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Fish Assemblage Concerning Physciochemical and Geomorphological Characteristics of Barak River, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author PR did the survey, collected and identified the specimen, wrote manuscript and helped in overall supervision. Author JSYK identified the specimens and supervised the study and finalized the manuscript. Author AS edited and formatted the draft. Author SB helped in survey and identification of specimens. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated the fish population, environmental characteristics, microhabitats, and soil erosion along the Barak River in Manipur and Assam. The survey covered 18 sites spanning from Maram in Senapati district, Manipur, to Badarpur in Karimganj district, Assam. The assessment involved analysing six physciochemical parameters and collecting fish specimens, focusing on

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human activities affecting different sections of the river. The environmental conditions varied significantly between two distinct geographical regions: the hilly area in Manipur and the plains in Assam. The river exhibited narrowness, shallow depths, rapid flow, and a substrate composed of stones and gravel in the hilly region of Manipur. Conversely, in the plains of Assam, the river was wider, slower flowing, deeper, and featured a substrate consisting of silt and clay. Bank erosion and river meandering were prevalent in the plains, which were densely populated and extensively cultivated. The survey documented a total of 35 fish species from 15 families and 7 orders. Interestingly, the distribution pattern indicated an absence of certain fish species in one region that were present in the other. The highest species diversity was recorded in Namtiram, Tamenglong district, Manipur, for the hilly stretch, and Srikona, Cachar district, Assam, for the plains. Surprisingly, the study noted that physciochemical parameters had minimal influence on fish distribution; instead, it appeared that habitat and other environmental factors played a more significant role in regulating the presence of fish species.

Keywords: Assam; environmental impact; ichthyofaunal diversity; Manipur; North-eastern India.

1. INTRODUCTION

The biodiversity of freshwater ecosystems is a crucial part of our planet's ecological balance, exhibiting higher species richness compared to terrestrial and marine environments [1]. Despite covering only a minute fraction of Earth's surface (0.8%) and water resources (0.01%), freshwater sustains 6% of all known species [2]. This ecosystem hosts diverse animal orders, contributing significantly to vertebrate (25%) and invertebrate diversity. Rivers, complex in their makeup with distinct habitats, varying climatic zones, landscapes, and biogeographical regions, are among the most productive and valuable freshwater ecosystems on Earth [2,3].

Northeast India is part of the Indo-Burma biodiversity hotspot, recognized globally among 25 such hotspots [4]. This region, classified as the 10th biogeographic region in India, encompasses over one-third of the country's total biodiversity [4]. The Barak River, a major river in Northeast India, traverses six states (Meghalaya, Manipur, Mizoram, Assam, Tripura, and Nagaland) before continuing its course into Bangladesh. This river basin spans across parts of India, Bangladesh, and Myanmar. Originating from the Manipur hills in Senapati district at an elevation of 2331 meters, the river flows through the Nagaland-Manipur border, meandering into Assam. The Barak River extends approximately 464 km from its source to its division at the India-Bangladesh border. The primary transboundary tributaries from India include the Jiri, Dhaleshwari (Tlawng), Longai, Madhura, Sonai (Tuirial), Rukni, and Katakhal. The river's regime comprises two distinctive sections in India: the hilly catchment and the alluvial plain known as the "Barak Valley." In India, the Barak River basin covers an area of 41,723.12 sq.km, accounting for nearly 1.38% of the country's total geographical area. This entire basin falls within the Eastern Himalayan region of the Agro Climatic Zone, characterized by a Hot Subhumid to Humid ecoregion with alluvial and red and lateritic soils. Forests predominantly cover a significant portion of this basin, with agriculture being the primary income source for the population. The population growth rate in the Barak Valley was recorded at 17.93% according to the Census of India 2011. Over recent decades, urbanization and infrastructural developments have been ongoing, often leading to threats such as overexploitation, water pollution, habitat destruction, and degradation, endangering freshwater biodiversity [5]. Thus, preserving freshwater habitats and their associated fauna has become an increasing priority.

The aquatic ecosystem's vitality hinges on the interaction between living organisms and their physical and chemical surroundings, including the habitat, nutrients, oxygen, and temperature. Fishes, known for their sensitivity to pollution, are valuable indicators of water quality in aquatic ecosystems [6]. The unique physical and chemical environments of various places, influenced by factors like seasons and human activities, shape fish communities, reflecting environmental distinctions. Fish assemblages typically comprise species occupying different trophic levels, offering insight into overall stream quality. Despite this, there's a scarcity of studies examining fish species assemblages, their habitat requirements, and mapping in the streams of Northeast India. Works by Kar [7,8] have initiated investigations into macro and micro-habitat aspects in North-East Indian water bodies.

