab Gogoi, S.C.S. Das, Kavita Kumari, A.K. Yadav, B.C. Ray, Amulya Kakati, B.K. Bhattacharjya, and B.K. Das

Abstract

The present study was carried out during 2017-20 to study the fish community structure and physico-chemical properties of River Siang in Assam and Arunachal Pradesh. Sampling was carried out at seasonal intervals, pre-monsoon, monsoon and post monsoon across six stations (5 in Arunachal Pradesh and 1 in Assam). A total of 78 fish species under 14 families have been recorded during the course of the survey. Cyprinidae was found to be the most dominant family with 39 species. Shannon index (H) ranged from 1.111-3.308, Simpson index (1-D) from 0.6304-0.9547 and Evenness index from 0.3387-0.8927. During the study period the highest number of species was reported during post-monsoon and along lower stretches of river *viz.* Pasighat in Arunachal Pradesh (53) and Oiramghat in Assam (65). Low species diversity was observed during monsoon season. Year-wise analysis showed that the lowest number of species was reported during 2017-18 (31), which may be due to poor water quality, particularly high turbidity (147.14±90.56 NTU) and low transparency (8.93±8.12) recorded during the period.

Water quality improved in the subsequent years and so did fish diversity with 60 species reported in 2018-19 and 78 in 2019-20. Canonical correspondence analysis to determine the influence of water quality parameters on fish species abundance revealed that water temperature and ORP has a positive influence and turbidity has a negative influence on abundance of *Aspidoparia jaya*. Dissolved oxygen has a positive influence on abundance of *Opsarius barna* and *Pethia conchonius*, while depth has a positive impact on abundance of *Bangana dero* and *Labeo dyocheilus*. The present study can help in understanding fish diversity and community structure in relation to ecological attributes on a spatial and temporal scale in River Siang and can contribute towards formulating specific conservation measures in this headwater of Brahmaputra, the lifeline of north-east India.

Presentation



Research Overview

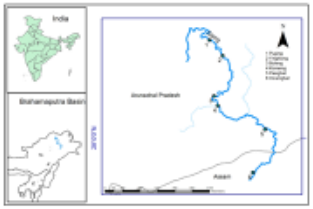
- Headwaters of Brahmaputra in Arunachal Pradesh is known as Siang and has a length of 160 km (Bhattacharjya et al., 2017), criss-crossing the hills before draining the plains of Assam.
- Geomorphological, ecological characteristics of aquatic systems govern fish community structure both in terms of species richness and distribution (Orrego et al., 2009; Alexandre and Almeida, 2010).
- Seasonal variation greatly influence fish abundance (Novaes et al., 2014) and plays an important role in recruitment, breeding patterns and food and feeding habits of a species (Das et al., 2012).

Research Overview Contd...

- Fish assemblage pattern also offers insights into health status of aquatic ecosystems (Oberdorff et al., 2002; Hamzah, 2007; Gregory et al., 2009).
- Present study was undertaken to analyze fish community structure and physico-chemical properties of River Siang in Assam and Arunachal Pradesh.
- Study period: 2017-20.

Study Methodology

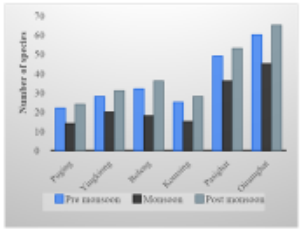
- Sampling frequency: Seasonal (Pre monsoon; Monsoon and Post monsoon)
- Sampling stations: 6
- Fishes were identified with standard literature (Talwar and Jhingran, 1991).
- Water quality (13 parameters) analysed following multiparameter water quality probe (Model 9829, HANNA, Romania) and APHA (2005).
- Statistical analysis using PAST ver 4.0 and Primer ver 6.0.

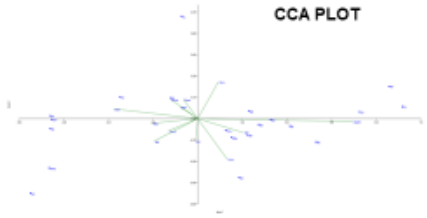


Key Threats and Opportunities

- **Threats**
  - ✓ Habitat destruction (Siltation etc.)
  - ✓ Dams and barrages
  - ✓ Destructive fishing practices
- **Opportunities**
  - ✓ Rich biodiversity hotspot
  - ✓ Least explored waters
  - ✓ Ornamental fisheries
  - ✓ Aqua tourism and sport fisheries
  - ✓ Mostly under exploited

Key Observations/Findings





Diversity Index	Max	Min
Simpson_1-D	0.9547	0.6304
Shannon_H	3.308	1.111
Evenness_e^H/S	0.8927	0.3387

- Cyprinidae was most dominant family with 39 species.
- Lowest number of species was reported during 2017-18 (31), which may be due to poor water quality, particularly high turbidity (147.14±90.56 NTU) recorded during the period.
- Water quality improved in the subsequent years and so did fish diversity with 60 species reported in 2018-19 and 78 in 2019-20.
- Canonical correspondence analysis revealed that water temperature has a positive influence and turbidity has a negative influence on abundance of *Aspidoparia jaya*. Dissolved oxygen has a positive influence on abundance of *Opsarius barna* and *Pethia canchanius*, while depth has a positive impact on abundance of *Bangana dero* and *Labeo dyocheilus*.

Key Recommendations

- Ecological profile of any aquatic system plays a key role in its biodiversity. Hence, emphasis is to be given to sustain the ecological profile of natural systems in event of any developmental activity.
- Restricting destructive fishing practices like dynamiting and electric fishing through awareness and legislations is of urgent need.
- Development of sport fisheries.

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Presenter 20: Sarbojit Thaosen

Study Title: Exploration and Evaluation of Ichthyofaunal Diversity of Dima Hasao District, Assam, Northeast India

Authors: S. Thaosen, H. Choudhury, D. Sarma and K. K. Lal

Abstract:

Dima Hasao District is one of the twin hill districts of Assam, northeast India. The district has untapped potential for fish and fisheries in terms of vast aquatic resources like rivers, streams and lakes, including inundated areas of rice cultivation. However, studies on the ichthyofaunal assemblage, and habitat structuring and mapping of the region are deficient. In view of this, a survey was carried out from January 2012 to December 2015 to analyze the pattern of distribution, taxonomic richness and abundance of fish species of the major river systems, viz. Diyung, Mahur, Kopili and Jatinga rivers of Dima Hasao. To examine the fish fauna, experimental fishing was carried out on a monthly basis with the help of local fishers. Fishes were collected regularly from locally-appointed collaborators at all sampling sites. Efforts were made to collect the fishes at different hours, including morning, daylight, evening and night, from all sites. A total of 90 fish species were collected under 8 orders and 20 families comprising torrential, semi-torrential, migratory and plain water forms. Seasonal variation of fish abundance was also observed with least collection in the monsoon season. Occurrence of hill stream fishes of the genera *Garra*, *Glyptothorax*, *Psilorhynchus* and *Pseudolaguvia* suggested linkage with the habitat morphology of fast-flowing rivers and streams, with rocky bed and shallow depth; whereas, plain-water species like *Chitala chitala*, *Sperata aor* and *Rita rita* were found in deep pools of the rivers. Species like *Badis tuivaiei*, *Glyptothorax scrobiculus* and *Amblyceps laticeps* were restricted to the Jatinga River of the Barak drainage. Proper taxonomic identification along with studies on biology and phylogeny among certain endemic species from the region for asserting conservation is demanding. It was observed that the contribution of riverine capture fisheries is declining sharply. Extraction of sand and gravel from river bed has direct and indirect negative impacts on the semi-torrential and migratory fishes. Notably, stone quarrying and sand mining in the Diyung, Mahur, and Jatinga rivers is another man-made activity responsible for water pollution and as well as habitat destruction of fish species. Semi-torrential fishes of the genera *Lepidocephalicthys, Schistura, Paracanthocobitis, Gonorhynchus* and *Botia* are mostly at risk as these fishes feed and take shelter beneath the sand, pebbles and crevices of rocks. The present study will act as a baseline data for conservation and management of aquatic biodiversity of the districts.

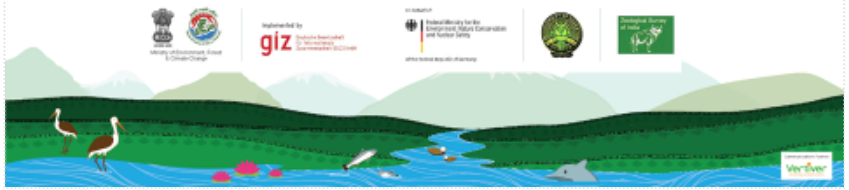
Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Exploration & Evaluation of Ichthyofaunal diversity of Dima Hasao District, Assam, Northeast India.

Presenter: Associate Professor, Sarbojit Thaosen.
Institute: Haflong Govt. College.



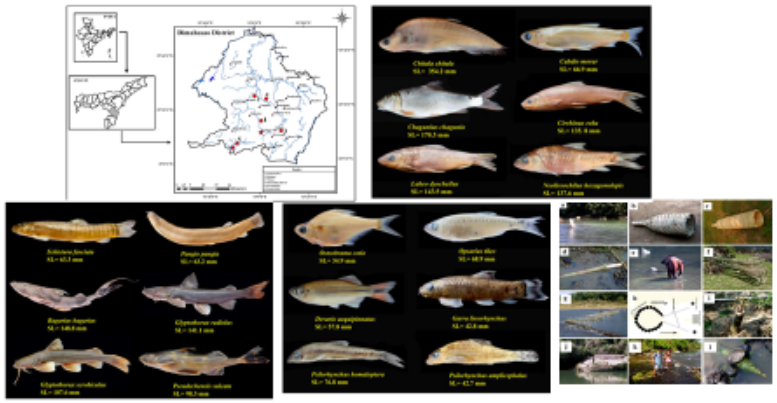
Research Overview

Study Objective:

- Dima Hasao District is one of the twin hills districts of Assam, northeast India. The district has untapped potential for fish and fisheries in terms of vast aquatic resources like rivers, streams and lakes, including inundated areas of rice cultivation. However, studies on the ichthyofaunal assemblage, and habitat structuring and mapping of the region are deficient. In view of this, a survey was carried out.
- Study timeline: January 2012 to December 2015.
- Goegraphic Scope: The major river systems, viz. Diyung, Mahur, Kopili and Jatinga rivers, of Dima Hasao.

Research Overview Contd...

- Map, Fish Species and fishing gears:



Study Methodology

- Tracing of the rivers was carried out physically .
- An electric fishing device has been fabricated to catch the fishes in various sampling site.
- Different fishing gears were used.
- Collected species were preserved in 10% formalin.
- Evaluation of habitat ecology of the rivers, diversity pattern of the species, taxonomic status of the collected species have been carried out following standard method.
- Indigenous Technological Knowledge (ITK) and demographic data collected from the villagers through interview.
- Physico-chemical parameters of water, estimated following APHA (2005).
- Fishes were identified following Talwar and Jhingran (1991), Jayaram (1999), Jayaram (2006) and Vishwanath *et al.* (2014).

Key Threats and Opportunities:

- Over exploitation of fishes using destructive fishing.
- Water pollution.
- Sand and stone quarries.
- Potential for Eco-tourism.

Key Observations/Findings :

- A total of 50 fish species were collected under 8 orders and 20 families comprising torrential, semi-torrential, migratory and plain water forms.
- Seasonal variation of fish abundance was observed with least collection in the monsoon season.
- Occurrence of hill stream fishes of the genera *Garra*, *Glyptothorax*, *Psilorhynchus* and *Pseudolaguvia* suggested linkage with the habitat morphology of fast-flowing rivers and streams, with rocky bed and shallow depth;
- Plain-water species like *Chitalachitala*, *Sperataaor* and*Rita rita* were found in deep pools.
- Species like *Badis tuivaiei*, *Glyptothorax scrobiculus* and *Amblyceps laticeps*were restricted to the Jatinga River of the Barak drainage.

Key Recommendations:

The Dima Hasao district represents a rich granary of ichthyofaunal resources, for 50 different species have been identified so far, and these together, comprise a complex which has the potential to form an ichthyofaunal hub of freshwater fishes within the northeastern region of India. The Diyung, Mahur and Jatinga rivers are torrential water bodies flowing through undulating hills and dense tropical deciduous forests. These rivers may still harbour many rare fish species, possibly undescribed yet, that demands further exploration, taxonomic identification and validation for proper management of these indigenous resources of Northeast India.

Conservation of both rivers and fish species is of utmost importance

As of today 02 (two) new species have been described from the area, *Garra clavirostris* and *Pschylorynchus nahlongthai*.

Efforts in conservation of species has started locally by Local Government, Forest department and also an NGO (DHARA).

Contact Details

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Presenter 21: Yengkhom Chinglemba

Study Title: Diversity of Nemacheiline Loaches of Manipur and its Conservation

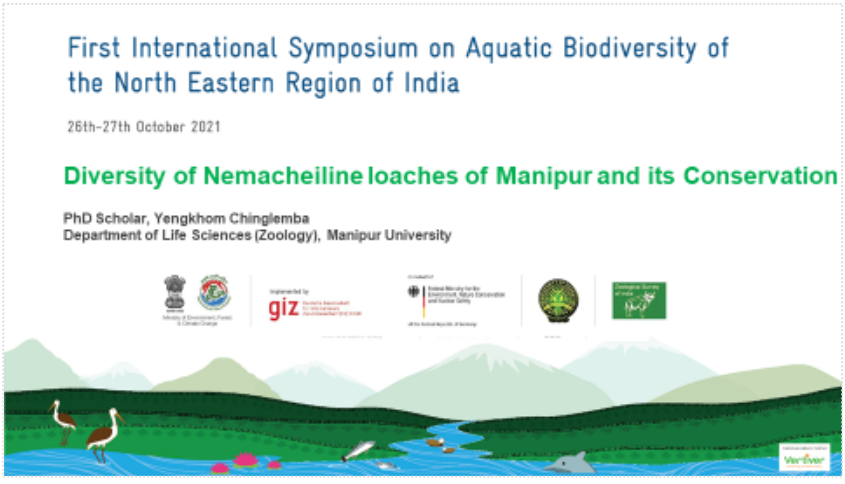
Authors: Yengkhom Chinglemba and Yumnam Rameshori

Abstract:

Manipur, one of the Northeastern states of India, is a part of the Eastern-Himalaya Freshwater Biodiversity Hotspot. The diversity of Nemacheiline loaches is very high in the state due to its varying topography and presence of two important drainages of Northeast India viz., the Chindwin and the Barak drainage. Nemacheilid fishes typically inhabit fast flowing water of small streams and are diagnosed in having small size; body colour pattern usually with saddles or bars or both; and fleshy lips with grooves, forming cushions and pads. In the present study, the diversity of Nemacheiline loaches of Manipur have been studied. A preliminary study shows the occurrence of 22 species belonging to five genera viz., *Mustura*, *Neonoemacheilus*, *Paracanthocobitis*, *Rhyacoschistura* and *Schistura*, of which 13 species are distributed in the Chindwin drainage while 9 species are distributed in the Barak drainage. Among these five genera, the genus *Schistura* accounts for about 54% of all nemacheiline loaches in the state with 12 species.

Morphological characters exhibited in the form of oromandibular structures, suborbital flaps, pectoral fins, air bladder capsules, coiling pattern of alimentary canal and body colour pattern of *Mustura*, *Neonoemacheilus*, *Paracanthocobitis*, *Rhyacoschistura* and *Schistura* are studied in detailed. Many of these loaches are endemic to Manipur and facing numerous threats owing to various anthropogenic activities. Additionally, several parts of the state remain inaccessible due to difficult hill terrain, poor transport and communication facilities and lack of funding for research. Therefore, further exploration is needed in the future for proper documentation of the Nemacheiline loaches of Manipur. New taxa are expected as well. Conservation strategies for these fishes are also discussed in the present study.

Presentation



Research Overview

- Study Objective:
  1) To study the diversity of nemacheiline loaches of Manipur, Northeast India
  2) To describe new taxa (many new species and genera are expected)
  3) To develop DNA barcodes of loaches of Northeast India
- Study Timeline: May 2019 to September 2021

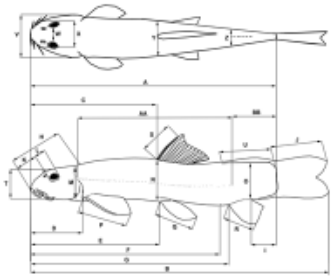
Study Methodology

Collection
- Using electro-fishing equipments, Nets and Traps
- Market sampling

Preservation
- 10% formalin following Walsh & Meador (1998)
- Tissue samples (muscle tissue, fin clips, whole specimens) preserved in 95% ethanol

Identification
- Counts and measurements followed Kottelat (1990)

Genomic DNA Isolation
- Followed Sambrook et al., 1989 with slight modification



Schematized nemacheilid loach to illustrate measurements taken on the head and body (Kottelat, 1990)

PCR Amplification
- Using Universal primers F1 & R1

Sequence analysis
- using Gene Runner V 3.0 software, Clustal W & MEGA V.7.0 software

- Geographic scope: Chindwin and Barak drainage of Manipur, Northeast India
- Species covered: Nemacheilid genera – *Mustura*, *Neonoemacheilus*, *Paracanthocobitis*, *Rhyacoschistura* and *Schistura*

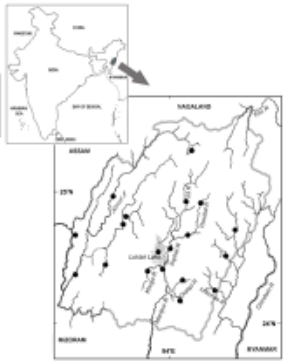
Mustura prashadi (Hora)

Neonoemacheilus morehensis Arunkumar

Rhyacoschistura manipurensis (Chaudhuri)

Paracanthocibitis marmorata Singer et al.

Schistura chindwinica (Tilak & Hussain)



- Study Methodology: Integrative taxonomy

Key Threats

- Sand and gravel mining
- Dams, hydroelectric project and barrage
- Water pollution
- Climate change

a) Catching fish using local dynamo

b) Sand and gravel mining

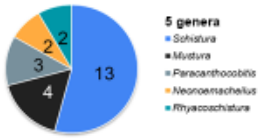
Opportunities

- Opportunity for researchers and conservationist to explore the rich diversity of Nemacheiline loaches of Manipur
- Identify and categorisation of species at risks
- Farmers can uplift their economy through captive breeding

Key Observations/Findings

- 24 species of Nemacheiline loaches under five genera found in Manipur
- Chindwin drainage – 15; Barak drainage – 9

Sl No.	Species	IUCN status	Remarks
1	*Schistura Aangjupkhulensis*	Endangered	Endemic to Imphal Valley
2	*Schistura minuta*	Endangered	Endemic to Barak drainage of Manipur
3	*Schistura reticulata*	Endangered	Endemic to eastern hill streams of Manipur
4	*Schistura tigrina*	Endangered	Endemic to Barak drainage of Manipur
5	*Schistura chindwinica*	Vulnerable	
6	*Schistura khugae*	Vulnerable	
7	*Schistura nagaensis*	Vulnerable	
8	*Schistura singhi*	Vulnerable	
9	*Mustura prashadi*	Vulnerable	



- In the last two decades, Vishwanath and co-workers (including our team) have discovered 11 species of nemacheiline loaches new to science from Manipur
- Recently, our team have recorded two species from Manipur – *Schistura rubrimaculata* and *Paracanthocobitis linypha*
- *Mustura* sp. – an expected new stone loach from Manipur [paper under review, Zootaxa ZXRP-369]
- Many new species awaiting discovery
- Rate of pace of discovery slow
- DNA barcoded for 15 species of nemacheiline loaches from Manipur

Key Recommendations

- More exploration to interior parts of Manipur for proper documentation of Nemacheiline loaches
- Awareness programmes involving the locals and farmers about the value of conserving the fish diversity
- Prevention of used of piscicides in rivers
- Environment Impact Assessment (EIA) before constructing dams and barrages
- Setting up of fish sanctuaries for threatened species
- Adoption of selective captive breeding and culture techniques
- Regulating introduction of invasive species

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Session 2: Threats for Aquatic Ecosystems

Presenter 22: Dr Bandita Talukdar

Study Title: Evidence for Mutagenic Effects of Acid Mine Drainage on Fish Fauna on Simsang River, Meghalaya, India

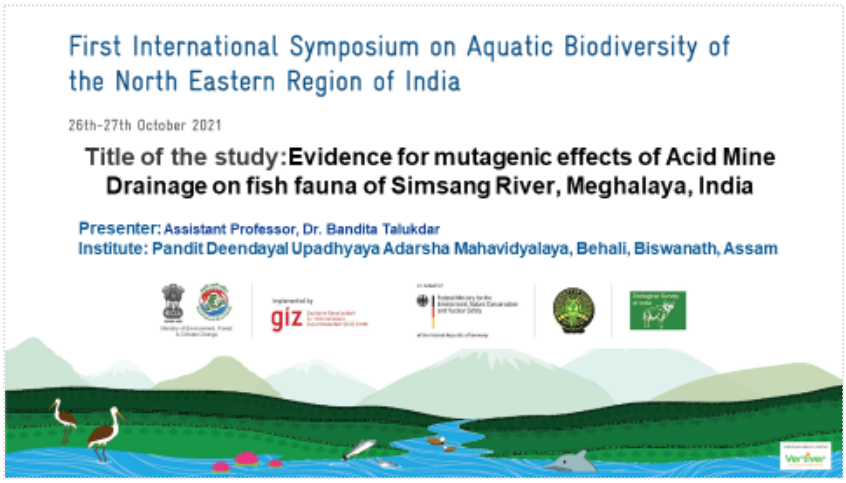
Authors: Dr Bandita Talukdar and Prof. Dandadhar Sarma

Abstract:

Aquatic biodiversity of the Simsang River, Garo Hills, Meghalaya has been threatened by large-scale environmental degradation caused due to extensive Acid Mine Drainage (AMD) of coal mines. In the present study, an effort has been made to detect the mutagenic effects on Simsang River due to AMD of coal mining on *Channa punctata* (Bloch) as a model organism; using comet assay, micronucleus and chromosome aberration tests. For this, water samples were collected seasonally from three pre-selected sampling sites and exposed to fishes and assessed under laboratory conditions. Physico-chemical analysis of water samples indicates very low pH, increased level of sulphates and iron beyond permissible limit. The mutagenic effects, which were assessed by the comet assay, micronucleus and chromosome aberration test, demonstrate significant differences in different seasons in different sampling sites. The frequency of cells with DNA damage was higher in water samples collected from the affected site (S_2). The results of this study indicate that some of the area of the Simsang River is contaminated with substances that are mutagenic to fish fauna of the river.

Keywords: Mutagenic, coal mining, comet assay, micronucleus, chromosome aberration

Presentation



Research Overview

• **Study Objective**: To assess the mutagenic effects on fish (*Channa punctata)* exposed to the water of Simsang River contaminated by AMD of coal mines through comet assay, micronucleus and chromosomal aberration test.
• **Study Timeline**: From December 2012 to June 2016
• **Sampling sites**: Simsang River, the longest river of Garo Hills, originated from Nokrek Biosphere Reserve of West Garo Hills, Meghalaya (altitudes of 1412 m MSL).Three sampling sites were selected in the Simsang River, with different degree of coal mining impact.

- ❖ Site 1, Near Rombagre, (S_1, {longitude $90^0 34' 21''$E & latitude $25^0 32' 41''$N} free from coal mining activities and was used as the reference site.
- ❖ Site 2, Nangalbibra (S_2, {longitude $90^0 44' 39''$E & latitude $25^0 28' 22''$N} maximum coal mining activities are practiced (Fig. 2) in the hills of the vicinity) and
- ❖ Site 3, Baghmara (S_3, {longitude $90^0 37' 9''$E & latitude $25^0 12' 1''$N} coal dumping activities are found at the bank of the River) in the downstream.
- **Species covered** (if any): *Channa punctata* (Bloch) as a model organism

Research Overview continues....

• Coal mining is done through rat hole mining techniques to exploit shallow reserves with severe environmental impact.
The largest water quality problem associated with coal mining is undoubtedly Acid mine drainage (AMD) which makes water highly acidic and rich in heavy metal concentration
• High metal concentration in mining areas may lead to its bioaccumulation in fish tissue which leads to mortality.
• Therefore in this study the micronuclei assay, comet assay and chromosomal aberration has found wide application as a sensitive method for evaluating DNA damage in fish exposed to xenobiotics in the aquatic environment.

Study Methodology

• Freshwater fish *Channa punctata* (Bloch) 17.47±2.21 g (mean± SD) has been selected for the exposure tests. Prior to experiments, the fishes were acclimatized for 7 days. For the experiment, they were released into the aquariums with water from each sampling site within 4 hours after collection of the sample water. Static toxicity tests were performed for a period of 20 days.
• pH, salinity, dissolved oxygen (DO), free carbon-dioxide (FCO2), alkalinity, conductivity, total dissolved solid (TDS), sulphate, lead, chromium, copper, nickel, iron and zinc of water sample collected from the river was performed as per method of APHA (2005).
• Micronuclei analysis were performed (Fenech.,1993) with the erythrocytes of fish after exposures.
• Alkaline (pH > 13) Comet assay was performed adopting the method of Singh et al., (1988).
• Chromosomal aberration test was performed following the method of Bertollo et al., 1978.
• All Statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS) 18.0.

Key Threats and Opportunities

THREATS

➢The unscientific rat-hole mining damages the landscape causing death of rivers, streams, ultimately killing aquatic biota.
➢Coal mines have a heavy water demand, to wash off its impurities-the effluents are diverted to downstream.
➢The course of river can be affected.
➢Rat-holes are death traps and, hot and humid inside of rat-holes endanger the health of miners.

OPPORTUNITIES

➢Focus should be on the combination of a controlled transition, increasing domestic supply, growing renewable energy, and cleaning up coal emissions.
➢Eco-Mine tourism

Key Observations/Findings

✓Results showed low pH, DO and relatively high level of sulphates and some heavy metals in the S_2. The heavy metals Fe, Pb, Ni, Mn and Zn were detected above the permissible limit in site 2 and concentration was found.

✓Increase in micronucleus frequency was observed in fish populations exposed to affected river water collected from site-2.

✓In site 2, fish group shows a significant increase in DNA migration maximum observed in monsoon season.

✓A significant increase in clastogenic damage was found in water collected from site 2.

✓Analysis of chromosome aberrations showed structural alterations (*e.g.* gaps and breaks), de-condensation of chromatin and ring formation.

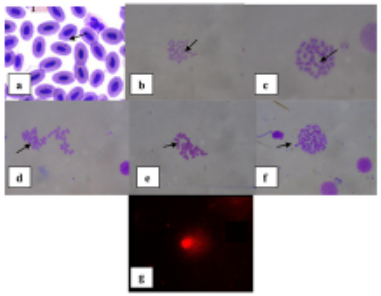


Fig. 1. Arrow indicates (a) Micronucleus; (b) chromatid gape; (c) chromatid breaks; (d) Ring formation; (e) Decondensation; (f) End to end joining; (g) Type 3; high-level damage,observed in comet assay.

Key Recommendations

✓Modernise mining operations (Desulfurization, deashing and demineralization techniques).
✓Public awareness and clean coal technologies should be developed and used to limit particulate emissions, waste from coal production.
✓ Appropriate implementation of mining policy.
✓Utilization of mine water.
✓Extraction and use of sand from over burden.
✓First mile connectivity project.
✓Bio Reclamation and tree plantation.
✓Setting up solar plants.

Encourage and emphasize on alternative clean source of energy to meet future energy demands

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Presenter 23: Hemanta Pokhrel

Study Title: Ecological Integrity and Fish Diversity of Dzii and Doyang River System, Northeastern Himalayan Region Nagaland, India

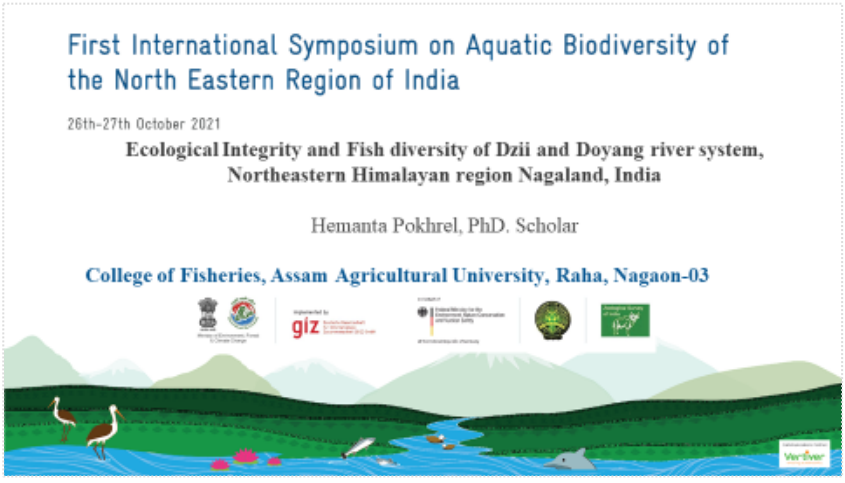
Authors: Hemanta Pokhrel, Kedolhouse Kuotsu, Sarada Kanta Bhagabati, Rajdeep Dutta, Abdul Malik Ahmed, Dipanka Nath, Raktim Sarmah and, Lowanu Prasad Mudoi

Abstract:

A 12 months' study was conducted from January, 2019 to December, 2019 along 152 km stretch (263 msl to 867 msl) on a monthly interval in-order to assess the fish diversity and ecological integrity of Dzii and Doyang rivers system, Nagaland, India. During the study period, a total of 45 fish species belonging to 5 orders, 9 families and 21 genera were recorded. The Cypriniformes order was dominant with 28 species, followed by Siluriformes with 5, Perciformes with 3 and 1 each from Beloniformes and Synbranchyformes. According to IUCN, 2017 conservation status among the recorded 45 fish species 1 (*tor putitora*) was Endangered (EN), 2 (*Schistura Naganensis; Schizothorax richardsonii*) were vulnerable (VU), 3 (*Neolissochilus hexagonolepsis; Neolissochilus hexasticus; Glyptothorax striatus*) were Near Threatened (NT). A total of 30 genera of plankton were also collected from the study area out of which phytoplankton consist of 18 genera under 3 family namely: Chlorophyceace (30%), Bacillariophyceae (17%) and Cyanophyceae (13%) and Zooplankton of 12 genera under 3 family namely Cladocera (20%), Rotifera (13%) and Copepoda (7%). Water quality parameters like surface water temperature, water velocity, pH, DO, Total alkalinity, Total Hardness, Electrical conductivity, COD, BOD_3, Nitrate, Ammonia, Phosphate were found to be congenial range for fish round the year except few parameters like turbidity, Total dissolved solid which is recorded slightly in the upper range during monsoon season. Overall productivity of the river system was also estimated, gross primary productivity ranged from 0.090 - 0.154 g C m^{-3} d^{-1} and net primary productivity ranged from 0.041 - 0.071 g C m^{-3} d^{-1}.

Keywords: Diversity, Ichthyofaunal; River; Doyang, Nagaland.

Presentation



Research Overview

A 12 months study was conducted from January, 2019 to December, 2019 along 152 km stretch (263 msl to 867 msl) on monthly interval in-order to assess the fish diversity and ecological integrity of Dzii and Doyang rivers system, Nagaland, India

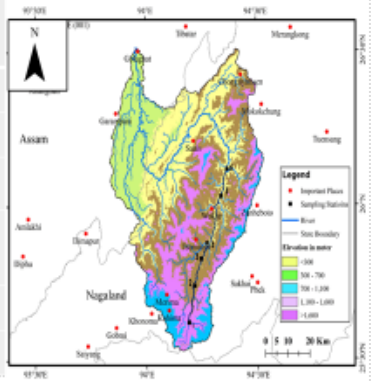
OBJECTIVES

1. To systematically study and record ichthyofaunal diversity of Dzii and Doyang river system of Nagaland
2. To identify anthropogenic factors affecting ichthyofauna of the river systems

A total of 45 number of fish species belonging to 5 orders, 9 families and 21 genera were recorded.

Research Overview Contd...

Stations	Sites	Latitude	Longitude	Alt (mtr)
1	Mithelephe Kohima	25°37'20.7 "N	94°11'27.1 "E	867
2	Kohima-meluri road	25°39'19.6 "N	94°11'11.6 "E	754
3	Chakabama Nagaland	25°41'10.6 "N	94°11'04.7 "E	695
4	Wokha Mokochung Road	25°32'65" N	94°36'43" E	610
5	Longidang, Nagaland	26°01'24.0 "N	94°21'29.9 "E	410
6	Mukhami, Nagaland	26°06'54.0 "N	94°23'11.5 "E	285



Study Methodology

- Selection and demarcation of complete course of the river.
- Identification of different zones of the river based on flow characteristics and fixation of sampling stations
- Periodic sampling. Collection and proper preservation of fish specimens.
- Identification of fish specimens following taxonomic keys.

- Fish species were identified using standard keys (Jayaram 1981&1999; Talwar & Jhingran, 1991; Kottelat, 2013 & Vishwanath, 2014).
- Fish Diversity indices for fish was calculated for Shannon, Simpson, Evenness and Margalef according to Tucker et al (2017) using Past 3 software.

