<div align="center">**CHAPTER III**</div>

Abundance Study of Fish Species from the *Hel* river, Kokrajhar, Assam

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III.1. Introduction

Biodiversity is the variety and variability of life that exists on Earth. It includes quantity, variety and distribution, ranging through genetics to species, populations, communities and ecosystems (Gowda et al., 2015; Hashemi et al., 2015). It starts with a measure of the number of species that make up a biological community and is considered as one of the most significant aspects of the community organization and structure (Ahmed et al., 2018). This provides a brief idea about the species diversity and richness, and the richness of the species and relative species abundance designates the key elements of biodiversity (Yadav and Mishra, 2013). The biodiversity study is important for sustainability of natural resources. The most common natural biodiversity study is fish diversity within different locations because fishes are very important from the biodiversity point of view, enjoying different ecosystems, habitats and niches of the aquatic environment (Parvathy, 2018). Biodiversity indicates the potential of any aquatic system and also depicts its trophic status (Kumar et al., 2011). Biological evaluation is a useful tool for measuring the ecological value of the aquatic ecosystems as the biological societies integrate the environmental effects of water (Jafari and Gunale, 2006). Study of fishes are not only important indicators of ecological health and abundance but also it maintains a balance in the food chain by consuming plankton and small animals to form food for many animals, and also fishes are commercially important species that can improve the livelihood of the people around the rivers (Thirumala and Kiran, 2017). Fishes are found in the water bodies of both marine and freshwater environments (Tessema and Mohamed, 2016). It is reported that in the past three decades, freshwater biodiversity has been declining faster than either marine or terrestrial biodiversity (Jenkins, 2003). Therefore, it is very crucial to have the idea of the diversity of fish species, distribution, and abundance for the development of conservation and management programs. With this regard, studies of temporal and spatial patterns of diversity, composition and distribution of fish species of freshwater are important to be examined that may influence the structure of fish community (Galacatosa et al., 2004). Biodiversity also disturbs the capability of living systems to

respond in changes of the environment, supports of ecosystem function and provides the ecosystem services that sustenance the human well-being (Hooper et al., 2005; Diaz et al., 2006). Based on the abundance of fish species, India is having one of the most diversified and largest natural resources in the world (Vivekanandan, 2013; Mohanty et al., 2015). The information on the abundance and diversity of the fish species is the main obligatory for management policy (Hossain et al., 2012). The diversity of any natural community partially depends on the conditions of the environment and unfortunately, interferences of anthropogenic activities are diminishing the living resources due to degradation of coastal habitats affecting the fish diversity (Chowdhury et al., 2011). Many studies have been reported about the diversity of freshwater fishes (Jayaram, 1994; Vijaylaxmi et al., 2010; Basavaraja et al., 2014). However, there is no information about the fishery potential and fish biology of the *Hel* river, BTR, Assam. In the present work, the relative abundance study of fish diversity from the *Hel* river of Kokrajhar, Assam was carried out along with the evaluation of species richness and species evenness, and a total of nine fish species of the *Cyprinidae* family were selected based on the high relative abundance report. These nine fish species were morphologically identified.

III.2. Materials and Methods

III.2.1. Sample collection

The fish species were collected from the *Hel* river located within the North: Dhanguri, South: Lungsung, East: Sialmari, and West: Moinaguri near the Serfanguri of Kokrajhar district (Latitude – 26.56°, Longitude – 90.13°, Altitude – 57.9 m, Accuracy: 2.0 m, Bearing – 48.21°), Assam. Sampling of the fish species was done on monthly basis during the day morning and night time throughout the study period from August 2014 to July 2015. For sample collection, different types of gears including the case net (1–2 m diameter with the mesh size of 0.05 cm) and scoop net (mesh size of 0.25 cm), and fishing mosquito net was spread on the water ground at the study sites. The net was placed close to the ground at one side and was lifted slightly up at another site to catch the fish. The water depth of the fishing sites of the river was measured by bamboo stick and it was found to be 2 to 5 feet. The fish samples were counted and the diversity indexes such as relative abundance (%), species richness (H′), and species evenness (J) were calculated. Relative abundance (%) was calculated using the relation (Win and Myint, 2020) given below.

Relative abundance (%) = (Total number of individuals in each of a species/Total number of individuals of all the observed species) × 100.

Species richness (H′) was calculated by using Shannon-Weiner diversity index (Tessema and Mohamed, 2016; Parvathy, 2018).

$$H' = -\sum_{i=1}^{s} pi \ln(pi)$$

Where, pi – the proportion of the individuals in the ith species, s – total number of species.

