FISH FAUNA AND ECOLOGY OF DOYANG RIVER SYSTEM, NAGALAND

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By

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C E R T I F I C A T E

This is to certify that the thesis entitled "Fish Fauna and Ecology of Doyang River System, Nagaland" is a compilation of the results of research work carried out by Mr. Imnatoshi under my supervision and guidance.

This is also to certify that Mr. Imnatoshi is a registered research scholar (Regn. No. 294/2007) of the Department of Zoology, Nagaland University, Headquarters: Lumami. The work is original and the candidate has fulfilled all the requirements as laid down by Nagaland University for the submission of his Ph.D thesis. Neither the thesis nor any part of it has been submitted elsewhere for the award of any degree of distinction.

The thesis is therefore, forwarded for adjudication and consideration for the award of degree of Doctor of Philosophy in Zoology under Nagaland University.

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D E C L A R A T I ON

I hereby declare that the content of this thesis entitled “Fish Fauna and Ecology of Doyang river system, Nagaland” is the comprehensive original research work done by me. The content of this thesis did not form the basis of award of any previous degree to me or to the best of my knowledge to anybody else and that the thesis has not been submitted by me for any research degree in any other University/Institute.

This thesis is being submitted to Nagaland University, Lumami, for the award of the degree of Doctor of Philosophy in Zoology.

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CHAPTER 1

INTRODUCTION, REVIEW OF LITERATURE AND AIMS AND OBJECTIVES

CHAPTER 1

1.1 INTRODUCTION

Fishes are an important resource worldwide, especially as food. Commercial and subsistence fishers hunt fish in wild fisheries or farm them in ponds or in cages in the ocean. They are also caught by recreational fishers, kept as pets, raised by fish keepers, and exhibited in public aquaria. Fish have had a role in culture through the ages, serving as deities, religious symbols, and as the subjects of art, books and movies (Wikipedia). Although we recognize the value of our dependency upon fishes, threats to the integrity of the environment pose a serious problem for their existence. It is desirable to maintain the diversity and systematists can play a leading role in protecting their diversity (Nelson, 1994).

Fishes are abundant in most bodies of water. They can be found in nearly all aquatic environments, from high mountain streams e.g., char and gudgeon, to the abyssal and even hadal depths of the deepest oceans (FishBase, 2011). Nelson (2006) estimated 27,977 valid species of fishes under 62 orders, 515 families and 4,494 genera, and the eventual number of extant fish species was projected to be close to 32,500. About 11,952 species or 42.72%, normally live in freshwater lakes and rivers that cover only 1% of the earth's surface and account for a little less than 0.01% of its water. The secondary freshwater species number 12,457 and the remaining 3,568 species are exclusively marine.

India is one of the megabiodiversity countries in the world (Mittermeier & Mittermeier, 1997). The Indian subcontinent, occupying a position at the confluence of three biogeographic realms, viz., the Palaeartic, Afro-Tropical and Indo-Malayan, exhibits a great variety of ecological habitats, harboring rich ichthyofaunal diversity (Devi & Indra, 2009). In

the Indian region alone out of 2500 species, 930 are freshwater inhabitants and 1570 are marine (Jayaram, 1999).

The northeastern region of India has been identified as a hotspot of biodiversity by the World Conservation Monitoring Centre (WCMC, 1998). Roach (2005) notes that North east India forms a part of two of the 34 biodiversity hotspots listed by Conservation International, the Himalayas and Indo-Burma (Fig.1). The diversity within the freshwater ecosystems in this region, forming part of the Himalayas and Indo-Burma are both highly diverse and of great regional importance in terms of the people livelihood and the economic importance of the people living around it. (Allen et al., 2010). The rich fish diversity of the region has been attracting many ichthyologists. The diversity is attributed to many reasons, viz., the geomorphology, consisting of the hill streams, rivers, lakes and swamps, drainage pattern which include Ganga-Brahmaputra, Koladyne and Chindwin-Irrawady systems. Another important factor is the tectonic setting in Southeast Asia resulted by collision of Indian, Chinese and Burmese plates resulting in the formation of the Mighty Himalayas and Indo-Burman ranges (Vishwanath, 2002).