The freshwater resources of India have been extensively utilized for economic purposes, including irrigation, urban-industrial water supply, hydroelectric power, and waste disposal. However, the exponential rise in human population and consequent demands for water and its resources have led to the loss of stream habitat and a decline in aquatic organisms, notably fisheries resources. The primary threats to freshwater fishes stem from habitat modification, pollution, overexploitation, and the introduction of non-native species, resulting in their global decline [9]. Hence, this study aims to scrutinize the influence of environmental conditions on the Ichthyofaunal diversity of the Barak River.

2. MATERIALS AND METHODS

2.1 Study Area

The survey of the Barak River covered 18 sites, extending from Maram in the Senapati district of Manipur to Badarpur in the Karimganj district of Assam (Fig. 1). Specific details regarding the locations and their geographical coordinates can be found in Table 1. All these locations underwent recording of physciochemical and environmental parameters, while fauna collection was conducted only at certain designated sites. Notably, in the Assam region, where existing literature indicated higher pollution levels, a comprehensive physciochemical analysis was extensively performed [5]. Each site's geographical coordinates were meticulously recorded using GPS technology. The survey took place between November and March from 2021 to 2022, a period chosen specifically when the river flow remained in its natural state without any influence from rain or floods. Selection of sampling sites was based on the presence of anthropogenic activities, such as towns or cities situated along the riverbank or nearby developmental projects, factors known to potentially impact the river's ecological balance and diversity of fauna.

