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Present Status of Freshwater Fish Diversity and Human impact with Particular Reference to North-East India Biodiversity Hotspot

Devashish Kar[1]* and Ankush Kumar[2]

[1]*Micro-Institute of Water and Human Studies, India*

[2]*Department of Civil Engineering, National Institute of Technology, India*

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Corresponding author: Devashish Kar, Micro-Institute of Water and Human Studies, India Email: devashishkar@yahoo.com

Abstract

Biodiversity (BD) is the living component in nature. Biodiversity in the freshwater (FW), domain comprise the FW BD, where `Fish' is the prime component. In fact, fish is said to constitute almost half of the total number of vertebrates in the world and is said to provide with answer to the diminishing protein supply in the globe; having been one of the staple food items in diet of people, particularly, in the developing countries. c 21,723 living species of fish have been recorded out of 39,900 species of vertebrates. Of these, 8411 are freshwater species and 11,650 are marine. However, of late, there has been a depleting trend in fish diversity and yield principally due to shrinkage in the water spread area being impacted mainly by humankind. The present status of Freshwater Fish diversity and the impact of Human interventions have been discussed.

Keywords: Freshwater; Fish Diversity; Human impact

Introduction

The Indian sub-continent is one of the biggest Mega biodiversity regions in the World, occupying 9th position in terms of freshwater Mega biodiversity (Mittermeier and Mittermeier, 1997). In India, there are c 2500 species of fishes; of which, c 930 live in freshwater (FW) and c 1570 are marine [1-3]. This bewildering ichthyodiversity of this region has been attracting many ichthyologists both from India and abroad. Concomitantly, North-Eastern (NE) region of India has been identified as a `Hotspot' of Biodiversity by the World Conservation Monitoring Centre [4]. This rich diversity of this region could be assigned to certain reasons, notably, the geomorphology and the tectonics of this zone. The hills and the undulating valley of this region gives rise to large number of torrential hill streams, which lead to big rivers and, finally, become part of the Ganga-Brahmaputra-Barak-Chindwin-Kolodyne-Gomati-Meghna system [5].

Based on IUCN categories, the CAMP Workshop [6] for FW fishes has identified certain fish species which have attained threatened/endangered status. Concomitantly, there has not been much in-depth study with regard to details of endemism and species richness in North-East (NE) India; although, some amount of works in this regard have been done [7-9]. As such, a detailed study related to Germplasm inventory, evaluation and gene banking of freshwater fishes would not only help us to land at a concrete decision on the above-mentioned aspects but would also contribute to fulfilling India's obligation to CBD with special emphasis on Articles 6 and 8 [10]. Further, development of database on the biological parameters is a pre-requisite for preparation of detailed Fish Inventory. Genetic characterization and Gene Banking is a step forward towards further confirmation of the species at the molecular level.

The river is the basic storehouse of water to meet our country's demand for water for various uses. Indian sub-continent is singularly blessed with unparalleled riverine resources, harboring one of the richest fish wealth in the world. Out of c 2500 species of fishes occurring in India, c 450 species of fishes occur in the Indo-Gangetic plains [11-13]. Menon [14] had listed 207 species of fish from the Gangetic plains which belong to 29 families and 82 genera. According to another estimate, the Gangetic system alone harbour not less than 265 species of fishes [15].

Besides lotic territories, the lentic water bodies having 0.72 × 106 ha lake coverage in India, constitute great potential of fishery resources. The NE region is blessed with a number of

lentic systems, locally called `Beel, Haor, Anua, Hola, Doloni, Jalah, etc., which alone constitute c 81 % of the total lentic area (0.12 × 10^6 ha) in Assam. These lentic systems are generally shallow and open, ranging in size from 35 to 3458.12 ha and with depth ranging from 0.25 to 6.0 m (Dey, 1981) [5,16].

In the Eastern India and in Bangladesh, the wetlands are usually classified into 3 broad categories. These are as follows:

a) Beel: These are the perennial wetland, which generally retain water throughout the year, e.g., Sone Beel, Sat Beel, etc. Sone Beel, one of the biggest (Area-3458.12 ha at FSL) wetlands in India and Asia. Sone Beel has been declared as a Wetland of National Importance by the Government of India mainly based on the research works of the Professor Devashish Kar, the present author of this paper (vide Resolution No. 11 dt. 16.10.2008 of the Meeting of the Expert Group of MOEF, Govt. of India, New Delhi; and Letter No. FRM 41/2008/63-A, dt. 8.9.2008 from Commissioner and Secretary to the Govt. of Assam, Department of Environment and Forests) [17].

b) Haor: These are the seasonal floodplain wetlands, which retain water only for part of year and, are otherwise dry during the rest of the year, e.g., Chatla Haor, Puneer Haor, etc.

c) Anua: These are the river-formed oxbow wetlands formed due to the change of course of a river. Barak being a highly serpentine river, there are a number of such `Anua' s in the Barak valley region of NE India, e.g., Baskandi Anua, Algapur Anua, Satkarakandi Anua, Dungripar Anua,Ramnagar Anua, Salchapra Anua, Fulbari Anua, etc.