- Assessment of ecosystem integrity of river Doyang is carried out on periodic monitoring of physico-chemical parameters of river water samples collected from 6 sampling sites of the rivers following standard protocol (APHA, 2005; CPCB, 2011).
- Water quality index was developed according to Brown et al., (1972).

Key Threats and Opportunities

Key Threats

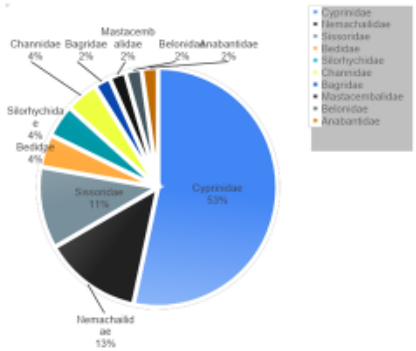
- Constant removal of sand gravel and boulders from the river bed.
- Constant dumping of solid waste like polythene bags, paper waste and domestic sewage in the river system
- Unethical fishing practices

Opportunities

- Community based conservation
- Ornamental value of fishes
- Establishment of Cold water fish hatcheries
- Ecotourism

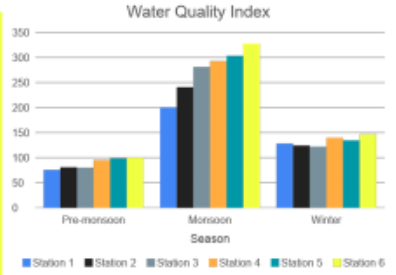
Key Observations/Findings

- A total of 45 number of fish species belonging to 5 orders, 10 families and 25 genera were recorded
- Diversity indices indicates that stations 5 and 6 are more diverse compared to other stations
- For the first time Cytochrome Oxidase subunit I (COI) of mitochondrial gene sequences of (41) fish species was generated and successfully submitted to NCBI gene database from the study area.



Key Observations/Findings

- Water quality indices when compared to the standard suggested that water quality was unsuitable for drinking and fish culture during monsoon and winter season after proper treatment.
- Pre-monsoon water quality index values indicates that the water is suitable for fish culture but not for drinking purpose.



WQI range, status and possible usage of the water sample (Brown *et al.*, 1972)

WQI	Water Quality Status (WQS)	Possible usage
0-25	Excellent	Drinking, irrigation and industrial
26-50	Good	Drinking, irrigation and industrial
51-75	Poor	Irrigation and industrial
76-100	Very Poor	Irrigation
Above 100	Unsuitable for drinking and fish culture	Proper treatment required before use

Key Recommendations

- Stop extraction of sand, pebbles and boulders from the river system
- Declaration of green zone for prevention of illegal fishing practices
- Strict enforcement of existing fishery laws
- Development of conservation plan for economically important fish species

Acknowledgement

I, would like to acknowledgement National Mission on Himalayan Studies (NMHS), Nodal Institute GBPNIHESD, Ministry of MoEFCC, Govt of India, for the financial assistance under Project ID: GBPNI/NMHS-2017-18/HSF-04/600. I also offer my sincere gratitude to Dean, College of Fisheries, Dr. S. K. Bhagabati and Dr. R. Dutta, PI, Himalayan Research Fellowship Programme, College of fisheries AAU, Raha for kind support and guidance.

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Presenter 24: Yumnam Rameshori

Study Title: Uncharted Alien Fishes in Manipur: Friend or Foe?
Author: Yumnam Rameshori

Abstract:

Unquestionably, the issue of alien or introduced freshwater fish species is on the rise. Particularly, the increasing presence of alien fishes in recent years in the freshwater ecosystem of Manipur is alarming. In order to assess this issue of complex and evolving relationship with the native species, in conjunction with the degrading freshwater ecosystem, inventory and new approach is paramount. In Manipur, a number of freshwater alien species have been introduced to increase the fish productivity, since 1975 which have caused extensive, sometimes catastrophic, changes to our native ichthyofaunal component. A preliminary study shows as many as 18 alien fish species viz., *Ctenopharyngodon idella* (Grass carp), *Hypophthalmichthys molitrix* (Silver Carp), *Cyprinus carpio* (Common Carp), *Labeo rohita* (Rohu & Jayanti Rohu), *Catla catla* (Catla), *Cirrhinus mrigala* (Mrigal), *Clarias macrocephalus* (Thai Magur), *Clarias gariepinus* (African Catfish), *Oreochromis nilotica* (Tilapia), *Oreochromis mossambicus* (Tilapia), GIFT Tilapia, *Piaractus brachypomus* (Pacu), *Pangasius hypophthalmus* (Pangasius), *Anabas* (Vietnamese Koi) *testudineus*, *Hypophthalmichthys nobilis* (Big Head), *Chitala chitala* (Chitala), *Ompok pabda* (Pabda), *Mylopharyngodon piceus* (Black Carp), *Cyprinus rubrofuscus* (Amur Carp). Of these only three species viz, *Clarias macrocephalus* (Thai Magur), *Clarias gariepinus* (African Catfish) and *Piaractus brachypomus* (Pacu) have been identified as having negative impact and has been banned in the aquaculture sector of the state.

However, apart from recorded alien species introduced, there are indications of increasing illegal entry of new alien species through grey markets and aquarium trades making the problem more serious. An inventory study is carried out to evaluate the impact of alien species on the freshwater ecosystem. At present, our study shows that there is no comprehensive database on alien fishes of Manipur and NE India in general. We conclude that consideration of alien species as non-invasive (friend) or invasive (foe) requires a multi-dimensional holistic study including socio-economic, ecological and local dimensions.

Presentation

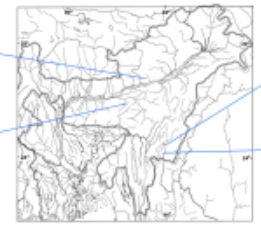
Study Objective:

1. to assess the alien species in Manipur
2. to understand the impact of alien species on the native fishes
3. to provide a plausible solution to the problem of alien species

Geographic scope: case study in Manipur but this problem is relevant to the entire states of Northeast India

Red-bellied Pacu

Sucker mouth catfish



Sucker mouth catfish

Oreochromis mossambica

"Alien": species having been introduced outside its natural distribution ("exotic", "non-native" and "non-indigenous" are synonyms

"Invasive": tending to expand into and modify ecosystems to which it has been introduced.

Thus, a species may be alien without being invasive, or, in the case of a species native to a region, it may increase and become invasive, without actually being an alien species.

(Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES) definition of an IAS)

Wallago attu

Clarias gariepinus

Gambusia affinis

Cyprinus carpio

Impacts on Native fish

Ecological

- Competition (food & space) or predation with native species leading to elimination of the natives
- alter habitat in ways that render it unsuitable for the local species
- bring with them novel parasites and pathogens into the invaded area

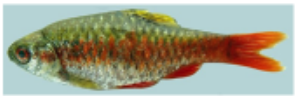
Genetic

- erode or dilute local genetic diversity through crossbreeding or hybridisation with the native species

Socio-economic

- There is decline of native species owing to the presence of alien species in natural waters, so economic decline for stakeholders involved in capture fisheries. It reduces ecosystem productivity and thus cause economic losses
- In aquaculture, however it provides immediate gain in most cases without considerations of long term ecological sequences.

Clarius magur



Pethia manipurensis (Endangered)

Osteobrama belangeri (Extinct in the wild)

Study Methodology

1. Review of literatures
2. Through Internet and social media
3. Through data from farmers and fish anglers
4. Through Questionnaires

Key Observations/Findings

Table 1. List of ornamental aquatic species

Sl. No.	Scientific name of species	Common name
1.	Balantiocheilos melanopterus	Bala shark
2.	Barbodes everetti	Clown barb
3.	Betta smaragdina	Blue betta
4.	Botia macracantha	Clown loach
5.	Capoeta tetrazona	Tiger barb
6.	Carassius auratus	Gold fish
7.	Epalzeorhynchus kalopterus	Red tailed black shark
8.	Labeo frenatus	Rainbow shark/ minnow
9.	Macropodus opercularis	Paradise fish
10.	Paracheirodon innesi	Neon Tetra
11.	Poecilia latipinna	Sail fin molly
12.	Poecilia reticulata	Guppy (developed and cultivated)
13.	Pterophyllum scalare	Angel fish
14.	Rasbora heteromorpha	Harlequin rasbora
15.	Symphysodon discus	Red Discus
16.	Symphodon aequifasciatus (controlled)	Blue Discus
17.	Trichogaster leeri	Pearl spotted tail
18.	Xiphophorus helleri	Red sword tail (green/wild caught not allowed)
19.	Xiphophorus maculatus	Platy
20.	Cyprinus carpio var. koi	Koi carp (Ban from Ampanallur)
21.	Betta modesta	Red tailed betti
22.	Betta leoctiti	Silver betch
23.	Apistogramma luthergi	Dwarf cichlid
24.	Betta mahiti	Shanti betta
25.	Betta rutilitaenia	Dwarf chained loach
26.	Betta splendens	Siamese fighting fish
27.	Cichlasoma urophale	Texas cichlid
28.	Cichlasoma severum	Emerald cichlid
29.	Hypancistrus zebra	Gold spotted Sella

Table 2: List of food fish

Sl. No.	NAME OF FISH	INTRODUCED IN YEAR	STOCK	PURPOSE	FROM	ORIGIN	VIA	BY	REMARK
1.	**Grass Carp** *Ctenopharyngodon idella*	Around 1975	Ponds/ Lakes	Aquaculture	West Bengal/ Assam	China	Air/Road	Govt./Private	Food & Habitat competition
2.	**Silver Carp** *Hypophthalmichthys molitrix*	Around 1975	Ponds/ Lakes	Aquaculture	West Bengal/ Assam	China	Air/Road	Govt./Private	Food & Habitat competition
3.	**Common Carp** *Cyprinus carpio*	Around 1975	Ponds/ Lakes	Aquaculture	West Bengal/ Assam	China	Air/Road	Govt./Private	Food & Habitat competition
4.	**Rohu & Jayanti Rohu** *Labeo rohita*	Around 1975 & 2014	Ponds/ Lakes	Aquaculture	West Bengal/Andhra Pradesh/Assam	India	Air/Road	Govt./Private	Food & Habitat competition
5.	**Catla** *Catla catla*	Around 1975	Ponds/ Lakes	Aquaculture	West Bengal/ Assam	India	Air/Road	Govt./Private	Food & Habitat competition
6.	**Mrigal** *Cirrhinus mrigala*	Around 1975	Ponds/ Lakes	Aquaculture	West Bengal/ Assam	India	Air/Road	Govt./Private	Food & Habitat competition
7.	**Thai Pangas** *Clarias macrocephalus*	Around 1980	Ponds	Aquaculture	West Bengal	Thailand	Air/Road	Private	BAN
8.	**African Catfish** *Clarias gariepinus*	Around 1980	Ponds	Aquaculture	West Bengal	Africa	Air/Road	Private	BAN
9.	**Magur** *Clarias batrachus*, *Clarias macrocephalus*	Around 1985	Ponds	Aquaculture	West Bengal	Africa	Air	Private/ Japanese Army	Negative impact
10.	**GIFT Tilapia**	Around 2000	Ponds/ Bheels	Aquaculture	West Bengal	Africa/India	Air	Private	Only Hormone treated BAN
11.	**Puta** *Caranx hippos*	Around 2000	Ponds	Aquaculture	West Bengal/ Bangladesh	South America	Air	Private	BAN
12.	**Pangasius** *P. hypophthalmus*	Around 2005	Ponds	Aquaculture	West Bengal	Thailand/ South East Asia	Air	Private	Culture under Guidelines
13.	**Vietnamese Koi** *Anabas testudineus*	Around 2006	Ponds/ Bheels	Aquaculture	West Bengal	South East Asia	Air	Private	Food & Habitat competition
14.	**Big Head** *Hypophthalmichthys nobilis*	Around 2006	Ponds	Aquaculture	West Bengal	China	Air	Private	Negative impact
15.	**Climbi** *Channa striata*	Around 2006	Ponds	Aquaculture	West Bengal/ Bangladesh/ Assam	India	Air	Private	Negative impact
16.	**Pabda** *Ompok pabda*	Around 2006	Ponds	Aquaculture	West Bengal/ Orissa	South East Asia/ India	Air	Private	Food & Habitat competition
17.	**Black Carp** *Mylopharyngodon piceus*	Around 2010	Ponds	Aquaculture	West Bengal	China	Air	Private	Negative impact
18.	**Amur Carp** *Cyprinus rubrofuscus*	Around 2010	Ponds	Aquaculture	West Bengal	China	Air	Private	Negative impact

Table 1 (contd...)

Sl. No.	Scientific name of species	Common name
20	*Pseudotropheus zebra*	Zebra
21	*Poecilia reticulata*	Black cichlid
22	*Poecilia sphenops*	Platy
23	*Trichogaster trichopterus*	Blue gourami
24	*Pterophyllum altum*	Altum angel fish
25	*Sphaerichthys osphromenoides*	Chocolate gourami

Table 3. List of restricted, banned and not approved exotic freshwater ornamental fish species

Sl. No.	Scientific name of species	Common name	Category
1.	*Astronotus ocellatus*	Oscar	Restricted
2.	*Aequidens rivulatus*	Green Severum	Restricted
3.	*Labeo Chrysophekadion*	Black shark minnow	Banned
4.	*Ophiocephalus Punctatus*	Murrel or Snake Head	Banned
5.	*Helostoma temminckii*	Kissing gourami	Banned
6.	*Hoplosternum littorale*	Hora	Restricted

Key Recommendations/ plausible solutions

1. Comprehensive and systematic Inventory of Alien species – a must in Northeast India; Criteria - categorising invasive species should be clearly identified.
2. Database for alien species in Northeast India- absent. Great potential in community involvement & citizen science initiatives through use of mobile apps and other social media tools for large scale data compilation. This will help local communities to locate alien-invasion hotspots and to track the spread of invasive species into new areas.
3. Time-lag between introduction and noticeable impacts of an alien species on ecosystems. Thorough risk analysis - needed before any new alien species is introduced into a system.
4. Introduction pathways needs to be identified & manage through effective and targeted action including fish stocking policy.
5. Reproductive biology and the of Alien species need to be determined.
6. Building awareness within local communities and civil society- extremely important, especially among fish farmers & aquaculturists.

Friend or Foe?

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Presenter 25: Ratul Arya Baishya

Study Title: Physico-Chemical Attributes of the Upper Reaches of River Brahmaputra, India: Assessment, Threats and Conservation Issues

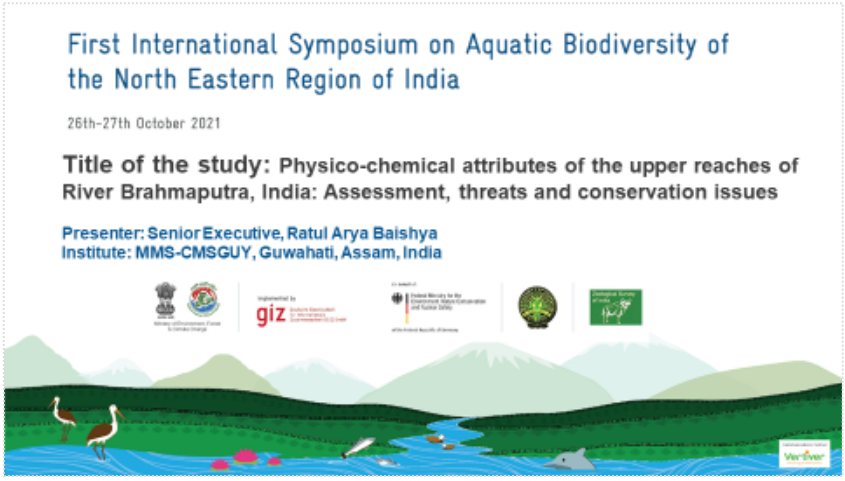
Authors: Ratul Arya Baishya and Dandadhar Sarma

Abstract:

Assessment of the physico-chemical attributes of the upper reaches of River Brahmaputra (27°34′52.6″N latitude & 95°18′58.2″E longitude to 26°11′10.2″N latitude & 91°45′03.6″E longitude) in Assam, India has been carried out and examined for a period of three years from February, 2013 to January, 2016. Multivariate statistical techniques were applied to estimate the characteristics of water quality in the sampling sites. Student's t-test and z-test were applied at 0.05 level of significance and 95% confidence interval for checking the significance status. Intense human intervention viz., siltation; water abstraction, industrial and private use; pollution; and impacts of global climate change results in habitat loss and degradation of few fish species that have become highly endangered, particularly in the sampling sites. Despite these fact, the Pearson (n) Correlation matrix among the variables, water temperature (°C) with pH; FCO_2 (mg l^{-1}); DO (mg l^{-1}); total alkalinity (mg l^{-1}) and turbidity (NTU) showed positive correlation (R = 0.445, 0.049, 0.706, 0.561 and 0.437) at 5% significance level respectively. Thus, the study reveals that the physico-chemical variables of the upper stretches of River Brahmaputra are within the permissible limits. However, promotion of strong policies towards comprehensive monitoring programs is imperative to prevent the upper River Brahmaputra basin contamination.

Keywords: Water quality; Correlation matrix; Principal Component Analysis; Cluster analysis; River Brahmaputra.

Presentation



Research Overview

- Study Objective:

➢ To assess the physico-chemical attributes in the upper reaches of River Brahmaputra.

➢ To study the present status and statistical correlation-ship of the physico-chemical attributes of the upper reaches of River Brahmaputra.

- Study Timeline:

The study was conducted for a period of three years from February, 2013 to January, 2016.

Research Overview Contd...

- Geographic scope: The present study covers a length of 500 km (approx.) of the total river length in Assam. The sampling sites were –

Sl. No.	Sampling Site	GPS Position	Altitude	Description of study sites
1	Guijan ghat, Tinsukia (S_1)	95°18'58.2"E and 27°34'52.6"N	95m MSL	Soil sandy, more water current and turbidity; and continuous water transport system.
2	Dibrugarh ghat, Dibrugarh (S_2)	94°54'45.4" E and 27°29'22.5" N	83m MSL	Soil sandy and clay, normal water current, slightly turbid water and no water transport system.
3	Nematighat, Jorhat (S_3)	94°15'01.7" E and 26°51'28.7" N	96m MSL	Soil sandy, more water current and turbidity; and except rainy season continuous water transport system.
4	Bhairabi ghat, Tezpur (S_4)	92°52'08.28" E and 26°37'32.5" N	51m MSL	Soil sandy, normal water current, slightly turbid water and less water transport system.
5	Kachari ghat, Guwahati (S_5)	91°45'03.6" E and 26°11'10.2" N	53m MSL	Soil loamy, more water current as the region is narrowest, less water turbid.

- Species covered : During the present investigation the following records of aquatic species were made–
- A total of 100 numbers of fish species belonging to 28 families, 66 genera and 9 orders were recorded.
- A total of 102 genera of planktons comprising 73 (70.87 %) genera of phytoplankton and 29(28.43 %) genera of zooplankton were also recorded.

Study Methodology

➢ For physical and chemical parameters analysis, water samples were collected from all the selected sites twice in each season - pre-monsoon (March to May), monsoon (June to August), retreating monsoon (September to November) and winter (December to February) following Barthakur (1986). Sampling of water was done between 7.00 am to 10.00 am.

➢ All the physico-chemical parameters have been analysed using the method of APHA (2017) and Trivedi and Goel (1986).

➢ The Agglomerative Hierarchical Clustering (AHC), Principal Component Analysis (PCA), One- sample t-test and z-test; and Pearson (n) Correlation matrix were estimated using software XLSTAT 2019 version 2019.1.2. The Principal Component Analysis (PCA) for estimating the correlation among the physico-chemical variables was followed after Gower (1966); Legendre and Legendre (2012).

Key Threats and Opportunities

➢ Intense human intervention viz., siltation; water abstraction, industrial and private use; pollution; and impacts of global climate change results in habitat loss and degradation of few fish species that have become highly endangered, particularly in the sampling sites.

➢ Moreover, the laxity of the State Government's Authority and the concerned department dealing with river ecosystem have cause the water qualities of the river system in detrimental stage.

➢ In addition, there is a little concern as the global warming effects are making a number of aquatic species vulnerable in their natural habitat.

➢ But the scientific practices and knowledge regarding the harvest of aquatic species and proper utilization of water resources for various needs may alter the condition to a positive side.

Key Observations/Findings

- Physico-chemical parameters like pH, Dissolved Oxygen (DO), Free Carbon-dioxide (FCO_2), Total Hardness, Total Alkalinity, Chloride, Total Dissolved Solid (TDS), Conductivity and Turbidity were found fluctuating significantly from one sampling site to another.
- The Pearson (n) Correlation matrix shows that the relationship between Water Temperature (°C) and pH, Water Temperature (°C) and FCO2 (mg l^{-1}), Water Temperature (°C) and DO (mg l^{-1}), Water Temperature (°C) and Total Alkalinity (mg l^{-1}), Water Temperature (°C) and Turbidity (NTU) showed positive correlation (R = 0.445, 0.049, 0.706, 0.561 and 0.437) at 5 % significance level respectively.
- The t-test and z-test of the mean value of studied physical and chemical variables at 0.05 level of significance and 95 % confidence interval shows a varied t (Observed) value for the individual parameters.
- The Agglomerative Hierarchical Clustering analysis revealed a comparable picture of similarities and associationship among the studied variables.
- The Principal Component Analysis (PCA) indicates that DO and Water Temperature, DO and FCO_2, Water Temperature and pH, pH and Chloride as well as DO and Chloride are positive correlated with each other.

Key Recommendations

- For effective maintenance of the important physico-chemical variables of the Upper River Brahmaputra, a comprehensive abiotic assessment programme should be planned.
- Hence, for the conservation purposes varied strategies such as halting of siltation and control of water pollution are the need of the hour. The present hydrological approaches may be applied to the entire Brahmaputra River and other river systems of the North Eastern part of India for identification of the other imperative hydrological factors which influences the ecosystem of the river basin.
- Many active conservation organizations should come forward for formulating effective maintenance strategies for sustaining riverine ecosystem of the region and Southeast Asia which have similar trend of agro-climatic conditions.
- It is therefore, recommended that the State Government, Scientific Research Organizations of the State along with NGOs should have active participation in research and developmental activities of water quality of River Brahmaputra and its conservation.

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Presenter 26: Barasha Baruah

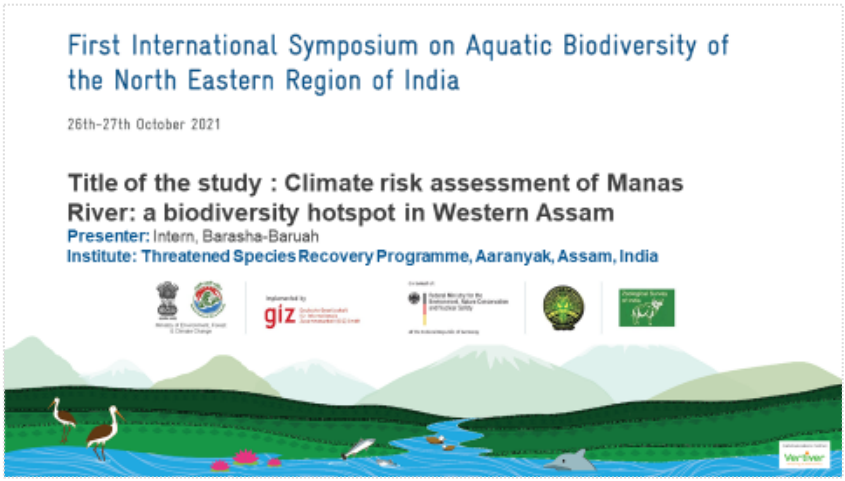
Study Title: Climate Risk Assessment of Manas River: A Biodiversity Hotspot in Western Assam

Authors: Barasha Baruah and Dhritiman Das

Abstract:

The Manas river is a key tributary of Brahmaputra River. This glacial feed river is a transboundary river and a key attribute of Manas world heritage site. This river system supports a unique variety of aquatic biodiversity along with some of the very rare and threatened species like *Ardea insignis.* A study on climate risk assessment of the Manas river as part of climate risk assessment of sub-Himalayan grassland was conducted. The land use change in the Manas river was analyzed for the year 1995 and 2020. The results obtained from both the years were compared. It was found that the river was highly dynamic in nature as it changes its courses and geomorphological characters. With these changes, the biodiversity configuration of river basins may also change. Another important finding from the study is that the area gets a sufficient amount of rainfall. Infect a significant increasing trend has been observed in case of Monsoon rainfall. In case of winter, pre-monsoon and post monsoon rainfall, no significant trend has been observed but a slight decreasing trend has been observed in winter rainfall and pre-monsoon rainfall. The increasing trend in the Monsoon rainfall might increase the intensity of the river water and result in flash floods. Also, due to the change in the climate, the threats of the flash floods might increase and this would result in affecting aquatic life. Climate change might also impact the melting of the glacier, which might increase the water flow. The impact of increase or decrease of the water volume also impacts different aquatic species differently depending on their level of sensitivity and adaptive capacity. A detailed study is highly recommended to analyze the various impacts of climate change on the aquatic diversity of Manas river basin.

Presentation



Research Overview

- Study Objective:
  - To assess the climate trends and variability.
  - To identify key climate risks in the region.
- Study Timeline: From 11/09/2021 to 11/03/2022
- Geographic scope:
  - Upper Indo-Manas basin

Research Overview Contd…

- Study Methodology:
  - Climate trend analysis
  - Model projection
  -Vulnerability and Risk-Impact Index Assessment Framework
  -Land Cover Classification

Study Methodology

Details

- Primary and Secondary data – Research papers and articles were collected and stakeholder consultation was carried out.
- Climate data – Temperature and rainfall data were collected from NASA Power and WMO.
- Satellite data – Data were extracted from USGS and land cover classification was done using QGIS.
- Risk assessment – Stakeholder assessment was carried out and expert's perception was taken.

Key Threats and Opportunities

- Increasing trend in the rainfall might be one of the causes for the change in river area.
- Flood is found to be the key risk and variation in temperature to be emergent risk.
- In case of river and woodland, increase in the area have been observed.
- The impact of increase or decrease of water volume also impact different aquatic species differently depending on their level of sensitivity and adaptive capacity.

Key Observations/Findings

- Significant increasing trend have been observed in Monsoon rainfall.
- No significant trend has been observed in case of winter rainfall, pre-monsoon rainfall and post monsoon rainfall.
- In case of maximum temperature, significant increasing trend have been observed during post monsoon.
- In case of minimum temperature, significant increasing trend have been observed for winter, pre-monsoon, monsoon and post-monsoon.
- By land cover classification, increase in the area of the river and woodland have been observed.

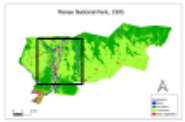


Figure 1: Classification of MNP for the year 1995

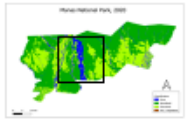


Figure 2: Classification of MNP for the year 2020

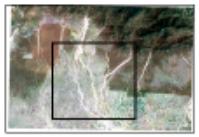


Figure 3: Satellite imagery for 1995

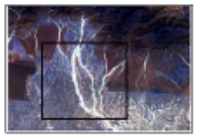


Figure 4: Satellite imagery for 2020

Key Recommendations

- Further study and research is highly recommended to analyze the various impacts of climate change on the aquatic diversity of Manas river basin.

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Presenter 27: Bashida Massar

Study Title: Conflicting Issues in Fish Conservation
Author: Bashida Massar

Abstract:

Through our ongoing Critical Ecosystem Partnership Fund (CEPF) project, we are beginning to contribute towards conservation of fishes in River Rymben in Lapalang village of East Khasi Hills, Meghalaya, India by establishing fish conservation zone (FCZ) for a particular stretch of the river. This initiative to conserve and protect the ten fish species including the three near threatened species - chocolate mahseer (*Neolissocheilus hexagonolepis*), Gray's stone loach (*Balitora brucei*) and a river catfish (*Glyptothorax striatus*) is done by involving the village community. In the FCZ, fishes are able to live freely in their natural habitat without being disturbed by humans' interference of any kind. Fishing of all kinds is banned and human activities such as washing clothes and bathing are restricted. Within 3-4 months of the inception of the project, stakeholders witnessed the positive impact of the project in which many fishes are seen swimming freely in the FCZ, unlike in the past years when none could be seen due to over exploitation.

While the population of fishes in Rymben is trying to bounce back to its glorious past, there are conflicting issues that contradict the progress and thus, disturb the whole set up: (1) Mining of limestone- The villagers of Lapalang informed that in the month of August, 2021, the water in Rymben turned whitish-brown in colour due to the mining activity for limestone that is going on upstream of the river. Heavy rain carries waste water from the mining area directly to the river and pollutes it. Some villagers reported that there were no more fishes at that particular time in the river. (2) Government's project: Through the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) scheme, the village authority is constructing a small dam (sausage dam) to collect water which acts as a pool for fishes and at the same time the water collected is meant for villagers to use during dry winter months. As part of the project activities in constructing artificial pools, workers broke and removed big boulders which destroyed the breeding grounds for fishes. Though the aim is to collect and store water for fishes and people, this activity disturbed the natural habitat of fishes that will now have to adapt to the new habitat and otherwise look out for fresh habitat elsewhere. This kind of activity by village authority is practiced in many villages in the area.

The aim of this communication is to bring to the notice of all concerned that any development projects and all other activities whether private, public and government-led projects should be carried out without disturbing nature. Implementing Government agencies should consider all aspects before sanctioning projects that disturb natural resources and habitats of organisms and whenever possible, no clearances should be given for projects that damage the environment and its biological resources.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study : Conflicting issues in Fish Conservation

Presenter: Dr. Bashida Massar
Institute: St. Anthony's College Shillong, Meghalaya

Research Overview

- Study Objective:
  To highlight the impact of Government and Private implemented projects (construction of check dam for water conservation and water harvesting and mining) on fish conservation
- Study Timeline: January 2020 to August 2021
- Geographic scope: Rivers Rymben, Wahniai and Sohkha of East Khasi Hills and Jaintia Hills Districts, Meghalaya, India
- Species covered: 10 fish species including 3 near threatened
  Chocolate mahseer (*Neolissocheilus hexagonolepis*)
  Gray's stone loach (*Balitora brucei*)
  River catfish (*Glyptothorax striatus*)

Research Overview Contd…

Study Methodology
Field visit

Documenting the river bed in the damming site

Monitoring the water quality and fish population

Study Methodology

1. **Local field assistant visited the river weekly**
2. **Activities by villagers in damming the river through the Mahatma Gandhi National Rural Employment Guarantee Act (Ministry of Rural Development, Govt. of India) were recorded**
3. **Documenting fish population though photography and interaction with village elders**
4. **Other fish conservation and water harvesting sites through check dams construction were visited**

Key Threats and Opportunities

1. Fish habitat destruction due to check dam construction and removal and breaking of boulders
2. Loss of normal flow of water
2. water pollution due to wastewater from mining area

Key Observations/Findings

1. Check dams created pools of water instead of naturally fast flowing water bodies
2. River beds have changed – big stones and boulders broken down
3. Fish population is disturbed – too crowded, stunted growth?
4. Water changes in colour – release of waste water from mining area

Key Recommendations

1. Implementing Government agencies should consider all aspects before projects that disturb natural resources and habitats of organisms are implemented

2. No clearances should be given for projects that damage the environment and its biological resources

3. Rain water harvesting is to be carried out in a large scale

Presenter 28: Dipima Sarma

Study Title: Vulnerability of the Fringe Areas of Urpad Beel (Part of the Proposed Ajagar Wildlife Sanctuary), Goalpara, Assam in Context of Climate Change and Strategies for Adaptation

Authors: Dipima Sarma, Dw Imu Narzary, and K.S.P.V. Pavan Kumar

Abstract:

Climate change is a globally recognized concern in recent times, and studies have indicated that due to climate change, there will be changes in the rainfall pattern of the state including occurrences of extreme events and rise in temperature. A district level vulnerability assessment was carried out for the entire state based on socio-economic features and livelihood, biophysical aspects and, institution and infrastructure of the state. Vulnerability was assessed in terms of adaptive capacity and it was found that Goalpara is one of the relatively highly vulnerable districts of the state. The main drivers of vulnerability of the district are identified as, percentage (%) of households with improved drinking water source, forest area per 100 rural population and road density.

Urpad Beel, being the largest wetland of Goalpara district of Assam spreads over an area of about 700 ha and is located in the Lower Brahmaputra Valley Agro-climatic Zone. The beel is surrounded by the Pancharatna Reserved Forest in the west and Ajagar Hills in the south and is part of the proposed Ajagar Wildlife Sanctuary. This freshwater wetland is connected to *Patakata* and *Matia beel* in the east and is fed by (inlets) the Jinari river, a tributary of the Brahmaputra river and Bolbola river that originates from the Garo Hills,

Meghalaya. The Jinjiram river in the west, serves as the outlet for the wetland. The wetland is rich in aquatic flora and fauna and is home to several migratory birds in winter. The richness in water lilies and lotus species of the wetland increases the aesthetic value of the entire area. Also, the wetland is rich in various fish species including ornamental fishes.

The livelihood of the fringe villages of the wetland is mainly dependent on fishing and other natural resources, in addition to agricultural farming. However, climate change has threatened the biological richness of the wetland and its fringe areas as well as life & livelihoods of the villagers.