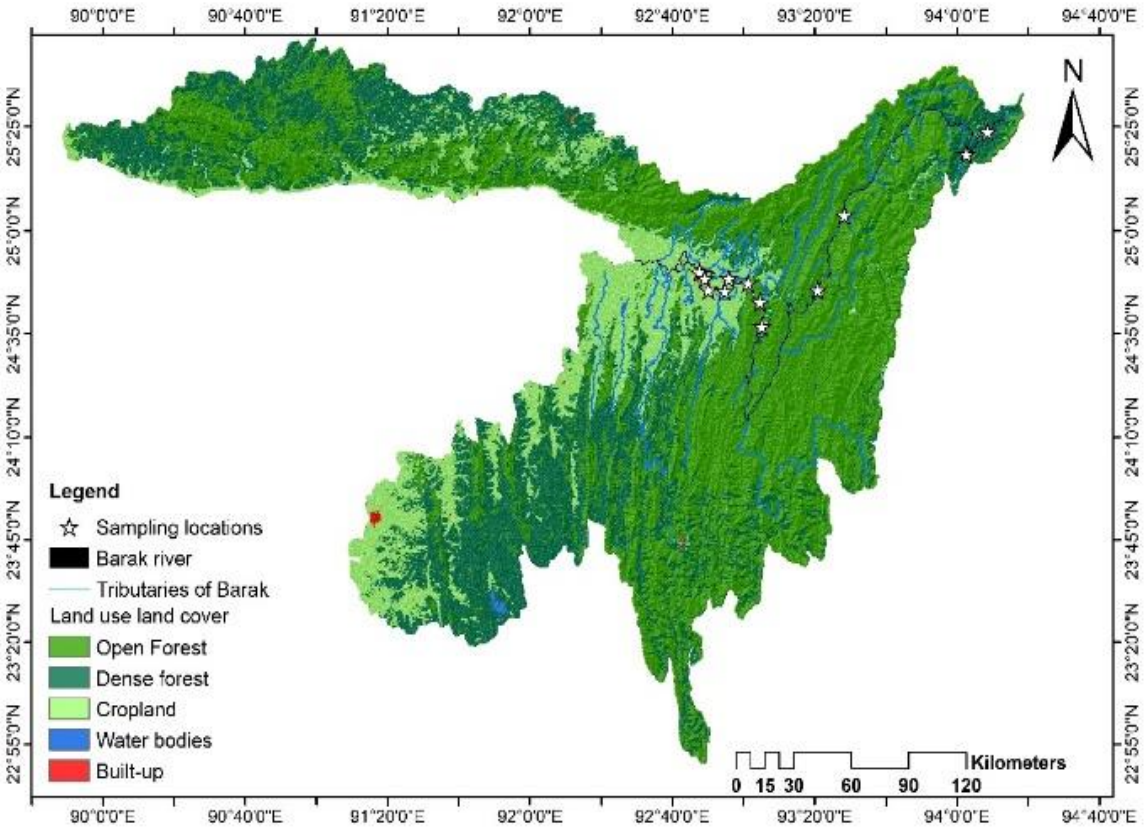

Fig. 1. Study area map of River Barak

Table 1. Details of the survey localities

Locality	District	State	Elevation (In mtr)	Latitude	Longitude
Site.1- Koide Biisho, Maram	Senapati	Manipur	1091	25.39704° N	94.14275 ° E
Site. 2- Kathikho, Karong	Senapati	Manipur	1000	25.30683 ° N	94.04366 ° E
Site. 3- Namtiram, Tousem	Tamenglong	Manipur	168	24.76001° N	93.34765 ° E
Site. 4-Sibilong bridhe NH37, Tousem	Tamenglong	Manipur	103	25.06063° N	93.47139 ° E
Site. 5- Jakuradhor Part -1, Jiribam	Imphal East	Manipur	10	24.613529° N	93.084944 ° E
Site. 6- Jirimukh, Jiribam	Imphal East	Manipur	23	24.71206° N	93.07725 ° E
Site. 7- Fulertal, Lakhipur	Cachar	Assam	18	24.78930° N	93.02091 ° E
Site- 8-Annapurna ghat, Silchar	Cachar	Assam	5	24.83211° N	92.79332 ° E
Site-9- Kanakpur ferry ghat, Silchar	Cachar	Assam	11	24.80737 ° N	92.81874 ° E
Site-10 -Sonabarighat Part-1, Sonai	Cachar	Assam	12	24.76041 ° N	92.83640° E
Site-11- Chandrapur Part-3, Lakhipur	Cachar	Assam	29	24.80717 ° N	92.93084 ° E
Site-12- Doyal Ferry ghat, Gobindapur Part-1 Lakhipur	Cachar	Assam	4	24.75668 ° N	92.91148 ° E
Site-13-Pachgram ghat, Algapur	Hailakandi	Assam	1	24.86897° N	92.59911 ° E
Site-14- Katakhal ghat, Hailakandi tehsil	Hailakandi	Assam	5	24.82872° N	92.63719 ° E
Site-15- Srikona ghat, Salchapra	Cachar	Assam	5	24.83592° N	92.69855 ° E
Site-16- Ranighat, Bhairab Nagar	Cachar	Assam	4	24.916197° N	92.725766° E
Site-17- Masimpur, Silchar	Cachar	Assam	5	24.867675° N	92.768537 ° E
Site.18-Srigouri ghat, Badarpur	Karimganj	Assam	2	24.86742 ° N	92.52140 ° E

2.2 Physciochemical Analysis

Field-based physciochemical analysis was conducted using a multi-parameter kit consisting of Hanna Multiparameter waterproof- HI98194 and Hanna Digital pH/Conductivity/TDS Meter 0 - 14.00 pH HI98129. A comprehensive assessment of six physciochemical parameters, namely temperature, pressure, pH, dissolved oxygen (DO), total dissolved solids (TDS), and conductivity, was performed at every sampling site. Samples were gathered in triplicate from three sub-sites within each study site for physciochemical analysis, and the averages of these measurements were duly recorded.

2.3 Habitat Inventory Parameters

At each study location, habitat inventory parameters were directly documented in the field. Using GPS, the geographical coordinates and altitude above mean sea level (m.s.l.) were recorded. Various aspects such as terrain type, microhabitat characteristics, substrate composition, vegetation cover, indications of erosion, and riparian land use were thoroughly examined and documented at each sampling site along the Barak River.

2.4 Fish Sampling, Preservation and Identification

Fish sampling at study sites involved covering a 500-meter stretch at specific locations detailed in Table 1. Local community members were engaged in the process of netting and collecting fish. Selection of fish sampling sites primarily considered areas influenced by human activities to assess their impact on fish diversity in the environment. Initially, fish specimens were

preserved using concentrated Formaldehyde directly in the field. Subsequently, these specimens were transferred to the laboratory, where they were preserved in 10% formalin and stored in sealed plastic bottles. In the laboratory, the specimens were identified by following standard literature, notably, Day [10,11], Misra [12], Roberts [13], Rainboth [14], Sen [15-17], Talwar and Jhingran [18], Jayaram [19-21], Nath and Dey [22], Kar [7,8,23], Kar et al. [24,25], Kar and Khynriam [26], Menon [27].

3. RESULTS

3.1 Physciochemical Parameters of River Barak

The physicochemical parameters measures showed a mean value of Temparature, TDS, DO, pH, etc. as depicted in Fig. 2. Temperature as well as pressure was increased from Manipur hilly stretch of river towards Cacher plain of Assam (Figs. 2a,b). pH remained constant throughout our stretch of the river except for a slight increase in plains in Assam. In general, a pH in the range of 6.5 to 8 is considered safe for fish growth and reproduction and the pH of river Barak was in the safer range (Fig. 2c). There was no constant variation in DO, yet the value of DO in plains of Assam was higher as compared to the hilly stretch of Manipur (Fig. 2d). There was no clear trend in variation of conductivity and TDS was found, however, their value relatively decreased from hill to plains (Figs. 2e,f). Furthermore, conductivity and TDS variation follow the utmost similar pattern, which suggests their dependency on each other.