The northeastern region of India, comprising the states of Assam, Meghalaya, Manipur, Arunachal Pradesh, Mizoram, Tripura, Nagaland and Sikkim Possess a unique potential of fishery resources and is considered as one of the hotspots of freshwater biodiversity in the world (Kottelat and Whitten, 1996). The region lies between 21.50° to 29.50° North latitude and 85.50° to 97.50° East longitudes and is bounded on the north by China and Bhutan, on the west by Bangladesh and on the east by Burma and covers an elevation from 15 to 5000 metres from the mean sea level (MSL). The total land coverage of the area is 2.55 lakh sq. km. which is about 7.76% of the country, out of which 70% is the hilly area (Mahanta et al., 2001). The rivers Brahmaputra, Barak and Tista form the principal

drainage of North East India with its numerous tributaries flowing through the different states along with myriads of rivulets and lentic water bodies, which harbors diversified fish fauna. Owing to the diversity of topographic and climatic features of northeastern India, the aquatic resources are rich in fish germplasm (Mahapatra et al., 2006). The natural home of endemic fish species of Northeastern India are hill streams, rivulets, lakes, water holes, beels, swamps, low lying cultivable area, paddy fields of flood prone areas etc. covering 19,868 kilometers and 2,11,301 hectares.

Jayaram (1999) listed 852 freshwater species of fishes under 272 genera, 71 families and 16 orders. The checklist of Menon (1999) includes 446 primary freshwater species under 33 families and 11 orders from the Indian region alone. Of the primary freshwater species 68% are constituted by the cyprinoids, 18% by siluroids and 14% by other groups. The checklist of the native fresh water fishes of India numbers 667 species (Devi and Indra, 2009) including mostly siluroids and a few cyprinoids and those resurrected from synonyms excluding exotic and secondary fresh water species. The 667 species are grouped under 12 orders, 35 families and 149 genera. Sen (2000) stated that, so far, 267 fish species belonging to 114 genera under 38 families and 10 orders has been recorded and reported from the northeastern region. This is approximately 33.12% of total Indian freshwater fishes. However, recently a checklist of 442 fish species was recorded from north east India belonging to 133 genera and 38 families. This survey shows that the north eastern region of India contains more than 62.81% of total freshwater fish available in the country, as against the 667 freshwater species reported (Goswami et al., 2012). Among the northeastern states, Assam has the largest number of ichthyospecies numbering 216 (Bhattacharjya et al., 2003), followed by Arunachal Pradesh (167), Meghalaya (165), Tripura (134), Manipur (121), Nagaland (68) and Mizoram (48 species) (Sen, 2000). However, these figures are continuously increasing, with Manipur

recording highest with 325 species (Goswami et al, 2012). Thus, portraying a vivid spectrum of ichthyofauna, offering challenging avenues of taxonomical and biological pursuits. Although considerable work has been done by ichthyologists and fish biologists, much still remains to be accomplished, where environments are rapidly changing due to human impact of one sort or the other.

Nagaland is a hilly mountainous state of the North East corner of the country. The state is located between 25.6 and 27.4 N degrees latitudes and between 93.20 and 95.13 E degrees longitudes . It encompasses a geographic area of 16,579 Sq. km. and supports about 1.98 million people (2011 census). The state has unique topography, diverse physiographic features and water shed pattern. This remote part is still lacking far behind in terms of infrastructure development and could not be able to keep pace with progress made by the rest of the country in the post independence era. The state portrays a retarded growth in the field of aquaculture industry since its development is riddled with many constraints.

Riverine fishery forms the major aquatic resources of this hilly state and plays a significant role in harbouring natural stocks of the fish . The principal rivers of Nagaland are Dhansiri, Doyang, Dikhu, Züngki and Tizu, of which Doyang river is the largest and the longest of the state .The rivers of Nagaland flow either into Brahmaputra in the west in Assam or into the Chindwin in the east in Myanmar. It is easily discernible from this that no rivers of Nagaland flow into the sea directly. The catchment areas of the rivers in Nagaland that drains into Brahmaputra and the catchment area of rivers that drains into Chindwin are roughly equal, but one interesting difference between the two catchments is that, in the case of Brahmaputra catchment a couple of rivers drain the area and they join the Brahmaputra in Assam separately, whereas in the case of Chindwin catchments all the

tributaries join together and finally run into the Chindwin. The rivers that flows into the Brahmaputra drainage includes : (a) the Dhansiri river (b)the Doyang river (c) the Tsürang river (d) the Milak river (e) the Dikhu river (f) the Tirü and Tizit rivers. The rivers that flows into the Chindwin drainage system includes :(a) the Züngki, biggest tributary of the Tizu river (b) the Likimro river another tributary of the Tizü river and (c) the Lanye river. After the Lanye joins Tizu, the Zungki and the Likimro rivers joins the Tizu River and pass the mountainous region into Myanmar where it flows into the Chindwin river. There are as many as eleven major and nine minor rivers distributed over the eleven districts of the state. The river systems of Nagaland along with some relevant parameters are purported in Table 1. These rivers along with other small streams and rivulets have a total length of 1,600 km. Other existing aquatic resources of the state includes 215 ha of beels, lakes and swamps, 500 ha of ponds and 200 ha of low lying paddy cum fish culture area.