To formulate strategies for climate change adaptation, Participatory Rural Appraisal (PRA) exercises were carried out in the fringe villages of the wetland. Based on the PRA exercise, three major zones were identified viz. Recreational Zone, Conservation Zone and Livelihood Zone. In the Conservation Zone, activities like ban on overfishing, ban on poaching of birds, for mation of Nature Conservation Clubs (NCC) to involve students in conservation, protection of elephant sites, formation of committee for planning and monitoring, ban on high level noise inside the beel and, plantation were proposed. In the Livelihood Zone different training programmes such as, fish farming, homestay/hospitality for tourists, traditional cuisine preparation for restaurants, product development from bio-resources like water hyacinth and formation of local tourist guides were proposed to ensure alternative livelihood options for the fringe villagers which in turn will increase the adaptive capacity of the area.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

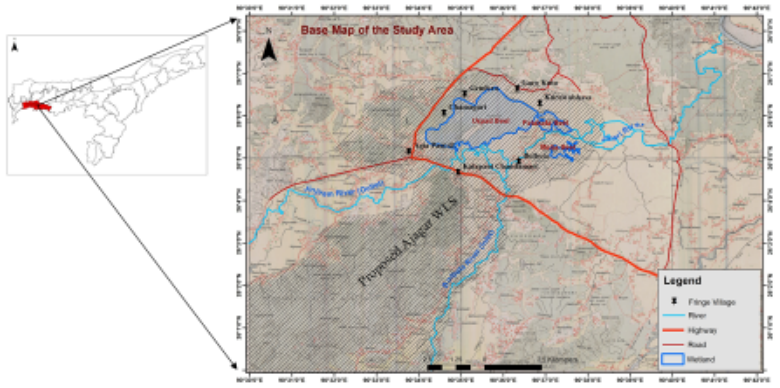
Vulnerability of the Fringe Areas of Urpad Beel (part of the proposed Ajagar Wildlife Sanctuary), Goalpara, Assam in context of Climate Change & Strategies for Adaptation

Presenter: Research Associate-II, Ir. Dipima Sarma
Institute: Climate Change Cell, Assam - Assam Climate Change Management Society (ACCMS)

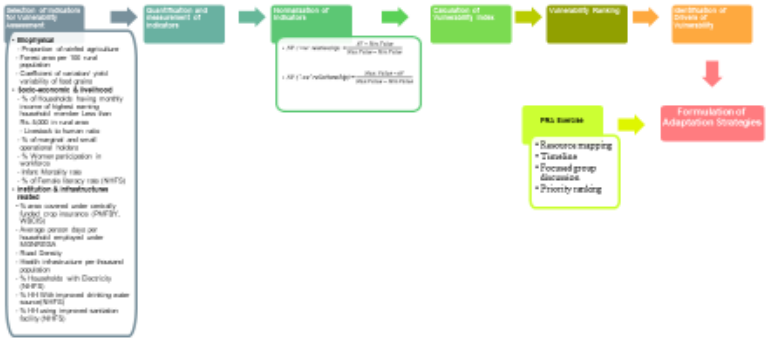
Research Overview

- Study Objectives:
  - To assess vulnerability of the fringe areas of Urpad Beel (part of the proposed Ajagar Wildlife Sanctuary) in context of Climate Change.
  - Identify the Drivers of Vulnerability.
  - To formulate strategies for adaptation.
- Study Timeline: 2011 to 2019*
- Geographic scope:
  - The study has been conducted at *Urpad Beel*, Goalpara, Assam and its fringe areas.
  - Located in the Lower Brahmaputra Valley Agro-climatic zone.
  - Largest wetland of Goalpara district and spreads over an area of around 700 ha.

Research Overview Contd...



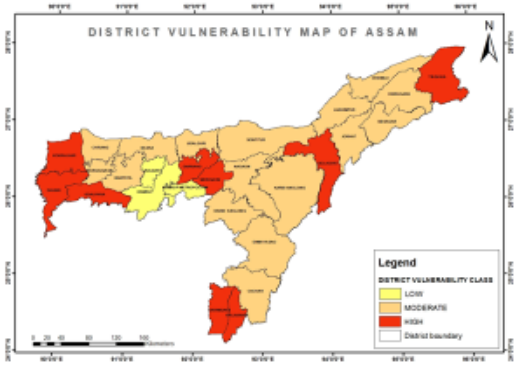
Study Methodology



Key Threats and Opportunities

DRIVERS OF VULNERABILITY FOR GOALPARA DISTRICT:

- Forest area per 100 rural population
- Percentage (%) of households with improved drinking water source
- Road density



Key Observations/Findings

- *Urpad Beel* is rich in many aquatic flora & fauna – Assam roofed turtle, Lotus, Water lily, Makhana, Water hyacinth, Water spinach etc.
- Home to migratory birds in winter.
- Rich in various fish species including ornamental fishes.
- Existing rights of the fringe villages – Community fishing, plant harvesting, agriculture within wetland, grazing, plying of boats.

Key Recommendations

Based on Participatory Rural Appraisal (PRA) exercise, three major zones have been proposed:

- Recreational Zone – Homestay/Eco-camp, Paved walking path, Bird watching site/Watch Tower, Boating arrangements etc.
- Conservation Zone - ban on overfishing, ban on poaching of birds, formation of Nature Conservation Clubs (NCC), protection of elephant sites, formation of committee for planning and monitoring, ban on high level noise inside the beel, plantation.
- Livelihood Zone - Training programmes on fish farming, homestay/hospitality for tourists, traditional cuisine preparation for restaurants, product development from bio-resources like water hyacinth and formation of local tourist guides

Active participation of the villagers in PRA exercise

Contact Details

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Acknowledgement: Department of Science & Technology, GoI, New Delhi and National Mission on Himalayan Studies (NMHS) for their financial support; All the team members of Climate Change Cell, Assam, Assam Climate Change Management Society (ACCMS) and Him-Nature Learning Centre, Assam.

Presenter 29: Dr. Limatemjen

Study Title: Endangered River Fish: Reasons Hindering Conservation and Restoration

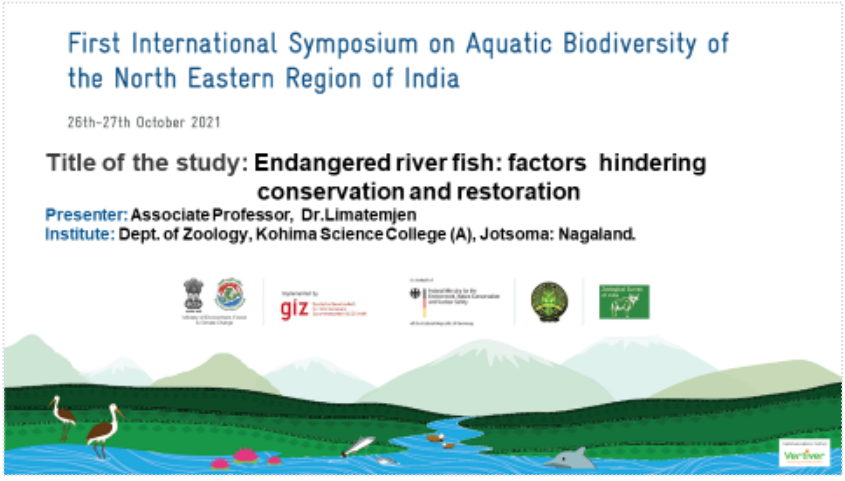
Author: Dr. Limatemjen

Abstract:

Riverine fish face many anthropogenic threats including riparian habitat degradation, altered hydrology, migration barriers, fisheries exploitation, environmental changes, and introduction of invasive species. Collectively, these threats have made riverine fishes some of the most threatened taxa on the planet. Although much effort has been devoted to identifying the threats faced by river fish, there has been less effort devoted to identifying the factors that may hinder our ability to conserve and restore river fish populations and their watersheds. Therefore, we need to focus on our efforts on identifying and discussing the factors that constrain or hinder effective conservation action plan under the following parameters;

(1) Level of migrations and how to sustain populations; (2) Understanding the relationship between fish and river flow; (3) To understand the seasonal aspects of river fish biology; (4) To predict the response of river fish and river ecosystems to environmental changes; (5) To undertake restoration or management actions; (6) To understand the human dimension of river fish conservation and management; (7) The role of governmental agencies to address the endangered river fish population and rivers across multiple jurisdiction. Therefore, these issues may need to be addressed with utmost seriousness to help protect, restore, or conserve the river fish, particularly those that are endangered.

Presentation



INTRODUCTION

- Freshwater ecosystems, represent some of the most endangered ecosystems in the world.
- Rivers represent important freshwater habitats.
- Rich in biodiversity - invertebrates, amphibians and fish.
- Knowledge of freshwater biodiversity is incomplete.

- Certain factors like - overexploitation of species, introduction of exotic species, pollution(industrial, and agricultural areas) , habitat loss and alteration through damming and water diversion.
- Contributing to the declining levels of freshwater fish diversity

FACTORS HINDERING CONSERVATION AND RESTORATION OF RIVERINE FISH POPULATIONS

Limited information on basic taxonomy and life history of riverine fishes

- Inadequate faunal data of many river ecosystem.
- In some cases, the only information known about a given fish species is its name and a basic morphological description.
- Many species are yet to be discovered.

Limited understanding of fish–flow relationships

- The flow regimes are a key element for many life history stages of riverine fishes and a primary driver of river ecosystems.
- Rivers and streams need a natural flow regime to facilitate ecological function and biotic integrity .
- River flows have been severely altered in many part of the world.

Limited understanding of seasonal aspects of river fish biology

- Limited understanding of the mechanisms for seasonal shifts in fish populations.
- Monitoring orients around the dry and wet (or monsoon) periods.
- Very less monitoring during the extremes of the wet or dry seasons
- There is a need for information on river fish biology during that period.

Predicting responses of river fish and river ecosystems to both environmental change and restoration/ management actions

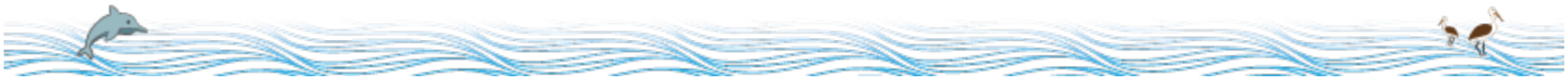
- Alteration of riverine systems due to environmental changes.
- Climate change will alter both river flows and temperatures.
- Environmental changes likely will have an effect on fish and it is necessary to predict such changes to facilitate adaptation/ management strategies.
- Research efforts to identify the hydrological conditions necessary to positively impact fish recruitment under future climate conditions.
- Necessary to predict the effects of development activities (e.g. dams)

Limited understanding of the human dimension in river fish conservation and management

- Rivers are particularly challenging environment in which to study fish .
- Human dimensions research is particularly needed to improve conservation of endangered river fish
- Priorities for river restoration and management.

Efforts focused on a single species often fail to address broader-scale problems

- A primary challenge with riverine species management and conservation is to ensure that river ecosystems as a whole and not just a single species is conserved.
- Efforts to conserve only one species may lead to decline in other fish population.



Key Recommendations

- Restoration of habitat & population.
- Establishment of aquatic bioreserve where fishing is banned.
- Bioregional management to regulates factors affecting aquatic biodiversity by balancing conservation, economic, and social needs within an area.
- Watershed management.

Contact Details

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Presenter 30: Lawonu Prasad Mudoi

Study Title: Estimating Pollution Load from Continuous Discharge and Monthly Flow in Umtrew River

Authors: D. Rajdeep, K.B. Sarada and Lawonu Prasad Mudoi

Abstract:

The river Umtrew and its tributaries have a total water area of 1369.6 km2, with the majority of it falling within the Meghalaya plain region and the rest falling inside the low-lying Brahmaputra plain in Assam. The monthly discharge was assessed along six stations of the Umtrew river system in Meghalaya and Assam. Several anthropogenic factors were identified throughout the research, including large-scale damming, hydrological change, pollution, sand, and bolder mining, all of which might compromise the river ecosystem's integrity. Industrial activity in the Byrnihat area produces a considerable number of contaminants with a diverse spectrum of characteristics. The aim of the present study is to estimate the relation between flow rate and concentration of different water quality parameters like BOD, COD, TDS, Nitrate and Nitrite. The average monthly discharge value for BOD, COD, TDS, Nitrate and Nitrite was found 5.13kg, 9.31kg, 34.85kg, 0.048kg and 0.014kg respectively. During monsoon season the discharge rate was on peak since the volume of the river water was at its highest. The river water discharge is also affected by Umtrew hydroelectric project dam.

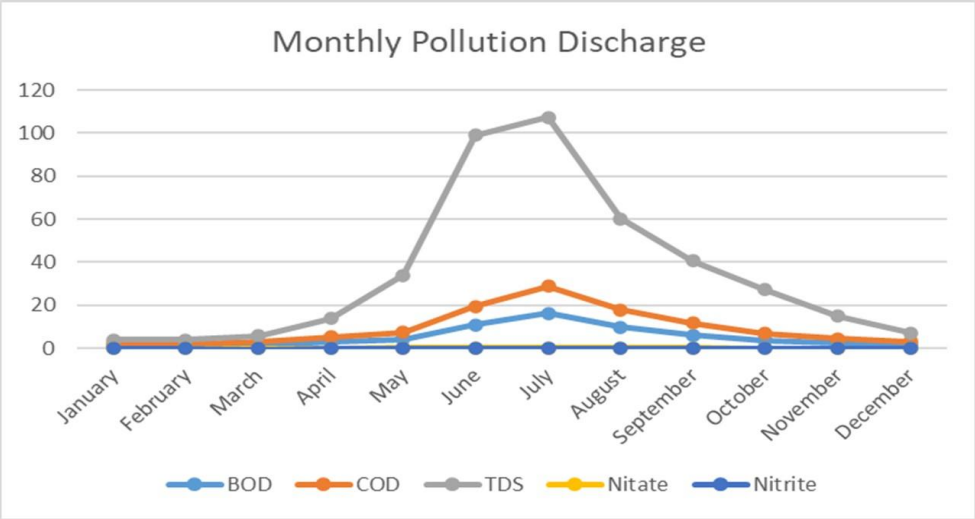


Fig: Monthly Hydrograph for the year 2019

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Estimating pollution load from continuous discharge and monthly flow in Umtrew river

Presenter: Ph.D. Scholar, Lawonu Prasad Mudoi

Institute: College of Fisheries, Assam Agricultural University

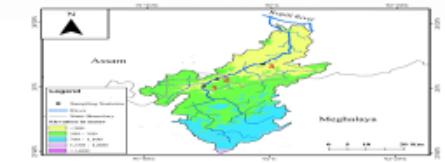
Research Overview

Study Objective:

- To study the pollution status of Umtrew river in Meghalaya and Assam
- Anthropogenic factors that are affecting the biota

Study Timeline: From January 2019 to December 2019

Geographic scope:



Research Overview Contd...

Station No.	Station Name	River Name	Longitude	Latitude	Elevation(Ft.)
1	Umtrew Dam	Umtrew, Meghalaya	26°00'27.6" N	91°52'02.7" E	403
2	Bornihat Bazer	Umtrew, Meghalaya	26°02'31.7" N	91°52'02.7" E	213
3	Digaru Kopili Confluence Point	Kopili, Assam	26°13'51.8" N	91°37'28.8" E	192

Study Methodology

Study Methodology:

- Water samples were collected from three different stations on monthly basis (2019)
- Pollution Indicators like BOD, COD, TDS, Nitrate and Nitrite was estimated as per standard method

=>Monthly Pollution Load= Total Monthly Discharge* Evan Mean Concentration (EMC)

Key Threats and Opportunities

THREATS:

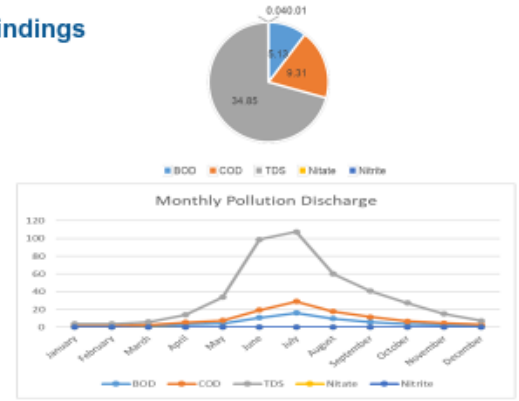
- INDUSTRIAL AREA NEAR RIVER BANK
- UMTREW DAM FOR HYDROELECTRIC PROJECT
- HUMAN INTERFERENCE
- DESTRUCTION OF RIVER BED
- COAL MINING

OPPORTUNITIES:

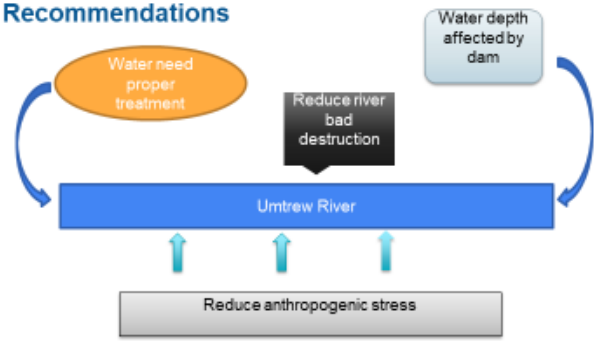
- CONSERVATION OF RIVER BIODIVERSITY
- RECREATIONAL FISHERY
- ECO TOURISM

Key Observations/Findings

Parameters	Average Monthly Discharge Maximum (Kg)	Maximum	Minimum
BOD	5.13	July	February
COD	9.31	July	February
TDS	34.85	june	January
Nitrate	0.04	july	December
Nitrite	0.01	june	January



Key Recommendations



Acknowledgement

I would like to acknowledge National Mission on Himalayan Studies (NMHS) (Project ID: GBPNI/ NMHS-2017-18/HSF-04/600), Ministry of Environment Forest and Climate Change (MoEFCC) and Nodal institute GBPNIHESD, Kosi-Katarmal, Almora, for financial support provided to carry out the present study under the Himalayan Research Fellowship Programme. I also offer my heartfelt obliged and sincere gratefulness to Authority of Assam Agricultural University, Dean college of Fisheries, AAU, Raha, Dr S.K Bhagabati and Dr. Rajdeep Dutta, PI, Himalayan Research fellowship Programme for their kind support and guidance.

Presenter 31: Kangkan Sarma

Study Title: Impact of AMD of Open Cast Coal Mines on Fishes of Simsang River, Garo Hills; Meghalaya Using Genotoxicity Biomarkers in Channa Punctata (Bloch)

Authors: Kangkan Sarma, Bandita Talukdar and Dandadhar Sarma

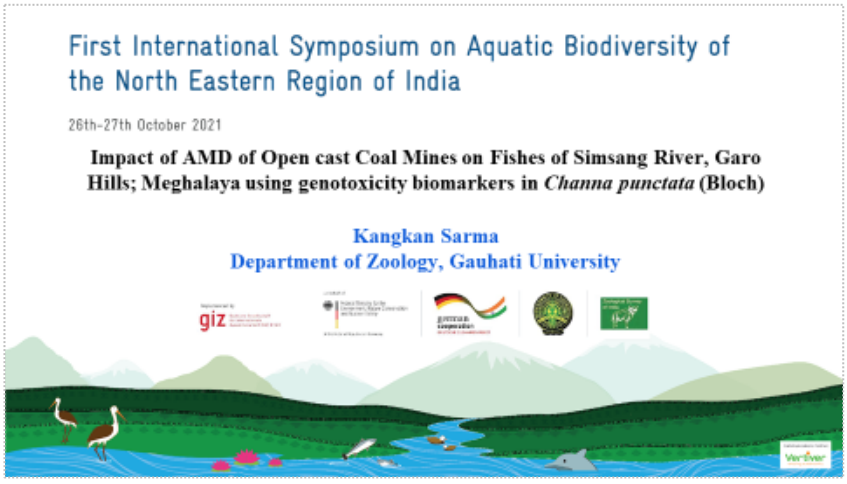
Abstract:

The present investigation deals with the studies on genotoxic and mutagenic potential of Acid Mine Drainage (AMD) of open cast coal mines on fishes of Simsang River, Meghalaya, India. *Channa punctata* (Bloch) were collected from three different sites of the river in various seasons and blood samples were processed for micronuclei test and comet assay as genotoxic biomarkers.

A significant ($p < 0.05$) high micronuclei induction, nuclear abnormalities and percent of tail DNA was recorded in the specimen collected from the affected site. The findings of the present investigation indicated contamination of Simsang River water with AMD which induces genotoxicity in fish.

Keywords: Acid mine drainage, Channa punctata, Simsang, Meghalaya.

Presentation



Research Overview

- East Garo Hill region is a major producer of coal and coal excavation is commonly done by primitive mining method known as 'rat-hole' mining, causing posing serious threats to the fish and fisheries of Simsang River, the longest River of Garo Hills, Meghalaya, India.
- The large number of coal mine quarries in Garo Hills, Meghalaya drains AMD directly into the river as well as dumping of coal for auction on its bank are responsible for hazards to the biota of the river.
- AMD streams generally contain low pH, a more diverse blend of toxic metals (e.g., Al, Fe, Mn, Zn, Cu, Ar, Pb) higher conductivity and higher sulphate concentrations.
- High metal concentration in the coal mining areas may lead to its bioaccumulation in fish tissue [5] which leads to fish mortality.
- Fish serve as useful genetic models for the evaluation of pollution in aquatic ecosystems (Mitchell & Kennedy; 1992, Park *et al*., 1993).

Research Overview Contd…

- Micronucleus assays have emerged as one of the preferred methods for assessing chromosome damage because they enable both chromosome loss and chromosome breakage to be measured reliably (Fenech M, 2008).
- The formation of nuclear abnormalities (NA), apart from micronuclei formation, in fish cells exposed to genotoxic substances also considered to be indicators of genotoxic damage, and therefore they may complement micronucleus scoring in routine genotoxicity surveys(Toni *et al.,* 2009).
- The comet assay or single cell gel electrophoresis has also found wide application as a simple and sensitive method for evaluating DNA damage in fish exposed to various xenobiotics in the aquatic environment(Dhawan *et al.,* 2009; Frenzilli *et al.,* 2009) .
- Therefore in this study The comet assay or single cell gel electrophoresis has also found wide application as a simple and sensitive method for evaluating DNA damage in fish exposed to various xenobiotics in the aquatic environment.

Study Methodology

Water sample were collected from river at three location, i.e. near Rombagre,free from coal mining activities and was used as the reference site.The two other sites were Near Siju, (maximum coal mining activities are practiced in the hills of the vicinity) and Baghmara coal dumping activities are found at the bank of the River) in the downstream. The specimens of test species *Channa punctata* (Bloch) were collected from the affected sites and processed for comet assay and micronuclei test.

Micronucleus test - Prepared blood smear was stained with 8 % Giemsa in phosphate buffer.

Comet assay-Alkaline Comet assay was performed for detecting single strand breaks and alkali labile sites, adopting the method of Singh et al. [22] with certain modifications.

Key Observations/Findings:

The physico-chemical parameters of water from the three sampling sites found to be highly fluctuated. The low pH, DO and, relatively high level of sulphates and few heavy metals were observed in site 2. The heavy metals Fe, Pb, Ni, Mn and Zn were detected above the permissible limit in site 2. The site 1 and 3 showed lower concentrations of heavy metals than the permissible levels established by WHO guidelines.

Micronuclei and nuclear abnormalities such as binuclei, lobed nuclei, notched nuclei and blebbed nuclei have been observed in the erythrocytes of the specimen collected from the AMD discharge site.

The extent of DNA damage of the specimens of site 2 was higher as compared to site 1 and 3.

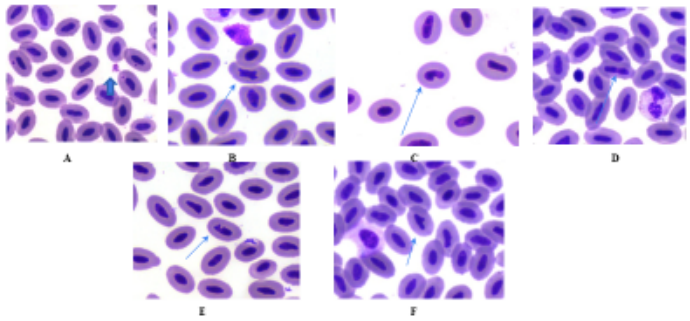


Fig 2- Photomicrograph of erythrocyte of *C. punctata* with micronuclei **(A)** and with other nuclear abnormalities : lobed nuclei **(B)**; notched nuclei **(C)**; binuclei nuclei **(D)**;blebbed nuclei; **(E)**; **(F)**

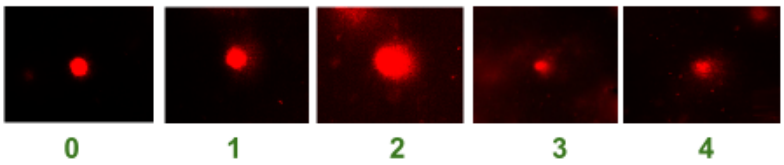


Fig. Classification of the comet formations in kidney tissues of fish *Channa punctata*. Type 0; no damage, Type 1; low-level damage, Type 2; medium-level damage, Type 3; high-level damage, and Type 4; complete damage.

Recommendation: On the whole, the study reveals that the deleterious effect of AMD generated from coal mine on the resident fish diversity and distribution of fish species in the Simsang River. The findings underscore the need for policy makers to regulate coal excavation and other mining activities, and initiate efforts to restore degraded habitats and conserve native fish species.

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Session 3: Opportunity and Tools for Livelihoods and Sustainable Management

Presenter 32: Bikramjit Sinha

Study Title: Potential of Natural Frog Farming in North East India for Sustainable Development Vis-À-Vis Biodiversity Conservation

Authors: Bikramjit Sinha and Bhaskar Saikia

Abstract:

Along with having a rich biodiversity, the North Eastern Region of India is ethnically diverse too; possibly the former contributing to the diverseness of the later, as environment including biodiversity is known to influence the amplification of genetic diversity. These ethnic communities live in close harmony with nature beginning from their birth till death. Biodiversity components are ingrained in their various activities like rituals, culture, food, fodder, shelter, medicine and similar others. A large part of their dietary intake is met from the wild including wild vegetables and game. While hunting and consumption of wild animals, especially higher vertebrates is legally prohibited, there are no such restrictions on amphibians, particularly frogs. There is ample evidence that the indigenous communities of North Eastern India consume different species of frogs as a source of protein as well as for medicinal purposes. One can also witness the selling of frogs, both fresh and dried, in different markets in the hill areas of the Region, indicating the demand and supply of the item.

The North Eastern Region including the NERAQ project areas has one of the highest diversities of about 163 species of amphibians in the country which is next only to highest diversity of 252 species known from the Western Ghats, another biodiversity hotspot in the country. Because of the high diversity and its abundance in the region, the local communities might have found an easy source of delicacy and protein in the Amphibians. Even though there is relatively less legal protection of amphibians, the present traditional and unregulated continuous and unsustainable extraction from the wild is not wise and justified. Because every species has an ecological role and still some species are of aesthetic and conservation importance. For instance, the Indian Gliding Frog, *Pterorana khare* is consumed in Nagaland but it is a vulnerable species. So, this is an issue of concern and needs to be addressed immediately.

Herein, we argue that a regulated and scientific frog farming, *in-situ* and/or *ex-situ* depending on the species and habitat are quite essential and practically feasible in North East India. This will be in tune with couple of India's National Biodiversity Targets and Aichi Biodiversity Targets under the CBD and realization of the 2030 agenda for Sustainable Development Goals (SDG) of striking a balance between human well-being and development priorities, and address global societal challenges. A preliminary model of the prospective frog farming in North East India is proposed for critical deliberation by all stakeholders.

Presentation

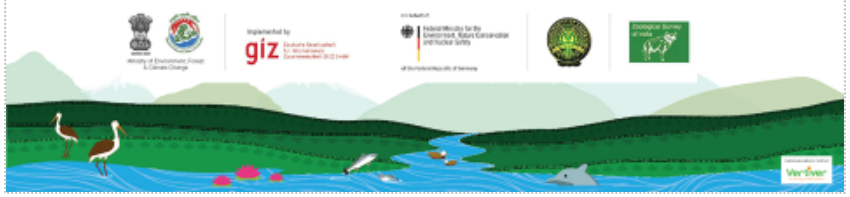
First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: Potential of natural frog farming in N E India for sustainable development *vis-à-vis* biodiversity conservation

Presenter: Bikramjit Sinha, Scientist-E

Institute: Zoological Survey of India, North Eastern Regional Centre, Shillong



Research Overview

Study Objective:

- To explore the possibility of natural frog farming in N E India.

Study Timeline: Till date.

Geographic scope:

- North East India w.s.r. to Assam, Manipur, Meghalaya & Nagaland.

Taxon covered (if any): (Amphibia: Anura).

- Indigenous communities of N E India consume different species of frogs
  - as source of protein as well as for medicinal purposes.
- Sold in the markets, both fresh as well as dried
  - indicating demand and supply of the commodity.
- Present method of extraction from the wild is unsustainable and harmful
- Amphibians have relatively less legal protection,
  - Natural frog farming is a promising possibility

Study Methodology

- The present study has been carried out based on already available research publications.
- A preliminary review of existing literature on consumption of frogs by the different ethic communities of the region was done.
- National/International legal protection worked out based on WPA & CITES
- Conservation status is based on latest IUCN assessment

Key Observations/Findings

- Seventeen species of frogs are consumed by different ethnic tribes of NE India
- Out of which 16 species are consumed as food, 2 species for medicinal values
- Maximum consumption is witnessed in the state of Nagaland
- Out of 17 species, 2 species namely ***Euphlyctis cf. hexadactylus**** & ***Hoplobatrachus tigerinus*** enjoy both national/international legal restrictions while another one species, ***Hoplobatrachus crassus*** has national legal restrictions.
- 1 species ***Pterorana khare*** is vulnerable

SN	Species	Uses	State where used	CITES	WL(P)A	IUCN
1	*Duttaphrynus melanostictus*	Medicine	Assam			LC
2	*Euphlyctis cf. cyanophlyctis*	Food	Assam, Nagaland			LC
3	*Euphlyctis ghoshi**	Food	Nagaland			DD
4	*Euphlyctis cf. hexadactylus**	Food	Assam	Appendix II	Sch IV	LC
5	*Minervarya teraiensis*	Food	Nagaland			LC
6	*Hoplobatrachus crassus*	Food	Nagaland		Sch IV	LC
7	*Hoplobatrachus tigerinus*	Food/Medicine	NERAQ states/Assam	Appendix II	Sch IV	LC
8	*Hoplobatrachus litoralis*	Food	Nagaland			NE
10	*Xenophrys major*	Food	Nagaland			LC
11	*Xenophrys flavipunctata**	Food	Nagaland			NE
12	*Odorrana mawphlangensis*	Food	Meghalaya			DD
13	*Amolops spp.*	Food	NERAQ states			–
14	*Pterorana khare*	Food	Nagaland			VU
15	*Polypedates teraiensis*	Food	Nagaland			NE
16	*Rhacophorus bipunctatus*	Food	Nagaland, Meghalaya			LC
17	*Zhangixalus smaragdinus*	Food	Nagaland			LC

Key Threats and Opportunities

Threats

- **Uncontrolled & unsustainable extraction**
- **Issues of legal complication,**
- **Consumption of RETE species** leading to extinction

Opportunities

- Scope for developing a viable and sustainable frog culture
- Fulfills couple of NBTs (1, 7, 8, 11) under CBD
- Fulfills couple of ABTs (1, 4, 6, 13, 14, 18) under CBD
- Realization of SDGs (1, 2, 3) to contribute to human well-being & address societal challenges

Key Recommendations

- Extensive survey of literature to collect all possible data on edible frogs,
- Conduct ethnozoological studies in the gap areas: states, communities
- Extensive survey of markets especially in the hill areas
- Generate a robust database on frog consumption in the region
- Work out status of legal protection/conservation/endemicity/population
- Select potential species for frog culture
- Find out nutritional value and medicinal properties
- Detail study of habitats & breeding/feeding behaviour
- In-situ farming in the line of CR, CCA, & similar others
- R&D for developing induced breeding protocols for ex-situ farming
- Licensing of farmers and products.

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Presenter 33: Rajdeep Das

Study Title: Osteological and Molecular Approaches as a Taxonomic Tool in Tracing Phylogenetic Diversity of Fishes and its Role in Conservation

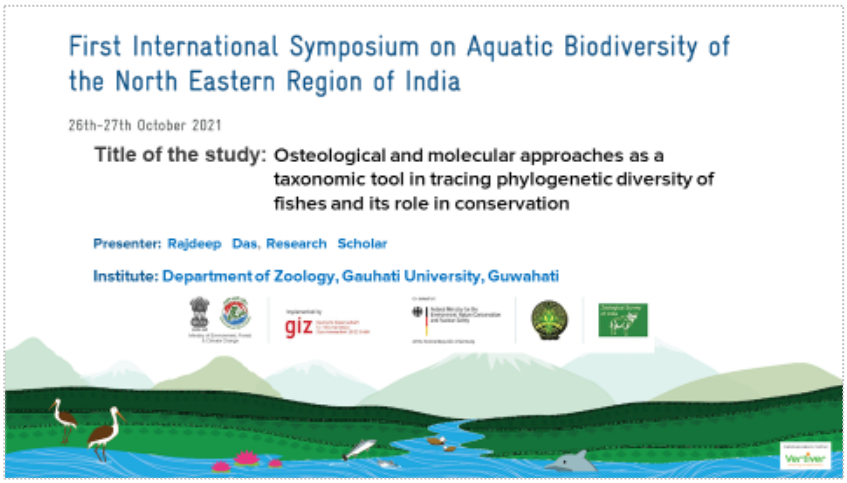
Authors: Rajdeep Das, Hrishikesh Choudhury and Dandadhar Sarma

Abstract:

The present study infers the phylogenetic relationship based on osteological modifications and molecular variations of three *Pethia* species found in Brahmaputra drainages of Assam namely, *Pethia phutunio, Pethia conchonius* and *Pethia guganio.* The whole endoskeleton of the above species was cleared and stained to observe the modifications of bones of skull, dorsal fin, supraneural series, infra orbital series and caudal skeleton. Molecular phylogenetic analyses were conducted based on the cytochrome c oxidase 1 (Cox1) and cytochrome b (Cyt b) sequences of the above species. The phylogeny was traced on construction of a phylogenetic tree based on the above two approaches. The study clearly indicated the modifications of bone structure, shape and counts between the species and also the remarkable trace of evolution based on the genetic distances between the species. The above data revealed that the current two approaches are a necessary and remarkable tool in conserving the genetic diversity of fishes.