3.2 Habitat Inventory of the River Barak

River Barak was geographically divided into two distinct regions i. e. Upland (hilly terrain of Manipur) and Lowland (Cacher plain of Assam) as displayed in Fig. 3. The terrain was a valley in the Manipur region from Senapati to Jirimukh, whereas open land in Assam region was plain from Fulertal to Badarpur. In the plain region of the river, the valley segment was alluvial, while in hilly regions of the river, the valley segment was colluvial. The substrate type was dominated by boulders, gravels, and cobbles with frequently occurring quite a large number of boulders and some bed rocks while fine sand in the upland, whereas silt and clay in the lowland region. Pools, riffles, and runs were generally found to dominate the micro-habitat type with frequent occurrence of trench pools. The vegetation type was generally deciduous trees with some amount of shrubs and grasses. Moreover, the river Barak was generally wider in plains as compared to the hills area. Signs of erosion had been predominantly visible in all the studied segments of the river. Soil erosion was common in plains, mainly due to bank erosion. River meandering was sever in Cachar plain of Assam, which caused flood problems in this region. As compared to the hill, the human population around river in plain was much larger, where the river was used for transportation, fishing as well as cultivation. In the current research, it was also uncovered that human-induced actions leading to disruptions in the distribution of fish populations include habitat destruction through the building of roads and bridges, extensive extraction of sand and stones from riverbeds, unselective fishing practices, both point and non-point pollution resulting from sewage discharge and agricultural activities, and bank erosion due to the meandering of rivers (Fig. 4).

3.3 Species diversity

In total 173 examples of fish were examined and 35 species belonging to 15 families and 7 orders have been identified, the list of the same is given in Table 2. Cypriniformes and Siluriformes were the most dominant order and more than 75% species belong to these orders. Cyprinidae and Bagridae were the most dominant family which account approx. 40% of identified species. The details of species distribution of identified samples are given in Table 2. The survey area can be distinctly divided into two geographic zones; Hilly (Maram to Sibilong) and Plains (Fulertal to Badarpur). Jakuradhar and Jirimukh were also hilly in nature but these areas can be considered as an interface between hills and plains. Clear distinction in fish diversity can be found between river stretches of Manipur hills to Assam plains. Fishes found in hilly regions were relatively small as compared to plains where water pool-like structures were common. Mostly fishes found in the upper stretch of the river were sheltered beneath the stones of river bed. In plains, fishes were easily found at places where encroachment or disturbance, such as the use of motor boats, agricultural use of river banks, use of water harvesting pumps, sand mining, etc. was limited. Srikona in Cachar plains of Assam and Namtiram in the hilly stretch of Manipur was rich in species diversity. It can be seen from table that species features in plains were absent in hilly stretches and vice versa. Fishes found in the hills of Manipur were small in size and low in abundance as compared to the plains in Assam.

