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Habitat Ecology and Ichthyofaunal Diversity in the Subansiri Sub-Basin, North-East India

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ABSTRACT

The instream and riparian zones of the Subansiri offer a variety of microhabitats each having distinct physico-chemical characteristics and fish biota. We recognised 14 habitat types based on their limnological parameters, and collected 204 fish species belonging to 101 genera and 34 families of which cyprinids were the most dominant (72 species). Ichthyofauna of Subansiri sub-basin was grouped into 10 trophic classes based on their morpho-anatomy of feeding organs and gut contents. The physico-chemical parameters of the river water were within the permissible limit of BIS except at Chauldhuwaghat where transparency was exceedingly low even during winter months and pH was relatively high (8.2). There is an increasing trend of siltation in the deep pools of the river. The Shannon diversity index ranged from 2.684 to 5.792, with a mean of 4.709±0.943. The maximum value was observed for floodplain lakes from where 54.41% of the fish species were recorded.

Key Words: Fish Biodiversity; Habitat Ecology; Floodplain Lakes; Subansiri River

INTRODUCTION

A healthy river provides a wide range of habitats for its biota. All the biotic components, right from the micro-organism to higher plants and animals of a river act as a functional element to support its health. Their effective linkages and balanced coordination make the river healthy. The richness of the fauna often increases as habitat complexity increases, with depth, velocity, and cover being the most important variables governing this relationship (Gorman and Karr 1978, Schlosser 1982). Fish are good indicators of the environmental health of rivers and their catchments as well as important conservation targets (Schiemer et al. 2003). From a global perspective, large river ecosystems are the critical lotic resources with respect to fisheries (Dodge and Biette 1993). Fish yields from riverine floodplain eco-systems are directly related to the height and duration of floods (Goulding 1981, Welcomme 1985).

River Subansiri, the largest tributary of the mighty river Brahmaputra, is a glacier-fed perennial Himalayan River (Figure1). The alteration of river flow regimes associated with dam operations has been identified as one of three leading causes, along with non-point source pollution and invasive species, of the imperilment of aquatic animals (Richter et al.1996). The ongoing construction of 2000MW Lower Subansiri Hydroelectric project at Gerukamukhin on Assam-Arunachal Pradesh border may also create some similar unexpected situation on the ecology of the river in near future. Keeping all these views in mind, the present study has been conducted to have a vivid picture of fish diversity of Subansiri sub-basin.