Species evenness (J) was calculated by using Pielou's evenness equation (Vijaylaxmi et al., 2010; Thirumala and Kiran, 2017).

$$J = \frac{H'}{\ln(s)}$$

III.2.2. Sample selection and identification

A total of nine fish species of the *Cyprinidae* family were selected based on their high relative abundance value. The selected species were taken into a specimen jar containing preservative (4% formalin) for morphological characterization and identified with the help of the Zoological Survey of India (ZSI) located at Shillong, Meghalaya (**Appendix section**; **Fig. III.A.1a** and **Fig. III.A.1b**). The selected species were further sequenced by molecular identification tool using COI gene marker from fish fins and it was stored at -20°C in the freezer for further studies. All the chemicals and solvents used were of analytical grade.

Table III.1. Local name, scientific name, family and order of fish species found in the *Hel* river, Assam

Sl. No.	Local name of the species	Scientific name of species	Order	Family
1	Elang	*Barilius bendelisis*	*Cypriniformes*	*Cyprinidae*
2	Siltoka	*Garra gotyla*	*Cypriniformes*	*Cyprinidae*
3	Nangdor	*Mastacembelus armatus*	*Synbranchiformes*	*Mastacembelidae*
4	Pahari Tangna	*Gogangra viridescens*	*Siluriformes*	*Sisoridae*
5	Bhangna	*Cirrhinus reba*	*Cypriniformes*	*Cyprinidae*
6	Pitkata	*Chagunius chagunio*	*Cypriniformes*	*Cyprinidae*
7	Vuluk	*Neolissochilus hexagonolepis*	*Cypriniformes*	*Cyprinidae*
8	Chela	*Raiamas bola*	*Cypriniformes*	*Cyprinidae*
9	Puthitor	*Tor tor*	*Cypriniformes*	*Cyprinidae*
10	Poia	*Canthophrys gongota*	*Cypriniformes*	*Cobitidae*
11	Chanda	*Parambassis ranga*	*Perciformes*	*Ambassidae*
12	Ghoira	*Labeo pangusia*	*Cypriniformes*	*Cyprinidae*
13	Vutia puthi	*Cyprinion semiplotum*	*Cypriniformes*	*Cyprinidae*
14	Baluchata	*Psilorhynchus sucatio*	*Cypriniformes*	*Psilorhynchus*
15	Boal	*Wallago attu*	*Siluriformes*	*Siluridae*
16	Gol	*Psilorhynchus nudithoracicus*	*Cypriniformes*	*Psilorhynchidae*
17	Kabri peri	*Barilius barna*	*Cypriniformes*	*Cyprinidae*
18	Jongator	*Tor putitora*	*Cypriniformes*	*Cyprinidae*
19	Rita	*Rita rita*	*Siluriformes*	*Bagridae*
20	Rani	*Botia dario*	*Cypriniformes*	*Botiidae*
21	Tengra	*Gagata cenia*	*Siluriformes*	*Sisoridae*
22	Zebrafish	*Danio* rerio	*Cypriniformes*	*Cyprinidae*
23	Botia	*Botia rostrata*	*Cypriniformes*	*Botiidae*
24	Telchitta	*Glyptothorax telchitta*	*Siluriformes*	*Sisoridae*
25	Zig zak baim	*Mastacembelus armatus*	*Synbranchiformes*	*Mastacembelidae*

Table III.2. Relative abundance (RA) study of fish species found in the *Hel* river of Kokrajhar, Assam