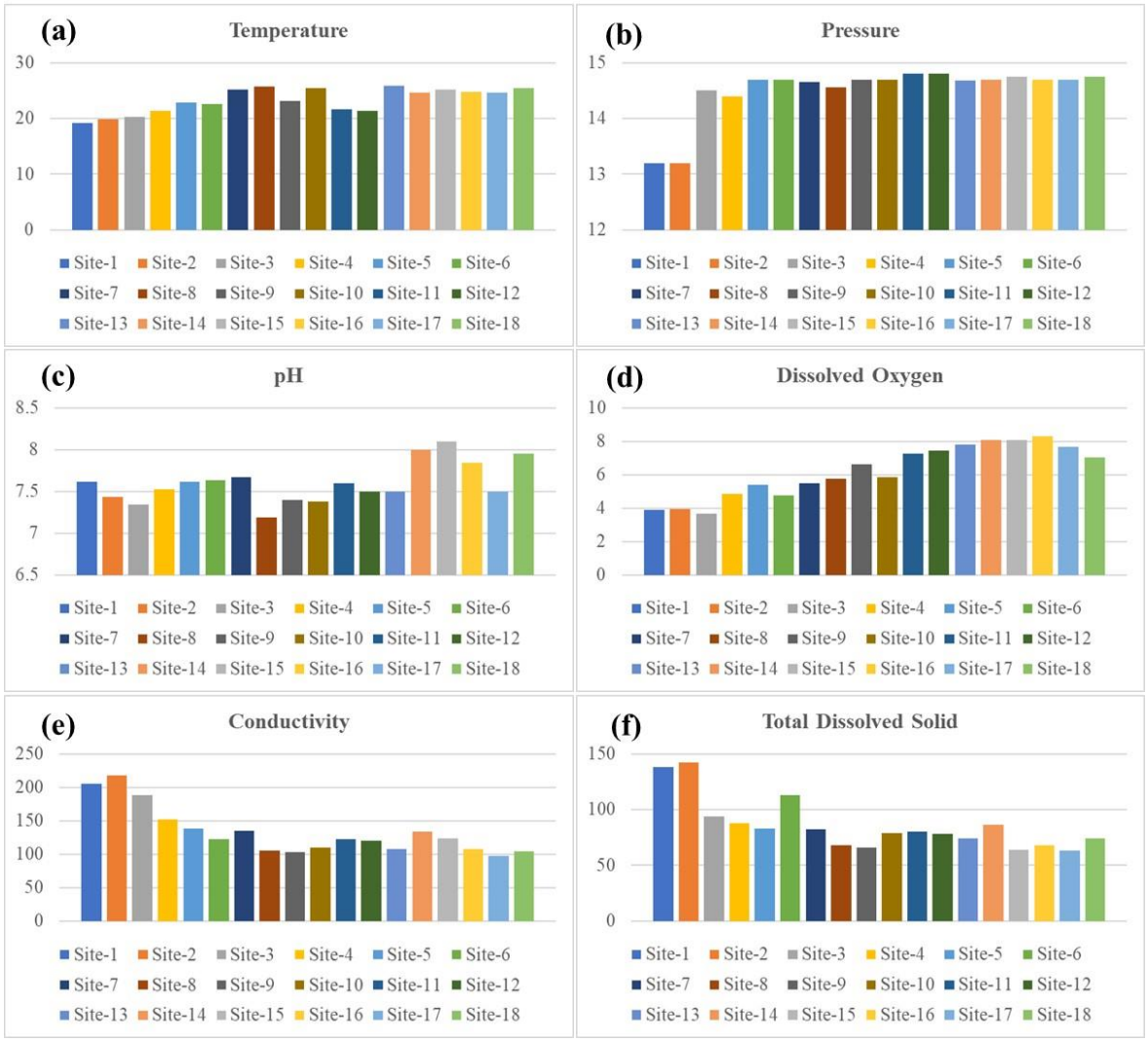

Fig. 2. (a) Temperature (˚C), (b) Pressure (psi), (c) pH, (d) DO (mgL-^{1}), (e) conductivity (µs/cm) and (f) TDS (mgL-^{1}) variations at different selected sites of river Barak

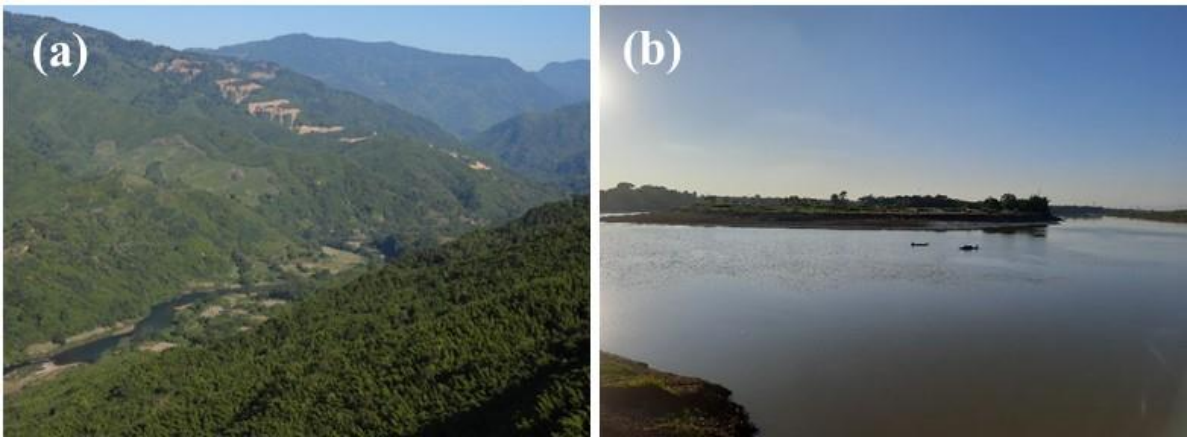

Fig. 3. Habitat of river Barak at (a) Namlalong, Tamenglong district of Manipur and (b) Srikona, Cachar district of Assam