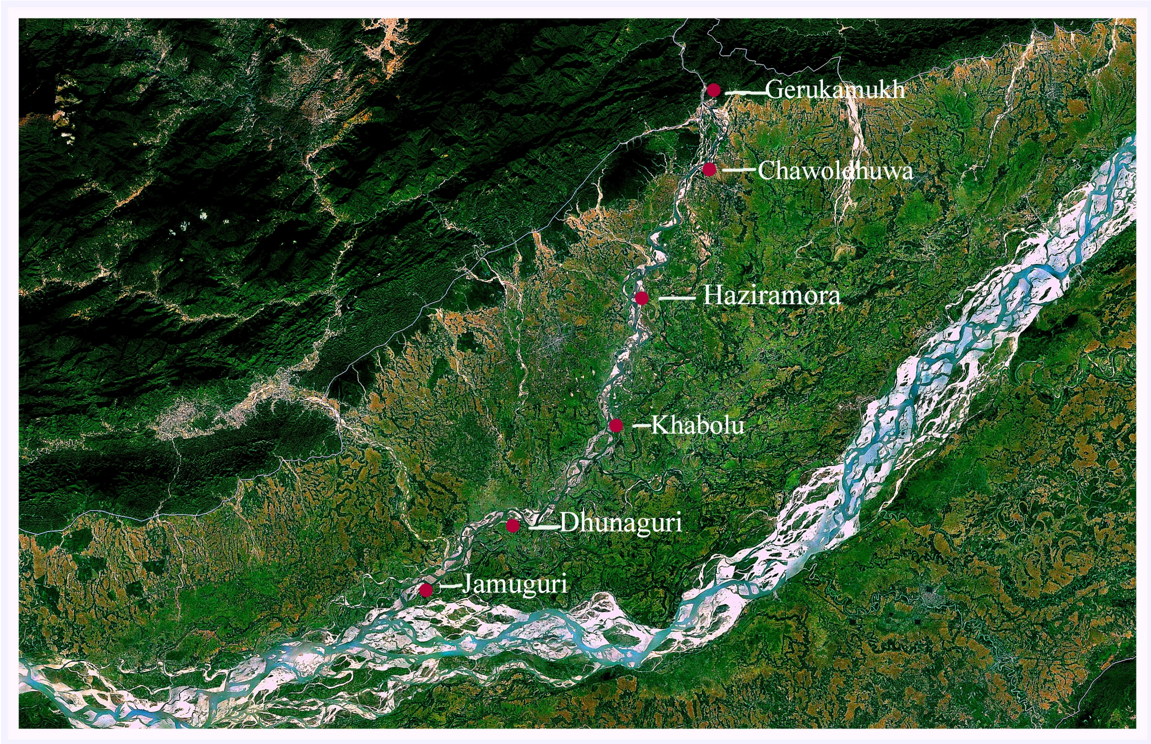

Figure 1. Satellite image of Subansiri sub-basin

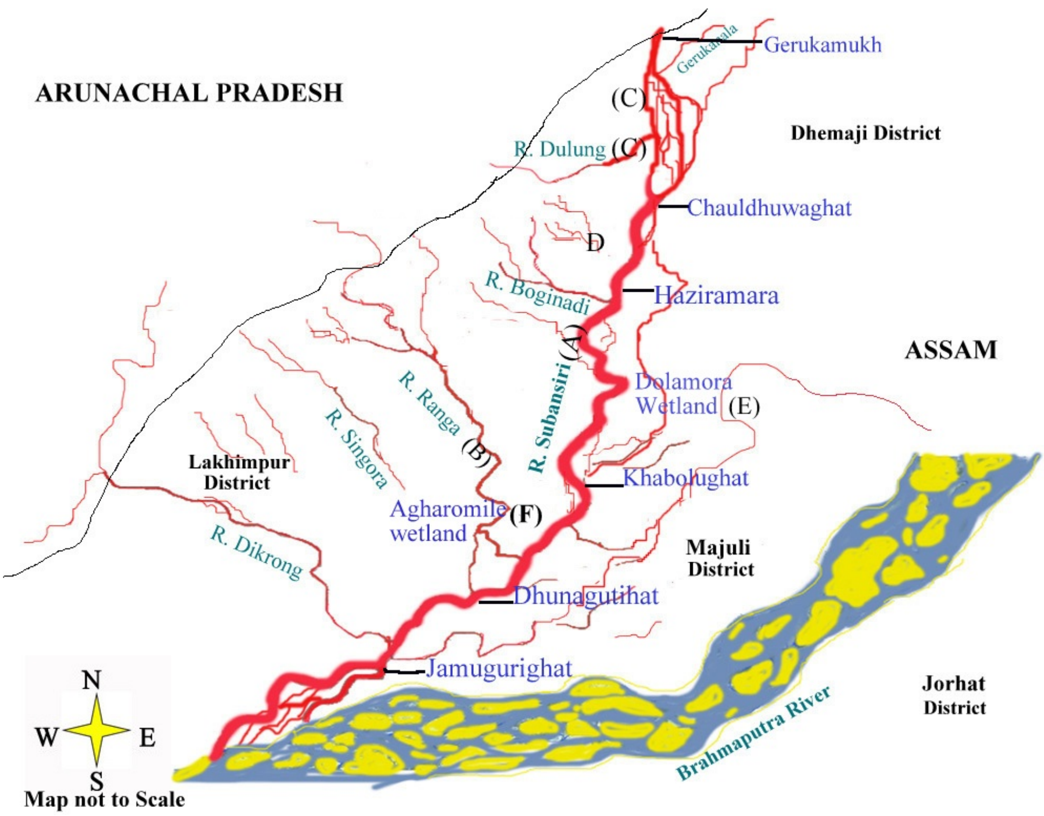

Figure 2. Outline map of the Subansiri River showing its major tributaries and dam site. Red spots indicate the deep pools. (Not to scale)

METHODOLOGY

The Subansiri from the dam site to its confluence with the Brahmaputra is approximately 130 km was divided into five sectors (Figure 1) and one representative station was selected from each sector for sampling of fish and recording of water quality. To include all possible habitat types and also to inventorization of existing fish fauna in the basin, sampling of fishes and water parameters were recorded from (A) R. Subansiri (mainstream), (B) R. Ranga (tributary), (C) Johing and Dulung (perennial stream), (D) Baghijan (ephemeral stream), (E) Dolamora *beel* (open wetland) and (F) Agharo mile *beel* (closed wetland) from January 2010 to December 2012 (Figure 2). Certain morphological features of the downstream like meandering, water depth and width of the river channels at different sites were recorded and the maximum and minimum values were calculated. Habitat preferences were evaluated by multivariate analyses relating to fish assemblage and environmental variables (Cao et al. 2000). Standard methods were followed for determining water quality (APHA 1989), fish identification (Talwar and Jhingran 1991, Nelson 1994), habitat types (Armantrout 1999, Johnson and Arunachalam 2010), trophic structure, diversity index (Shannon-Wiener 1949 and Magurran index 1988) and fish health (Peltrakis and Stergiou 1995) were followed. Statistical analysis was carried out using the statistical software SPSS for Windows (version 12.0) and Fishery Analysis and Simulation Tools (FAST version 2.0).