Keywords: Osteology, cytochrome c oxidase 1, cytochrome b, evolution, conservation

Presentation



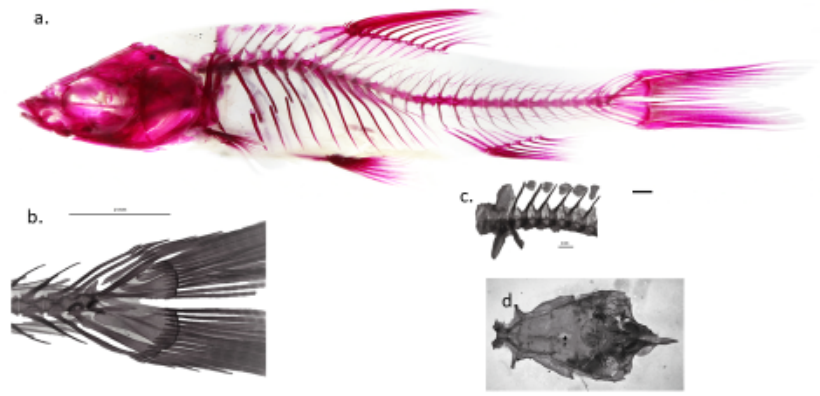
Research Overview

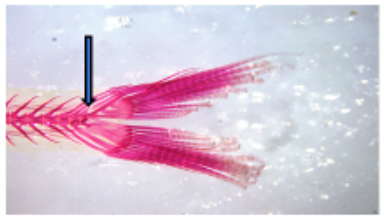
- The Teleost endoskeleton is a complex mixture of elements that emerged in evolution as a result of the interaction of the fish with their environment. Fish osteology is a necessity for complete understanding of the main functions of the fish viz., locomotion, feeding, breathing, predation and even reproduction. It also gives clues as to the species, sex, age, and geographical origin of the specimens.
- DNA based identification system, found on the mitochondrial gene cytochrome c oxidase subunit 1 (COI), can aid the resolution of the species diversity. However, COI barcoding has been criticised for its inability to accurately delimit species, particularly in young evolutionary lineage. Another mitochondrial gene, cytochrome b (cyt b) found in all eukaryotes and also in many prokaryotes, point towards its primeval origin. In fishes, the cyt b gene has been used to decode many phylogenetic ambiguities , due to its ability to more accurately resolve recent young diverged population and sympatric species and is one of the most reliable molecular markers.
- The combination of both molecular and classical (osteology) taxonomy provides in depth knowledge on phylogenetic relationship between the species.
- Biodiversity conservation is the prime need of the hour, as it is being lost more rapidly than any time in the past, million years. It should primarily aim at sustainable developmEnt for rational utilization of bio- resources. Conservation measures of a target species is conceivable only, if it is correctly identified. Therefore, proper species identification and knowing their inter/ intra relationships is most primary to any type of biological study, keeping in view the present study was carried out.

Study Methodology

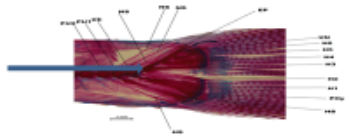
- Fishes were collected from fishing sites, fish landing centres, and fish markets. Expert fishermen were employed to catch of fishes with the help of locally fabricated fishing gears like caste nets, gill nets, etc.
- For osteological studies, specimens were stained and cleared by using the method of Taylor and Van Dyke (1985) with modifications. The specimens were kept under treatment of equal volumes of trypsin and potassium hydroxide solution for easy clearing of tissues. Stained skeleton and bones were photographed from which drawings were prepared using tracing papers and some directly studied from photographs. Details of the individual bones were studied under Leica Stereozoom microscope and photos were captured using a camera fitted to the above microscope.
- For molecular studies, DNA were extracted, followed by PCR amplification, followed by Sequence editing and then the genetic distance and phylogenetic analysis.
- The nucleotide sequences of the genus were aligned with available sequences of the genus Pethia obtained from GenBank using the default parameters in Clustal W built into MEGA 7 software. To analyse the evolutionary isolation and level of divergence between species, Kimura 2- parameter model (K2P) distance was computed by pairwise comparisons of nucleotide sequences across all individuals under gamma distribution and homogenous pattern among lineage incorporating both transition and transversion nucleotide substitution. Phylogenetic analyses were executed on the individual gene data set by Maximum Likelihood methods using the confidence limit of 1000 bootstrap replications.

Results





Pethia guganio



Pethia conchonius

Caudal skeleton

Differences in last neural spine structure

Pethia phutunio

Summary

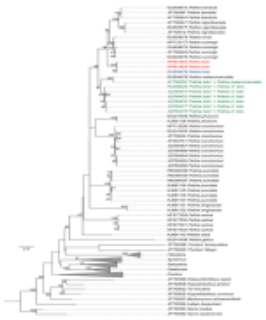
•The study of fish endoskeleton plays a vital role in understanding evolutionary development in various groups of fishes.

•Phylogenetics is important because it enriches our understanding of how genes, genomes, species (and molecular sequences more generally) evolve. Through phylogenetics, we learn not only how the sequences came to be the way they are today, but also general principles that enable us to predict how they will change in the future. This is not only of fundamental importance but also extremely useful for numerous applications.

•Phylogenetics can help to inform conservation policy when conservation biologists have to make tough decisions about which species they try to prevent from becoming extinct.

•Phylogenetics based on sequence data provides us with more accurate descriptions of patterns of relatedness than was available before the advent of molecular sequencing. Phylogenetics now informs the Linnaean classification of new species.

•With the advent of newer, faster sequencing technologies, it is now possible to take a sequencing machine out to the field and sequence species of interest *in situ*. Phylogenetics is needed to add biological meaning to the data.



Maximum likelihood tree for Pathia species based on cytochrome b sequences. Source: Katwate et. al, Zootaxa

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Presenter 34: Priyam Nath

Study Title: Studies on Comparative Growth of Tubifex Worms Grown in Different Culture Media and Observing the Change in Growth of Anabas Testudineus Fed on Tubifex

Authors: Priyam Nath and Dr. Dandadhar Sarma

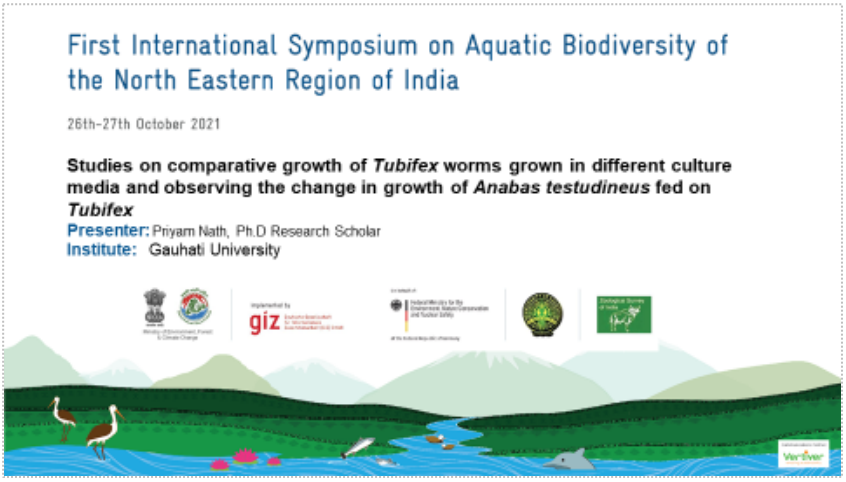
Abstract:

Tubifex sp. is one of the best and cheapest live feed for fish, prawns and frogs. It has been an important live feed in rearing the larvae of hatchery produced catfishes, prawns, ornamental fishes etc. They are considered as one of the nutritious foods for fish as they contain high food value. The purpose of this study was to find a suitable nutrient media containing simple culture ingredients in which maximum growth of *Tubifex* worms were observed. These worms grown in different culture mediums were further tested on the larval stage of *Anabas testudineus* so as to observe the change in growth and colour of the fish. Results of this study suggested that biomass of *Tubifex* was maximum when grown on culture media having 4% Fish Meal, 4% Soymeal, 40% Mud, 40% Cow dung, 8% Rice bran, and 4% Mustard oil cake (Culture medium III).

ANOVA test results indicated that there was significant difference in mean total calculated productions among the three different media. Statistical analysis showed that the standing biomass of *Tubifex* worms was significantly higher ($P<0.05$) in Culture medium-III than those of I and II throughout the experiment. Feeding the *Tubifex* worms grown in Culture medium III on larval offspring of *Anabas* showed contrasting results in colour too.

Keywords: Tubifex worms, Fishmeal, Soymeal, Rice bran, Mustard oil cake, Biochemical analysis

Presentation



Research Overview

Study Objective:

- To culture *Tubifex* worms in different culture media in raceway using readily available culture ingredients.
- To study the comparative growth of *Tubifex* worms in different culture media.
- To find a beneficial suitable nutrient media for the culture of *Tubifex* worms.
- To find out the cause of trend of increase or decrease during each culture.

Study Timeline: February to June 2019

Geographic location: Aquaculture and Biodiversity Centre, Zoology Department, Gauhati University

Research Overview

Materials and methods:

Culture media

Fish meal.

Soybean meal.

Mustard oil cake.

Rice bran

Culture medium I – Fishmeal+ rice bran + mustard oil cake + mud
Culture medium II– Soybean meal+ rice bran + mustard oil cake + mud
Culture medium III– Fishmeal + Soybean Meal + rice bran + mustard oil cake + mud + cow dung
Control – in mud

Research Overview

Materials and methods:

Composition of media ingredients:

Media ingredients	Culture medium I	Culture medium II	Culture medium III
Mustard oil cake	0.5 kg(7%)	0.5 kg(7%)	0.5 kg(7%)
Rice bran	1 kg(14%)	1 kg(14%)	1 kg(14%)
Cow dung	-	-	5 kg(40%)
Mud	5 kg(72%)	5 kg(72%)	5 kg(40%)
Fish meal	0.5 kg(7%)	-	0.5 kg(4%)
Soybean meal	-	0.5 kg(7%)	0.5 kg(4%)

Research Overview

Materials and methods:

- Culture system- small cement raceway culture system (100×30×10cm) and provided with a roof above so as to protect them from sunlight and rain
- Continuous subsurface flowing water
- Previously cultured worms: Parent *Tubifex* worms were collected from a farm
- Spreading of worms: Worms were spread homogeneously in each raceway at a density of 250 mg/cm^2 (i.e. 25 g/raceway)
- Culture ingredients: Culture media were spread evenly throughout each raceway at a density of 500 mg/cm^2
- Estimation of water quality- temperature, pH, dissolved oxygen
- Sampling: Samples collected on 30, 45, 60, 70, and 90th day of inoculation of worms.

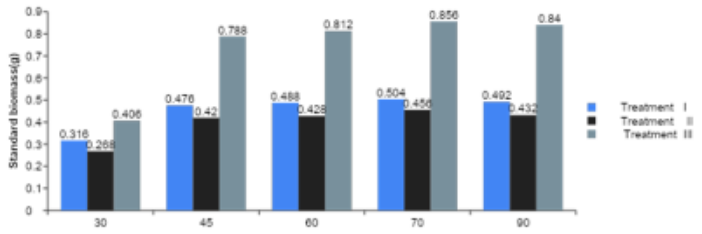
Observations

Standing biomass (mg/cm^2) of Tubificid worms in three different culture medium during 90 days experimental period (mean±SD)

CULTURE MEDIUM	EXPERIMENTAL PERIODS IN DAYS				
	30	45	60	70	90
I	316±0.65	476±0.83	488±1.67	504±1.26	492±0.86
II	268±1.30	420±1.67	428±0.66	456±0.98	432±0.98
III	406.8±1.63	788±0.93	812±0.59	856±1.48	840±1.79

Observations

Trend in successive development



Observations

Results of One way ANOVA:

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Row 1	5	2278	455.2	6155.2		
Row 2	5	2004	400.8	5691.2		
Row 3	5	3702.8	740.56	3549x.17		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	333044.2	2	166522.1	10.55327	0.002258	3.885294
Within Groups	189350.3	12	15779.19			
Total	522394.5	14				

Observations

Cost benefit analysis:

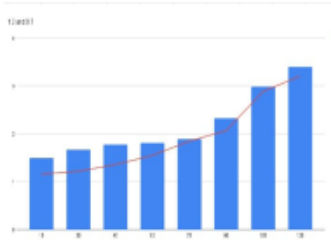
INGREDIENTS	LEVEL OF MEDIA INGREDIENTS IN %		
	Culture medium I	Culture mediumII	Culture mediumIII
Fish meal(kg)	0.5 kg	-	0.5 kg
Soya meal (kg)	-	0.5 kg	0.5 kg
Rice bran	1 kg	1 kg	1 kg
Mustard oil cake	0.5 kg	0.5 kg	0.5 kg
Cowdung	-	-	5 kg
Total price of medium	65 Rs	60 Rs	105 Rs
Total yield	1.52 kg	1.37 kg	2.57 kg
Cost of producing per kg worms (Rs)	42.76 Rs	43.79 Rs	40.85 Rs
Cost of producing per kg worms ($)	0.58 $	0.59 $	0.55 $

Colour change

	Initial	45 day	120 day
Fish fed on *Tubifex* (Culture medium I)			
Fish fed on *Tubifex* (Culture medium III)			

Changes in growth of fish

time interval (in days)	wt. of fish fed on *Tubifex* of Culture medium II (in gm)	wt. of fish fed on Tubifex of Culture medium III (in gm)
Initial	0.7	1.2
15 days	1.16	1.5
30 days	1.22	1.67
45 days	1.36	1.78
60 days	1.55	1.81
75 days	1.85	1.89
90 days	2.07	2.33
105 days	2.89	2.99
120 days	3.21	3.40



Summary

- There is no significant difference between the mean of the standing biomass of Culture medium I and Culture medium II
- Standing biomass of Culture medium I is slightly higher than that of Treatment II due to the presence of fishmeal as a nutrient media
- Standing biomass of Culture medium III is the highest of all due to the presence of all required medium
- Cost of producing 1 kg of worms in Culture medium III is the lowest ; this treatment is efficient if one need to grow large production of worms; cost efficient
- *Anabas testudineus* fed on *Tubifex* of Culture medium III shows a slight development in growth in comparison to the other two media; colour change is prominent with juveniles developing a brightish yellow colour

Thank you!

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Presenter 35: Shantabala Gurumayum and Ilona Kharkongar

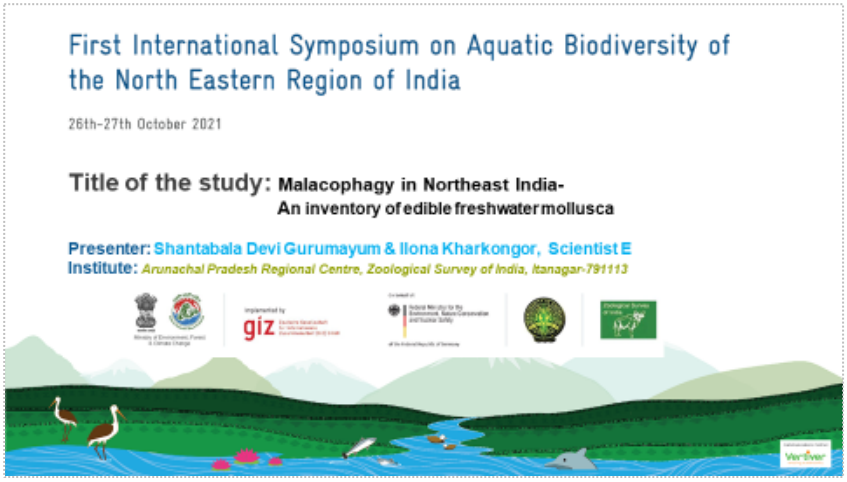
Study Title: Malacophagy in North-East India-An Inventory of the Edible Freshwater Mollusca

Authors: Sd Gurumayum and Ilona Kharkongar

Abstract:

The term “Malacophagy” is, perhaps, used for the first time in connection with consumption of mollusca as food by humans. In the present study, the term is used after comprehending the extensive use of both terrestrial and freshwater mollusca as food by the people inhabiting the north - eastern region of India and South East Asia. It is a known fact that many species of mollusca are relished as food by people in different parts of the world. But there is scant information on the taxonomy of the species used as food in India, particularly in the context of northeast India. Both terrestrial and freshwater species of mollusca are consumed as food by the indigenous people of this Region. In northeast India, people prefer the freshwater mollusca species more than the terrestrial ones, even though the diversity of former are exceedingly lesser than the latter. As such, a variety of freshwater snails are consumed by the people living here. During the present investigation, it was found that a total of 49 species under 2 class, 3 orders, 5 families and 16 genera represent the edible mollusca of the north - eastern region of India. Of this 49 species, 21 species come under Gastropoda, whereas the remaining 28 species are edible mussels of the region. Regular freshwater mollusca markets can be found in Assam, Manipur, Meghalaya (Garo Hills), Mizoram and Nagaland where these freshwater mollusca are a delicacy that are consumed with relish by the local populace. Almost all the large-sized freshwater snails are consumed by the people of these States. *Paludomus* sps., although comparatively smaller in size, are savor with equal relish by the people of Meghalaya and Manipur. Among the Meitei community of Manipur, a day before the Hindu New year, there is customary practice of eating *Brotia costula.* In Assam, freshwater gastropods and mussels are frequently collected and sold locally, as these are savoured by Bodo and Kachari people of the State. In public eateries in Nagaland, the empty leftover shells are even cooked twice and sold at a cheaper rate.

Presentation



Research Overview

- Study Objective: To inventorize the edible freshwater mollusca species present in North eastern Region of India
- Study Timeline: ongoing
- Geographic scope: North East India
- Species covered (if any): 49 species of Freshwater Mollusca

21 species – Gastropoda
28 species are edible mussels

Study Methodology:

- Mollusca species are collected from all the types of freshwater bodies present in the region viz., lakes, rivers, reservoirs, swamps, paddy fields and information also sourced from published literature.
- Market survey and interaction with local communities
- Identification of mollusca were done with the help of the relevant literatures and naming and classification follows that of https://www.molluscabase.org and http://www.marinespecies.org/

Mollusca (11 classes)

Gastropoda **Bivalvia** **Cephalopoda**

Malacophagy

Malaco **(soft)** **Phagy** **(eating" or "devouring)**

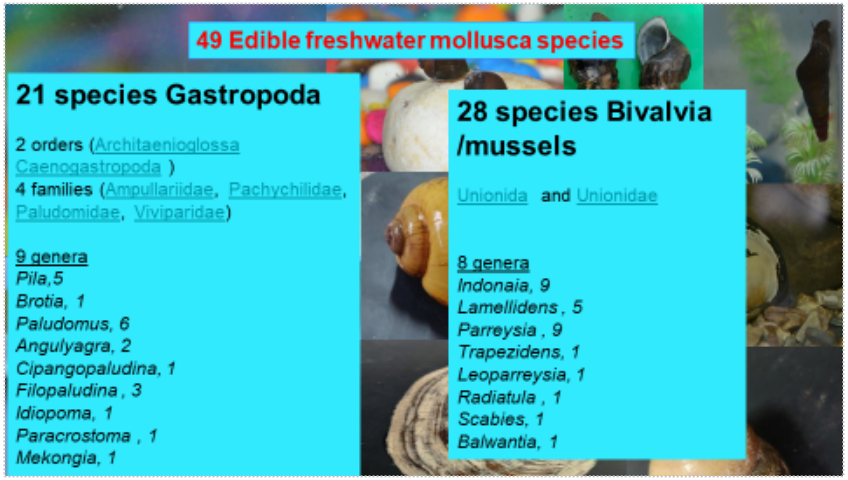
Key Threats and Opportunities

Key Threats

- Overexploitation of freshwater edible mollusca species in some areas of the region
- Habitat destruction due to pollution, sand mining, changing land use patterns leading to siltation of water bodies etc.

Opportunities

- Can be a alternate source of protein specially for lower income groups
- Scope for studying zoonotic diseases
- Alternate source of income through sustainable harvesting from nature
- Bio indicators of ecosystem health



Key Observations/Findings

Edible freshwater molluscs are known to various local names

Assam	Hamuk
Manipuri	Tharoi & Kong-greng
Meghalaya	Mattah
Nagaland	Hamuk

A total of **49** species under
2 class, 3 orders, 5 families and 16 genera
represent the edible mollusca of the north - eastern region

- 21 species comes under Gastropoda,
- 28 species are edible mussels of the region.

Key Recommendations

- ✓ Edible mollusca species available in the region can be good candidates for Aquaculture
- ✓ Sustainable utilization of freshwater edible mollusca
- ✓ Habitat protection and conservation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Presenter 36: Yengkhom Chinglemba

Study Title: Ornamental Fish Resources, Threats and Conservation Status of the Chindwin and Barak River Basins of Manipur

Authors: Yengkhom Chinglemba and Yumnam Rameshori

Abstract:

Manipur, which lies in the Northeastern corner of India, coming under the Eastern Himalaya Freshwater Biodiversity hotspot has rich ichthyofaunal diversity. The state is drained by two major drainages viz., the Chindwin and the Barak River basins. The torrential hill streams of Manipur form an ideal habitat for ornamental fishes. Ornamental fishes are small size fishes with beautiful body colour pattern, behaviour and compatibility for domestication. These fishes are in high demand worldwide. About 85% of all exports of ornamental fishes from India are from Northeast India including Manipur. In the present study, diversity, possible threats and conservation status of ornamental fishes of the two River basins of Manipur have been studied. A preliminary survey shows the occurrence of 221 species belonging to 62 genera and 25 families. Fish species of the genera *Balitora*, *Garra*, *Glyptothorax*, *Mustura*, *Paracanthocobitis*, *Pseudecheneis*, *Psilorhynchus*, *Rhyacoschistura*, *Schistura*, *Schizothorax* and *Sisor* shows hill stream structural modifications viz., oromandibular structures, thoracic adhesive apparatus, proboscis, paired fins, labial folds and caudal peduncle for adaptation to hill stream mode of life.

Most of these fishes are endemic to the two River basins, yet threatened due to numerous natural and anthropogenic activities as per the IUCN Red list data. 28 ornamental fish species are vulnerable while nine species viz., *Badis tuivaiei, Pethia manipurensis*, *Psilorhynchus microphthalmus*, *Pterocryptis barakensis*, *Schistura kangjupkhulensis*, *Schistura minuta*, *Schistura reticulata*, *Schistura tigrina* and *Tor putitora* are endangered. Further, many interior parts of Manipur remain inaccessible due to poor connectivity of roads. Thus, more detailed exploration needs to be undertaken in the future for proper documentation of ornamental fish resources of the two River basins of Manipur. There is scope for discovering many new species. The current study also suggests measures to conserve the rich ichthyofaunal diversity of Manipur.

Presentation

Research Overview

- Study Objective:
  - ➢ To carry out detailed inventory of Ornamental fish resources of the Chindwin and Barak River basins of Manipur
  - ➢ To assess the taxonomic status of Ornamental fishes of the two River basins of Manipur
  - ➢ To suggest measures to conserve Ornamental fish resources of Manipur
- Study Timeline: From May 2019 to September 2021

Study Methodology

Collection
- Using electro-fishing equipments, Gears, Netting
- Market sampling

Preservation
- 10% formalin following Walsh & Meador (1998)
- Tissue samples (muscle tissue, fin clips, whole specimens) preserved in 95% ethanol

Identification
- Counts and measurements followed Hubbs & Lagler (1947) and Kottelat (1990, 2001)

PCR Amplification
- Using Universal primers F1 & R1

Genomic DNA Isolation
- Followed Sambrook et al., 1989 with slight modification

Sequence analysis
- Using Gene Runner V 3.0 software, Clustal W & MEGA V.7.0 software

- Geographic scope:
  - ➢ Chindwin and Barak River basins in Manipur, Northeast India

- Species covered: More than 200 species

- Study methodology: Integrative taxonomy

Key Threats

- ➢ Destruction of habitat
- ➢ Illegal Ornamental fish trade
- ➢ Construction of dams and barrages
- ➢ Mining of River bed
- ➢ Water pollution
- ➢ Overexploitation
- ➢ Invasion by exotic species
- ➢ Change in climate pattern globally

a) Thoubal Multipurpose project

b) Use of local dynamo for catching fish

Opportunities

- ➢ Researchers have the opportunity to study the vast diversity of Ornamental fishes of Manipur
- ➢ Farmers can improved their economic status by adopting captive breeding and culture techniques
- ➢ Provide opportunity for entrepreneurship development in Ornamental fish industry
- ➢ Can contribute to the economy of the state
- ➢ Manipur can be a hub of aquarium industry

Key Observations/Findings

- Diversity of Ornamental fishes very high in Manipur

221 species → 62 genera → 25 families

- Maximum diversity observed in family Cyprinidae
- DNA barcodes were generated for 35 species
- Many species are threatened and at risk of extinction
- 9 endangered, 28 vulnerable ornamental fishes
- In the last 4 decades, Vishwanath and coworkers (including our team) have described more than 50 species from the two River basins in Manipur
- Many new taxa awaits discovery
- However, many interiors parts of Manipur remain inaccessible
- Reason: difficult hill terrain, lack of funding for research

Sl No.	Endangered Species	Endemic
1	*Pethia manipurensis*	Chindwin
2	*Psilorhynchus microphthalmus*	Chindwin
3	*Schistura kangjukhulensis*	Chindwin
4	*Schistura reticulata*	Chindwin
5	*Schistura minuta*	Barak
6	*Schistura tigrina*	Barak
7	*Badis tuivawei*	Barak
8	*Pterocryptis barakensis*	Barak
9	*Tor putitora*	

Key Recommendations

- More exploration needed to study the actual diversity of Ornamental fish resources of Manipur
- Awareness programmes especially to people residing near the river bank for sustainable use of fishery resources
- Environment Impact Assessment (EIA) before constructing dams, hydroelectric projects and barrages
- Assess the taxonomic and threat status for conservation
- Prevention of used of piscicides in rivers
- Introduced legislation to prevent illegal ornamental fish trade
- Regulating introduction of invasive species
- Adoption of selective captive breeding and culture techniques

Awareness programme at the bank of Sungvi River, Ukhrul, Manipur

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Presenter 37: Supongnukshi, IFS

Study Title: Doyang Reservoir Wetland (National Plan for Conservation of Aquatic Ecosystems)

Author: Mr. Supongnukshi, IFS

Abstract:

The Doyang Reservoir Wetland project under the National Plan for Conservation of Aquatic Ecosystems (NPCA) is the first of its kind for the state of Nagaland. Altogether, twenty (20) villages around Doyang Reservoir Wetland were taken up for Implementation of Conservation and Management of the wetland.

Works under the project included various activities and interventions that were targeted towards improving the overall health of Doyang Reservoir Wetland, while also addressing the needs and requirements of the local community in terms of livelihood generation.

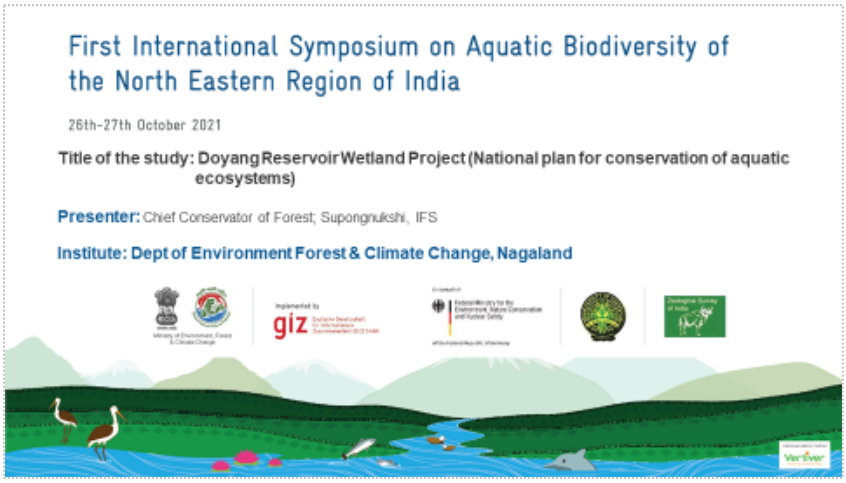
The various activities undertaken included livelihood options such as Assisted Natural Regeneration, Artificial Regeneration, Grassland and Fodder Plantation and Horticulture crop distribution. Pig Breeding Centers as well as Nurseries were also set up. Poultry chicks were also distributed to all the villages undertaken. Infrastructure works included construction of Brushwood Check Dams, Gully Plugs, Watch Towers, Water Hole cum Water Harvesting Structures, Food Processing Unit and Trenches. Awareness Program and Training Programs were also conducted.

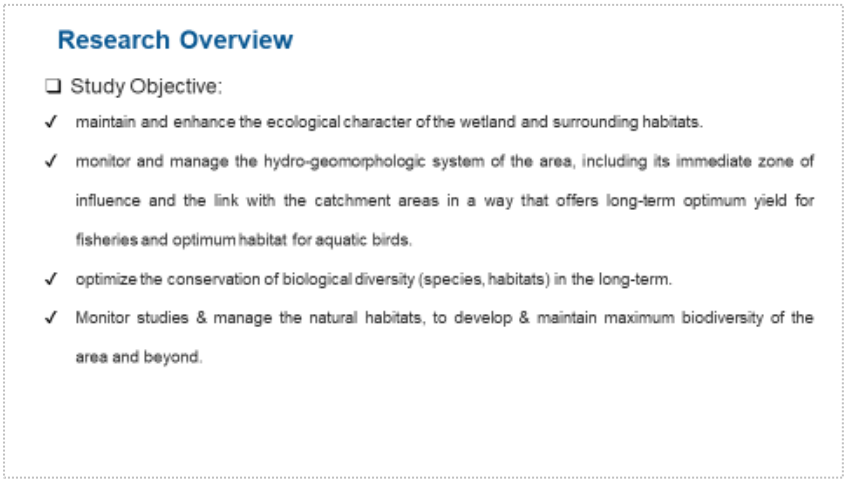
PROJECT OVERVIEW:

Management Objectives	1. To maintain and enhance, where appropriate, the ecological character of the wetland and surrounding habitats. 2. To monitor and manage the hydro-geomorphologic system of the area, including its immediate zone of influence and the link with the catchment areas and the river/streams that supplies water to it, in a way that offers long-term optimum yield for fisheries and optimum habitat for aquatic birds. 3. To optimize the conservation of biological diversity (species, habitats) in the long-term. 4. To investigate, monitor and manage the natural habitats in order to maintain and develop maximum biodiversity of the area and beyond. 5. To develop tourist-related activities and related infrastructure in a way compatible with the wetland and biodiversity conservation requirements and to provide the local villages in the immediate zone of influence with long-term sustainable forms of activities and income to assure their survival without harming the ecosystem. 6. To provide support to human activities and sustainable use of natural resources where compatible with biodiversity conservation. 7. To increase public awareness of the values of the Wetland.

Proposed Outcomes of the Project	1. Successful conservation of the Wetland and its biodiversity. 2. Reduction in siltation though large-scale plantation and soil and moisture conservation works viz-a-viz check dams, gully plugs, trenches etc. and at the same time, leading to enhancement of water holding capacity in the catchment area. 3. Increased public awareness of the values of the Wetland and ushering the people towards conservation and better management of the wetland area. 4. Livelihood improvement of the people through alternative livelihood interventions leading to wise-use of the wetland areas. 5. A balance where the sanctity of the wetland is maintained and the livelihood of the stakeholders are met.

Presentation





Research Overview Contd…

❑ Study Objective:

✓ develop compatible tourist-related activities & infrastructures in relation to wetland and biodiversity conservation requirements; provide the locals in the immediate zone of influence with long-term sustainable forms of activities and income to assure their survival without harming the ecosystem.

✓ support sustainable use of natural resources where compatible with biodiversity conservation.

✓ increase public awareness of the values of the Wetland.

❑ Study Timeline : From 2019 to 2025

❑ Geographic scope : 20 villages surrounding the Doyang Reservoir

Key Threats and Opportunities

Proposed Outcomes:

✓ Successful conservation of the Wetland and its biodiversity.

✓ Reduction in siltation though large-scale plantation and soil and moisture conservation works viz-a-viz check-dams, gully plugs, trenches etc. and at the same time, leading to enhancement of water holding capacity in the catchment area.