Table 2. Species classification and its distribution at selected sampling sites

Species	L1	L2	L3	L4	L5	L6	L7	L10	L15
Actinopteri									
Siluriformes									
Ailiidae Bleeker 1858									
Eutropiichthys murius (Hamilton, 1822)	-	-	-	-	-	-	-	+	+
Silonia silondia (Hamilton, 1822)	-	-	-	-	-	-	+	-	+
Bagridae Bleeker 1858									
Hemibagrus menoda (Hamilton, 1822)	-	-	+	-	-	-	-	+	-
Mystus cavasius (Hamilton, 1822)	-	-	+	-	-	-	-	-	+
Mystus tengara (Hamilton, 1822)	-	-	-	-	-	-	-	-	+
Mystus gulio (Hamilton, 1822)	-	-	-	-	-	-	-	-	+
Sperata seenghala (Sykes, 1839)	-	-	-	-	-	-	-	-	+
Ritidae Bleeker 1862									
Rita rita (Hamilton, 1822)	-	-	-	-	-	+	-	+	+
Sisoridae Bleeker 1858									
Gagata cenia (Hamilton, 1822)	-	-	-	-	-	-	+	-	-
Glyptothorax clavatus Rameshori & Vishwanath, 2014	-	-	+	+	-	-	-	-	-
Siluridae Rafinesque 1815									
Ompok bimaculatus (Bloch, 1794)	-	-	-	-	-	-	-	-	+
Ompok pabda (Hamilton, 1822)	-	-	-	-	-	-	-	-	+
Cypriniformes									
Botiidae Berg 1940									
Botia dario (Hamilton, 1822)	-	-	-	-	+	-	+	-	-
Cobitidae Swainson 1838									
Lepidocephalichthys guntea (Hamilton, 1822)	+	-	+	+	-	-	-	-	-
Cyprinidae Rafinesque 1815									
Garra annandalei Hora, 1921	-	-	-	+	-	+	-	-	-
Labeo rohita (Hamilton, 1822)	-	-	-	+	-	-	-	-	-
Pethia ticto (Hamilton, 1822)	-	-	+	-	-	-	-	-	-
Puntius sophore (Hamilton, 1822)	-	+	+	-	-	-	+	-	-
Danionidae Bleeker 1863									
Amblypharyngodon mola (Hamilton, 1822)	-	-	-	-	-	-	+	-	-
Barilius vagra (Hamilton, 1822)	-	-	-	-	+	+	+	-	-
Barilius bendelisis (Hamilton, 1822)	-	-	+	-	-	-	-	-	-
Chela cachius (Hamilton, 1822)	-	-	-	-	+	-	-	-	-

Species	L1	L2	L3	L4	L5	L6	L7	L10	L15
Opsarius bendelisis (Hamilton, 1822)	-	+	-	-	+	-	-	-	-
Rasbora daniconius (Hamilton, 1822)	-	-	+	-	-	-	+	-	-
Nemacheilidae Regan 1911									
Schistura ferruginea Lokeshwor & Vishwanath, 2013	+	-	-	-	-	-	-	-	-
Schistura minuta Vishwanath & Shanta Kumar 2006	-	+	-	-	-	-	-	-	-
Schistura sikmaiensis (Hora, 1921)	-	-	+	-	-	-	-	-	-
Anabantiformes									
Channidae Fowler 1934									
Channa gachua (Hamilton, 1822)	-	-	+	-	-	-	-	-	-
Channa melanostigma Geetakumari & Vishwanath, 2011	+	-	-	-	-	-	-	-	-
Channa punctata (Bloch, 1793)	+	-	-	+	-	-	-	-	-
Gobiiformes									
Gobiidae Cuvier 1816									
Glossogobius giuris (Hamilton, 1822)	-	-			-	-	+	-	-
Synbranchiformes									
Mastacembelidae Swainson 1839									
Mastacembelidae Swainson 1839									
Macrognathus aculeatus (Bloch, 1786)	-	-	+	-	-	-	-	-	-
Mastacembelus armatus (Lacepède, 1800)	-	-	-	-	+			+	
Cichliformes									
Ambassidae Klunzinger 1870									
Chanda nama (Hamilton, 1822)	-	-	-	-	+	-	-	-	-
Acanthuriformes									
Sciaenidae Cuvier 1829									
Johnius coitor (Hamilton-Buchanan, 1822)	-	-	-	-	-	-	-	-	+

4. DISCUSSION

The physciochemical characteristics of streams play an important role in biodiversity [28]. Temperature and pressure were increased from the hilly region of the Manipur to plains of Assam. This was attributed to the elevation as elevation decreased from the origin to the mouth of the river. The pH of a water body is very important in the determination of the water quality since it affects other chemical reactions such as solubility and toxicity of metals. Acidic water can accelerate the release of metals from rocks or sediments in the stream. Changes in the pH are very important as fish cannot survive in very acidic or basic water [29]. In general, pH in the range of 6.5 to 8 is considered safe for fish growth and reproduction. pH of river Barak falls in the safe range and remains constant thorough out stretch of the river except slight increase in Plains in Assam. This might be the mineralization of the river due to the weathering of rocks, which results in an increase in minerals in the river. DO is remarkably significant in determining the water quality criteria of an aquatic system. DO values usually remain lower in a system having high