RESULTS

A total of 204 species belonging to 101 genera and 34 families were collected in the downstream Subansiri Basin. Cyprinidae is the dominant family (Figure 3) with 72 species followed by Bagridae (16 species), Sisoridae (15), Erethistidae (13) and Nemacheilidae (11). Again, considering the species rich genus, *Labeo* was the richest with 10 species followed by *Channa* (8), *Garra* (7), *Mystus* (7) and *Glyptothorax* (7). The Shannon and Simpson index for deep pool habitat were 4.868 and 0.08365 respectively. In the deep pool 46 species were recorded, *Labeo pangusia* was the dominant (0.0906) species. In riffle habitat, 57 species were recorded, of which *Danio rerio* (0.0821) and *Danio dangila* (0.0748) were the two most dominant species. The Shannon Index for riffle habitat was found to be 5.18 (Figure 4) and Simpson Index was 0.071 (Figure 5). On the other hand, the run habitats were inhabited by 65 species of fishes. The Simpson Index, Shannon Index and Margalef Richness Index for this habitat type were calculated out as 0.1044, 4.933 and 9.658 respectively (Figure 6). In the edgewater habitat, 17 species were recorded among which *Danio rerio* (0.371) was the most prominent. The Shannon Index, Simpson Index and Margalef Richness Index values for edgewater habitat were 2.684, 0.4492 and 2.829 respectively. Rootwads provide habitat for some rare fishes, of which *Badis singenensis* (0.255), *Amblyceps mangois* (0.153) were notable (Table 1). Simpson Index was 0.2525 while Shannon Index and Margalef Richness Index were 3.419 and 2.477 respec-

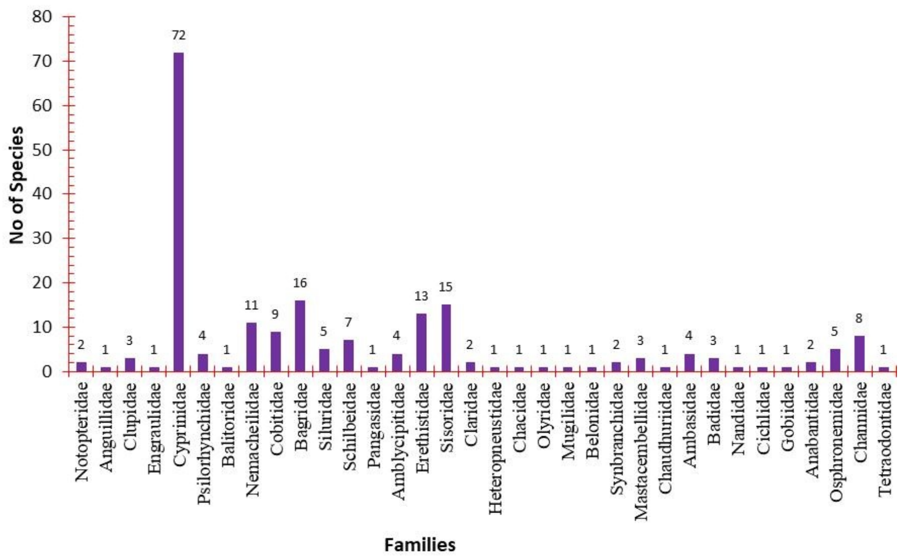

Figure 3. Abundance of fish groups in Subansiri drainage system

Table 1. Diversity indices for different habitat types of Subansirisub-basin

Habitat Type	No. of Species	Shannon Index	Indices Simpson Index	Simpson's Index	Reciprocal Simpson Index	Berger-Parker Dominance Index	Margalef Richness Index
Deep pool	46	4.868	0.084	0.916	11.950	0.091	7.109
Riffles	57	5.177	0.075	0.930	14.180	0.082	8.880
Run	65	4.933	0.104	0.896	9.577	0.117	9.658
Edge-water	17	2.684	0.449	0.551	2.226	0.371	2.829
Confluence	62	4.937	0.094	0.906	10.690	0.100	7.498
Woody debris	28	3.966	0.198	0.801	5.031	0.254	4.254
Mainstream	91	5.759	0.052	0.948	19.370	0.062	10.530
Meander	64	5.417	0.065	0.935	15.410	0.086	8.071
Sand bars	39	4.215	0.160	0.840	6.233	0.150	4.784
Rootwads	17	3.419	0.253	0.748	3.960	0.255	2.477
Pocket waters	22	3.860	0.171	0.829	5.853	0.147	3.643
Vegetated river bank	99	5.637	0.059	0.941	16.890	0.078	11.680
Floodplain wetlands	111	5.792	0.050	0.949	19.930	0.052	11.940
Wetlands margin	69	5.258	0.072	0.928	13.910	0.084	8.022
Mean (SD)	4.72 ±0.94	0.13 ± 0.11		0.87 ± 0.11	11.09 ± 5.79	0.14 ± 0.09	7.24 ±3.19

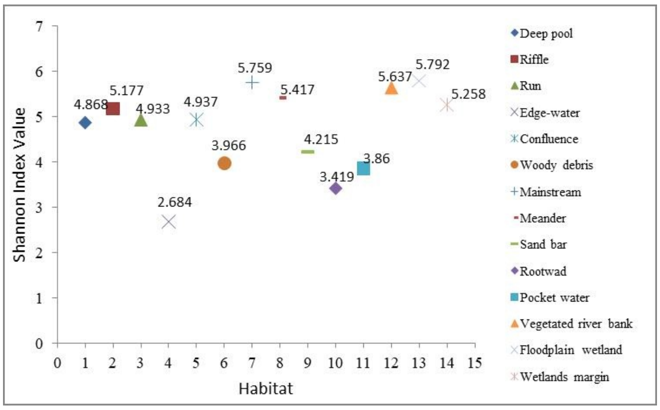

Figure 4, Shannon Index of fish diversity in different habitat types of Subansiri drainage