However, the above classification of water bodies is not very rigid and may vary from place to place. Notwithstanding the above, structural characteristics of the lotic environment are closely associated with the occurrence of fish species. The importance of habitats and the relationship between fish and habitat are of major concern to fishery biologists. A common use of fish habitats indicates the physical and chemical characteristics of the environment excluding biological attributes. Habitat features have been identified as the major determinants in the distribution and abundance of fish since earlier times [18]. Fish species diversity is associated with habitat complexity with regard to depth, water flow, microhabitat types and substrate types. Recently, fish assemblages have been used as indicators of environmental degradation [19], ecosystem health in streams [20] and environmental stress [21].

A review of literature pertaining to the studies on fish with other parameters (diversity, habitat parameters, use of remote sensing and GIS, fish food fauna, fishing gears and fish catching devices, fish parasites and fish disease with particular reference to Epizootic Ulcerative Fish Disease Syndrome or EUS and other associated aspects) are given below:

[1-4,5-7-9,10-14,15-19-209]

The icthyofauna of North-East (NE) region of India has elements of the Indo-gangetic region; and, to a some extent, of the Myanmarese and South-Chinese regions [15]. Ghosh & Lipton [55] had reported 172 species of fishes with reference to their economic importance, while Sen [200] reported 187 species of fishes from Assam and its environs. Sinha [202] compiled a list of 230 species of fishes from NE India. Nevertheless, Nath & Dey [189] recorded 131 species of fishes from the drainages in Arunachal Pradesh alone. Sen [199] comprehensively compiled a list of 267 species of fishes from NE India. Further, according to Sen [199], of the c 806 speices of fishes inhabiting the freshwaters of India [203], the NE region of India is represented by 267 species belonging to 114 genera under 38 families and 10 orders. This is c 33.13 % of the total Indian FW fishes. Of the 267 species, Cypriniformes dominates with c 145 species followed by Siluriformes (72), Perciformes (31), Clupeiformes (7), Anguilliformes (3), Cyprinodontiformes (3), Osteoglossiformes (2), Synbranchiformes (2), Syngnathiformes (1) and Tetraodontiformes (1). In addition, Kar [86,172] reported the occurrence of 133 species of fishes through a pilot survey conducted in 19 rivers spread in Barak drainage (Assam), Mizoram and Tripura. Kar [92], further, reported the occurrence of 103 species of fishes through an extensive survey conducted in six principal rivers in Barak valley (Assam), Mizoram and Tripura. Kar [172-174] and Kar and Sen (2007) have done detailed study on the biodiversity of fishes in NE India with reference to Barak drainage, Mizoram and Tripura.

Notwithstanding the above, studies on the fish assemblage structure and their habitat requirements in the streams of Northeast India are scanty. Few initiatives have started in South India [22]. A novel approach related to the study of Fish assemblage structure and species inventory and habitat requirement of individual ichthyospecies in the assemblage in a number of rivers in Barak valley region of Assam, Mizoram and Tripura have been undertaken and results reported by Kar [92-94, 172-174] (Sen, 2007).

Methodology

General survey of the Fish diversity and habitat parameters were studied using standard procedures [23,191]. Headwater to downstream studies were based on River Continuum Concept [207]. Spatial heterogeneity of river channel across small to large spatial scales [53], longitudinal (upstream vs downstream) and lateral (stream margin/mid-channel) dimensions were studied.

Fish samples were collected through experimental fishing using cast nets (dia.3.7m and 1.0m), gill nets (vertical height 1.0m - 1.5m; length 100m -150m), drag nets (vertical height 2.0m), triangular scoop nets (vertical height 1.0 m) and a variety of traps. Camouflaging technique was also used to catch the fishes. Fish have been preserved at first in concentrated formaldehyde in the field itself and then in 40 % formalin. Fishes have been identified after standard literature [1, 14, 41, 75-77, 183, 184, 196, 203]. Yield statistics were extrapolated (Dey and Kar, 1990) [5,79,172]

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from daily catch statistics recorded at the landing stations [52] while the trend and cyclic variations were constructed by applying 12 months moving average method [5, 30, 126, 172-174, 17].