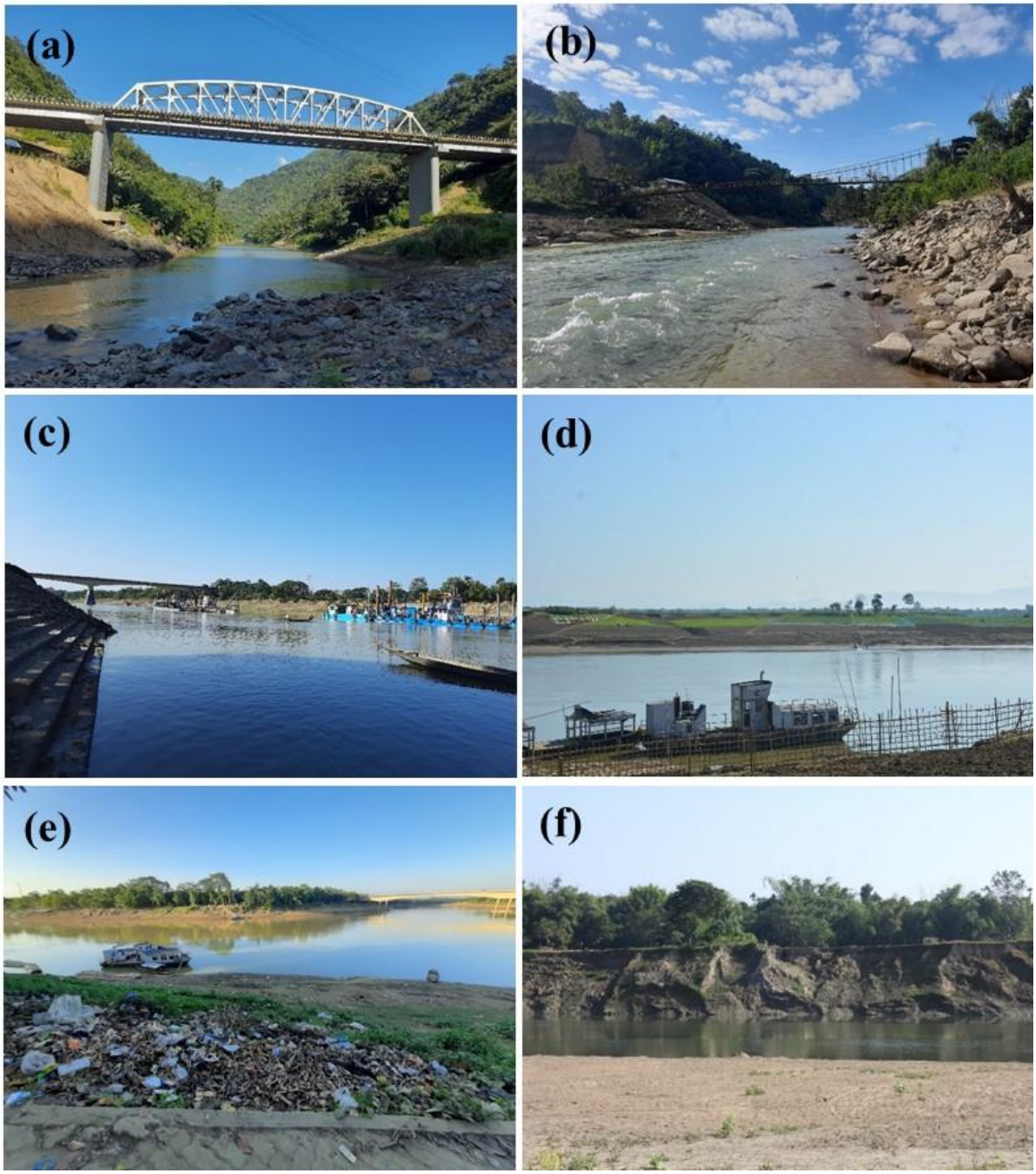

Fig. 4. (a) Newly constructed bridge over river Barak near Sibilong in Tamenglong district of Manipur, (b) Construction of new bridge over river Barak near Namtiram village in Tamenglong district of Manipur, (c) Sand mining in river Barak at Badarpur area of Assam, (d) Use of river bank for agriculture and transportation in Cachar plains of Assam, (e) Plastic pollution near river Barak at Annapurna ghat, Silchar and (f) Soil erosion in river Barak at Gobindapur area of Cachar, Assam

rates of respiration and organic decomposition as compared to those systems, where the rate of photosynthesis is high [30]. DO levels between 5-6 ppm are required for optimal health of fish. DO value of river Barak is optimal for fishes at most sampling sites except in the hilly stretch of Manipur. There was no constant variation in DO, yet the value of DO in plains of Assam was higher as compared to the hilly stretch of Manipur. In general, DO enters water through the air or as a plant by-product, such as photosynthesis. From the air, oxygen can slowly