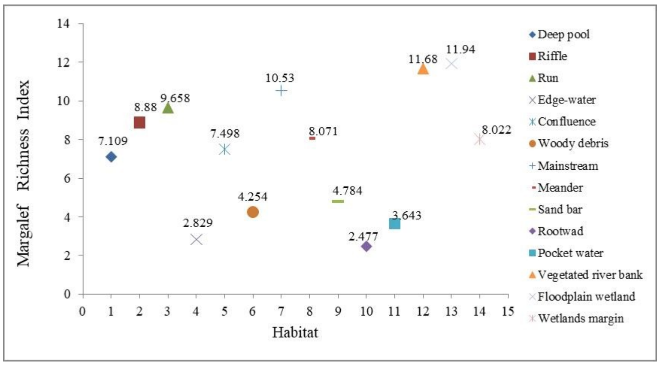

Figure 6. Margalef index of fish species richness in different habitats of Subansiri

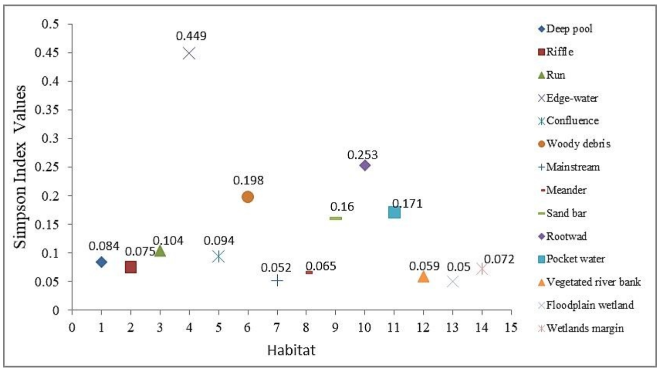

Figure 5: Simpson's Dominance index of fish species in different habitats of Subansiri

tively. River confluences show greater diversity of species (Table 1) with 62 species. *Mystus bleekeri, Mystus cavasius, Batasio tengana, Wallago attu, Ailia coila, Neotropius atherinoides* and *Gaga tacenia* were the most dominant species. Most of the abundant species of confluences are insectivorous or piscivorous in nature. On the other hand, a total of 39 species were recorded from sand bank habitat, of which *Pethia conchonius* (0.15), *Puntius ticto* (0.131), *P. sophore* (0.118) had notable contribution. Simpson Index, Shannon Index and Margalef Richness Index of this habitat were 0.1604, 4.215 and 4.784 respectively (Figures 4-6). Likewise in large woody debris habitat, the diversity indices were

0.199, 3.966 and 4.254 for Simpson Index, Shannon Index and Margalef Richness Index respectively (Table 1).

In the present study, nine physicochemical parameters of R. Subansiri were studied on a seasonal basis for three years (2010-12). The major limnological parameters along with the fish composition of all the 14 types of habitats identified (Figure 7) in the Subansiri sub-basin have been elaborated in the following:

(1) ***Deep pool*****:** It is characterized by flatter and deeper portion (>2m in lean months) of the river. These pools may be (a) mid-channel pool – present in the mid portion of the open river and (b) channel confluence pool – present at the confluence of two in-stream channels. Dissolved oxygen is relatively high (6.94-12.1 mg L^{-1}). Bottom substrate is mainly constituted by fine sediment. The major genera found in this habitat were *Labeo, Tor*, *Neolissocheilus, Aorichthys* and *Wallago*.

(2) ***Riffles*** are characterized by turbulent flow of water, shallow and with exposed bed materials. In this habitat, water current varied from 1.13 to 1.94 m s^{-1} while dissolved oxygen varied from 9.3 to 13.14 mg L^{-1}. Bed substrate is dominated by boulders, which also act as cover for fish. Major genera occurring in this habitat were *Garra, Glyptothorax, Hara, Balitora* and *Erethistes*.

(3) ***Run*** is the segment of river with almost uniform flow and bed substrate. Depth of the run varied from 0.61 to 2.74 m depending on dry or wet seasons. Major genera encountered were *Barilius, Crossocheilus, Devario, Schistura, Nemacheilus, Canthophrys, Psilorhynchus, Erethistes, Botia* and *Badis*.

(4) ***Edgewater*** or shallow marginal area of the river also provide good habitat for small sized fish (*Barilius, Danio, Devario, Aborichthys, Acanthocobitis, Schistura, Botia, Psilorhynchus* and *Badis)* and also nursery ground for large fish like *Labeo pangusia*. Off-channel boulders, stream bank semi-aquatic vegetation, uprooted tree or tree branch, and overhanging tree branches of terrestrial plants act as cover for this habitat type,

(5) River ***confluence****s* also provide good habitat for different fish species. The depth of confluence regions ranged from 2.1 to 21.3m in different seasons. Bottom of the river confluences are predominantly muddy. *Chitala, Setipinna, Aspidoparia, Labeo, Mystus, Rita, Sperata, Ompok, Wallago, Clupisoma, Eutropiichthys* and *Bagarius* are the main genera found in this habitat,

(6) ***Woody debris*** in water body provide shelter for many aquatic invertebrates and act as substratum for periphyton growth which results in assemblage of a variety of fish species in and around such woody debris.