✓ Increased public awareness of the values of the Wetland and ushering the people towards conservation and better management of the wetland area.

✓ Livelihood improvement of the people through alternative livelihood interventions leading to wise-use of the wetland areas.

✓ A balance where the sanctity of the wetland is maintained, and the livelihood of the stakeholders are met.

Artificial Regeneration

Assisted Natural Regeneration

Grassland & Fodder plantation

Habitat Improvement

Pig breeding centre

Poultry chicks distribution

Horticulture crop distribution

Water Hole cum Water Harvesting Structure

Gully plugs

WATCH TOWERS

Presenter 38: Yumnam Bedajit Singh

Study Title: Reproductive Biology and Optimisation of Hormone Dosage for Induced Breeding of Bangana Devdevi (Hora, 1936) for Ex-Situ Conservation and Mass Seed Production

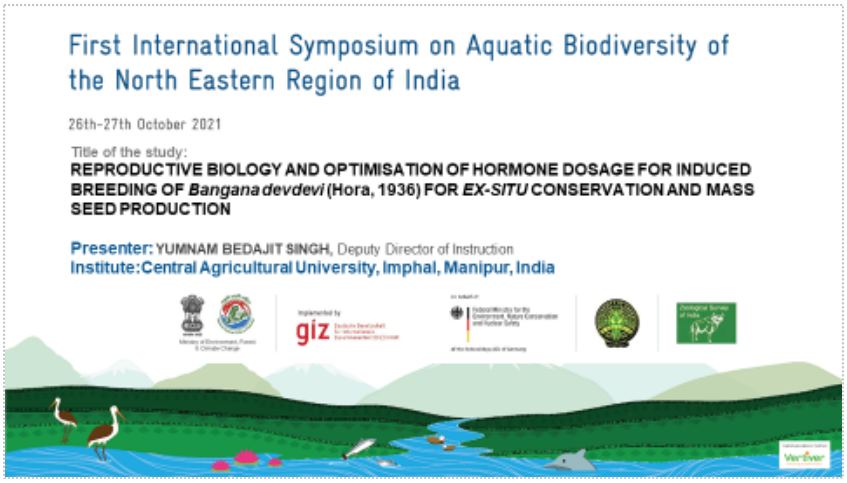
Authors: Yumnam Bedajit, Surajkumar Irungbam, Rameswori Yumnam, Wanglar Chimwar and Sanjenbam Bidyasagar

Abstract:

Bangana devdevi (Hora) is an indigenous medium-sized and bentho-pelagic minor carp, widely distributed in the Chindwin headwaters of Manipur, Northeast India. A study on reproductive biology of *B. devdevi* collected from different rivers of Manipur was carried out. The minimum size at which fish attains maturity was determined based on the examination of the maturity stages. Samples were collected monthly for detailed investigation on reproductive biology for two years and the data were pooled to one year. For studying maturity and spawning season, maturity stages were classified based on colour, shape, size of ovary and the space it occupied in the body cavity. The maximum value of GSI (1.17) was observed during August for males whereas for females the highest was observed during the month of July (2.24). Induced breeding of *B. devdevi* was done using Gonopro-FH in different doses @ 0.4mL, 0.5mL & 0.6mLKg^{-1} body weight in a set of three experimental groups T1, T2 and T3 respectively. All the males were given half the doses of females. Spawning commenced 6–10 hrs after injection and was completed within 4–5 hours. Fertilized eggs were hatched out after 11–16 hours of fertilization at temperatures of 26.4–27.5°C. Statistical analysis was carried out to determine the relation between the hormone dosage with egg output, fertilisation rate and hatching rate. The highest number of fertilisation (94.25%) and hatching rate (89.03%) were found in fish with Gonopro-FH @ 0.5ml/kg body weight female and significantly higher ($P<0.05$) than T1 and T3. The present study may be beneficial for species conservation and management strategies in rivers and tributaries as well as mass seed production of *B.devdevi.*

Keywords: GSI, Gonopro-FH, induced reproduction, sexual maturity, spawning

Presentation



Research Overview

- **Study Objective:** To study the reproductive biology of *Bangana devdevi* and to optimize the effective dosage of a synthetic hormone, Gonopro-FH for induced breeding in relation to spawning, fertilization and hatchability of the fish in captivity.
- **Study Timeline:** From **1st February, 2018** to **31st January, 2020**
- **Geographic scope:** Chindwin basin in Manipur (Thoubal river, Iril river and Imphal river)
- **Species covered (if any):** *Bangana devdevi*

Research Overview Contd…

Study Methodology:
- Samples were collected for two years and the data were pooled to one year.
- maturity stages were classified based on colour, shape, size of ovary and the space it occupied in the body cavity.

Induced breeding
- Gonopro-FH in different doses.
- Five different experimental group viz. T1, T2, T3 and Control
- Four different doses of hormone Gonopro-FH, *i.e.*, 0.4mL, 0.5mL, 0.6mL & 0mLKg^{-1} body weight respectively
- Males were given half the doses of females
- Another group was injected with CPE (Carp Pituitary Extract) with initial dose of 2mgKg^{-1} body weight of fish and after 6hrs final dose was injected with 4mgKg^{-1} body weight of fish as a positive control.
- The males were given a single dose of 4mgKg^{-1} body weight at the time of final injection.
- 12 fish (4 females and 8 males) were put in each experimental group in the ratio of 1:2 (female: male) and each group have 4 replicates.

Bangana devdevi

Injection of hormone

STUDY METHODOLOGY

Details:

Biology
- **220** no. of fish collected monthly for two years
- **Fecundity** and **ova diameter** were studied
- Ovaries were preserved in **5% formaldehyde** and for separation of ova, Gilson's fluid was used.

Formula used
- **GSI** = weight of gonad × 100/total body weight
- **Fecundity** = (No. of ova in the sub sample × Total ovary weight / weight of sample)

Experiment designs for optimization of hormonal doses
- **Gonopro-FH** in different doses.
- Five different experimental group viz. **T1, T2, T3** and **Control**
- Four different doses of hormone Gonopro-FH, i.e., **0.4mL, 0.5mL, 0.6mL & 0mLKg^{-1}** body weight respectively
- **males** were given **half** the doses of females
- Another group was injected with **CPE (Carp Pituitary Extract)** with **initial dose** of **2mgKg^{-1}** body weight of fish and after **6hrs final dose** was injected with **4mgKg^{-1}** body weight of fish as a positive control.
- The **males** were given a **single dose** of 4mgKg^{-1} body weight at the time of final injection.
- **12 fish** (4 females and 8 males) were put in each experimental group in the ratio of **1:2 (female: male)** and each group have **4 replicates**.

Calculation
- **Fertilization rate (%)** = [(Number of fertilized eggs)/(total number of eggs counted)]× 100
- **Hatching rate (%)** = [(Number of eggs hatched)/(total number of eggs in the batch]× 100

Statistical Analysis
- Statistical analysis was done by using **SPSS** version 16.0 for Windows. **One-Way ANOVA** was used to analyze the variance to determine the relation between the hormone dosage with different parameters like fertilization rate, egg output and hatching rate.

Key Threats and Opportunities

Threats:
- The species is widely distributed in the Chindwin river basin but due to **anthropogenic factors**, **pollution** and **overexploitation pressure** into the habitat area, the fish become **scarce** and chances of **EXTINCTION** is likely to face in near future.

Opportunities:
- **Evaluation** of habitat areas with the **identification** of **breeding ground** is required for **in-situ** and **ex-situ** conservation.
- Development of **in-situ GENE BANK** for future use of the genetic resource.
- Production of **seeds** for ranching into the wild habitats for augmentation of its natural production.
- Standardization of seed production technique and to **transfer the technology** to the farmers for its **mass production** and to recognised it as a **candidate species** for Aquaculture.

Key Observations/Findings

- In *Bangana devdevi*, **GSI** is high during **July-August** and maximum absolute fecundity observed was **26,287** eggs per female.
- The **relative fecundity** was in the range from **170** to **298** ova per gram of female body weight.
- All the mature ovaries gave **bi-modal** distribution showing spawning twice in a year
- The length at which 50% of the fish attain maturity was estimated to be **93mm** for *Bangana devdevi*
- sex ratio (male: female) recorded for *Bangana devdevi* is **1.2.**
- **Optimum dose** of Gonopro FH for successful breeding is **0.5ml/Kg** for **female** and **0.25ml/Kg for male**

Egg collection

Spawn

Fry

Key Recommendations

- The Breeding technique can be rollout to the farmers for **mass scale seed production** of *Bangana devdevi*
- This species could be one of the **candidate fish species for aquaculture**, that the farmer could fetch good market turnover.
- **Minimum legal size** of Bangana devdevi is **93mm**, below which the fish should not be caught from the Thoubal river .
- In the present study, **sex ratio** is found to be **1:2**, so, dominance of female in the catch may represent the breeding period of the fish.
- For the effective conservation of the fish, fishing band should be observe during the month of **JULY** and **AUGUST**
- There is a need of identification and establishment **FRESHWATER FISH SANCTUARY** in each river system for effective conservation of the fisheries resources in Manipur.

Dr. Yumnam Bedajit Singh

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Presenter 39: Anjela Ahmed

Study Title: Eripupa Based Ornamental Fish Food: A New Approach for Enhancing Economic Sustainability

Authors: Anjela Ahmed, B.C. Chutia, Chidananda Nath and F. Yasmin

Abstract:

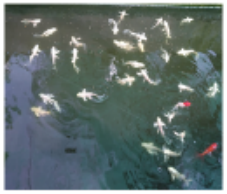
Eri silkworm rearing is an age old leisure time occupation of the people of Assam to obtain eri silk as well as to consume the pupa since it is a sought after delicacy for various indigenous tribes of Assam. Eri-pupae are a good source of essential amino acids and recognized to be rich in proteins and their amino acid composition is comparable to fish meal. The effect of eri-pupa based fish feed as well as commercial feed on the growth of different ornamental fish (Milky carp, Swankin Gold, and Gold fish) were studied and observed that, while feeding the commercial feed, the length, breadth, weight, caudal fin length, dorsal fin length, anal fin length of milky carp is 0.8±0.14 cm, 0.35±0.07 cm, 0.9± 0.14 cm, 1.1±0.14 cm, 0.45± 0.07 cm, 0.55±0.07 respectively. Similarly, the above mentioned parameters of milky carp while feeding with eri pupa based fish feed were observed as 0.9±0.5 cm, 0.55±0.07 cm, 3.15± 0.21 cm, 0.3±0.14 cm, 0.15± 0.07 cm, and 0.2±0.14 respectively and in respect with Swankin gold when feeding with commercial feed the results obtained are 1.25±0.21cm, 0.6±0cm, 1.1± 0cm, 0.85±0.07cm, 0.6± 0cm, 1±0.21 respectively, while the similar parameters of Swankin gold when feeding with eri pupa fish feed were observed as 0.4±0.14 cm, 0.3±0.14cm, 0.9± 0.21 cm, 0.65±0.07cm, 0.45± 0.07 cm, 0.2±0.14 respectively. In case of Gold fish, the above mentioned parameters when feeding with commercial feed are observed as 0.6±0.7 cm, 0.3±0.28 cm, 0.5± 0.42 cm, 0.3±0.28cm, 0.3± 0.21 cm, 0.65±0.21cm respectively, while results obtained from feeding them with eri pupa are 0.75±0.21 cm, 0.25±0.14 cm, 0.6± 0.28 cm, 0.35±0.07cm, 0.25± 0.07 cm, 0.3±0.28 cm respectively. Thus it can be concluded that eri pupa based fish feed can be used as an alternative ornamental fish feed which will be a new approach for enhancing economic sustainability.

Keywords: Eri silkworm, pupa, fish feed, economic sustainability.

Presentation

Research Overview



- Eri-pupae are a good source of essential amino acids and recognized to be rich in proteins and their amino acid composition is comparable to fish meal.
- Pupae also consist of essential fatty 2 acids (EFA), particularly polyunsaturated (PUFA), and have a higher n-3 to n-6 fatty acids ratio than other insects (Lin *et al.*, 1983 and Rao, 1994).
- The carotenoid compositions of silk worm pupa of *Bombyx mori* were reported to contain lutein and neoxanthin (Kotake-Nara et al., 2002).
- Longvah *et al.*, 2011 reported that dry pupae on dry weight basis contains: 54.0 % crude protein, 26.2% of fat, 8% of moisture and 4% of ash, and also it is a good source of essential amino acids most commonly glutamic acid, histidine and alanine. Alpha linoleic acid is the major component of pupal oil.

Research Overview Contd…

- Sasmal *et al.*, (2018), evaluate the impact of silkworm pupae in the practical diets for *Labeo rohita* fingerlings growth and survival and found that silkworm pupae incorporated (43.75%) diet having 40% protein level showed the best performance of the fish in comparison to those with the control diet.

Study Objective: To study the effect of eri-pupa based diet on the growth performance of ornamental fish Milky carp, Shubunkin Gold, and Goldfish).

Methodology:

1)Preparation of eri-pupa based fish feed:

The ingredients and approximate composition of the experimental diet is given in the following table:

Components	Percentage used
1. Eri -pupa	50%
2. Rice polish	12%
3. Wheat bran	12%
4. Starch	12%
5. Soya-oil	3 ml
6. Vitamins & Mineral mixture	3%
7. Algae	3%
8. Table Salt	5%

Study Methodology details contd..

2. Experimental procedure:
Grouping of animals: (in triplicates)

Controlled group fed with commercial feed	Experimental group fed with 50% eri-pupa based feed
1. Milky carp	1. Milky carp
2. Shubunkin goldfish	2. Shubunkin goldfish
3. Gold fish	3. Gold fish

➢ Acclimatized for 10 days.
➢Experimental groups were fed with 50% eri-pupa diet & Morphometric characters were recorded with the help of digital vernier caliper at an interval of 15 days. Growth parameters such as weight gain were calculated as follows:

Weight gain = Final body weight – Initial body weight (gm)





Observations and Findings:

Table: 1 Effect of commercial food on the growth of different ornamental fishes

Name of the Species	Length(cm)	Breadth(cm)	Weight(g)	Caudal Fin Length(cm)	Dorsal Fin Length(cm)	Anal Fin Length (cm)
Milky Carp	0.8± 0.14	0.35±0.07	0.9±0.14	1.1±0.14	0.45±0.07	0.55±0.07
Shubunkin Gold	1.25±0.21	0.6±0	1.1±0	0.85±0.07	0.6±0	1±0.21
Gold Fish	0.6±0.7	0.3±0.28	0.5±0.42	0.3±0.38	0.3±0.21	0.65±0.21

Values are expressed as mean±SD

Table: 2 Effect of eri-pupa based food on the growth of different ornamental fishes

Name of the Species	Length(cm)	Breadth(cm)	Weight(g)	Caudal Fin Length(cm)	Dorsal Fin Length(cm)	Anal Fin Length (cm)
Milky Carp	0.9±0.5	0.55±0.07	3.15±0.21	0.3±0.14	0.15±0.07	0.2±0.14
Shubunkin Gold	0.4±0.14	0.3±0.14	0.9±0.21	0.65±0.07	0.45±0.07	0.2±0.14
Gold Fish	0.75±0.21	0.25±0.07	0.6±0.28	0.35±0.07	0.25±0.07	0.3±0.28

Discussion:

From Table 1 and Table 2, it is noticed that, the growth rate is much better in the fishes fed with Eri pupa based food. The weight gain of the eri-pupa based food fed fishes mainly in Milky carp and Goldfish was comparatively higher than those which are fed with commercial feed. As compared to the other fin types, the enlargement of caudal fin is greater. In case of Goldfish and Shubunkin Gold, the caudal fin has a prominent growth as compared to the total body growth. Moreover during the study it has been observed that the creamy shades of the scales of the milky carp increased. The pigmentations of the Shubunkin Gold became prominent and the gold fishes became brightly orange – golden in colour.

Conclusion: The present study showed that eri-pupa based formulated feed enhances the growth performance in the selected ornamental fish species and also it enhances the pigmentation in same. Thus it can be replaced with the commercial fish meal. Since the people of Assam rears eri-silkworm, the pupa that were obtained from eri-culture can be further used as ornamental fish feed. And integrated eri cum ornamental fish unit will be a new approach for enhancing economic sustainability.

Opportunities & Recommendations

- Setting up of such eri-culture cum ornamental fish rearing unit by the people of Assam will be a new approach for economic sustainability.
- The eri-pupa obtained from the eri-rearing unit can be used as a fish feed.
- Moreover the left over feeds & excreta of eri-silkworm can be used for vermicomposting.
- The earthworms obtained from vermicomposting can be further used as fish feed.
- Hence there will be no requirement of buying commercial feed from the market.




Contact Details

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Presenter 40: Ben Belton

Study Title: Mass Production of Nutrient Rich Small Fish Species Seed is the Key to Unlocking the Potential of Nutrition Sensitive Aquaculture

Authors: Ben Belton, Francois Rajts, Suresh Rajendran, Arun Padiyar, C.V. Mohan and Shakuntala H. Thilsted

Abstract:

Small indigenous species (SIS) of fish are a rich source of key micronutrients, and make a crucial contribution to reaching recommended dietary micronutrient intakes in NE India and Bangladesh, including for women and children. However, availability of and access to these species is declining in many locations. Habitat degradation, overexploitation of inland fisheries, and population growth have made once plentiful and affordable SIS increasingly scarce and expensive, and they are increasingly at risk of becoming threatened or endangered.

WorldFish has promoted nutrition-sensitive carp-SIS polyculture technology in Bangladesh and India over the past decade. To date, these efforts have depended on project staff to collect SIS brood from the wild, oversee their maintenance in brood ponds operated by the project, and distribute seed to project participants for stocking. These efforts have raised intakes of SIS during the duration of active projects, especially for women and children, but the longer-term sustainability of adoption after the withdrawal of project support for seed supply is unknown.

The development of almost all farmed aquatic species that are cultured successfully at scale, such as Indian major carps (IMC), has followed a trajectory from reliance on wild seed, to closure of the life cycle, hatchery-based mass seed production, and the formation of dynamic seed multiplication and distribution networks by private sector hatcheries, nurseries and traders. However, in the case of SIS, broodfish are still sourced from the wild. Promoting SIS culture using wild broods is unlikely to be sustainable or eco friendly in the long run. Development of mass production of SIS might also help to restore self-sustaining populations of threatened species

The average price of formerly abundant and cheap SIS such as mola (*Amblypharyngodon mola*) and puti (*Puntius Sp.*) is now higher than the price of IMC in both Assam and Bangladesh indicating high unmet demand. This suggests high potential for the commercialization of SIS culture in systems including village tanks, rice fields, and homestead ponds, and thus latent demand for mass production of SIS seed. We hypothesize that a lack of breeding techniques for SIS is a key barrier to scaling of nutrition sensitive aquaculture to its full potential.

A new GIZ-funded project, implemented by WorldFish – *Taking nutrition-sensitive carp-SIS polyculture technology to scale* - seeks to address this key bottleneck through applied research on mass production of SIS seed in Assam and Odisha. The project has 4 components: (1) Assess factors influencing the adoption of carp-SIS polyculture technology under previous projects. (2) Develop protocols for the mass production and transport of seed of up to five nutrient-rich SIS; (3) Validate business models for reproduction and distribution of SIS species in partnership with private seed supply enterprises; and (4) Technical training and outreach to ensure integration into public and private investments for further scaling.

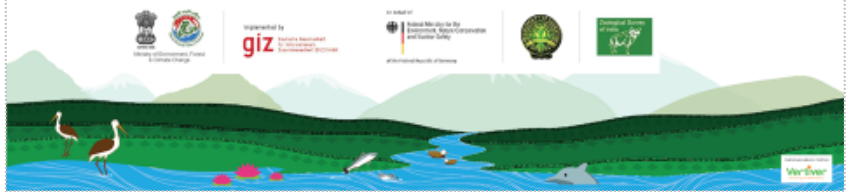
Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Mass production of nutrient rich small fish species seed is the key to unlocking the potential of nutrition sensitive aquaculture

Presenter: Ben Belton
Institute: WorldFish, Independent Consultant



Research Overview

- **Study Objective:** This study introduces the concept of hatchery-based mass production of SIS seed to unlock the potential of nutrition sensitive aquaculture.
- This research will be implemented under the GIZ-funded project, implemented by WorldFish – *Taking nutrition-sensitive carp-SIS polyculture technology to scale* (Scaling SIS).
- **Geographic scope:** Assam and Odisha, India, and Bangladesh.
- **Species covered:** Potential species identified for breeding experiments include *Amblypharyngodon mola; Puntius sophore; Esomus danricus; Osteobrama cotio; Trichogaster fasciata; Anabas testudineus.*

Study Methodology

- Small indigenous species (SIS) of fish are a rich source of key micronutrients such as vitamin A and zinc, but their availability is declining due to habitat degradation and overexploitation.
- SIS are increasingly scarce and expensive, and at risk of becoming endangered.
- WorldFish has successfully promoted nutrition-sensitive carp-SIS polyculture in Bangladesh and India by collecting wild SIS brood for distribution to project participants.
- These efforts have raised SIS consumption during active projects, but lack of dependable seed supply is a bottleneck for sustainability.

Key Observations

- Promoting SIS culture using wild brood is unlikely be sustainable in the long run.
- We hypothesize that a lack of breeding techniques for SIS is a key barrier to scaling of nutrition sensitive aquaculture to its full potential.
- Developing techniques for mass production of SIS might also help to restore self-sustaining populations of threatened species.
- The average price of formerly abundant and cheap SIS such as mola (*Amblypharyngodon mola*) and puti (*Puntius Sp.*) is now higher than the price of Indian Major Carps in both Assam and Bangladesh, indicating high unmet demand.
- These observations suggest high potential for commercialization of SIS culture in systems including village tanks, rice fields, and homestead ponds, and thus latent demand for mass production of SIS seed.

Key Recommendations

The Scaling SIS project has 4 components:

(1) Assess factors influencing the adoption of carp-SIS polyculture technology under by previous projects.

(2) Conduct breeding experiments in close partnership with private and public hatcheries Assam and Odisha and develop standard protocols for mass reproduction and transport of up to five nutrient-rich SIS species.

(3) Validate business models for reproduction and distribution of SIS species in partnership with private seed supply enterprises.

(4) Technical training and outreach to ensure integration into public and private investments for further scaling.

Contact Details

Ben Belton
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Presenter 41: Dandadhar Sarma

Study Title: Integrated Fish cum Duck Farming: A Model for Alternative Livelihood in Agro Climatic Condition of Assam

Author: Dandadhar Sarma

Abstract:

Livestock production and processing generate by-products that may be important inputs for aquaculture. The main linkages between livestock and fish production involve the direct use of livestock wastes, which function as fertilizers to stimulate natural food webs in fish ponds. Integrated fish farming techniques have been successfully applied in other developing countries and impressive yields have been reported. Today, aquaculture production stands at 50:50 to capture fisheries on a global scale due to the technological advancements such as hybridization, genetic engineering, formulated diets and integrated agri-aquaculture. In Asia including certain states of India, aquaculture is integrated with livestock providing millions of livelihood opportunities4. However, Assam is yet to report any significant quantities of integrated aquaculture products despite having huge natural potential. Considering the economic and ecological contributions of integrated livestock-fish farming as a means of enhancing rural livelihoods, the present investigation has been undertaken to evaluate the benefit of duck cum fish farming carried out in Baksa & Dima Hasao district of Assam.

Five derelict society ponds (size-0.20, 0.25, 0.24, 0.35 & 0.28 hectares) of five villages of Tamulpur of Baksa district & Three ponds (size-0.10. 0.12 & 0.18 hectares) of three selected beneficiaries of Gunjung area were selected to carry out Duck cum Fish farming.

To facilitate composite & integrated fish cum duck farming, all the selected ponds were renovated by dewatering, bottom scraping, dyke trimming followed by Manuring with cow dung and lime. Duckery of the size 8ftx 6ft were also constructed in each and every pond. The duckery was constructed in such a way that 70% of the area lying on the pond and 30% on the dyke of the pond. 30000 yearlings (20-30 g) of *Rohu*, *Catla* and *Mrigala* were procured and released in all the selected ponds (numbers of fishes were calculated on the basis of stocking density & size of the ponds) after proper acclimatization. 20 ducks were also released after one month of fish release. It has been observed that duck droppings increased the growth of all the species of Indian major carps. Catla growth was recorded (maximum 2.0 kg) in one year followed by rohu and mrigal was recorded at 1.0 kg each after one year of rearing along with production of average 900 eggs from 20 Ducks of each pond.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Integrated Fish cum Duck farming: a model for alternative livelihood in agro climatic condition of Assam

Presenter: Prof. Dandadhar Sarma
Institute: Department of Zoology, Gauhati University

Research Overview

- **Study Objective:** Integrated fish farming techniques have been successfully applied in other developing countries and impressive yields have been reported. Today, aquaculture production stands at 50:50 to capture fisheries on a global scale due to the technological advancements such as hybridization, genetic engineering, formulated diets and integrated agri-aquaculture. In Asia including certain states of India, aquaculture is integrated with livestock providing millions of livelihood opportunities
- **Study Timeline:** 1.4.2018 to 31.03.2020

  Geographic scope: Considering the economic and ecological contributions of Integrated livestock-fish farming as a means of enhancing rural livelihoods, the present investigation has been undertaken to evaluate benefit of duck cum fish farming carried out in Baksa & Dima Hasao district of Assam.

Brief Baseline Information of selected beneficiaries

1. Beneficiaries of Baksa district (No=150, Village=20)

Fig: 1. Annual Income

Fig: 2. Occupation

Fig: 3. House type

2. Beneficiaries of Dima Hasao district (No=150, Village=10)

Fig: 1. Annual Income

Fig: 2. Occupation

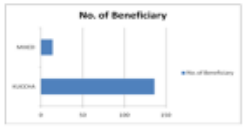

Fig: 3 House type

District-wise achievements made so far

1. Baksa district

- Six awareness and training programme have been organized so far from April/2018 to March/2020.
- Out of which three were In-house training program organized at Aquaculture & Biodiversity Centre, Department of Zoology; Gauhati University.

Activities made in Baksa district...



Renovation & fertilization of selected pond

Five derelict society ponds (size-0.20, 0.25, 0.24, 0.35 & 0.28 hectares) of five villages of Tamulpur area were selected from demonstration unit. To facilitate composite fish farming, all the selected ponds were renovated by dewatering, bottom scraping, dyke trimming followed by Manuring with cow dung and lime.

Activities made in Baksa district...

Rearing of fingerlings in composite fish farming manner

25000 fingerlings (20-30 g) of *Rohu*, *Catla* and *Mrigala* were procured from a private fish farm of Nalbari district of Assam and released in all the selected ponds (numbers of fishes were calculated on the basis of stocking density & size of the ponds)



Activities made in Dima Hasao...

1. **Formation of Working Group:**

   A total of 6 working groups have been formed . Three ponds (size- 0.10. 0.12 & 0.18 hectares) of three selected beneficiaries of Gunjung area were selected for demonstration unit for integrated duck cum fish farming.



Progress made in Dima Hasao...

- 15000 fingerlings (25-30 g) of *Rohu*, *Catla* and *Mrigala* were procured from a private fish farm of Nilbagan area of Hojai district of Assam and released in all the selected ponds (numbers of fishes were calculated on the basis of stocking density & size of the ponds) after proper acclimatization. Fifteen ducklings of 2-3 months old (size: 0.75 kg- 0.80 kg)



Cost benefit analysis of integrated duck cum fish farming

Sl.No	Particulars	Integrated duck cum fish farming (Pond area: 0.21 hectare)/year
A	Fixed cost(Renovation of pond, construction of duckery, ducklings, yearlings, pre stocking management etc)	45,100/-
B	Variable cost (Duck feed, fertilizer, lime, Medicine, supplementary feed probiotics etc.	15,820/-
C	Total cost (A+B)	60,920/-*
D	Returns	
	Sale of fish(Rs 350/kg)x 500 kg/year (Average)	1,75,000/-
	Sale of eggs(Rs. 10/egg)x 2200/year (Average)	22,000/-
E	Gross returns	1,97,000/-
F	Net returns (E-C)	1,37,000/-
G	Benefit: cost ratio (1st year)	3.23:1
	Benefit: cost ratio (successive years)	4.29: 1

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Presenter 42: Dr Sanjay Sarma

Study Title: Breeding Protocol of Ompok pabda at the Agro-Climatic Condition in Assam

Author: Dr Sanjay Sarma

Abstract:

Ompok pabda locally called pabda has been categorized as endangered(EN), according to IUCN based CAMP report (1998). The brood fishes were collected from the river and floodplain Wetlands in the vicinity of Lakhimpur District of Assam during December- February 2007-2008, and were stocked at specially prepared tank B (water area 0.1 Ha) of Ulubari Fish seed farm. The breeding and larval rearing experiments were carried out at the same farm. A total of 367 O. pabda were stocked and the fishes were fed with supplementary feed consisting of mustard oil cake, rice bran (1:1 ratio), small live fish like *Puntius, Chanda* etc @ 5 % of body weight per day. Fishes were reared for a period of 6 months and feeding schedule was maintained throughout the culture period.

Adult fish showed sexual dimorphism, when the pectoral fins of male become rough. In the case of females, the pectoral fin was smooth and genital papilla was found swollen and slightly pink in colour. The abdomen was bulging and soft in appearance. The spawner was selected for hypophysation in the month of June, 2008. Free oozing and ripe females were selected in the ratio of 3:2 respectively for breeding. The physicochemical parameters of the breeding pool are as follows:

Sl no	Parameter	Values
1	Air temperature	29-32^{0}C
2	Water temperature	28-31^{0}C
3	pH	6.5-7.5
4	Dissolved Oxygen	5-6 ppm
5	Free Carbon dioxide	2-3 ppm
6	Turbidity	2.5-3.5 cm

Length and weight of each were noted. The size of fish ranged from 15.2 – 16.5 cm and weight ranges from 50 gm – 65 gm. In the first set, 18 male and 12 female were taken for induced breeding whereas in the second phase 24 males and 18 females and third phase 16 males and 10 females were selected with the same doses. Induced breeding was done in a nylon hapa in a cement cistern and followed prescribed technique of hypophysation. Synthetic hormone Ovatide was used as an inducing agent. To select the optimum dosage for the complete spawning in relation to the climatic condition of that area, a series of tests were performed and the final dosage was determined. In the evening hours the injection was administered and the fishes were transferred into the breeding hapa. Mating started 5-6 hours after administration of the ovatide injection and the spawning was observed after 9-11 hours of injection. The one day old hatchlings were maintained in nylon hapa fixed in the pond and plastic pool. In hapa aeration was provided through sprinklers and in plastic pool aerators were provided.

The eggs were light brown in colour and small with 0.85-0.95 mm diameter. The relative fecundity of the species ranged between 83 – 125 eggs per gram body weight. The average fertilization rate was 91.5 % and the hatching rate was 65.2. The number of eggs was estimated by volume and number of eggs per litre was 1,05,625.

The one day old hatchlings were transferred into new rearing hapa and plastic pool and survival of hatchlings varied from 60-65 % upto 5-6 days of rearing period. The hatchlings were very active and moved very fast showing schooling behaviour and rested on their lateral side due to yolk content on the ventral side. After 3 days of hatchling, the mouth slightly developed and accepted external feed. Initially hatchlings were fed with egg yolk and the post larvae were fed on chopped tubifex worm from 7 days onwards. The mortality of post larvae stage *O. pabda* in nylon hapa was observed 30-40 % due to non-acceptance of feed, poor absorption of yolk sac and rapid fluctuation of temperature.

Observation: The success achieved in the present study paves the way of standardization of breeding protocols and broodstock development. The quite effective dosage for inducing agent is 0.5 ml/ kg body weight in case of female and 0.4 ml/ kg body weight of male subject to water temperature range between 28-31^{0}C.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: Breeding Protocol of *Ompok pabda* at the Agro-Climatic Condition in Assam

Presenter: Dr Sanjay Sarma
Institute: ARIAS Society, Govt of Assam

Research Overview

Study Objectives: Pabda occupies 6 – 10% - of total catch from *beels* and *manus* - early 80's.

- Sharp declination in population due to many anthropogenic upset ,pollution, climate change, destruction of breeding ground
- It is quite alarming and rather unfortunate that, this species is on the verge of extinction, and has been listed under **endangered fish species in India (IUCN 1990).**

It is preferred species due to:

- Shiny appearance
- High market demand
- Soft flesh
- Less spine content
- Unique taste and flavor
- Easily digestible high nutritional properties
- Cultured as an aquarium fish

Study Methodology

Technology of Pabda breeding, rearing and culture in captivity has been developed

- **Breeding Season :**
  During end of April to mid August (Pre- monsoon and monsoon period).
- **Maturity :**
  Attains maturity within a year, however 2(two) years old fishes are suitable for induced breeding.
- **Fecundity :**
  20,000 – 30,000 nos. eggs/100 gm of fish body weight.
- **Induced spawning:**
  Induced spawning takes place after 8-9 hours of administering the hormone injection.

➢**Collection of eggs**:.

Eggs will come out freely through application of gentle pressure on the abdomen and are collected on a dry enamel or plastic tray.