A variety of fish fauna have been recorded from the varied aquatic resources. However, the fish fauna of Nagaland is yet to be explored systematically. No comprehensive database on fishery resources of the state is worked out so far. Hence information on fish fauna of the state is very fragmentary and inadequate. A total of 149 species belonging to 64 genera under 22 families have been reported from the state (Ao et al, 2008). However, at present there could be many more species distributed in the river/hill streams of Nagaland. Bendangkokba and Ahmed (2007) have conducted a detailed survey on the occurrence of the fish fauna in the rivers of Mokokchung district, Nagaland. They reported 66 species of fish belonging to 16 families and 5 orders from three main rivers viz. Milak, Dikhu and Tsürang rivers of Mokokchung district. It appears that no detailed survey has been conducted to document the availability of diversified fish fauna in the various drainage systems of Nagaland. Therefore, the present investigation was carried out to study the fish fauna and ecology of Doyang river system in Nagaland.

Table-1: Location and tributaries of river system in Nagaland

SL. NO.	MAJOR RIVERS	DISTRICT	FLOWS INTO
1	Dhansiri	Dimapur	Brahmaputra
2	Dikhu	Mokokchung	”
3	Doyang	Wokha	”
4	Intangki	”	”
5	Meguiki	Peren	Barak
6	Milak	Mokokchung	”
7	Shili	Longleng	”
8	Tizit	Mon	”
9	Tizu	Phek	Chindwin
10	Tsurang	Mokokchung	Brahmaputra
11	Zungki	Kiphire	Chindwin
	MINOR RIVERS		
1	Arachu	Kohima	Chindwin
2	Chathe	Tuensang	Brahmaputra
3	Chokla	Mon	Chindwin
4	Dzulakie	Dimapur	Barak
5	Dzuna	Tuensang	Brahmaputra
6	Lanye		Chindwin
7	Likhimro	Phek	Chindwin
8	Sidzu	Kiphire	Brahmaputra
9	Tepuiki	Kohima	Barak
10	Tesuru	Peren	Chindwin

1.2 REVIEW OF LITERATURE:

Jayaram (1999) noted that, there is hardly any body of water which does not have some variety or other of fish. It is no wonder that interest in study of fish is as old as vedic times in India. The ancient Indians classified fish, based on shape and structure and their knowledge from keen observations are remarkable as seen from Kautilya's Arthashasthra (ca 300 B.C), King Somesvara's Manasollasa, 1127 A.D. (Hora 1951).

The first modern writer on Indian fishes, according to Day (1878) was Bloch, whose remarkable work "Auslandiche Fische" was published in 1785. Other studies with a more scientific, more accurate and fulfilling the needs of modern taxonomy on the Indian freshwater fish fauna started only from the 19^{th} century. Beginning with Hamilton-Buchanan's (1822) account of the fishes of the Ganges, followed by J. McClelland (1839), Col. W. Sykes (1839), T.C. Jerdon (1849), Bloch (1858, 1860). All these pioneer researchers laid a solid foundation for Indian systematic Ichthyology (Jayaram, 1999). Francis Day's epoch making contributions such as Fishes of Malabar (1865), Fishes of India (1878) and Fauna of British India, Ceylon and Burma (1889), have wide coverage and compactness which still remains an important reference manual for the Ichthyological studies of the Indian subcontinent.

During the present century, resplendent contributions has been made by Hora (1920-1952) which includes 440 published papers and establishing three families , 28 genera and 139 species many of which are still valid. Other noteworthy contributions were also made by Mishra (1947, 1952, 1953, 1969), Tilak (1987), Menon (1987, 1992), Talwar (1995), Jayaram (1991), Talwar and Jhingran (1991), Jayaram and Dhas (1999) and Jayaram and Anuradha (1999).