Sl. No.	Family	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total	RA (%)
1	*Cyprinidae*	9	5	18	12	21	40	25	35	10	9	11	6	201	**15.31**
2	*Cyprinidae*	10	8	10	5	11	33	31	26	20	15	9	7	185	**14.09**
3	*Mastacembelidae*	0	0	0	3	2	2	2	0	0	0	0	0	9	**0.68**
4	*Sisoridae*	0	1	2	3	1	2	0	0	0	0	0	0	9	**0.68**
5	*Cyprinidae*	2	4	0	6	7	9	5	2	3	0	1	0	39	**2.97**
6	*Cyprinidae*	6	3	9	5	10	8	12	15	10	13	9	4	104	**7.92**
7	*Cyprinidae*	2	3	6	9	8	6	8	10	5	4	3	4	68	**5.18**
8	*Cyprinidae*	7	5	6	11	6	9	10	6	4	3	3	1	71	**5.41**
9	*Cyprinidae*	0	0	0	3	0	5	2	0	0	1	0	4	15	**1.14**
10	*Cobitidae*	0	2	4	3	3	2	0	0	0	0	0	0	14	**1.07**
11	*Ambassidae*	0	4	6	4	0	3	1	4	0	0	0	2	24	**1.83**
12	*Cyprinidae*	4	6	3	2	6	10	16	11	13	6	2	3	82	**6.24**
13	*Cyprinidae*	9	5	3	2	9	15	10	13	11	9	5	11	102	**7.77**
14	*Psilorhynchus*	0	0	0	2	0	1	0	0	0	0	0	0	3	**0.23**
15	*Siluridae*	0	0	0	1	0	0	0	1	0	0	0	0	2	**0.15**
16	*Psilorhynchidae*	3	0	9	6	18	9	8	5	4	2	3	0	67	**5.10**
17	*Cyprinidae*	9	16	13	14	13	19	23	13	20	18	13	10	181	**13.78**
18	*Cyprinidae*	4	6	5	8	7	12	11	9	10	5	7	6	90	**6.85**
19	*Bagridae*	0	0	0	0	0	0	1	0	1	0	0	0	2	**0.15**
20	*Botiidae*	0	0	0	2	1	2	3	2	0	0	0	0	10	**0.76**
21	*Sisoridae*	0	0	0	1	0	2	2	4	0	0	0	0	9	**0.68**
22	*Cyprinidae*	0	0	0	2	1	3	2	3	2	0	0	0	13	**0.99**
23	*Botiidae*	0	0	0	0	2	2	0	4	0	0	0	0	8	**0.61**
24	*Sisoridae*	0	0	0	1	0	0	2	0	0	0	0	0	3	**0.23**
25	*Mastacembelidae*	0	0	0	0	1	1	0	0	0	0	0	0	2	**0.15**
Total individuals		**65**	**68**	**94**	**105**	**127**	**195**	**174**	**163**	**113**	**85**	**66**	**58**	**1313**	
Total species		**11**	**13**	**13**	**22**	**18**	**22**	**19**	**17**	**13**	**11**	**11**	**11**	**181**	
Shannon-Weiner diversity index (H′)		**2.27**	**2.37**	**2.40**	**2.82**	**2.56**	**2.60**	**2.53**	**2.47**	**2.32**	**2.15**	**2.19**	**2.24**	**2.61**	
Pielou's evenness (J)		**0.95**	**0.92**	**0.94**	**0.91**	**0.88**	**0.84**	**0.86**	**0.87**	**0.90**	**0.90**	**0.91**	**0.93**	**0.50**	

III.3. Results and Discussion

III.3.1. Abundance study

In this study, the scientific name, local name, family and order of the fishes studied from the *Hel* river of Kokrajhar, Assam is shown in **Table III.1.** The abundance study of the fish species was carried out from August 2014 to July 2015 and the results are shown in **Table III.2**. The results show that a total of 181 species and 1313 individuals could be found from the *Hel* river during the study period. This indicated that the *Hel* river is rich in fish diversity with varying numbers of species. The results (**Table III.1** and **Table III.2**) also showed that a total of 25 different fish species belonged to 4 orders *viz. Cypriniformes* (17 numbers), *Siluriformes* (05 numbers), *Synbranchiformes* (02 numbers) and *Perciformes* (01 number), and 9 families *viz. Cyprinidae* (12 numbers), *Sisoridae* (03 numbers), *Mastacembelidae* (02 numbers), *Psilorhynchidae* (02 numbers), *Botiidae*, (02 numbers), *Siluridae* (01 number), *Cobitidae* (01 number), *Ambassidae* (01 number) and *Bagridae* (01 number). It was observed that the fishes that belonged to the order *Cypriniformes* and the *Cyprinidae* family showed the maximum numbers in the study period. It was observed that high numbers of individuals (above 100) were found from November to April and the numbers of species were below 100 from May to October. The highest number of individuals (195 numbers) was found in January and the lowest (58 numbers) was found in July. The study of relative abundance (%) showed that the fishes belonging to *Cyprinidae* family were observed to be the highest in the *Hel* river. The relative abundance (%) occurrence of the fishes viz. *Barilius bendelisis*, *Garra gotyla,* and *Barilius barna* were 15.31 %, 14.09 % and 13.78 % respectively, and the lowest was found as 0.99 % in *Danio rerio* (**Table III.1** and **Table III.2**). This study indicated that the fish species of *Cyprinidae* family *viz. Cirrhinus reba*, *Tor tor*, and *Danio* rerio belonged to the low relative abundance in the selected study area.