➢ **Fertilization**

In the event of following the stripping method, testes are removed from the matured males, sperm suspension are prepared and thoroughly mixed with the eggs

➢**Incubation period and process**

Hatchling takes place after 20-24 hours of fertilization, (For good result: fertilized eggs are kept in cement cistern with low water depth (5 – 10 cm.) with a feeble water flow and aeration facility

Key Threats and Opportunities

Raising of Fingerlings from advance fry stage:

❖ Initial controlled rearing of pabda fry in cemented tank is preferable

❖ Proper feeding with finely chopped tubifex as well as boiled chicken viscera are the preferred food during this stage.

❖Segregation of unequal sizes are required.

❖Avoid excess heat and direct scorching sunlight.

Key Findings

❖ Better survivability in low water depth cemented tank

❖ Providing vegetative not easily decomposable shelter and shed

❖Covering with fine nylon net is required to save from predatory birds

❖. Fingerlings will be ready in one month after hatching for stocking in culture ponds

Key Recommendations

Rearing of Spawn to advanced fry stages :

Concerns:

Mass mortality of hatchlings from 2nd to 10th days was observed

High cannibalism

Remedies:

Proper feeding like finely chopped tubifex along with sieved small plankton from 2nd day onwards *adlibitum*

❖Proper oxygenation with low alkaline water is preferred

Contact Details

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Presenter 43: Dr KruolalieTsurho

Study Title: Paddy cum Snail Culture in Nagaland

Author: Dr KruolalieTsurho

Abstract:

Cultivation of paddy is practiced since time immemorial from generation to generation in Nagaland. Rice is the staple food and it occupies about 70 per cent of the total area under cultivation and constitutes about 75 per cent of the total food production in the state. The indigenous knowledge system of this cultivation had been developed through experience by tribal farmers using their ingenuity and skill and are believed to have sustainable agricultural base. Wise utilization of known food resources could be one major tool to keep parity with the increasing population and nutriment demand.

In Nagaland, paddy cum snail culture is practiced only in some selected areas on a larger scale even though the consumption of snails is widespread. Owing to its high nutritive value and noting the excellent nutritional potential which is characterized by high protein and mineral but low-fat content and considering the environmental benefits of making use of snails as human food, it must be now viewed as a source of nutritional comparable to conventional dietary habit. Therefore, the introduction of Paddy cum snail culture can be an important source of livelihood sustenance, economic upliftment and an indicator to climate change adaptation.

Presentation

Introduction

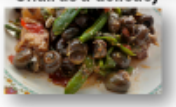
Paddy cum snail culture in terrace and flooded plain rice fields

- Snail is a traditional food.
- Available in local markets.
- Traditionally, some snails are not consumed during windy season.

- Rice is grown in paddy fields by few tribes in Nagaland either in terrace hills or in the plains.
- Besides rice, these wetland provide natural habitat, breeding environment and feeding grounds for varieties of aquatic life forms.
- Among the micro-livestock and unconventional sources of animal proteins, molluscs as a group hold tremendous prospects and amongst them the snails hold a very high promise.

From Paddy fields to Plates

Snail as a delicacy



Snail as an alternative diet

Research Overview

- **Study Objective:**
  - i. Identification and documentation of endemic/local snail species.
  - ii. Study on the breeding pattern in its natural habitat.
  - iii. Study on the economic prospect of paddy cum snail culture.
  - iv. Conservation of its genetic resources.
  - v. Snail as an alternative to dietary habit.
- **Study Timeline:** 2 years.
- **Geographic scope:**
  - i. Terrace rice fields in hill areas.
  - ii. Paddy fields in plains.
- **Species covered:**
  - i. Local snail species.
  - ii. Commonly available species.

Study Methodology

i. **Site selection** :
Study of paddy cum snail culture in selected terrace rice fields and paddy fields.

ii. **Identification of snail species**:
To Identify the endemic snail species taxonomically.
Sexually active adult of mixed sex to be selected.

iii. **Water levels**
Saturated water levels to be maintained during the study.
Effect of various density of snail to rice grown at saturated water levels.

iv. **Data collection and analysis**
Data collection begin one day after transplanting and continued on a weekly basis up to the maturity of crop.

For analysis, Two-way Analysis of Variance (ANOVA) or Three way Analysis of Variance to be used for different parameters

Key Threats and Opportunities

Threats

- Local snail species either becoming threatened or endangered.
- Accidental introduction of exotic species.
- Natural calamities.
- Loss of gene pool.

Opportunities

- Snail rearing can be taken up as an alternative farming in terrace rice fields and paddy fields.
- Low cost farming and high net returns.
- As an alternative source of protein and other nutrients
- Income generating sector for livelihood sustenance and upliftment of the economic status of the rural farmers.

Key Observations/Findings

i. Consumption of snail is widespread.
ii. Introduction of Integrated farming system of paddy with snail culture in the state.
iii. Improvement of stability due to diversification of enterprises.
iv. Producing high quality snails without polluting the ecosystem.
v. Providing additional income and generating employment opportunities.
vi. Conservation and protection of gene pool.
vii. Local snail as a niche where it is preferred and unique in taste.

Key Recommendations

i. Validation of Traditional Knowledge (TK) and its transformation shall benefit food production and income as well as farm integration.

i. Blending Indigenous Traditional Knowledge (ITK) with scientific technology shall help achieving the goal of sustainability and food security.

i. Plays an important role in enhancing rice plant performance through food web effects that result in nutrient release in the aquatic ecosystem.

i. Acts as an indicator for pollution.

v. Tool for biomonitoring.

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Presenter 44: Juri Konwar

Study Title: Studies on Fish Preservation Methods Adopted by the Deori Community in Dhemaji District of Assam

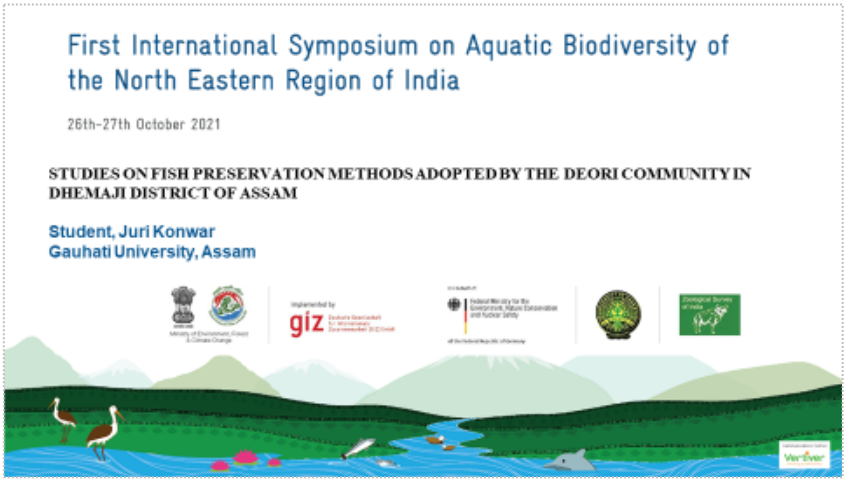
Authors: Juri Konwar and Sanghamitra Buragohain

Abstract:

Traditional fish preservation methods practiced by the tribal communities are based on Indigenous Technical Knowledge (ITK) of the community as well as the entire region. Due to lack of adequate scientific approaches and exposure, these methods are being explored very little till date. Taking these aspects into account, the present study demonstrates the different methods adopted by the Deori community of Dhemaji district in Assam for preservation of locally available fish species during monsoon season in order to consume during dry seasons. The study was conducted from the month of May to mid-September through survey, field visits, personal interview and spot observation. The people of Deori community primarily preserve fishes in different forms locally known as- Chucha, Aarhoi Chiya, Dujiba Chiya and Nakia Chiya. Methods of preparation and preservation of these products are based on the principles of dehydration and fermentation.

The fermented fish products are source of protein and used as delicacies in various ethnic cuisine due to their unique flavour and savory aroma. In the present context, ethnic fermented fish products of the tribals are gaining popularity even among the people of other communities of North-East India and beyond. Suggestions are put forward for promotion of marketing and commercialization of these ethnic food products. Sustainable utilization and management are very crucial and of utmost necessary in every step right from the collection of fishes, for sustainable development and conservation. Further, implications for creation of employment opportunities for the rural tribal people in the particular sector have been highlighted.

Presentation



RESEARCH OVERVIEW:

- **Study Objectives:**

1) To survey and collect data on indigenous fish preservation methods practiced by the Deori community of Dhemaji district in Assam.
2) To evaluate the process of indigenous fish preservation methods of the Deoris.

- **Study Timeline**: From 3rd March,2021 to 16th September,2021.
- Geographically, Dhemaji district is located between 94°12'18" E and 95°41'32" E longitudes and 27°05'27" N and 27°57'16" N latitudes on the north bank of river Brahmaputra in Assam.

STUDY METHODOLOGY:

- **Site Selection**-

Five Deori villages in Dhemaji district were selected for conducting the study- Sripani Gaon, Dhunaguri Gaon, Gainadi Gaon, Udaipur Gaon and Raimyapur Gaon.

- **Selection of Respondents for Survey**-

Six Deori households from each village were surveyed with a total sample of thirty. Survey was conducted through questionnaire.

- **Field Survey and Spot Observation**-

Few of the techniques were personally observed on spot during the visit.

- **Oral interview**-

Information were also collected through oral interview with the older members of the household.

OPPORTUNITIES

- Traditional ethnic fermented and preserved dried fish products used as delicacy in different authentic ethnic cuisines for their unique flavor and savory aroma. Currently, they are gaining popularity even among the non-tribal people and have the potential to attract more customers. Hence, high demand in the markets.
- It could be a booming business option.
- Sustainable utilization and management of the resources by rearing fishes every year and selective harvesting from time to time to prepare these products. No negative impact on the aquatic ecosystem.
- Polyculture of fishes as well as integrated fish farming could be done for additional income – Raw fishes as well as prepared traditional dried fish products could be sold throughout the year.
- Preserved fish products could serve as protein source during dry seasons when there is low availability of fish. Marketing of these products could serve as good source of income for livelihood.

OBSERVATION:

A) Nakiya Chiya - Medium-sized fishes are preserved whole after cleaning and drying. Large and medium-sized fishes strung to bamboo skewers are dried and preserved in airtight containers or sealed earthen pots.

B) Dujiba Chiya - Small-sized fishes are dried, ground, wrapped in fire-dried banana leaf and preserved in sealed earthen pots.

C) Chucha : Prepared by adding leaves and petioles of *Colocasia esculenta*. It remain suitable for consumption till 1.5-2 years if maintained properly.

D) Aarhoi Chiya -Same as Chucha preparation but *Colocasia esculenta* not added. Suitable for consumption till 1-1.5 years if maintained properly.

Fig.1:Traditional method of drying fishes in the kitchen of a Deori household.

Fig.2: Drying fishes strung to bamboo skewers and fishes placed on traditional woven bamboo trays(Saloni).

Fig.3: Dried fishes

Fig.4:Nakiya Chiya

Table 1: Major fish species utilized for preservation through different methods by the Deori Community

SCIENTIFIC NAME	LOCAL NAME	FAMILY
Amblypharyngodon mola	Mox	Cyprinidae
Anabas testudineus	Kawoi	Anabantidae
Channa marulius	Sol	Channidae
Channa punctata	Gonoi	Channidae
Channa striata	Soi	Channidae
Esomus danricus	Darikona	Cyprinidae
Eutropiichthys vacha	Bacha	Schilbeidae
Labeo bata	Bata	Cyprinidae
Labeo gonius	Kuchi	Cyprinidae
Labeo rohita	Rohu	Cyprinidae
Mystus tengara	Hingora	Bagridae
Nandus nandus	Gedgedi	Nandidae
Notopterus notopterus	Kanduli	Notopteridae
Ompok pabda	Pavo	Siluridae
Chanda sp.	Chanda	Ambassidae
Pethia sp.	Pethia	Cyprinidae
Puntius sp.	Puthi	Cyprinidae
Rasbora daniconius	Donikona	Cyprinidae
Trichogaster fasciata	Kholona	Osphronemidae
Wallago attu	Boali	Siluridae

Fig.5: Drying fishes, petioles and leaves of *Colocasia esculenta* traditionally to prepare Chuchu

Fig.6: Stems and petioles of *Colocasia esculenta*

Fig.7: Grinding dried fishes and *Colocasia* together by traditional Dheki into semi-solid paste.

Fig.8: Stuffing paste of dried fish and *Colocasia* mixture into Bamboo cylinders, followed by stuffing with salt, dried banana leaf, paddy straw; sealed with clay and dried banana leaf

Fig.9: Whole preparation kept on traditional bamboo roof

Fig.10: One-year old Aarhoi-Chiya and two-year old Chuca bamboo cylinders

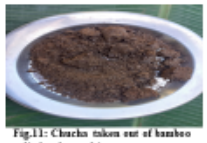


Fig.11: Chuchu taken out of bamboo cylinder for cooking

KEY RECOMMENDATIONS:

- The tribal communities of Assam- Deori, Mishing, Bodo, Sonowal-Kachari, Tiwa, Karbi, Dimasa etc. as well as the other North-Eastern states have their own unique fish preservation methods and preserved fish products. These methods and products need to be explored through scientific approaches and research.
- Application of scientific techniques for production of improved quality products in large scale. It must be ensured that the products do not lose its authenticity.
- Creating awareness among the tribal people to adopt business strategies for marketing and commercialization of their ethnic fish and other food products through various programs and projects under governmental and non-governmental organizations.
- This sector would create new employment opportunities for the rural tribal people in their own homeland.
- There would be emergence of markets throughout the country and abroad based on traditional ethnic food items, ethnic dresses, traditional cane and bamboo products etc. that would represent the rich heritage and culture of the North-East India.

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Presenter 45: Minakshi Kalita

Study Title: Culture of Ornamental Snakehead Species Collected from the Brahmaputra Drainage, NE India: A Valuable Overlooked Resource of Freshwater Ecosystem

Authors: Minakshi Kalita, Dandadhar Sarma and Hrishikesh Choudhury

Abstract:

Ornamental fish keeping is a popular hobby worldwide, supporting a significant global aquarium industry. Over one billion ornamental fish may be exported worldwide every year. To supply markets in the northern hemisphere, exotic pets and aquarium trades source a wide variety of species from countries on all continents, with a proportion of them taken directly from the wild. The freshwater species are one of the most threatened groups as freshwater species comprises an estimated 90% of all ornamental fish trade. Most wild caught aquarium fish originating from India come from the Eastern Himalaya and Western Ghats, hotspots known for their remarkable freshwater biodiversity and endemism. The harvest of freshwater fish in India is largely unregulated. Unlike marine species (11 of which, together with all syngnathidians (seahorses, pipefish, and seadragons) are listed on Schedule 1 of India's Wildlife (Protection) Act, 1972 [WPA] and thus protected from hunting and trade), none of the freshwater fish occurring in India (with the exception of the freshwater pipefish, *Microphis deocata* [Teleostei: Syngnathidae]) are included under any of the wildlife schedules of the WPA.

Trade report shows a new and emerging trade in an ornamental fish group (snakeheads, belonging to the genus *Channa*; Teleostei: Channidae), can be considered as the conservation risks. In view of this we have provided the report on culture and management of two snakehead species (*Channa andrao* and *Channa stewartii*) collected from Brahmaputra River drainage. The targeted snakehead species has been over-exploited from wild for aquarium trades worldwide but none venture for their culture and breeding. A proper culture setup is very necessary for an efficient provision of breeding and juvenile management in fish farming. Establishing a proper sustainable culture system can contribute to the protection and restoration of threatened fish populations living in the wild. A well-managed and responsible aquarium industry for snakeheads can also create livelihood opportunities and a sense of environmental management for thousands of local communities in rural and often remote locations.

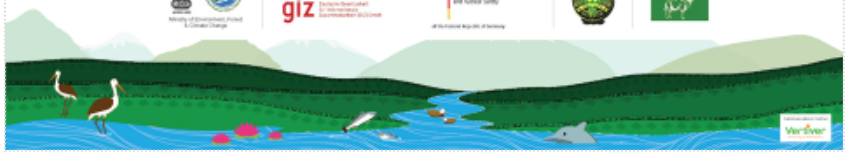
Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study: Culture of ornamental Snakehead species collected from the Brahmaputra drainage, NE India: a valuable overlooked resource of freshwater ecosystem

Presenter: Research Scholar Minakshi Kalita
Institute: Department of Zoology, Gauhati University



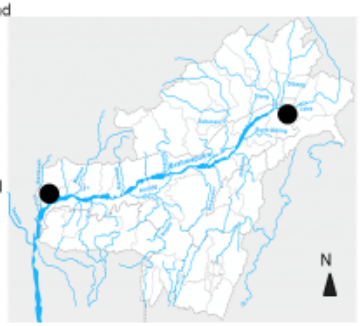
Research Overview

- **Study Objective:**
The objective of the study was to establish a proper culture system of snakehead that can contribute to the protection and restoration of the targeted fish populations living in the wild.

- **Study Timeline:**
The study was conducted from 2-02-2019 to 13-02-2019

- **Geographic scope:**

The study covered two riparian zone of Brahmaputra River :
1. Lower Brahmaputra River Range: Lefraguri, West Bengal (26.31 N, 89.50 E)
2. Upper Brahmaputra River range: Laika Village, Dibrusaikhuwa, Tinsukia (27.3953 N, 95.2003 E)



- **Species covered:**

The experimental fishes used in this study were *Channa andrao* and *Channa stewartii* with an average initial length of 10.1±0.3 cm and 17.6±0.4 cm respectively.

- **Species covered :**

- **Binomial name:** ***Channa andrao*** **Britz, 2013**
- **Conservation status:** Not Evaluated

•Scientific Classification:
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Perciformes
Family: Channidae
Genus: Channa
Species: *Channa andrao*

- **Binomial name:** ***Channa stewartii*** **(Playfair, 1867)**
- **Conservation status:** Least conservation (LC)

•Scientific Classification:
Kingdom: Animalia
Phylum: Chordata
Class: Teleostei
Order: Perciformes
Family: Channidae
Genus: Channa
Species: *Channa stewartii*

•Common names: Assamese snakehead; Sengalee (Assam, India; Talwar and Jhingran, 1992)

Study Methodology:

Collection	Acclimatization	Tank Setup	Stock management	Rearing of juveniles
Sampling site: 1. Lefraguri, West Bengal (26.31 N, 89.50 E) 2. Laika Village, Dibrusaikhuwa, Tinsukia (27.3953 N, 95.2003 E) **Sampling time:** Feb 2019 to April 2019 **Total no of sample collected:** 1. Channa andrao: 60 (40 male, 20female) 2. Channa stewartii: 75 (48 male, 27 female)	**Site of experiment:** Aquaculture and Biodiversity Centre, Gauhati University (26.14 °N 91.79 °E) **Quarantine tank size:** 1.5m X 1m X 1m (FRP tank) ****Potassium permanganate bath** (1000 mg/L) for 10–40 seconds prior to release **Quarantine period:** 15 days	**Rearing tank size:** 1. For *Channa andrao*: 1.5m X 1m X 1m 2. *For Channa stewartii*: 2m x 1.5m x 1.2m ** Recirculating tanks with dechlorinated water ** Photoperiod: 14 hrs of natural light daily ** Vegetations are introduced to stimulate a natural environment ** To provide shelter 3-4 pipes are placed in each tank	***Stocking density:** 1. *Channa andrao*: 66,500-1,00,000/ha (adult) 2. *Channa stewartii*: 7,000-10,000/ha (adult) ***Feeding:** Small fishes, Earthworm, Tubifex sp & Chironomous larvae. *Twice a day at 3-4% of average body weight/day (for adult) *** Water parameter monitoring:** using YSI Professional Plus Multi-parameter water quality meter	***Stocking density:** 1. *Channa andrao*: 1,20,000-4,00,000/ha (juvenile) 2. *Channa stewartii*: 18,000-2,00,000/ha (juvenile) ***Feeding:** Tubifex sp & Chironomous larvae. *Thrice a day at 10% of average body weight/day (for juveniles) *** Water parameter monitoring:** using YSI Professional Plus Multi-parameter water quality meter

Key Threats:

* Overexploitation from wild for the purpose of ornamental fish trade

* Human encroachment and habitat destruction

Opportunities:

***High food value:** Snakehead culture has expanded rapidly in the last five years, replacing Clarias (Catfish) farming as a result of the latter's disease problems and fluctuating prices in Thailand.

***High Ornamental demand in global market**

***Highly nutritious fish, rich in protein content**

*Snakeheads can tolerate wide range of pH level which makes it preferable for commercial culture

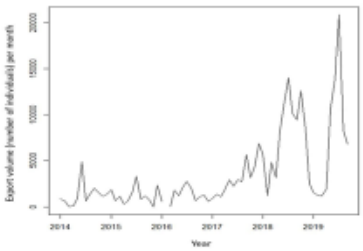


Fig: Snakeheads (*Channa* spp.) exported as ornamental fish from India, 2014 – 2018, showing (a) number of individuals exported per month (Feb 2016 missing)

Source: www.seair.co.in.

Key Observations/Findings

* Study reveals that both the **targeted species can tolerate wide range of pH, temperature and low oxygen level**, that makes them suitable for commercial culture.

* Natural breeding can be easily stimulate by providing a suitable environment. Introducing floating plants and macrophytes helps to provide shelter as well as also stimulate a natural environment.

* One of the major problem associated with almost all snakehead culture is the **poor survival rate** encountered during larval rearing due to its huge size variation (**size heterogeneity**) and **sibling cannibalism.**

* Our study shows that by **providing maximum feed and grading** the individuals according to their size to avoid the large size variation will eventually **help to reduce the cannibalistic activity** among the siblings.

Fig: Spawns of *C. stewartii*

Fig: Parental care of *C. andrao*

Fig: Growth of spawns of *C. stewartii*

Key Recommendations

***Culture** of *Channa andrao* and *Channa stewartii* **must be encouraged**, because--------

a) Both the targeted snakeheads are potential candidate species in aquaculture; they are also dominating the international freshwater ornamental fish market.

b) Our study reveals that the natural breeding of the two species is possible in captive condition providing suitable environment.

c) Technology aided snakehead culture will provide employment to the youth and becomes a source of income for rural households.

***Freshwater fish provide an important food source but the apparent current focus on collection for the aquarium pet trade suggests that a **review of snakehead harvest is needed.**

*** **Strategic decisions regarding the need for regulation** (e.g. through bans, licencing, and or quota systems) and listing of the threatened species that are currently in the trade under national legislation (the WPA) may require, a more in-depth understanding.

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Presenter 46: Bhargav Bhushan Nath

Study Title: Sustainable Livelihood Security and Community Development through Integrated Fish Farming System in Central Brahmaputra Valley of Assam

Authors: B.B. Nath, B. Phukan, M Talukdar Dutta, A. R. Kalita

Abstract:

The major purpose of the study was to determine the livelihood of fish farmers through integrated farming system in selected rural villages of Schedule Tribal (ST) community of central Brahmaputra valley of Assam. Present study aims to ensure the sustainable livelihood security of the grass root people with technological intervention to the existing resources. Livelihood security of fish farmers was measured on the basis of five dimensions such as changes in food intake, household condition, physical assets, sanitation, income due to involvement in fish farming activities. Integrated farming system consisting of tested technology modules pertaining to the rural assets of the project area shall lead to increased production, employment generation, higher income, better nutrition, health safety and stabilization of yields. Integration of enterprises, breed improvement of livestock, fish rearing in rice fields, water harvesting for irrigation, increased cropping intensity will lead to more livelihood options, additional income, poverty elimination, and livelihood security. Data were collected by using baseline survey report based on personal interview during December, 2019 to January, 2020 from hundred (100) fish farmers of central Brahmaputra valley of Assam. Trainings were conducted on different technologies use in fish farming system. From hundred (100) farmers, 50% fish farmers were involved in integrated pig-fish farming system and other 50% farmers were involved in integrated poultry-fish farming. Input distribution has been conducted in the month of April-May, 2020. Two numbers of Piglet HD-K75 (3-4 months old) in 1:1 (M:F) per farming family to 50 numbers of Farming family was given under Pig-Cum Fish module and 50 numbers of poultry VANARAJA was given per farming family (Total 50 numbers of farming family) under Poultry-Fish farming module. Fish Fingerling of IMC such as Rohu, Catla and Mrigal was given @ 1500no's/ farming family in 1:1.3:1 ratio to 100 numbers of Farming Family. The paired t test was used to measure the comparative changes of 'before' and 'after' involvement in farming system. The finding revealed that food intake, housing condition, physical assets, sanitation and income all are increased significantly among the respondents. Integrated fish farming system seem to be the possible solution to the continuous increase of demand for food and nutrition, income stability and livelihood upliftment particularly for small fish farmers with little resources.

Keywords: Livelihood security, integrated fish farming system, Central Brahmaputra valley, Assam

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the study:

Sustainable Livelihood Security and Community Development Through Integrated Fish Farming System in Central Brahmaputra Valley of Assam

Presenter: Bhargav Bhushan Nath, M.F.Sc.

Institute: College of Fisheries, Assam Agricultural University, Raha, Nagaon, Assam

Research Overview

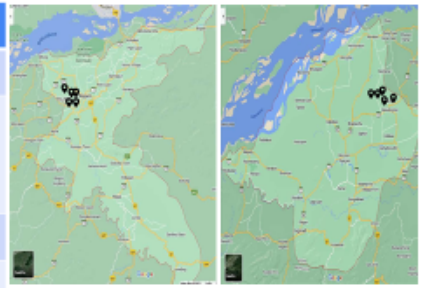
Study Objective:

1.To disseminate Proven Technology on Integrated Fish Farming System among Schedule Tribe community
2.To enhance income of farming family by introducing Integrated Farming System i.e. Fish cum pig and Fish cum Poultry.
3.To establish market linkage at local and regional level

Study Timeline: October, 2018-September, 2020
Geographic scope: Schedule Tribal (ST) dominated areas of central Brahmaputra valley of Assam mainly covered 10 (ten) villages of 2 (two) district.
Species covered (if any):
Pig Species: HD-K75
Poultry species: Vanraja
Fish species: Rohu (*Labeo rohita*), catla(*Labeo catla*) and mrigal (*Cirrhinus mrigala*)

Research Overview Contd...

Implement ation	Activity	Completion
October, 2018	Identification of selected beneficiaries	January,2019
February, 2019	Provide awareness on Integrated Fish Farming System (IFS). Installation of infrastructure for pig and poultry house and pond renovation	September, 2019
October, 2019	Distribution of pig-poultry-fish	December, 2019
January, 2020	Live-stock raising, provide vaccination to pig and poultry	December, 2020
December, 2020	Provide marketing linkage for pig and poultry, Fish harvested	April, 2021



Diag. Study areas (Nagaon and Morigaon district)

Key Observations/Findings

Household annual income of beneficiaries (1 bigha)

Sl no.	Source	Income from source (Rs.)	Total income (Rs.)
A.	Before intervention (2018)		
1.	Fish farming	64,160.00	64,160.00
A.	After intervention (2021)		
1.	Fish farming	70,350.00	1,50,850.00
1.	Poultry farming	20,240.00	
1.	Pig farming	60,260.00	

Key Threats and Opportunities

Threats

- It is feared that integrated fish farming system limits or destroys the natural habitat of most wild creatures, and leads to soil erosion, use of fertilizers may alter the biology of ponds and lakes.
- Not enough public funding (i.e. political will) for developing a network of demonstration and research sites to examine feasibility of Integrated aquafarming.
- Larger scale applications may have greater environmental impact and thus less social license.

Opportunities

- Utilizes wastes from different components, poultry, piggery by-products for fish production
- Complete recycling of wastes
- Raising of piggery and poultry on pond dyke.
- Drastic reduction in cost of production of fish and horticultural crops
- Better profit from the entire system
- Additional income for small scale farmers

Study Methodology

- Two module:
  1. Integrated pig-fish farming
  2. Integrated poultry-fish farming
- 100 beneficiaries were selected for Integrated fish farming system. 50 farmers were involved in integrated pig-fish farming system and 50% are were involved in integrated poultry-fish farming system
- Provide training and awareness programme on Integrated fish farming system
- Installed pig and poultry cages on selected sites
- Provide inputs (pig and poultry) to the selected beneficiaries
- Monthly survey, Interaction with beneficiaries
- Collection of data

Key Recommendations

- The waste products of one biological system serves as nutrients for second biological system
- The integration of fish and animal results in a polyculture that increases the diversity and yields multiple products
- Increase duel production from small size of farm
- Development of implementation these techniques for better production in low cost capital

Acknowledge

I would like to acknowledgement Department of Biotechnology, Govt. of India, for the financial assistance under project ID: BT/PR25798/SPD/9/1310/2017. I also offer my sincere gratitude to Mr. Bipul Phukan, P.I., DBT project and Dean (i/c), College of Fisheries, Assam Agricultural University, Raha, Nagaon, Assam for kind support and guidance.

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Presenter 47: Nayan Das

Diversity of Aquatic Plants and their Livelihood Prospects: A Case Study of Urpad Beel, Goalpara, Assam, India

Authors: Nayan Das, Rupali Barman and K.S.P.V Pavan Kumar

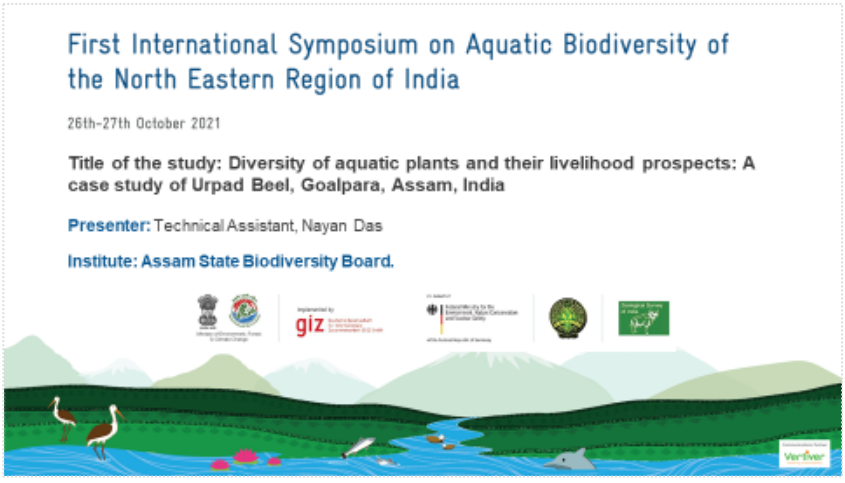
Abstract:

Wetlands are unique ecosystems which provide water and habitat for a diverse range of plants and animals. The primary factor that distinguishes wetlands from other land forms or water bodies is the characteristic vegetation of aquatic plants, adapted to the unique hydric soil. This aquatic plant not only acts as natural habitat for a variety of aquatic birds and animals but they also plays an important role in the livelihood of local communities. Urpad Beel is a natural wetland located at Balijana Block in Goalpara district of Assam, situated 9 km away from the district headquarters of Goalpara district between 26^0 $05^/$ $26.2^{//}$ N latitude and 90^0 $35^/$ $19.9^{//}$ E longitudes. The present study was carried out for one year during January 2020 to December 2020. Standared vegetation sampling methods were use to identify the aquatic plants and local market surveys and PRA exercise were conducted to study their livelihood prospects.

A total of 18 aquatic plant species belonging to 11 families were identified having livelihood prospects for the local communities during the study. Of the total 18 species, 12 are used as edible resources and three are used as fodder, one is used as firewood and two species are used for handicrafts. *Eichhornia crassipes* (Mart.) Solms is mainly used for handicraft items such as bags, container etc. and *Alpinia nigra* (Gaertn.) Burtt is used in rope making. Local communities collect the resources from the beel and sold in the nearby 3 local markets namely Balijana Bazar, Balbala Bazar and Agaia Bazar. Encroachment in the wetland body area, agricultural activities and bricklinks in the periphery of the beel are the major threats affecting the rich ecosystem of Urpad *Beel* and its resources.

Key Words: Wetland, Aquatic Plants, Habitat Livelihood, Urpad Beel

Presentation



Research Overview

- **Study Objective**:

  1. To identify the economically important aquatic plants of Urpad Beel.

  2. To study the associated traditional knowledge of the identified plants and livelihood prospects emerging out from these species.

  3. To understand the threat perception of the Beel.

- **Study Timeline**: The study was carried out for one year from January, 2020 to December, 2020

Research Overview Contd…

- **Geographic scope:**

Location: Goalpara district of Assam,
Coordinates: 26^0 05/ 26.2// N- 26^0 06/ 89// N
and 90^0 33/ 58.15// E-90^0 36/47.06// E
Area: 835 ha.

- **Species covered:**

18 aquatic plant species.



Study Methodology

- Primary data was collected using line transect method.
- Plant identification were done with the help of Kanjilal, *et.al.* (**1934-40**).
- For classification Bentham, G. & Hooker (**1862-1883**) was followed.
- Questionnaire survey was done in the surrounding villages to collect data regarding various uses of plants and their traditional & economical values.
- Nearby village markets were also surveyed.
- The local name was recorded as per information gathered from the local people.

Key Threats and Opportunities

Threats:

- Siltation
- Ecological Succession
- Encroachment
- Agricultural activities
- Brick kilns in the periphery of the beel.