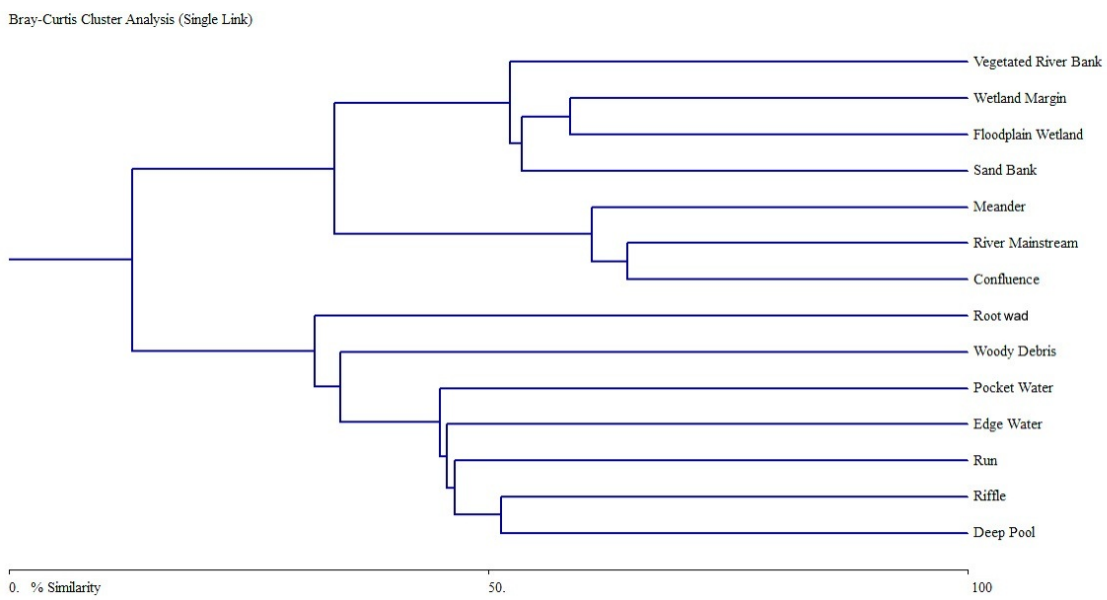

Figure 7. Dendrogram showing habitat similarity (Jaccard's index) in Subansiri drainage

It also provides hiding place both for prey and predators. The area covered by large woody debris ranged from 1.5 to 6 m^3. Bottom substrate consisted of fine sand and silt dominant. Common genera found in such habitat were *Chagunius, Chitala, Ompok, Puntius, Labeo, Gagata* and *Semiplotus,*

(7) The ***mainstream*** of the river serves as a habitat for genera like *Chitala, Setipinna, Aspidoparia, Cirrhinus, Labeo, Mystus, Rita, Sperata, Ompok, Wallago, Clupisoma, Eutropiichthys* and *Bagarius*.

(8) River ***meander*** is also a preferred fish habitat as the erosion activity of river banks provides allochthonous nutrients in the forms of terrestrial invertebrates. River bottom composed of mud and silt. Overhanging steam bank vegetation provides cover to this habitat in certain cases. Commonly encountered genera were *Chitala, Aspidoparia, Cirrhinus, Labeo, Mystus, Rita , Sperata, Ompok, Wallago, Clupisoma, Eutropiichthys, Bagarius, Gagata, Nangra* and *Gogangra*,

(9) ***Sand-bar zone*** is the shallow bank portion of river near mid channel bar or point bars. Some small sized fishes use it as their preferential habitat. Water current in this aquatic habitat is very feeble. Common genera of this habitat are *Devario, Chela, Danio, Puntius, Lepidocephalichthys, Aspidoparia*and*Oreichthys,*

(10) ***Rootwads*****:** The association of roots of stream bank plants with aquatic body often creates some unique habitats for fishes like *Pillaia, Pterocryptis, Channa*, *Badis*, *Olyra, Amblyceps* utilize such habitats. Some habitat generalist species like *Barilius* and *Pethia* are also found in this habitat,

(11) ***Pocket waters*** are that stagnant water found in low lying hill streams. It provides habitat for some nemacheilid loaches and smaller sized cyprinids. They are generally shallow water body ranging from 0.33 to 1.43 m in depth. The dominant substrate types were cobble, pebble and mud. Increased growths of filamentous algae were frequently observed in post monsoon and winter months,

(12) Close association of fishes in the **hydrophyte covered bank** of rivers was observed in the study indicated these plants provide good feeding and shelter options to different types of riverine fish like *Notopterus, Labeo, Puntius, Chanda, Nandus, Channa, Cirrhinus, Chela, Devario, Danio, Mystus, Rama, Batasio* and *Gagata* utilizes this type of habitat,

(13) ***Floodplain wetlands*** are excellent house of many 'resident dwellers' and breeding ground of several riverine fish species. Some commonly found fish genera in wetlands were *Chaca, Clarias, Heteropneustes, Chanda, Channa, Ompok, Labeo, Catla, Cirrhinus, Tetraodon, Xenentodon, Chitala* and *Wallago*,

(14)The ***wetland margin*** is utilized by some small sized fishes like *Badis, Chela, Esomus, Rasbora, Puntius* and *Trichogaster*.