In this study, the Shannon-Weiner diversity index (H′) for species richness observed in the particular area was 2.61 and on monthly basis, it was found to be the highest in November (2.82) and the lowest in May (2.15) (**Table III.2)**. The Pielou's evenness (J) for species evenness observed in the particular area was 0.50 and on monthly basis, it was found to be the highest in August (0.95) and the lowest in January (0.84). The graphical representation of the diversity index *i.e*. Shannon-Weiner diversity index (species richness), Pielou's evenness (species evenness) and the total number of species are shown in **Fig. III.1.** The Shannon-Weiner diversity index for species richness is used for the evaluation of species diversity of the sampling sites and rivers. It reveals both the relative abundance and variety of the fishes (Tessema and Mohamed, 2016). Species evenness is a measure of the relative abundance of

the different species making up the richness of the area (Vijaylaxmi et al., 2010). The species richness varies due to various factors like available nutrients, seasonal change, habitats, fish behavior, fishing effort, size and life stages of fishes, water level and turbidity of water (Tessema and Mohamed, 2016). However, aquatic species decline rapidly due to impact of the habitat degradation, anthropogenic activities, exotic species introduction, pollution, water diversions and global climate change (Vijaylaxmi et al., 2010). In present investigation, a total of nine fish *viz. Barilius bendelisis*, *Garra gotyla*, *Barilius barna*, *Chagunius chagunio*, *Cyprinion semiplotum*, *Tor putitora*, *Labeo pangusia*, *Raiamas bola* and *Neolissochilus hexagonolepis* belonging to *the Cyprinidae* family were selected for further studies based on their high relative abundance values (**Table III.2)**.   All these nine fish species were authenticated at the Zoological Survey of India (ZSI) located at Shillong, Meghalaya (**Appendix section**; **Fig. III.A.1a** and **Fig. III.A.1b**). These fishes are displayed in **Fig. III.2**, and can be concluded that the *Hel* river of Kokrajhar, Assam has rich sources of *Cyprinidae* family fish species.
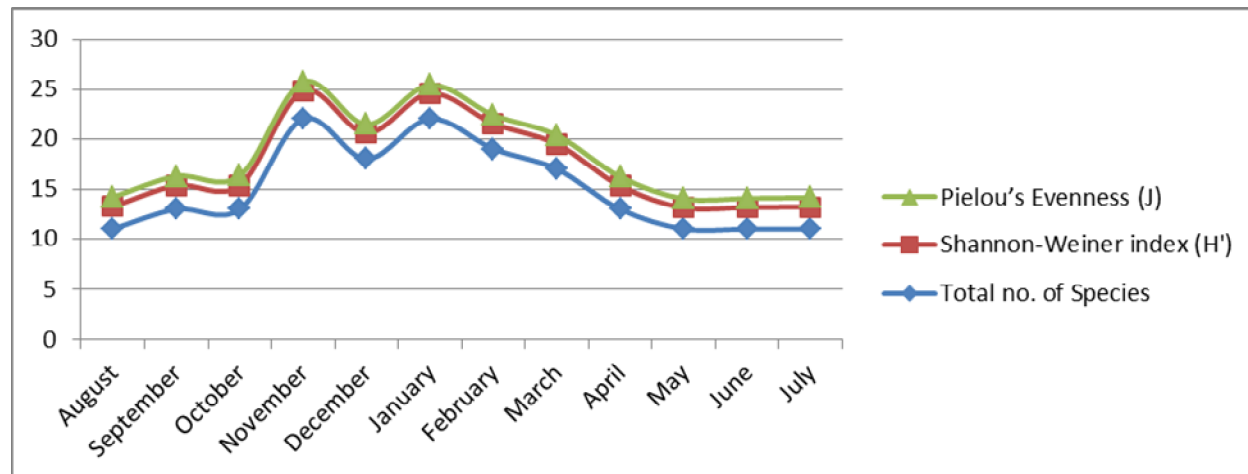

Fig. III.1. Representation of the total number of species, Shannon-Weiner index (H′) and Pielou's Evenness (J).

Barilius barna

Barilius bendelisis

Garra gotyla

Labeo pangusia

Neolissochilus hexagonolepis

Raiamas bola

Tor putitora

Cyprinion semiplotum

Chagunius chagunio

Fig. III.2. Selected fish species of the present study.