Pilot study on the Fishes of North-East India

As indicated, pilot survey conducted in 22 rivers in Barak drainage, Mizoram and Tripura, during the period 1999 to 2016, revealed the occurrence of 133 species of fishes [5, 7-9, 17, 34, 102-105, 209, 210].

According to our field observations, there is a difference in habitat preference within the species in many families. Young fishes are generally found to prefer benthic zone of the rivers while the adults tend to live in all the different niches (Smith, 1994). The Garra spp. and the balitorids have been generally found in the fast-flowing hill streams. Sections of the rivers not having many aquatic macrophytes revealed an abundance of fishes. The food of the adults generally consists of herbivorous items with occasional carnivorous components. The gut contents revealed the occurrence of mainly phytoplankton food with zooplankton encountered only occasionally.

Of the fish species recorded, the cyprinids were the most abundant group. Altogether, 754 number of cyprinid fishes have been collected from six prominent rivers in NE India, viz., rivers Barak, Jatinga, Sonai, Dhaleswari in Barak valley region of Assam, river Tuirial in Mizoram and river Gomati in Tripura. The contribution of cyprinids to the total fish collection depicts its highest contribution in river Tuirial and lowest in river Dhaleswari. Among the *cyprinids, Salmophasia bacaila, Aspidoparia morar, Barilius vagra vagra, Amblypharyngodon mola, Neolissochilus hexagonolepis & Pethia conchonius* were recorded in almost all the study sites. Further, of the total fish species recorded, five species, viz., *Puntius sarana sarana, Ompok bimaculatus, Ailia coila, Eutropiichthys vacha & Bagarius bagarius* could be categorized as `vulnerable' [186]. Still further, species like *Gudusia chapra, Tor mosal, Labeo gonius, Crossocheilus latius latius, Balitora brucei, Mystus tengara, Xenentodon cancila, Mastacembelus armatus & Nandus nandus* could be typified as `Indeterminate' (Ibid, 1998).

Notwithstanding the above, freshwater (FW) fishes of this region have been infected by a hitherto unknown fish disease called the Epizootic Ulcerative Syndrome or EUS. A summary of our studies on EUS fish disease is given below:

Summary of EUS fish disease

The EUS fish disease, having profound impact on fish sustenance vis-a vis human health and nutrition and economy of the fishermen and the nation, is being dealt with here briefly based mainly on the present author's study. The dreadful and virulent EUS has been sweeping the FW in the globe in an epidemic dimension, unhindered, unimpeded and unabated, almost semi-globally. This disease has caused large-scale mortality among fish since 1988, rendering many of them endangered. It also leads to fear psychosis among the fish-eating people, causing untold misery to the fishermen and fish farmers, as well as devastation to the economy of the nation. EUS had initially affected four species of fishes very widely, viz., *Pethia conchonius, Mystus vittatus, Macrognathus aculeatus & Channa punctata*. Our study revealed fluctuation in the intensity of the disease in relation to species affected. Large hemorrhagic cutaneous ulcers, epidermal degeneration and necrosis followed by sloughing of scales are the principal symptoms of EUS. Low total alkalinity (TA) could be a pre-disposing `Stress factor'. Sick fishes show low haemoglobin and polymorphs, but high ESR and lymphocytes. The communicative nature of EUS revealed variation in time gap between fish and infection in different species. Inoculation of microbes in the test animals did not reveal any sign of ulcerations for two years. Bacterial culture revealed occurrence of haemolytic *E. coli*, *Aeromonas hydrophila, Pseudomonas aeruginosa, Klebsiella sp., Staphylococcus epidermitis* in the surface lesions as well as in the gut, liver, gills, heart, kidney and gonads of sick fishes. All these have been found to be sensitive to Chloramphenicol, Septran, Gentamycin, etc. Fungal isolation revealed the occurrence of *Aphanomyces sp.* with concomitant occurrence of the same fungal genus in histological sections of EUS-affected fishes. Histopathological (HP) studies showed focal areas of increased fibrosis and chronic inflammatory cell infiltration in muscles; focal areas of fatty degeneration of hepatocytes surrounding the portal triads in the liver. Inoculation of 10 % tissue homogenate of EUS-affected Clarias batrachus into 80% confluent monolayer form RTG fish cell line in Leiboitz L-15 medium, revealed progressinve CPE which was passable in subsequent cultures: thus, indicating the `isolation' of virus.