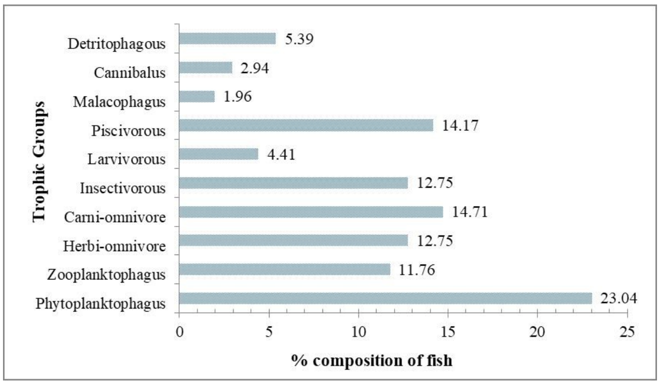

Figure 8. Trophic classification of fish species in Subansiri drainage system

The fishes of the Subansiri were broadly grouped into 10 trophic classes (Figure 8) after examining their morpho-anatomy of feeding organs and gut contents. These are:

i) Phytoplanktophagus: The major genera of this group are *Aspidoparia, Amblypharyngodon, Barilius, Bengala, Danio, Danionella, Devario, Rasbora, Oreichthys, Pethia, Puntius, Systomus, Garra, Psilorhynchus, Neo-noemacheilus, Schistura, Botia, Canthophrys* and *Rhino mugil*.

ii) Zooplanktophagus: Major genera are *Batasio, Chandramara, Ailia, Neotropius, Amblyceps, Hara, Erethistes, Erethistoides, Pseudolaguvia, Conta, Gagata, Glyptothorax, Nangra, Sisor, Pillaia* and *Anabas*.

iii) Herbi-omnivorous fishes consume about 75% materials from plant origin like *Gudusia, Gonialosa,* *Setipinna, Chela, Laubuca, Esomus, Raiamas, Securicula, Bangana, Chagunius, Labeo, Neolissochilus, Pethia, Puntius, Systomus, Cyprinion, Balitora, Chanda, Parambassis* and *Badis.*

iv) Carni-omnivorous are those fishes like *Anguilla, Channa, Glossogobius, Wallago, Sperata, Hemibagrus, Rita, Bagarius, Ompok, Clupisoma, Eutropiichthys, Silonia* and *Pangasius* in which analysis shows that more than 75% gut materials are of animal origin.

v) Insectivorous included the genera *Rita,Notopterus, Batasio, Chandramara, Hemibagrus, Mystus, Ompok, Pterocryptis, Ailia, Clupisoma, Eutropiichthys, Amblyceps, Hara, Erethistes, Erethistoides, Pseudolaguvia, Conta, Gagata, Gogangra, Nangra, Sisor, Olyra, Pillaia, Nandus, Glossogobius, Anabas, Trichogaster* and *Channa* who prefer different aquatic and terrestrial insects as their food.

vi) Larvivorous fishes like *Channa, Esomus, Pethia, Puntius, Mystus, Pterocryptis, Anabas* and *Trichogaster* mainly feed upon insect larvae.

vii) Piscivorous genera like *Wallago, Sperata, Hemibagrus, Rita, Bagarius, Ompok, Clupisoma, Eutropiichthys, Silonia, Pangasius, Nandus, Glossogobius, Anabas, Channa* and *Tetraodon* which consume fish or their body parts.

viii) Malacophagus feeding on molluscs like *Leiodon (Tetraodon), Chitala, Notopterus*, *Tor, Pangasius, Neolissocheilus* and *Glyptothorax.*

ix) Cannibal fishes consume their own species like *Clarias, Heteropneustes* and Channa.

x) Detritophagous subsist on detritus like *Labeo pangusia, Labeo dyocheilus* and *Bangana dero*.

DISCUSSION

Except the short braided stretch in the foothill zone, the Subansiri is typically a meandering river with drastic channel shifts, chute cut-offs and neck cut-offs. The river banks from the foothills to Chauldhuwaghat are composed mostly of sand, gravel and silt, beyond which they are composed almost exclusively of alluvial silt. The climatic condition of the Subansiri sub-basin is sub-tropical having an average annual rainfall of 2,356 mm and average minimum and maximum temperature being 7.85°C and 34.15ºC respectively. The downstream of Subansiri also received a substantial amount of discharged from some other feeder streams (Figure 2). According to Rao (1975), annual runoff contribution by the Subansiri is 57,296 mm which estimated to be about 10% of the total discharge of the Brahmaputra (Goswami 1985). Further, Subansiri river carries a relatively large volume of sediment load which synchronizes with its water discharge. Goswami (1985) estimated sediment yield of 959 Mg km^{-2} yr^{-1} which is lower compared to other major tributaries of Brahmaputra. However, it has been observed that there is sudden increase of silt load from about 70,000 Mg day^{-1} in 2005 to about 450000 Mg day^{-1} in 2006 and about 500,000 Mg day^{-1} in 2007. This rise of sediment load in the downstream is likely to be contributed by the construction activity in the dam site (Anon 2010).