Opportunities:

- Potential conservation site (Ramsar site)
- Eco-tourism (Homestay, birdwatching, boating, angling etc.)
- Sustainable use of bio-resources for livelihood generation


Key Observations/Findings

Economically important species:

Edible:
Monochoria vaginalis (Burm.f.) C.Presl,
Monochoria hastata (L.) Solms,
Euryale ferox Salisb,
Nelumbo nucifera Gaertn.,
Nymphaea pubescens Wild.,
Nymphaea alba L.,
Ipomoea aquatica Forssk.,
Enhydra fluctuans Lour,
Trapa natans L.,
Acorus calamus L,
Ottelia alismoides (L.) Pers,
Lasia spinosa (L.) Thwaites

Key Recommendations

• **Documentation of fauna of Urpad beel:** Avian fauna, reptilian fauna, amphibia, fish fauna, molluscan, mammals and other invertebrates (lepidoptera, odonata etc.)

• **Aforestation:** Plantation of native species in the periphery of the beel.

• **Prevention of Siltation**: Measure should be taken to prevent silt from nearby hills and agricultural land.

• **Use of fertilizer and pesticides**: Biofertilizer should be used as use of inorganic fertilizer can cause eutrophication.

• **Declaration of Urpad Beel as a conservation site:** Urpad Beel is the largest lake in western Assam, comprising a water spread of 835 ha. It is connected with two more water bodies, Patakata and Matia beels to the east, which makes the total area of the wetland more than 1,000 ha. during monsoon. The Ajagar Hill Reserve Forest to the south, Rakhashini RF to the north and Sagunbahi RF to the west surrounds Urpod beel. The Beel has the potential to be an important conservation site harbouring rich floral and faunal diversity.

• **Eco-tourism site**: bird watching, angling, boating, homestay etc.

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Presenter 48: Pronob Das

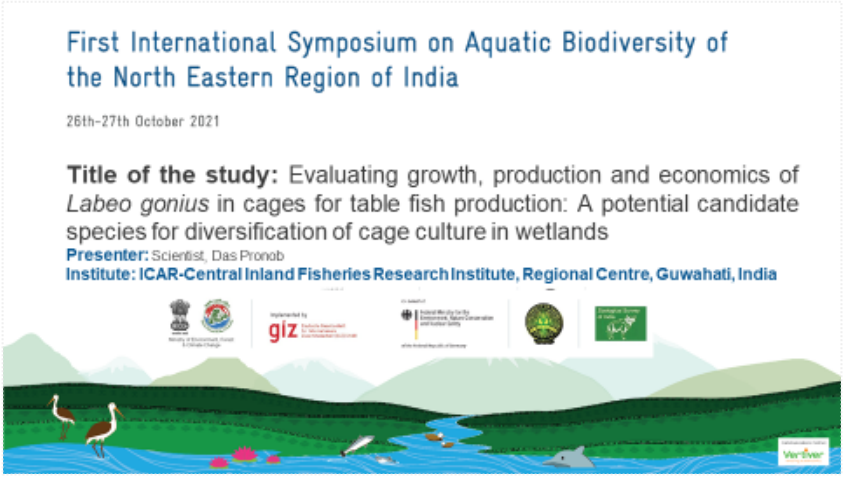
Study Title: Evaluating growth, production and economics of *Labeo gonius* in cages for table fish production: A potential candidate species for diversification of cage culture in wetlands

Authors: Pronob Das, B. K. Das, S. Yengkokpam, D. Debnath, A. K. Yadav, S. Borah, N. Sharma, B.C. Ray, A. Kakati, and B. K. Bhattacharjya

Abstract:

A cage aquaculture experiment was carried out to optimize the stocking density of *Labeo gonius* fingerlings for table fish production under monoculture system in CIFRI GI-cages (individual cage dimension: 5 x 5 x 2 m) for the first time in a seasonally open floodplain wetland of Assam, Samaguri beel. Fingerlings of *Labeo gonius* (av. length 7.54 cm; av. weight 4.48 g) were stocked at five different stocking densities i.e., 10 (S1), 20 (S2), 30 (S3), 40 (S4) and 50 fingerlings/m^3 (S5) in triplicates in cages. Fish were fed with CIFRI CageGrow feed containing 30% CP @ 3-5% body weight twice-a-day for six months. Sampling for growth and water quality was carried out monthly. Water quality was monitored inside all the cages and also outside the cages at 1 m and 5 m away from the cages. The water quality parameters were observed to be similar in all the sites at any particular sampling time. Results of the experiment indicated that growth performance of the fish at highest density was the lowest and those at lowest density was the highest. The final body weight, weight gain percent, specific growth rate and feed conversion ratio of the fish at 20, 30 and 40 fingerlings/m^3 was not significantly different ($p>0.05$) from each other. However, the highest biomass was achieved at stocking density of 40 fingerlings/m^3 (83.96 kg/cage). Economic analysis showed that B:C ratio was the highest (1.68) at stocking density of 40 fingerlings/m^3. Hence, a stocking density of 40 fingerlings/m^3 can be considered optimum for producing table-sized *L. gonius* in cages in the beels of Assam, which can be replicated in other parts of the country with similar climatic condition.

Presentation



Research Overview

- Floodplain wetlands of India are productive ecosystems supporting rich aquatic biodiversity and contribute to total fish production of the country.
- Indian state of Assam has vast water resource under floodplain wetlands (locally called beels) with 100,815 ha area (Das et al., 2010; Das et al., 2017, 2018).
- The estimated fish production potential of these wetlands is 1000-1500 kg ha-1yr-1 (Sugunan and Bhattacharjya, 2000).
- However, fish production is not sufficient to meet the demand despite having vast aquatic resources in the state (Yadav et al., 2020). These wetlands offer potential for capture as well as culture-based fisheries.
- Cage aquaculture is one of the options in these wetlands either for in-situ rearing of fish fingerlings followed by stocking them in the beel proper for stock enhancement or for rearing table-size fish for consumption.

Research Overview Contd…

- Standardization of package-of-practice for locally-demanded fish species and their culture in cages is essential for increasing fish production. In other words, diversification of species for cage aquaculture is very important for promoting the technology for wider adoption, growth, farmers' livelihoods and regional sustainability.
- *Labeo gonius* is potential species for diversification of aquaculture in India (Das et al., 2010). However, there is scanty of information on the cage culture of the species in a floodplain wetlands of Northeastern India.
- **Study Objective**: To optimize the stocking density of *Labeo gonius* fingerlings for table fish production under monoculture system in cages in a seasonally open floodplain wetland of Assam.
- **Study Timeline**: From (date) to (date): June, 2019 to Dec, 2019
- **Geographic scope**: Floodplain wetlands
- **Species covered** (if any): *Labeo gonius*

Study Methodology

- A battery of ICAR-CIFRI GI-cages (16 nos.) installed in Samuguri beel, Nagaon district of Assam.
- Depth of the cage site: 6-7m and free from aquatic weeds.
- Dimension of the individual cage: Total area: 5 x 5 x 2m (50 m^3) and total water area : 5 x 5 x 1.6 m (40 m^3).
- The cages were stocked with fingerlings of *Labeo gonius* at five stocking densities i.e., 10 (S1), 20 (S2), 30 (S3), 40 (S4) and 50 fingerlings/m^3 (S5) in triplicates.
- The average length and weight of the stocked fish was 4.48cm and 7.54g, respectively.
- Fish were fed with CIFRI CAGEGROW floating feed containing 28% CP @ 3- 4 % body weight.
- Monitoring of growth and water quality parameters were carried out every month.

Study Methodology (Contd…)

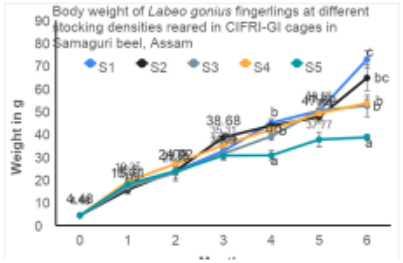
- Water samples were collected from inside all the cages in replicates for assessing important water quality parameters governing fish production and were analyzed with standard methods (APHA, 1998).
- 30 fish were sampled for length and weight measurements from each cage at monthly interval.
- Growth performance of the fishes were estimated in terms of weight gain percent (WG %), specific growth rate (SGR) and daily weight gain (DWG).The daily mortality was noted and survival rate was calculated.
- FCR = Dry feed supplied (g) / wet weight gain (g).
- PER : Body weight gain (wet wt)/ crude protein fed.
- The total harvest from each cage gives the biomass or gross yield (kg cage-1). The net yield (in kg cage-1) was calculated as: Biomass harvested – Biomass stocked.
- Benefit-cost ratio (BCR) was calculated as gross revenue/ total cost.
- One-way ANOVA was used to analyze the data statistically.

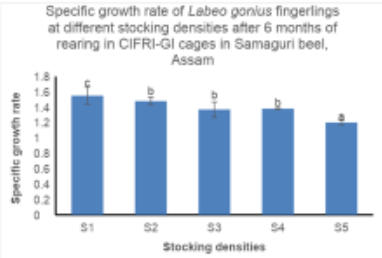
Key Threats and Opportunities

- ✓ Fish production is not sufficient to meet the demand despite having vast aquatic resources in Assam.
- ✓ Lack of scientific knowledge and awareness among wetland beel fishers on cage culture.
- ✓ Scope for fish production enhancement in floodplain wetlands (beels). These wetlands offer potential for capture as well as culture-based fisheries.
- ✓ Cage culture in deeper wetlands for raising fish seed/ production of table fish.
- ✓ *Labeo gonius* as potential candidate species for wetland cages.
- ✓ Sustainable utilization of beels fisheries resources.

Key Observations/Findings

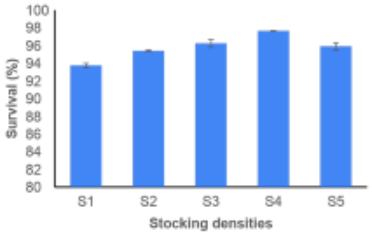
- ➢ Growth performance of the fish at highest density was the lowest and those at lowest density was the highest.
- ➢ The final body weight, weight gain percent, specific growth rate and feed conversion ratio of the fish at 20, 30 and 40 fingerlings/m3 was not significantly different ($p>0.05$) from each other.

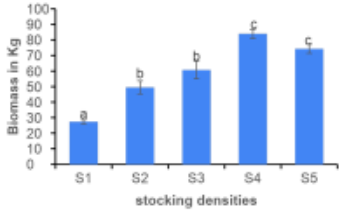




Key Observations/Findings

- Survival of 93.75 to 97.65% was recorded in the different stocking densities.
- Highest biomass (83.96 Kg/ cage) in the six months rearing period was recorded at stocking density of 40 fingerlings/ m^3.
- The water quality parameters were observed to be similar in all the sites at any particular sampling time.
- Economic analysis showed that B:C ratio was the highest (1.68) at stocking density of 40 fingerlings/m^3.





Key Recommendations

- ➢ Fishes stocked at 40 fingerlings/m^3 yielded the highest production (84 kg/cage) and economics with B:C ratio of 1.68.
- ➢ Hence, stocking density of 40 fingerlings/m^3 can be considered optimum for producing table-sized *L. gonius* in cages in the beels of Assam, which can be replicated in other parts of the country with similar climatic condition.

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Presenter 49: Robertson Basan

Study Title: Enhancing Sustainable Management of Aquatic Resources: “Friends of the Umngi River” and Community: A New Approach to Riverine Biodiversity Conservation

Author: Roberston Basan

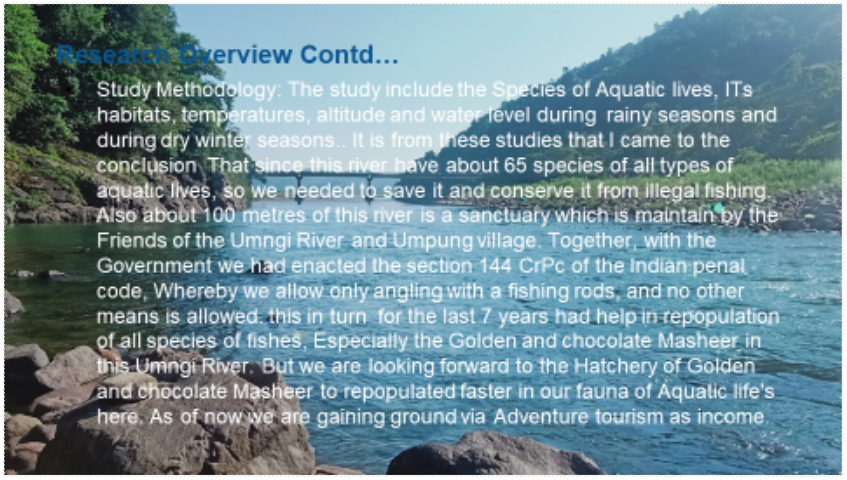
Abstract:

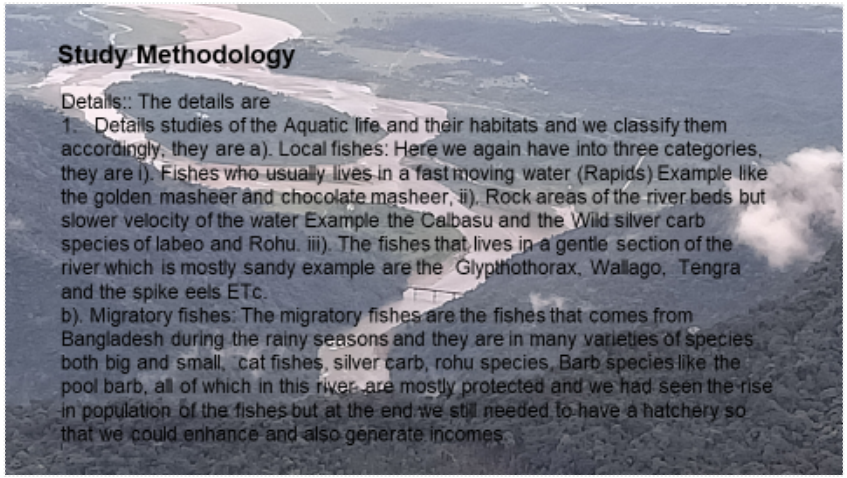
Since, 2014, the Friends Of The Umngi River, an organization looking into making the eco system of the River Umngi from southwest khasi hills district had been form with about twenty villages as it’s core member, with two representative from each village. Intensive research to safeguard this river started. This is due to the facts that, over fishing, by Fishing nets, fish traps, using of chemicals and blasting of dynamites, to such and extent that the population of the local fishes and aquatic life’s is becoming very less. Seeing this The Friends of the Umngi river had approach the then Deputy Commissioner of Southwest Khasi Hills District and requested the Government Administration and then by 2015 this whole Umngi River had been apply with the section Crpc 144 of the Indian penal code, banning the uses of fishing nets, using of chemicals and dynamites and fish traps. The twenty villages from Southwest khasi hills district, under the umbrella of The Friends Of the Umngi River are the ones looking for the welfare of this river and to see that this Section CrPc 144 in enacted and strict vigilance are been done to safeguard the aquatic life’s and fishes. After three to four years and till date we can see the river is trying to repopulate itself and our group are still strong and are looking to repopulate this river and only angling by fishing lines and hooks is allow. This in turn boost adventure tourism and thereby help the locals to get employ via the eco tourism and also, by angling they can also get earning by selling there catches to the local markets. It is here, that we as the friends of the umngi river wanted to started with whatever less amount of finance we have from donation from well wisher to carry out the hatchery for Golden and Chocolate masheer, because only this will help in bringing back the local exotic fishes and as well as repopulate not just this river but other rivers in the whole state. Because, Meghalaya, is a natural habitat for golden masheer and chocolate masheer, whereby, after these small fishes are fit to release in the river the organization will release them back in the river in particular parts of the whole river Umngi and if we could have a hatchery for these exotic fishes then definitely we can repopulate better for this Umngi in particular and other rivers in the state in general. This Hatchery will also needed a diesel water pump to pump fresh water from the river to the hatchery making a water current in the pool as to went ever needed as these types of masheer needed more oxygen dissolved and slow moving water. The Organization will operate the whole setup of the hatchery with Umpung village to take care of these hatchery facilities. It is to be noted and with gratitude for Umpung village as it donates the plot of lands to the friends of the Umngi River for this hatchery mission of Golden mahseer and chocolate mahseer.

Presentation

Research Overview: Conservation of Golden and Chocolate Mahseer and Hatchery which will help repopulate the Umngi River again.

- Study Objective: Hatchery and conservation of Golden and Chocolate Mahseer at Umngi River, Umpung village.
- Study Timeline: From (2000) to (2020)
- Geographic scope: The river flows for about 84 Km. all the way to one big lake at Bangladesh and from here through a series of channel it reaches the Bay of Bengal. This River have rich Biodiversity in Flora and Fauna.
- Species covered : The species study are : Golden Mahseer, Chocolate Mahseer, Glipthothorax (Goonch), Wild carp, Wild silver carp,Garra, Balitora, Wallago, Mottled eel, spike eel and many other species of small fishes and shrimp and crabs. All of which lives in different habitats like stones areas , sandy areas, Depth of the river and rapids etc. in the full stretch of the river of about 84 Km.from source to lake at Bangladesh.





Key Threats and Opportunities:

The Key Threats to this conservation efforts is we had started voluntary and involve 20 villages along this bank of the river for about 30 Km. all the way to Bangladesh border. But not all of the villages are as active as Umpung village at conservation So in remote areas of this river people still uses illegal fishing methods like the uses of fish nets, chemical, and blasting of dynamites, but if our organisation finds out we would take stern actions against the person concern. The Opportunity we had seen from this is the fact Eco- Adventure tourism, whereby we had started a sister partners at Umpung village called Saviba Eco Angling tourism association. where we cater adventure tourism for Anglers, Kayakers, Trekkers, Cavers, Rafters Etc. It is here we earn incomes and as well as generate employments and investing in the conservation efforts.

Key Observations/Findings

The Key Observations and findings in these last 10 years and now is the fact the population of all species of the fishes are better but until we have a hatchery then the local fishes like the Golden and Chocolate masheer for a start would be repopulate to 100%, this in turns would help other rivers in the state or the country as whole to buy these fingerlings from us thus earning incomes to maintaining the hatchery and would generate employments.

Key Recommendations

The Key Recommendations and conclusions are the facts that the fishes and aquatic life in the river Umngi is healing again and we could see the fishes bothe in summer and winter seasons and this leads us to finds ways to generate incomes and so adventure tourism is what we had started. Also, the fact that we needed a hatchery is to repopulate our local fishes and the exotic fishes whereby this would attract the attention of tourism and thus we maintain this facility and as well as generate incomes and employment to the local youths or any other institute who wish to come here for their studies at higher levels this would serve the goodwill of our people in the rural sector and a platform for all rural areas to take up this issues and make it work and worth.

Contact Details

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The Friend's Of the Umngi River Association
an Organization to make the local river greener and save the aquatic life.

Presenter 50: Anil Kumar Yadav

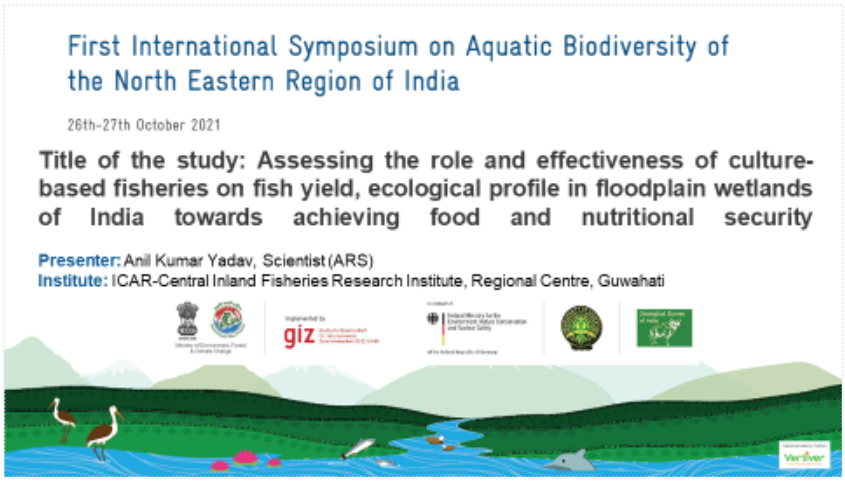
Study Title: Assessing the Role and Effectiveness of Culture-Based Fisheries on Fish Yield, Ecological Profile in Floodplain Wetlands of India towards Achieving Food and Nutritional Security

Author: Anil Kumar Yadav

Abstract:

The present study is a first attempt to assess the role and effectiveness of supplementary stocking of Indian major carps and minor carps covering a large number (37) of floodplain wetlands (*beels*) located in the agro-climatic zone of Brahmaputra basin, North Eastern Region of India. Data on culture based fisheries (CBF) including stocking of fish fingerlings and yield was obtained for the years 2011-12 to 2014-15. The fish yield had a significant positive relationship with stocking density, while a negative insignificant ($p>0.05$) correlation was found between fish yield and area. Mean fish yield increased significantly ($p<0.05$) from 234.51 kg/ha/year during 2011-12 to 443.65 kg/ha/year, 452.43 kg/ha/year and 704.60 kg/ha/year during 2012-13, 2013-14 and 2014-15 respectively through adoption of CBF management regime. Fish production per capita increased significantly ($p<0.05$) from 119.40 kg/fisher/year during 2011-12 to 225.42 kg/fisher/year, 232.77 kg/fisher/year and 358.46 kg/fisher/year during 2012-13, 2013-14 and 2014-15 respectively, which benefitted 2262 fisher families. Floodplain wetlands of Brahmaputra basin are characterized by optimum dissolved oxygen levels with few exceptions and are slightly acidic to alkaline by nature. Physico-chemical properties of these resources are within optimum range except nitrate and phosphate. The findings of the study have the potential to act as baseline information on the impact of stocking on fish yield in floodplain wetlands and their ecological characteristics with reference to Eastern India. Further, suitable management measures are also recommended and discussed which can pave way for improving fish yield, ensuring food security from floodplain wetlands of tropical region on a sustainable basis.

Presentation



Research Overview

- Development of fisheries sector, an important agenda of GoI for nutritional security, income and livelihood opportunities for an increasing population in addition to foreign exchange through export.
- India is blessed with vast floodplain wetland resources of 0.5 million ha and are distributed in the Eastern and North Eastern States. They possess varying morphometry, ecological profile and biota.
- Abundant natural fish food resources which expedite high growth rate in fishes stocked from outside sources makes floodplain wetlands an ideal candidate for CBF (Sugunan and Bhattacharjya 2000; Sugunan et al. 2000; Vinci 2001).
- In recent past, the research and impact of enhancement technologies in inland open waters is being pursued with varying success (Sarkar et al. 2018, 2020). However, most of the reports are based from the reservoirs and the assessment from floodplain wetlands are inadequate
- Thus, systematic information on stocking and its relationship with yield is essential to refine existing management strategies for floodplain wetlands at different ecoregions and pave way towards realizing it production potential.
- **Study Objective:** To assess the impact of culture-based fisheries on fish yield from a large number of floodplain wetlands, effectiveness of stocking and also to discuss the ecological characteristics of the wetlands located in the agro-climatic zone of Brahmaputra basin, NER of India
- **Study Timeline:** April, 2011 to March, 2015
- **Species involved:** Wetlands were stocked with fingerlings of IMCs (*Labeo catla*, *L. rohita* & *Cirrhinus mrigala*), minor & medium carp (*L. bata* & *L. gonius*)

Study Methodology

- Surveys of 37 floodplain wetlands (under AFDC) of Assam were conducted to assess final fish yield per unit area (kg/ha/year), per capita fish production (fish catch/fisher/year) and to establish the relationship between area, stocking density and fish yield.
- Information on stocking and fish yield was collected from the lessee or co-operative societies managing the wetlands. Data on wetland area were gathered from the AFDC.
- Relationships between average stocking density, area and fish yield of the selected wetlands were determined through regression analysis
- Primary and secondary hydrological data were collected from the wetlands following standard methodology (APHA 2012; Sugunan and Bhattacharjya 2000; Sarkar et al., 2020).

Key Threats and Opportunities

Threats

- ✓ High fishing pressure on natural stocks
- ✓ Indiscriminate fish stocking practices
- ✓ Loss of connectivity to parent river & siltation

Opportunities

- ✓ High production potential of floodplain wetlands
- ✓ Scope for fish stock enhancement in seasonally open and closed beels
- ✓ High demand of fish cultures/ caught from wetlands
- ✓ Community fisheries management
- ✓ Steady development of CBF in wetlands in the state during last decade

Key Observations/Findings

- ✓ Fish yield had a significant ($p<0.05$) positive relationship with stocking density, while a negative insignificant ($p>0.05$) correlation was found between fish yield and area.
- ✓ Mean fish yield increased significantly ($p<0.05$) from 234.51 kg/ha/year during 2011-12 to 443.65 kg/ha/year, 452.43 kg/ha/year and 704.60 kg/ha/year during 2012-13, 2013-14 and 2014-15 respectively through adoption of CBF management regime. Study observed that 40.54%, 37.84% and 78.38% of total wetlands showed two times increase in mean fish yield during the period of supplementary stocking viz. 2012-13, 2013-14 and 2014-15 respectively as compared to pre-stocking period 2011-12.
- ✓ Fish production per capita increased significantly ($p<0.05$) from 119.40 kg/fisher/year during 2011-12 to 225.42 kg/fisher/year, 232.77 kg/fisher/year and 358.46 kg/fisher/year during 2012-13, 2013-14 and 2014-15 respectively, which resulted in increased revenue from 0.43 million US $ in 2011-12 to 0.96 million US $, 1.08 million US $ and 1.92 million US $ during 2012-13, 2013-14 and 2014-15, respectively, thereby benefitted 2262 fisher families dependent on these 37 beels across 12 districts.

Key Recommendations

- ✓ About 60% of the total available area of a floodplain wetland may be brought under culture-based fisheries regime; 30% for capture fisheries and 10% for conservation of fish stocks.
- ✓ As recommended by ICAR-CIFRI, SD of 3000 fingerlings/ha for closed wetlands and 3600 fingerlings for open wetlands) may be followed. Stocking with advanced fingerling (>10cm) would result in better survival and return. Stocking with yearlings should be promoted, subject to availability.
- ✓ Certain floodplain wetlands retain critically low water levels during summer and experience floods during monsoon season. In such cases in deep pools, pen culture with extendable pen walls above high flood level, late stocking and early harvesting can be an efficient management measure.
- ✓ Fishers' co-operatives and co-management regime should be promoted. Co-operatives should be strengthened to take up fisheries enhancement programs in near future in an independent manner.
- ✓ Documentation/ log books on stocking, harvesting, gear used, CPUE and fisher's income should be maintained by concerned departments/ agencies to quantify the impact of management regimes and developmental schemes.

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Presenter 51: Dr Simanku Borah

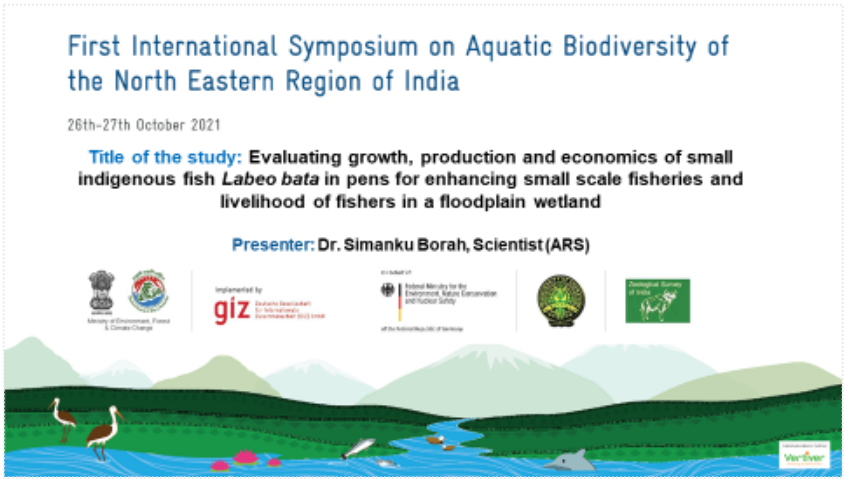
Study Title: Evaluating Growth, Production and Economics of Small Indigenous Fish *Labeo Bata* in Pens for Enhancing Small Scale Fisheries and Livelihood of Fishers in a Floodplain Wetland

Authors: Simanku Borah, Nilmani Rabha, A.K. Yadav, Gunjan Karnatak, B.K. Bhattacharjya, and B.K. Das

Abstract:

Fry of *Labeo bata* were reared in HDPE pens at different stocking densities to determine the growth, survival, feed utilization efficiency and economics in Borkona beel, Barpeta district, Assam. Pens (500 m^2 each) were stocked with fry (6.47 ± 0.22 cm mean total length and 2.38 ± 0.30 g mean weight) at four different stocking densities of 3 (SD3), 5 (SD5), 7 (SD7) and 9 (SD9) no. m^{-2} in triplicates. Feeding was done with floating pelleted feed containing 28% crude protein and 5% fat two times at the rate of 3-5% body weight. During the culture period fish grew from 2.38 ± 0.30 g to 82.78 ± 3.18, 75.94 ± 0.89, 71.94 ± 0.89 and 61.81 ± 3.35 g at stocking densities of 3, 5, 7 and 9 no. m^{-2} respectively. Weight gain percent and specific growth rate decreased with increasing stocking density. Weight gain percent was found to range from 2491.85 ± 140.56 to 3371.33 ± 133.16 and specific growth rate from 1.41 ± 0.02 to 1.55 ± 0.02. Net and gross yield increased with increasing stocking density and found highest at SD9 (239.85 ± 13.53 kg pen^{-1} and 249.48 ± 13.53 kg pen^{-1} respectively). Benefit cost ratio increased with increasing stocking density and was highest at SD7 (1.42), following which benefit cost ratio declined slightly. Fish yield per unit cost was found to be highest at SD7 (0.53 kg $US\$^{-1}$) and cost per unit yield was found to be lowest at SD7 (1.90 US$ kg^{-1}). Thus, stocking density of 7 no. m^{-2} can be considered as economically optimum for table fish production of *L. bata* in pens. Important water quality parameters influencing fish growth were measured and significant difference ($p>0.05$) was not observed across treatments (inside pens) and with reference site (outside pen at 10 m distance). Harvested fishes were released in the wetland for enhancing small-scale fisheries and livelihood of fishers. The present study can provide impetus towards diversification of fish species in pen enclosures for table fish production as well as enhancement in floodplain wetlands.

Presentation



Research Overview

- Pen is a type of fixed enclosure, enclosed on all sides except bottom (Kutty and Campbell, 1987).
- Small-scale fishers (SSF) refer to fishers operating labour-intensive traditional crafts and gears (Smith and Basurto, 2019).
- Floodplain wetlands are one of the major SSF resources of India, providing source of livelihood to sizeable fisher population (Das et al., 2021).

Research Overview Contd…

- Present experiment was undertaken to:

✓ Document growth, survival and economics of table fish production of *Labeo bata* in pens in floodplain wetlands.

✓ Improvement in income and livelihood of SSF through pen culture of indigenous fish in floodplain wetlands of north-eastern region.

- Experiment was conducted from November 2020 to February 2021.

Study Methodology

- Fry of *L. bata* (0.47 ± 0.22 cm, 2.38 ± 0.30 g) were stocked at 3 no. m^{-2} (SD3), 5 no. m^{-2} (SD5), 7 no. m^{-2} (SD7) and 9 no. m^{-2} (SD9) in triplicates.
- Culture period: 100 days.
- Growth of fish and water quality (inside and outside pens) monitored at 20 days interval.
- Growth performance: weight gain percent (WG%), specific growth rate (SGR) and daily weight gain (DWG).
- BCR = gross revenue / total cost.

Key Threats and Opportunities

- **Threats**

✓ Although listed under 'Least Concern' IUCN category (IUCN, 2020), this species is declared endangered in Bangladesh (Debnath et al., 2021).

✓ Severe population decline witnessed from natural water bodies (Rahman et al., 2012).

- **Opportunities**

✓ Pen culture protocols for this important and prized small indigenous fish (SIF) will help in reducing fishing pressure on its natural stocks.

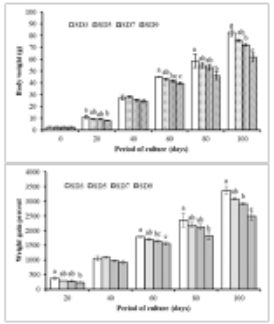
✓ *L. bata* in the size range of 15-150 g is marketable and >50 g size fish fetches high market price in India.

✓ Pen culture of *L. bata* will contribute towards improving income and livelihood of small scale fishers in floodplain wetlands.