Table III.3. Fish species from the *Hel* river selected for the present study

Scientific name	Local name (*Assamese*)	Family	IUCN Status [2015]
Barilius bendelisis (Hamilton, 1822)	Elang	Cyprinidae	LC
Chagunius chagunio (Hamilton, 1822)	Pitkata	Cyprinidae	LC
Garra gotyla (Gray, 1832)	Siltoka	Cyprinidae	LC
Labeo pangusia (Hamilton, 1822)	Ghoira	Cyprinidae	NT
Neolissochilus hexagonolepis (McClelland, 1839)	Vuluk	Cyprinidae	NT
Raiamas bola (Hamilton, 1822)	Chela	Cyprinidae	LC
Tor putitora (Hamilton, 1822)	Jongator	Cyprinidae	EN
Cyprinion semiplotum (McClelland, 1839)	Bhutia puthi	Cyprinidae	VUL
Barilius barna (Hamilton, 1822)	Kabri peri	Cyprinidae	LC

LC – Least concerned, NT – Near threatened, EN – Endangered, VU – Vulnerable.

Table III.3 showed the local name, scientific name and family of the nine fish species with the conservation status of the IUCN category. According to IUCN Status, 2015, it was shown that the fish species *Barilius bendelisis*, *Garra gotyla*, *Barilius barna*, *Chagunius chagunio*, *Raiamas bola* were fall under least concerned category and *Labeo pangusia*, *Neolissochilus hexagonolepis* were falling under the near threatened category. *Tor putitora* falls under endangered and *Cyprinion semiplotum* under vulnerable category. It was observed that the variable number of fish species was found on different variable periods. This may be because of numerous environmental issues. It was reported that the occurrence of fish species in a particular area depends on the environmental factors including water temperature, pH, salinity, dissolved oxygen and many other factors and also some fish species changes their external appearances for survival in the particular area, and some do not tolerate in another environment (Gowda et al., 2015). Due to the tolerance capacity in other environments, fishes fall into several conservation categories based on IUCN status. Some fishes are reducing day by day due to a lack of their proper environmental conditions and many other factors. Therefore, the abundance study is very important for knowing the species number and also the seasonal effects on the relative abundance of fish species. With that aim, many researchers have reported many abundance studies to save aquatic fish species. Gupta et al. (1992) recorded that physical and chemical variables such as air temperature, rainfall and

water temperature showed a fairly wide seasonal variation. They recorded a total of seventeen species that belonged to five families and eight genera from Meghalaya, India. Bhata (2003) studied the diversity and composition of freshwater fish species from Western Ghats, India, and in the study, a total of 10771 individuals belonging to 92 species representing 25 families and 48 genera excluding the *Cyprinidae* family were reported. Bisht et al. (2009) reported that the difference in availability of fish-fauna is directly related to the nature of profile and slope of tributary, which affects the migration and breeding grounds of the fishes inhabited in the main river. Vijaylaxmi and Vijaykumar (2011) conveyed that the *Cyprinidae* family was observed to be the most dominant one among all the other families in their study. Sarkar et al. (2012) recorded a total of 143 fish species belonging to 11 orders, 72 genera and 32 families from the river Ganges, India. Basavaraja et al. (2014) reported 25 fish species belonging to 04 orders, 09 families and 18 genera and found that the order *Cypriniformes* was the most predominant one followed by the order *Siluriformes*, *Perciformes* and *Osteoglossiformes*. Rumana et al. (2015) showed that the regulation of water has an impact on species richness, relative abundance and habitat heterogeneity which has decreased due to the change in environmental conditions. Mohanty et al. (2015) reported that greater diversity values may be because of the abundant availability of the food resources and appropriate environmental situations. Badoni (2017) mentioned that the availability of fish fauna is directly related to the profile of the stream, the natural pattern of temperature, organic resources, discharge of water and water chemistry. The present study is also the report of fish diversity of freshwater *Hel* river of Kokrajhar, Assam and this showed that the *Cyprinidae* family is the most dominant family among the fish species found in the *Hel* river.

Conclusion

The abundance study of the fish species was performed from August 2014 to July 2015. The results show that a total of 181 species and 1313 individuals could be found from the *Hel* river. The relative abundance (%) study showed that the fish species belonging to the *Cyprinidae* family were found to be the highest in the *Hel* river. The highest relative abundance (%) occurrence of the species was *Barilius bendelisis* (15.31 %) followed by *Garra gotyla* (14.09 %) and *Barilius barna* (13.78 %). The study reveals that the selected *Hel* river is rich in fish species of *Cyprinidae* family along with other varying numbers of species, and this report can be used as a reference source for future research work.