The physico-chemical parameters of the river water were found within the permissible limit of BIS except at Chauldhuwaghat where the transparency was found exceedingly low even during winter months and pH was relatively high (8.2). There is an increasing trend of siltation in the deep pools of the river.

The instream and riparian zones of the Subansiri offer a variety of microhabitats each having distinct physico-chemical characteristics and fish biota. Cluster analysis of different habitat types revealed that in Subansiri river basin, there are two groups of fishes are present. First group is the relatively fast flowing habitat preferring fish while the second group is warm water river-floodplain habitat preferring group. Among the first group, close relation between deep pool, riffle and run habitat was observed. They share about 50% of their fish species with each other. In the other lineage, two more distinct branches were formed, of which the assemblage of fishes in meander, mainstream and confluence habitat were found to be identical to some extent. However, mainstream and confluence habitat were more close to each other than the meander habitat. Again, the floodplain wetland habitat showed more 60% species similarity (Table 1) with floodplain margin vegetated river bank and sand bank habitat forms two separate lineage in the dendrogram but shared more than 50% fish species with each other and floodplain –floodplain margin habitats (Figure 4).

Most of the fish species recorded from the entire Brahmaputra basin were recorded from the Subansiri sub-basin. Besides, a good number of species viz. *Tor* *putitora* (Hamilton 1822), *Amblyceps arunachalensis* Nath and Dey 1989, *Clarias magur* (Hamilton 1822) and *Pillaia indica* Yazdani 1972 belongs to endangered category of IUCN (2011). While *Devario assamensis* (Barman 1984), *Cyprinion semiplotum* (McClelland 1839), *Schizothorax richardsonii* (Gray 1832) and *Botia rostrata* Günther 1868 belong to vulnerable category. The species *Danionella priapus* (Britz 2009), *Garra arupi* (Nebeshwar, Vishwanath and Das 2009), *Psilo-rhynchus arunachalensis* (Nebeshwar, Bagra and Das 2007), *Amblyceps arunachalensis* (Nath and Dey 1989), *Erethistoides infuscatus* (Ng 2006), *Pseudo-laguvia ferruginea* (Ng 2009), *Pseudolaguvia flavida* (Ng 2009), *Pseudolaguvia foveolata* (Ng 2005), *Pillaia indica* (Yazdani 1972) and *Badis singenensis* (Geetakumari and Kandu 2011) were recorded for the first time from the water bodies of Assam.

In Subansiri drainage system, four fish species were found belonging to 'endangered' category viz. *Tor putitora, Clarias magur*, *Amblyceps arunachalensis* and *Pillaia indica*. The first two species was more or less abundant in the river and floodplain region while *A. arunachalensis* was rarely encountered. On the other hand, *Pillaia indica* was restricted to a small area of the basin. Further, species belonging to 'vulnerable' category in the study area were *Botia rostrata*, *Cyprinion semiplotum*, *Cyprinus carpio*, *Devario assamensis* and *Schizothorax richardsonii.* However, *Cyprinus carpio* is an introduced species and only regarded 'vulnerable' by IUCN based on the population at its origin place. Again 10.78% of the total fishes of Subansiri drainage are 'near threatened' category. Again, most of the fishes (68.14%) of the studied area are under'least concerned' category from conservation point of view. Geomorphic charac-teristics are known to affect individual species of stream fish in a variety of ways (Montgomery et al. 1999, Baxter and Hauer 2000, Walters et al. 2003). Stream fishes have evolved to inhabit the mosaic of patches created by this geomorphology and where there is greater structural diversity, there also tend to be increased niche habitats (Brierley et al. 1999).

The functional habitats concept was developed by Harper et al. (1992) who identified a suite of sixteen organic and inorganic habitat units associated with distinct invertebrate assemblages from a more compre-hensive list of 'potential habitats'. The existence of sunken objects such as roots, fallen trees and eroded banks, increase the diversity of sites and provide shelters for fish (Lamouroux et al. 2004). Many fish species display a preference for particular types of habitat such as pools, riffles, or backwater areas (Matthew 1985, Angermeier 1987, Pusey et al. 1993). Several workers treated the mainstream river as fish habitat including meander or confluences as a component of it (Baird et al. 2001, Næsje 2004, Cheimonopoulou 2011).Mixed assemblage of fishes in mainstream habitat of river Brahmaputra was reported by Biswas and Boruah (2000a) and Boruah and Biswas (2002) while Lakra et al. (2010) observed that certain fishes like *E. vacha, C. chitala* were confined to open river or mainstream habitat of river Ganga. Omnivores of larger, mainstream rivers are adapted to use benthic trophic pathways associated with the smaller-sized invertebrate fauna and vegetative material of ner substrata and detritus while insectivores depend on drifting insects (Vannote et al. 1980, Minshall et al. 1985).River meander is a rich habitat in terms of fish biomass and species (Sinha 1997, Matthews 1998, Biswas and Baruah 2000b, Boruah and Biswas 2000). Again, meanders often experience major erosion activity (Trimble 1997, Pizzuto et al. 2000, Tewari 2004) and thus provide a good number of terrestrial organisms as allochthonous input to the river ecosystem. Many fishes use deep pools as feeding ground (Arunachalam 2000) while some others as breeding ground (Poulsen and Jørgensen 2000, Viravong et al. 2005). In a river stretch, increasing number of pools also increases the fishing success (Boruah and Biswas 2002). A reduction in pool frequency may adversely affect migrating adults that require holding pools (Spence et al. 1996). Large fish of the river remain in deep pools during dry season while the young fish enter floodplain habitats during rainy season.