Key Observations/Findings

Parameters	Stocking Densities			
	SD3	SD5	SD7	SD9
Final length (cm)	$20.31^{a} \pm 0.11$	$19.84^{ab} \pm 0.13$	$19.26^{bc} \pm 0.01$	$18.82^{c} \pm 0.46$
Final weight (g)	$82.78^{a} \pm 3.18$	$75.94^{ab} \pm 0.89$	$71.94^{b} \pm 0.89$	$61.81^{c} \pm 3.35$
WG%	$3371.33^{a} \pm 133.16$	$3084.78^{ab} \pm 37.66$	$2917.03^{b} \pm 37.66$	$2491.85^{c} \pm 140.56$
SGR	$1.55^{a} \pm 0.02$	$1.50^{ab} \pm 0.01$	$1.47^{b} \pm 0.01$	$1.41^{c} \pm 0.02$
DWG	$0.80^{a} \pm 0.03$	$0.74^{ab} \pm 0.01$	$0.70^{b} \pm 0.01$	$0.59^{c} \pm 0.03$
FCR	2.32 ± 0.19	2.34 ± 0.19	2.35 ± 0.19	2.37 ± 0.18
PER	1.52 ± 0.30	1.42 ± 0.27	1.35 ± 0.26	1.20 ± 0.22
CV	0.37 ± 0.06	0.42 ± 0.07	0.47 ± 0.08	0.34 ± 0.07
Survival (%)	$95.60^{a} \pm 0.81$	$94.30^{ab} \pm 0.86$	$92.30^{b} \pm 1.01$	$89.70^{c} \pm 0.70$
Gross yield (kg pen^{-1})	$118.70^{a} \pm 4.55$	$179.04^{b} \pm 2.12$	$252.42^{c} \pm 2.90$	$289.48^{d} \pm 13.53$
Net yield (kg pen^{-1})	$115.28^{a} \pm 4.55$	$173.42^{b} \pm 2.12$	$224.71^{c} \pm 2.90$	$259.85^{d} \pm 13.53$

*Values with different superscripts indicate significant difference ($p<0.05$)



- BCR Ranges from 1.10 (SD3) to 1.42 (SD7).
- No significant difference in water quality parameters (DO, pH, TDS, CO_2, Alkalinity and Transparency) was observed inside and outside pens.
- Income per fisher increased from 6.16-40.95%.

Key Recommendations

- Development of pen culture protocols for indigenous fish species having high demand across regions like *L. bata* can contribute towards better income for SSF in floodplain wetlands.
- Pen culture of *L. bata* in floodplain wetlands is economically and ecologically viable.
- Results indicate that stocking density of 7 no. fry m^{-2} has the highest BC ratio of 1.42 followed by 9 no. fry m^{-2} (1.41). Thus stocking density of 7-9 no. m^{-2} can be recommended for culture of this species in pens.

Contact Details

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Presenter 52: Pratap Sinha & Jeherul Islam

Study Title: Sustainable Aquaculture for Food and Livelihood (Safal)

Authors : Stephanie Vogel, Pratap Sinha and Jens Kahle

Abstract:

Even though fish farming is well established in India, there are bottlenecks in the technical and financial capacity of fish producers as well as in the access to quality fingerlings, feeds and financial services. This slows down the expansion and sustainable development of aquaculture and the supply of fish products to the population. Fish is an important source of nutrients for humans and due to its competitive price; it is of exceptional importance for vulnerable parts of the population. The project "Sustainable Aquaculture for Food and Livelihood (SAFAL)" aims to promote sustainable and resource-efficient aquaculture, to increase availability of fish on local markets accessible for the food insecure. This shall be achieved by increasing production and generating more income and employment in the fish value chain. SAFAL is implemented in the States of Assam and Odisha, because their aquaculture sectors have an exceptional potential for growth in a sustainable way. The state of Assam in the North East Region (NER) of India produces 71% of the total fish production in the NER. The current aquaculture productivity ranges around 500 kg/ha and has a potential for doubling within a short time. In East India, the state of Odisha also has a long tradition in fish farming. To satisfy the market demand for fish products, Odisha currently depends on imports from neighbouring states (especially Andhra Pradesh), although the aquaculture sector has the potential to meet this demand. To support the development of the aquaculture sector, advisory services and financial literacy among producers shall be improved and production techniques shall be adapted to
Combat the challenges of climate change.

The Indo-German Cooperation project SAFAL is part of the Global Program "Sustainable Fisheries and Aquaculture" (GP Fish) under the special initiative "One World No Hunger" (SEWOH). The target groups of SAFAL are small-scale fish farmers, Farmer Producers Organization (FPOs), Self Help Groups (SHGs) and Aquaculture Service Providers (ASPs). The following activities are foreseen:

1. **Training** on aquaculture techniques, business education and organizational structures of fish farmers and multipliers to improve productivity, profitability and the ability to successfully access financial services provided by government schemes.
2. **Organizational capacity building** for FPOs, SHGs and ASPs, to diversify their income generating activities, their services to farmers and to strengthen their organizational structure.
3. **Support the policy framework,** which provides the frame for the development of a sustainable and resource-efficient aquaculture. Sharing of experiences from project implementation and the support of a multi-stakeholder platform shall promote knowledge exchange among aquaculture stakeholders, government agencies, civil society organizations and academia.

The Ministry of Fisheries, Animal Husbandry & Dairying (MoFAHD) will be the main partner at the national level and will coordinate with the fishery departments of Odisha and Assam. Further important actors at state and local level are the Assam State Rural Livelihood Mission (ASRLM), Odisha Livelihood Mission (OLM), NGOs, the Central Institute of Freshwater and Aquaculture (CIFA), Odisha, College of Fishery Science, Assam, as well as Central Inland Fishery Research Institute (CIFRI), Assam.

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Title of the project: Sustainable Aquaculture for Food and Livelihood (SAFAL)

Presenter: Project Leader, Pratap Sinha & Technical Advisor, Jehirul Islam

Institute: GIZ India

Federal Ministry for Economic Cooperation and Development (BMZ) Special Initiative ONE WORLD – No Hunger

Global Objective: Eradicating hunger and malnutrition through agriculture, rural development and food Security

Focal Points:

- Creating ways out of poverty through sustainable agriculture.
- Increase income through capacity building and promotion of value chains.
- Contributing to greater prosperity in rural areas.
- Using natural resources sustainably.
- Offer young people livelihoods alternatives.

Global Programme Sustainable Fisheries and Aquaculture

Global Programme Sustainable Fisheries and Aquaculture

- Increase supply of sustainably sourced fish
- Boost jobs and incomes

Project Overview

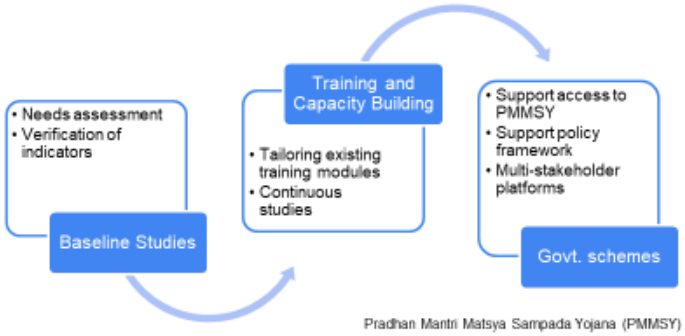
- Project Objective: Improving food security by **enhancing fish production and income** from sustainable and resource-saving aquaculture in ponds.
- Project Timeline: From 05/2021 to 05/2024
- Geographic scope: **Assam** and **Odisha**
- Species covered: Fish species used in aquaculture ponds (**Indian Major Carps, exotic and minor carps, tilapia, pangasius**, etc.)
- Project Indicators:

Project Overview

Target Groups	Training and Capacity Building Activities	(Potential) Partners	Objectives
SHGs FPOs ASPs	• Aquaculture principles and techniques • Financial literacy • Diversification of income (feed production, training centers, processing, hatchery) • Business development • Linkage in the fish-value-chain	• State Government/Schemes • Research Institutions • NGO • Consultancy • Financial Institutions	• Food and nutrition security • Income enhancement • Entrepreneurial and financial skill development • Value-chain development • Economic sustainability • Improved Access to Finances and Schemes

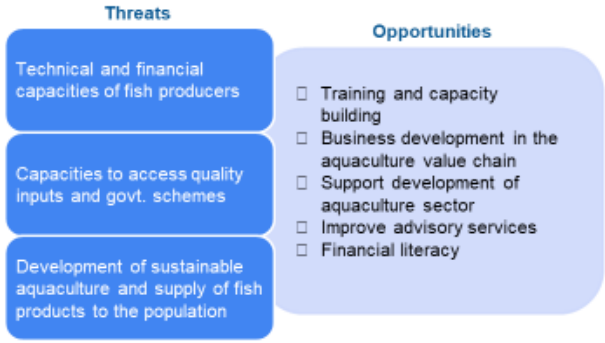
Self Help Groups (SHGs), Farmer Producer Organisations (FPOs), Aquaculture Service Providers (ASPs)

Project Methodology

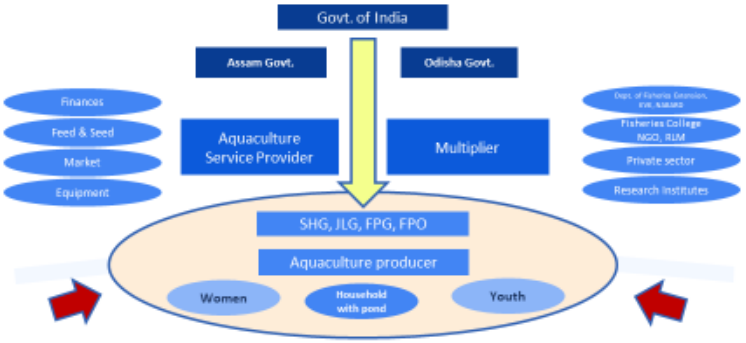


Pradhan Mantri Matsya Sampada Yojana (PMMSY)

Key Threats and Opportunities



Key Observations/Findings



Key Recommendations

Training and capacity building of community resource persons (CRPs)	sustainability/reach out to farmers
Tailoring existing training manuals on sustainable and resource-saving aquaculture	ensure didactic methodology
Capacity building on financial literacy and organizational structure of FPOs/SHGs/ASPs	improve access to govt. schemes
Promote business development in the fish value chain	empower women and youth
Support multi-stakeholder platforms	knowledge exchange among value chain actors, govt., civil society and academia

Zambia: Fish traders selling dried fish

GP Fish: 22,900 jobs created for women

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Presenter 53: Trishna Burman

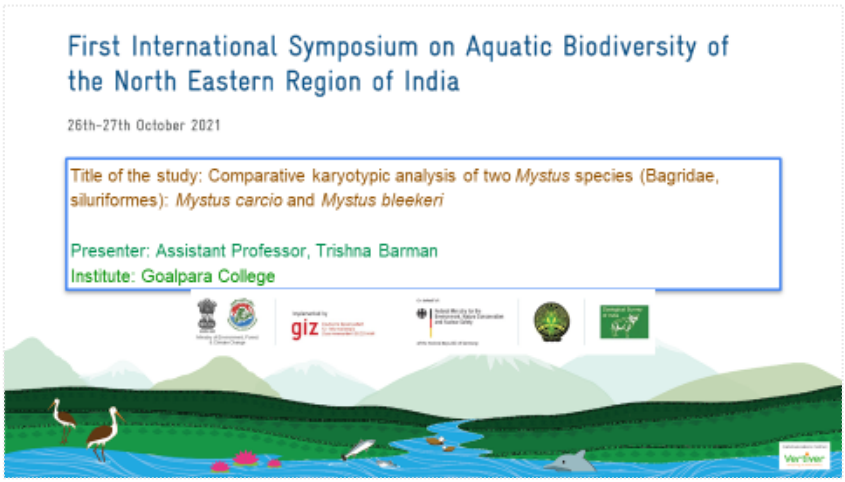
Study Title: Comparative Karyotypic Analysis of two Mystus Species (Bagridae, Siluriformes): *mystus carcio and mystus bleekeri*

Authors: J Deka, B Mech,T. Barman, H Choudhury, KK Lal and D Sarma

Abstract:

Comparative karyotypic analysis of two bagrid catfishes, *Mystus carcio* (Hamilton, 1822) and *Mystus bleekeri* (Day, 1877) were performed by conventional cytological techniques. Obtained data revealed that the two studied species have different chromosome numbers and karyotype complements. The diploid chromosome number for *Mystus carcio* is 2n=52 consisting 18 metacentric, 6 submetacentric, 6 acrocentric, and 22 telocentric chromosomes while that of *Mystus bleekeri* is 2n=56 with 32 metacentric, 14 submetacentric and 10 telocentric chromosomes. Fundamental number is 76 and 106 for *Mystus carcio* and *Mystus bleekeri* respectively. No heteromorphic sex chromosomes were detected for these two species. This comparison confers different cytological patterns for both the studied species and specifies the existence of karyotypic diversity within the genus. This study may contribute to better taxonomic characterization of the studied species.

Presentation



Objectives of the study

1. To investigate the cytogenetic profile of two *Mystus* species, *Mystus carcio* and *Mystus bleekeri*.
2. To recognize the karyomorphological variation between the two selected *Mystus* species.

Relevance of the study: Geographical scope

- Despite of so much diversity of freshwater fish in NE India only a few works have been reported from the region regarding their cytological characterization.

1. Assam always seizes the importance when it comes to species richness and endemism of fish. Though the state holds significant potential for aquatic research & development; in recent years a reasonable number of fish species have been exploited and found under harsh declination due various natural and anthropogenic stresses.
2. There is a possibility that some important fish species may undergo unrecognized extinction unless they are documented at a faster pace.
3. Knowledge of genetic diversity of fish species will definitely help to adopt conservation strategies.

Selected fish species

- *Mystus carcio* (Hamilton, 1822)
- *Mystus bleekeri* (Day, 1877)

Methodology

- Collection of live fishes.
- The specimens were transported to the laboratory in oxygen-filled polythene bags and kept in a well-aerated aquarium for acclimatization for 24 hours.
- For karyotyping they were injected intramuscularly with 0.05% colchicine (Sigma, USA) @ 1 ml/100 g of body weight. After 2 hours, they were euthanized with an overdose of clove oil.
- The gill and kidney tissues were processed for chromosome preparation following the KCl-acetomethanol flame-drying method (Kushwaha *et al.*, 2018).

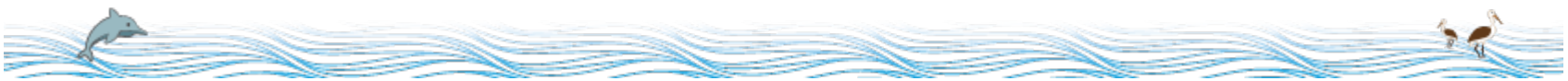
- Chromosome preparations were stained with 5% Giemsa in phosphate buffer (pH 6.8) and observed under a Leica DM3000 microscope.
- The best metaphase spreads were identified and subsequently photographed under 100X oil immersion lens using a Leica DFC295 camera fitted to the microscope.
- For each fish specimen, at least 50–100 metaphase spreads were studied. Chromosome complements of three well-spread metaphase were measured individually, and their centromeric indices and arm ratios were determined to assign the respective morphology as per Levan *et al.* (1964).

Major threats

- Freshwater fishes now have become the most threatened group of vertebrates due to habitat modification, fragmentation, and destruction; invasive species; overfishing; environmental pollution etc. (Reid *et al.*, 2013).

Opportunities

- Global surveys indicate that an average of 300 new fish species are described each year and there could be at least 5,000 fish species more to be discovered.
- Assam is considered as the home of diverse fresh water fishes but cytogenetic characterisation is still left over. There is a huge possibility that many more fresh water fish species inhabiting this region are yet to be discovered.
- Proper genetic documentation may introduce new & cryptic species.



Results

- Somatic metaphase complements from a majority (80%) of cells studied ascertains the diploid chromosome number in *Mystus carcio* & *Mystus bleekeri* to be *2n*=52 & 2n=56 respectively.
- For *Mystus carcio* the karyotype consists of 9 pairs of metacentric (m), 3 pairs of submetacentric (sm), 3 pairs of acrocentric (a) and 11 pairs of telocentric (t) chromosomes with fundamental arm number (FN) of 76. The largest chromosome pair is a subtelocentric chromosome pair (No. 10).
- For *Mystus bleekeri* the karyotype comprises 16 pairs of metacentric (m), 7 pairs of submetacentric (sm) and 5 pairs telocentric (t) chromosomes with fundamental arm number 106. The largest chromosome pair is submetacentric (No. 17).
- No heteromorphic sex chromosomes were detected.

Results

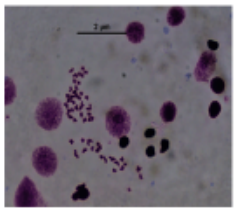


Fig 1: Metaphase spread of *Mystus carcio*, 2n=52

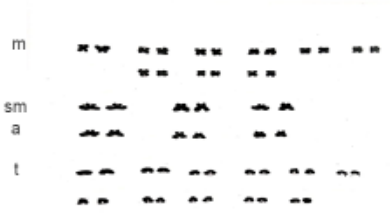


Fig 2: Somatic karyotype of *Mystus carcio* *2n=52 (18m+6sm+6a+22t)*

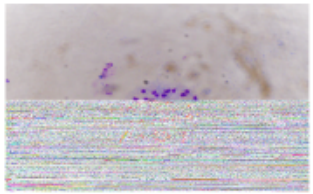


Fig 3: Metaphase spread of *Mystus Bleekeri*, 2n=56

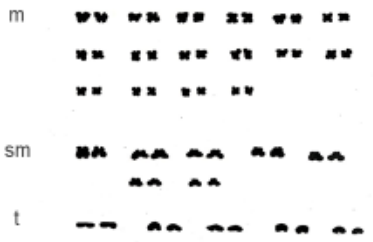


Fig 4: Somatic karyotype of *Mystus bleekeri* 2n=56 (32m+14sm+10t)

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Kushwaha, B., Srivastava, S. K., & Kumar, R. (2018). *Integrative Taxonomy and Systematics in Freshwater Fishes*. Training manual, ICAR-National Bureau of Fish Genetic Resources, Lucknow, Uttar Pradesh.

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Presenter 54: Nirmali Mahanta

Study Title: Osteological Study of *Pethia guganio* (Hamilton, 1822)

Authors : Nirmali Mahanta, Hrishikesh Choudhury and Dandadhar Sarma

Abstract:

Pethia is a genus of small freshwater fish native to South Asia,East Asia and Mainland Southeast Asia.The name *Pethia* is derived from the Sinhalese “Pethia”, a generic word used to describe any of several small species of Cyprinid fishes. For decades, members of this genus were included in *Puntius* until a recent revision (Pethiyagoda et.al 2012).

Although there are reports on the osteological studies of different species of the genus *Pethia* viz, Unmesh Katwate (2013,2014 & 2016) on P.setnai, P.punctata and P.sanjaymoluri respectively, there are no reports on the osteology of *Pethia guganio. Pethia guganio* (Hamilton,1822) is an Actinopterygian fish belonging to family Cyprinidae under order Cypriniformes. It is widely distributed in India (Ganga, Brahmaputra, Yamuna river systems in the Gangetic Provinces, Assam, Bihar, Uttar Pradesh, West Bengal), Bangladesh. Jayaram (1991). This species breeds in upper reaches of permanent rivers, ponds and lakes. *P. guganio* is a widespread species with no known major widespread threats. It is therefore assessed as Least Concern. Current study provides osteological details of *P.guganio* as well as variations in bones in different species of the genus *Pethia.*

Key Words: Osteology, Pethia

Presentation

Research Overview

- Study Objective:

a) To prepare an articulated skeleton of *P. guganio*.

b) To identify the different bones of the endoskeleton

c) To study the similarities as well as differences in endoskeleton among other *Pethia* sp.

- Geographical Area: Dima Hasao

- Species covered: *Pethia guganio*

Research Overview Contd...

- Study Methodology:

❑Collection: Fishes were collected from Diyung river, Haflong (Dima Hasao District, Assam) in the year 2016.
❑Preservation: Fishes were fixed and preserved in 10% formaldehyde solution.
❑Identification: Fishes were identified following Talwar and Jhingran (1991), and Jayaram (1999). Yazdani and Talukdar (1975) were followed for identification of Pethia guganio.
❑Dehydration: Specimens were dehydrated in 50% ethanol for two days, followed by absolute ethanol for another two days.
❑Staining cartilage: Alcian blue powder is used to stain the cartilage.

Study Methodology Contd.....

❑Neutralisation: Specimens were then neutralised in saturated Sodium-Borate solution for 12 hours.
❑Bleaching: Specimens were kept solution containing 3% hydrogen peroxide and 1% potassium hydroxide solution for 40 minutes to remove the pigments.
❑Trypsin digestion
❑Staining bone: Bones were stained by keeping the specimens in 1% potassium hydroxide solution with Alizarin red stain powder.
❑De-staining
❑Preservation

Key Importance

a)Necessary for a complete understanding of the main functions of the fish.

b)It also gives clues as to the species, sex, age, and geographical origin of the specimens.

c)Several morphological and meristic characters of the skeleton have been used to identify and classify some taxonomic groups

d)The evolutionary trend in the appearance and development of some of these features provides a clue for the understanding of the position of the fish in the evolutionary scale.

Key Observations/Findings

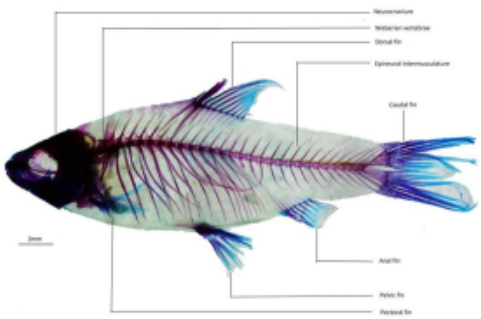

FIGURE: *Lateral view of entire skeleton of Pethia gugonio*

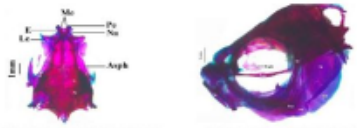

FIG 1: DORSAL NEUROCRANIUM

FIG 2: LATERAL NEUROCRANIUM

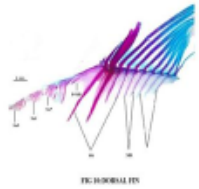

FIG 10:DORSAL FIN

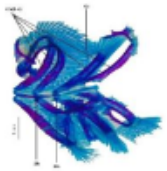

FIG 3: BRANCHIAL ARCH

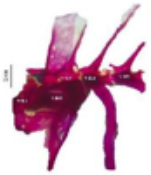

FIG 4: COMPLEX VERTEBRAE

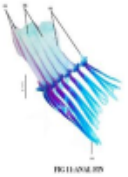

FIG 11:ANAL FIN

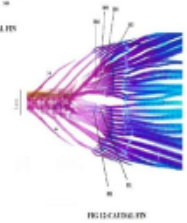

FIG 12:CAUDAL FIN

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Presenter 55: Abhishek Mazumder

Study Title: Histopathological Alterations in the Liver and Kidney Tissues of *Labeo rohita* (Ham, 1822) Infected by *Argulus foliaceus*

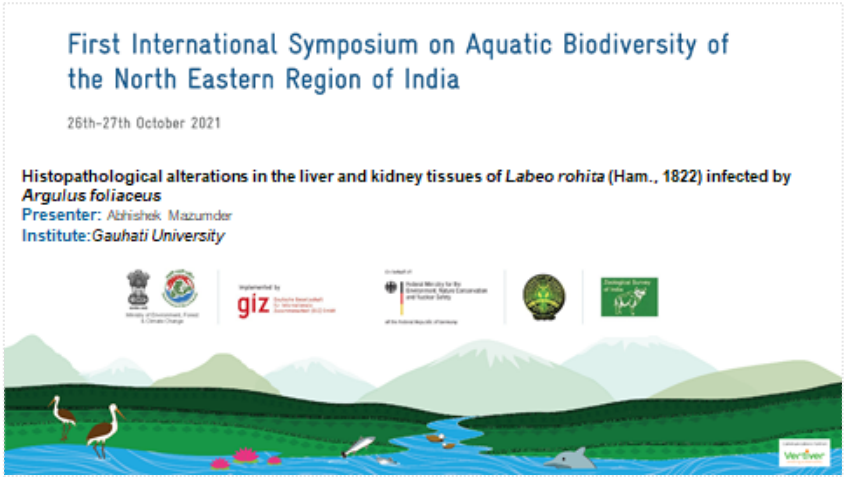
Author: Abhishek Mazumder

Abstract:

The present investigation was carried out in pathological and histological alteration findings from acute and chronic infection in *Labeo rohita* naturally infected with *Argulus*. Fish samples were obtained from fish farmers' kamrup district of Assam. The clinical signs in infested adult fish were lethargy, anorexia, poor growth, erratic swimming and mortality. Histological study revealed marked alterations in liver and kidney tissues in comparison to normal architectures observed in control fish. Degeneration of blood vessels, hypertrophy, increased pyknotic nuclei and lesions were observed in liver. In kidney, shrinkage of the glomerulus, and hyaline degradation. These results can be suggested that histopathological variations influenced by the *Argulus foliaceus* in *Labeo rohita* can act as a susceptible for diseases, a potential threat to fish farmers and leading to economic loss.

Keywords: histology, Argulus, Labeo rohita

Presentation



Research Overview

- **Study Objective:** To investigate histological alterations in *Labeo rohita* naturally infected with ***Argulus foliaceus***
- Study Timeline: From (2017) to (2019)
- Geographic scope: Deepor beel, Ramsar site, wetland ecosystem of Assam, NE India (91.35°–91.43° E and 26.05°–26.11° N)

Research Overview Contd…

- Study Methodology: For the invetigation sample Collection and preservation of *Argulus* followed by Aalberg et al. (2016). Identification of genus *Argulus* followed by G. L. Hoffman(1977), Sophie K. Rushton-Mellor et al.(1994) & K. Aalberg et al.(2016).
- Histopathological study followed by Stockopf's method (1993).

Study Methodology

✔ The infected specimens of carp were brought to the laboratory in live condition and thorough patho-anatomical and histo-pathological observations were made. Macroscopically inspection of the infected specimens including examination of the fins, skin, mucous and blood for ecto-parasitic forms was followed by examination of fresh tissues of liver, kidney.

✔ Tissue samples from the internal organs were also fixed in Bouin's fluid for histo-pathological studies. Paraffin embedded sections were cut by a Rotary microtome and stained by haematoxylin and eosin (H & E). The histological preparations were examined under light microscope and photomicrographs of the stained preparations were made.

Key Threats and Opportunities

✔ Fish disease is a substantial source of monetary loss to aqua culturists.

✔ Parasitic infestation and disease is one of the major problems of fish culture that can cause mass mortality in culture operations

✔ Argulosis performed better at higher temperature in other parts of the world, but in this present investgation we have encountered higher mortalities in winter seasons, therefore, this need to be extensive study for the NE aquaculture environment.

Key Observations/Findings

- ✔ Marked toxic effects were observed at structural and cellular level in the liver from affected site. Disintegration of cell boundaries and slight dilation of blood sinusoids were observed, many damaged hepatic cells and intracellular vacuolation were also apparent. Swollen hepatocytes, lose connection between the cells and increase accumulation of pyknotic nuclei.

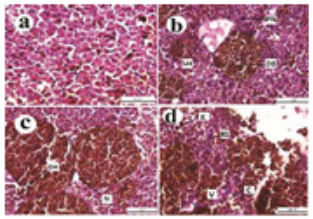


Fig: T.S. of Liver (**a**: Control; **b, c &d**: infected)

- ✔ On microscopic examination kidney tissue of the fish *Labeo rohita* infected with parasite demonstrated necrosis of cell and renal tubules, cloudy swelling in renal tubules, degeneration of cytoplasm within pyknotic nuclei, and disorganization of connective tissue (haemopoietic tissue). The disintegration of cell membrane, hypertrophy of nuclei, vacuoles, and the swelling of glomeruli were also appeared.

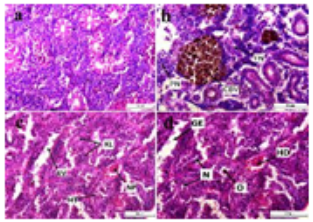


Fig: T.S. of Kidney (**a**: Control; **b, c &d**: infected)

Key Recommendations

- ✔ **Regular monitoring of fish disease will be needed for the better growth of fishes as well as for sustainability of wild stock**

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Presenter 56: Dr Ch. Basudha

Study Title: Ornamental Fish Biodiversity of North-Eastern Region of India: An Opportunity for Entrepreneurship Development

Authors: Ch. Basudha, S.K. Swain, S.K. Das and V.K. Mishra

Abstract:

Northeast India is considered as one of the hotspots of freshwater fish biodiversity in the world. It has rich freshwater resource and the region is a genetic treasure house of the ornamental fish resources. The ornamental fishes have less food value in comparison to others but are the most fascinating, beautiful and lively creatures providing high recreational, economic and aesthetic values. Ornamental fish farming is a promising sector within aquaculture that creates ample growth opportunities, generating income and employment to a large number of unemployed youths in the region. The waters of the region pose a rich diversity of ornamental fish, with 3over 100 varieties. At present, the ornamental fish export from the country is mainly confined to freshwater varieties. It is limited to collected from nature, predominantly in the north eastern states 85% and projected as '**Sleeping Giant'** because a yet untapped potential resource

A comprehensive survey of ornamental fish fauna of northeast India includes 296 species belonging to 112 genera, 36 families and 13 orders with family Cyprinidae representing the maximum number of species i. e., 108 in total and followed by Nemacheilidae. Among the fishes, Cyprinidae and Cobitidae exhibit the greatest variety of colouration and fin modifications rendering them to fit as aquarium fishes. Fishes under the genus, *Aborichthys, Acantopsis, Acantopthalmus, Aplocheilus, Badis, Batasio, Barilius, Botia, Brachydanio, Channa, Danio, Devario, Esomus, Gagata, Lepidocephalichthys, Mystus, Nandus, Notopterus, Pangio, Puntius, Raiamas, Rasbora, Sisor, Sperata, Synchrossus, Trichogaster,* etc are the genera without special devices while *Akysis, Amblyceps, Acanthocobitis, Erethistis, Exostoma, Garra, Glossogobius, Glyptothorax, Hara, Homaloptera, Macrognathus, Mastacembelus, Myerglanis, Olyra, Physoschistura, Pseudecheneis, Psilorhynchus, Pterocryptis, Schistura, Tetraodon, Xenentodon,* etc have special structural modifications for adaptation to their habitats. The state is attributing in having certain endemic fish genera *viz. Aborichthys, Akysis, Amblyceps, Badis, Conta, Erethistes, Erethistoides, Exostoma, Meyersglanis, Sisor* etc.

Most of fish species under these genera are having ornamental value. Most of these fishes are also reported rare and endangered. Standardized breeding and farming techniques of these beautiful fishes will contribute to the economic growth of the state and sustainable development of aquatic resources.

To overcome the challenges, ICAR Research Complex for NEH Region, Manipur Centre initiated study on bioecology and breeding competent of some of selected ornamental fishes in captivity and developed breeding and rearing protocols. Moreover, the Centre initiated demonstration of ornamental fish breeding and rearing in farmer's field in the state in collaboration with ICAR CIFA, Bhubaneshwar.

Key words: Ornamental Fish, indigenous, breeding and rearing

Presentation

First International Symposium on Aquatic Biodiversity of the North Eastern Region of India

26th-27th October 2021

Ornamental Fish Biodiversity of North-Eastern Region of India: an opportunity for entrepreneurship development

Presenter : Dr. Ch. Basudha, Senior Scientist

ICAR Research Complex for NEH Region, Manipur Centre, Lamphelpat, Imphal-795004, Manipur, India.

Overview

- Northeast India being considered as one of the hotspots of freshwater fish biodiversity in the world.
- It has rich freshwater resource and the region is a genetic treasure house of the ornamental fish resources.
- The ornamental fishes have high economic and aesthetic values.

The Region

- The region has immense potential resources of fish and harbours valuable fish germplasm resources.
- The region is blessed with ornamental fishes. Several varieties of fishes that are known in International ornamental Fish market for many years are available in the region.
- 422 + 30 fish species in NE including more than 70 species endemic to this region and have been reported

Objectives

The present study was undertaken the ornamental fish diversity and to analyze the opportunity for entrepreneurship development viabilities ornamental fisheries in the north-eastern region.

Key Threats & Opportunities

- Ornamental fish farming is a gifted aquaculture which creates employment in terms of generating income and employment to the large number of unemployed youth in the country.
  - Presently, the ornamental fish trade in the region is unorganized, sporadic and mostly from wild collection.
- Pollution, land degradation, indiscriminate collection and over exploitation poses a great threat to the survival of the rare varieties of endemic ornamental fish.

Key Observations/ Findings

- 877 fish species inhabit in freshwaters of India. The total fish species reported from north east are consisting of 114 genera under 38 families and 10 orders.
- At Present, 58 species of indigenous ornamental fish species occurring in the north east i.e., 33% of the total export are currently being exported as per MPEDA, India

Assam	217
Arunachal Pradesh	167
Meghalaya	165
Manipur	121
Mizoram	48
Nagaland	68
Sikkim	29
Tripura	134

Key Observations/ Findings

- Since the region is very diverse, it is difficult to obtain scientific-based information on the current status of diversity.
- The region is attributing in having certain endemic fish genera viz *Aborichthys, Akysis, Amblyceps, Badis, Conta, Erethistes, Erethistoides, Exostoma, Meyersglanis, Sisor* etc.

  - Of these, the family Cyprinidae and Cobitidae exhibit the greatest variety of colouration and fin modifications rendering them to fit as aquarium fishes.
  - Small size, hill stream adapted fishes like Nemachiline loaches, cat-fishes, *Puntius/pethia* spp. and the Asiatic glass fishes of the genus *Parambassis* also find important place in the list of aquarium fishes owing to their interesting shapes, transparent body, colourful and lively nature.

Recommendations & Future Strategies

- Ornamental fish farming is a promising venture for many people of this region.
- To conduct research on various aspects including cataloguing and characterization of species, potential methods of collection and from wild, captivity, conditioning, breeding, nutrition, suitable environment, methods and diseases, transportation, channelization of marketing, etc.
- There is need to take plan of action for proper intervention that includes motivation programmes like training and financial support.

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