diffuse across the water's surface from the surrounding atmosphere. Since, the atmospheric pressure was low in the hilly stretch of river Barak in Manipur, therefore it might be one reason for low DO as compared to plains where atmospheric pressure was slightly high. Furthermore, most photosynthesis takes place at the surface by shallow water plants and algae, a large portion of the process takes place underwater by seaweed, sub-surface algae and phytoplankton. This might be another reason for high DO value of rivers in plains as compared to hill as the depth of rivers in plains was much larger as compared to hills as per observation [30]. This might be the reason why fishes in the hills of Manipur were smaller and low in abundance as compared to the plains of Assam where the DO value was high. However, no clear trend in variation of conductivity and TDS was found throughout the river stretch. TDS may be influenced by changes in pH which can affect the solubility of the suspended matter. Similarly, the conductivity of water is proportional to its dissolved mineral matter content. Therefore, conductivity varies directly with the temperature and pH. In conclusion, the physciochemical characteristics of river Barak are optimal from hill to plains for fish growth and survival. Since there was no significant variation in physciochemical parameters of river from hill to plains which can drastically affect the species distribution. Hence, the impact of physciochemical parameters on faunal diversity can be neglected in the present study.

The distinct distribution of fishes in different geographic regions i. e. Manipur hills and Cachar plains of Assam suggest that habitat played an important role in their distribution. As can be seen from Table 2, species found in the hilly area of Manipur were not recorded from the plains of Assam and vice versa. Freshwater rivers, and habitats are classified as upland and lowland. These two types of habitats are very different and usually support very different populations of fish [31]. Upland habitats in mountainous areas are cold, clear, rocky and fast-flowing rivers. This kind of environment supports fish species with limited temperature tolerances, high oxygen needs, strong swimming ability, and specialized reproductive strategies to prevent eggs or larvae from being swept away. In contrast, Lowland habitats are warm, coloured water due to sediment and organic matter and slow-flowing rivers, which encourages fish species with broad temperature and low oxygen levels tolerances. Therefore, the habitats of river Barak can also be classified as upland and lowland [31]. Upland habitats were in mountainous areas, mainly in the Manipur region from Senapati to Jirimukh, having cold weather, clear water, rocky substrate, and fast-flowing rivers. Lowland habitats were plain, mainly in the Assam region from Fulertal to Badarpur, having warm weather, coloured water, silty substrate, and slow-flowing rivers. Therefore, this geographic difference has a significant effect on species distribution. Furthermore, the river ecosystem was maintained in the hilly stretch of Manipur, where threats to its biodiversity are insignificant. At some places roads were running parallel to the river, such as NH37 which may cause some concern. As compared to Manipur hills, the plains of Assam were highly populated and river encroachment was visible. Agriculture, transportation, water consumption for city and towns, plastic and sewage discharge, etc. was very common in the plains of Assam, which is the cause of concern for the biodiversity of the river in the future.

5. CONCLUSION

River of Barak was surveyed from Maram, Senapati district of Manipur to Badarpur, Karimganj district of Assam for making an inventory of fish fauna, physciochemical characteristics, and other environmental parameters, such as microhabitat, soil erosion, land use pattern, etc. Several physciochemical parameters were analysed, such as DO, pH, etc, which were found suitable for the growth and breeding of fishes across the river. River was geographically divided into two distinct regions, Upland (hilly region in Manipur) and Lowland (plains in Assam). The river was narrow, fast flowing, and low in depth in the hilly stretch of Manipur, whereas wider, slow flowing and high in depth in the plains of Assam as per observation. The river bed was composed of stone and gravel and the river bank was covered with hanging trees in the upland of Manipur. Contrary to this, the river bed was composed of mainly silt, and clay, and the bank was covered with grass and trees in the lowlands of Assam. Constant depth range, and same type of bottom is the key for distribution of river fishes and as it has been mentioned that constant habitat is maintained except the populated areas in a long stretch is the main reason behind this high diversity of fishes from the range. River meandering and bank erosion were very common in plains. River valley in the plain of Assam was highly populated and cultivated. In total, 35 species were recorded

from the study sites. It was found that fishes found in plains were often not recorded from hilly region of river and vice-versa. The highest number of fish species were recorded from Namtiram, Tamenglong district in Manipur and Srikona, Cachar district of Assam. The dependency of species distribution on physciochemical parameters was less, as there were no significant changes in these parameters of the river from head to mouth. It was suggested that species distribution was mainly affected by habitat and other environmental factors, as the river was geographically divided into two distinct regions.

ETHICAL APPROVAL

Ethics approval was obtained from the Zoological Survey of India, Sunderban Regional Centre, Canning, India for conducting a survey to collect, preserve & identify faunal specimens for better knowledge of the diversity, as well as preparation of the ichthyofaunal catalogue.

SPECIMENS DEPOSITION

The specimens used for the study are deposited in the National Zoological Collection of Zoological Survey of India, Sunderban Regional Centre, Canning 743329, India.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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