Natural and undisturbed river floodplains are characterized by a broad range of ecotones with different physical habitat conditions, which are differently affected by surface and groundwater exchanges and provide a high species diversity (Copp 1989, Schiemer and Zalewski 1992, Shiel et al. 1998, Ward et al.1999, Tockneret al. 2000). Flooding sets into motion by incorporation of extra-channel allochthonous organic material as well as nutrients of terrestrial origin into aquatic dimensions of the riverine ecosystem (Vannote et al. 1980, Junk et al. 1989, Bayley 1988, Sparks 1995). Flooding facilitates not only exchanges of water, but sediments, nutrients and biota between the river channel and the floodplain. The Subansiri sub- basin has 1581.52 ha of wetlands, most of which are less than 25 ha (Anon 2010). Floodplain–river ecosystems are dynamic mosaics of patches (Thoms et al. 2004). Connectivity between a river channel and a wetland is dictated by the position of the wetland (both elevation and distance from channel) with respect to the main channel and the flow regime of the river. Important roles attributed to large woody debris (LWD) of river include controlling stream channel morphology, regulating storage and routing of sediment and organic matter, and creating and maintaining fish habitat (Hicks et al. 1991). Moreover, LWD makes a critical contribution to complex fish habitat, nutrients generation from the terrestrial ecosystem support, the invertebrate populations that fish feed on, and sediment provides substrate for spawning and benthic habitat (Ralph et al. 1994, Montgomery et al. 1995, Abbe and Montgomery 1996).

In large rivers, the spatial distribution of fish is associated with microhabitat scale (Grossman et al. 1987, Jurajda 1995, Greenberg et al. 1996, Watkins et al. 1997). Jayaratne and Surasinghe (2010) found that the Margalef index was higher in run habitat followed by pool and riffle habitat of RawanOya stream of Sri Lanka. Similarly Offem et al. (2009) used Margalef index to compare middle and upper portion of River Cross of Nigeria and found the value 5.33 and 10.09 respectively. In Mondego estuary of Portugal, Salas et al. (2004) applied Margalef index and found value ranging from 0 to 2.32. Similar observation was also used by Boruah and Biswas (2002) for upper Brahmaputra Basin (2.15-4.24), Johnson et al. (2012) in Ken River basin of Madhya Pradesh (0.75-3.72), Vijaylaxmi et al. (2009) in Mullameri River of Karnataka (1.5-2.3), Chen et al. (2009) in Kuwait bay (7.5-10.17). However, maximum value 12.4 was observed in Ikwori Lake of South-Eastern Nigeria (Offem et al. 2011).

As a rule, fish require different habitats during their complex life-cycles (Schiemer and Waidbacher 1992). Thus, habitat loss, fragmentation and modification is considered as a major thread for many riverine fish species and declining biodiversity (Lelek 1987, Schiemer and Waidbacher 1992, Muhar et al. 2000). Disturbance to physical habitat (e.g. riparian vegetation, alteration, impoundments and water quality) have resulted in fish assemblage shift, decreased native species diversity, community homogenization and extinction (Strayer 2010, Turak and Linke 2011).

The ecological effects of regulated flow below dams have been a subject of interest (Ligon et al. 1995, Richter et al. 1996, Poff et al. 1997, Friedman et al. 1998). Flow regulation often dramatically alters the regime of alluvial rivers both through confined water-release scenarios and through substantial reductions in transported sediment below dams (Petts 1979, Church 1995, Brandt 2000). Channel beds and banks may undergo a wide range of adjustments to regulation (Williams and Wolman 1984, Grant et al. 2003). Craig (2000) calculated that large dam creates 73% of negative impacts on fish biodiversity resulting from obstructing rivers. The impact of dam on downstream fish ecology and diversity in Indian subcontinent are scanty and needs in depth study for maintain the downstream fish diversity (Jhingran and Ghosh 1978, Quraishee 1988, Natarajan 1989, Dudgeon 1992).

CONCLUSION

The closeness or distance in the similarities between species composition among habitats might be due to the habitat preference, physical nature of habitat, foraging or due to habitat specialist–habitat generalist nature of particular fish species.

The general well being of the Subansiri fish was found within the recommended limit except fishes found near to the construction site of the hydel project such as *Gaga tacenia, Glyptothorax indicus, Labeo boga* etc. Further, the study bears scope of further research on the ecology, taxonomy, habitat preference and microhabitat utilization, economic importance of the fishes, and response of the native fish species to probable impact of mega dams of the region. The negative impact of river dam on aquatic biodiversity is a matter of wide concern. Therefore, an extensive study is necessary to assess the cumulative impact of 168 proposed hydroelectric projects on the fish and other biodiversity of the entire eastern Himalayan region.

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