Electron Microscopic studies with the ultra-thin sections of EUS-affected fish tissues, revealed the presence of virus-like particles (inclusion bodies); and, preliminarily, the picobirna virus has been electron microscopically identified as the primary aetiological agent of EUS. Further studies in this regard are being conducted [2,5,17,172,100].

Potentials and Problems of the Water Bodies and Human Impact

There are a number of standing (Lentic) and running (Lotic) water bodies in the Indian sub-continent. North-East (NE) India contain a bewildering diversity of fishes in innumerable water bodies. But both the precious water bodies and the coveted fishes are not much being taken care of with regard to their proper management and conservation; thus, leading to their depletion [211-215].

Nevertheless, it is, probably, essential to emphatically portray some of the potential, problems and difficulties in these water bodies and the fishes therein; and the present communication is a humble contribution to that.

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Potentials and problems in the lentic systems

Potentials

The potentials of Beels, Haors and Anuas are reflected in the many aspects as stated below:

a) Vast water spread area, presence of continuous inlets and outlets (in many wetlands), maximum depth sometimes up to 6.0m.

b) The occurrence of rich fish diversity to the extent of 70 species in a single Beel (Sone Beel), presence of migratory Hilsa in some of the Beels, Haors, etc.

c) Likewise, some of the Haors have rich diversity of Phyto- and zooplankton and occurrence of juveniles of IMCs and Hilsa; thus, indicating such wetlands serving as possible natural breeding grounds of IMCs and Hilsa.

d) The Anuas, being detached from original course of the rivers, could serve as ideal sites for culture fishery [47,112,113,126,127].

Problems

Notwithstanding the above, significant problems faced by these wetlands are mostly human induced, e.g.,

a) Diversification of the course of the inlets and blocking of the outlets, which results in siltation of the Beels and the channels due to less expulsion of silt from the Beel and leads to diminution of depth and water-spread area rendering loss of breeding ground for the large growing fish (LGF); exposure of the land, their subsequent encroachments and paddy cultivation often using chemical fertilizers and pesticides.

b) Day-in and day-out fishing operations by thousands of unrehabilitated fishermen using 26 different types of fishing gears (some of which are fine-meshed) and methods [17,172] is a problem of concern.

c) Acute weed problems in some of the "Anuas" are another problem of serious concern.

d) Also, the EUS fish disease, sometimes kill innumerable fishes, which is also to be tackled [2,100].

Suggestions

Some of the important suggestions include the following:

a) Removal/modification of man-made blockades in order to revive large-scale migration of fish, to help boost fish trade through navigation and to enable some amount of natural desiltation.

b) Furthermore, proposed measures could include: some amount of human-involved desiltation, which could revive the breeding ground of the Large Growing Fishes) (LGF), discourage paddy cultivation due to re-submergence of the exposed wetland beds; rehabilitation of the innumerable immigrated and unrehabilitated fishermen.

c) Further, to impart minimum education and monitoring of the riparian wetland users by the NGOs for less input towards eutrophication, etc. All these measures could help in the improvement of the Beel environment in an affirmative way.

d) In addition, culture of IMCs in the deep fishing centres at the DSL to boost local earnings; and, initiation/re-vamping of the Fishermen Co-operative Societies, could go a long way in the emancipation of the fisherfolk.

e) These measures could contribute to maintaining the health of the Wetlands, Wetland-users and fishes therein and, could go a long way in the socio-economic upliftment of the poor fishermen.

A list of some of the wetlands in the NE Region of India indicating their potentials and problems have been tabulated below. Further, the potentials and problems of Sone Beel alone which is the biggest wetland in Assam (Area at FSL= 345812 ha) and one of the biggest wetlands in the Indian sub-continent and in the Asian Continent, has been tabulated separately.

Potentials and problems of Sone Beel (wetland)

Potentials of Sone Beel

a) Very Big size

b) Continuous inlet, outlet

c) High Fish yield, IMC Naturally growing, also could be cultured

d) Occurrence of Hilsa *(Tenualosa)* ilisha

e) Ideal site for rehabilitation of Fishermen

Problems of Sone Beel

a) Inlet and outlet diversifications

b) Outlet blockade, siltation inlet (max. 350.0 mg lit^{-1}) in contrast to low expulsion through the outlet (max. 216.0 mg lit^{-1})

c) Mahajal operation

d) Paddy cultivation, Siltation, weeds

e) Big size carnivorous fish

f) Presence of exotic carps

g) Day-in, day-out fishing operations

h) EUS fish disease problem

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