Foreign workers notably Roberts (1989), Eschmeyer (1990), Kottelat (1990), Howes (1991), Pethiyagoda (1991), Rainboth (1991), Banarescu and Nalbant (1995) had also added further to the existing research and literatures on Indian Ichthyology.

Review of literature indicates that only limited information is available on aquatic resources and fish fauna of north east region including Nagaland with special reference to its potential as cultivable, sports and ornamental fishes. These scattered information available from survey of this region by several workers include Hora (1921, 1936) Hora and Mukherji (1935), Menon (1954, 63), Jayaram (1962), Chaudhury and Banerjee (1965), Shukla (1965), Malhotra and Suri (1969), Dey (1973, 1975, 1976), Choudhury and Sen (1977), Sen and Choudhury (1977), Yazdani (1977), Ghosh and Lipton (1982), Nath and Dey (1982, 1997, 2000, 2008), Sen and Dey (1984), Barman (1994), Sen and Biswas (1994), Sinha (1994), Yadava and Chandra (1994), Sehgal (1995), Selim and Vishwanath (1998), Vishwanath et al. (1998), Vishwanath and Kosygin (1998), Sen (2000, 2003), Dey and Kar (2002), Ahmed (2003), Dey and Ao (2005), Kar et. al (2006), Karmakar and Das (2006), Goswami et al. (2007), Ao et al. (2008), Ramanujam et al. (2010).

A few reasearchers have made significant contribution on the occurrence and distribution of ichthyofauna in NE region with special reference to Nagaland. Some of the Notable works are Hora (1921) reported Fish and Fisheries of Manipur with some observation on those of Naga Hills; later, Hora (1936) worked on a further collection of fish fauna from the Naga Hills; Hora and Mukherji (1935) surveyed on Fish of the Naga Hills; Jayaram (1962) studied on the Fish and Fisheries of Brahmaputra river system, Assam; Menon (1963) appraised the distributional list of fishes of the Himalayas; Malhotra and Suri (1969) assessed the Fishes of Nagaland; Dey (1976) ascertained the significance of fish in the hill streams of Assam and Meghalaya, India; Ghosh and Lipton (1982) studied on the Ichthyofauna of the

N.E.H. Region with special reference to their Economic importance; Sen and Dey (1984) evaluated the Fish geography of Meghalaya; Barman (1994) estimated the Fish Fauna of Tripura, N.E. India; Sinha (1994) determined the Fish Genetic resources of the Northeastern Region of India; Vishwanath and Kosygin (1998) reported on fish diversity of Tizu river, Nagaland with some new records; Sen (2000) assessed the Occurrence, distribution and status of diversified fish fauna of North East India; Vishwanath (2002) worked on the Fishes of North East India: A field guide to species identification; Kar et al. (2006) surveyed the Fish Diversity and Conservation Aspects in an Aquatic Ecosystem in Northeastern India; Goswami et al. (2007) worked on the fish fauna of north east India; Ao et al. (2008) extensively studied the Fish and Fisheries of Nagaland; Nath and Dey (2008) worked on the Ecology and Fisheries of Barak river system of India.

A perusal of literature also reveals a wide variation in the number of fish reported from these regions. Menon (1963) recorded 161 species from Brahmaputra drainage system which also includes the drainage of Khasi hills in Meghalaya. Ghosh and Lipton (1982) accounted 172 fish species with reference to their economic importance, while Sen (1985) recorded altogether 187 fish species from Assam and neighboring north eastern states of India. Sinha (1994) in his comprehensive review gave a list of 230 fishes as available from north eastern region while Yadava and Chandra (1994) listed a total of 129 species. Nath and Dey (1997) recorded a total of 131 fish species from the drainage of Arunachal Pradesh. Sarkar and Ponniah (2000) evaluated 186 fish species belonging to 27 families under 84 genera from the north east of India. Sen (2000) has also reported 267 fish species from north east region. Vishwanath (2002) reported 239 species belonging to 104 genera, 34 families and 12 orders. The various report show a wide variation in the total number of fish species reported ranging from 161 (Menon, 1963) to 267 fish species (Sen, 2000) from the north east region. All these

afore mentioned citation portrays that substantial work have been carried out by numerous workers on the diversity of fishes in the different parts of north east India. However, on the contrary ichthyofaunal accounts from the different drainage system of Nagaland are fragmentary and inadequate. Day (1889) first reported 3 new species viz. *Erythistes hara* (Hamilton-Buchanan), *E. elonga* (Day) and *Danio aequipinnatus* (McClelland) from the Naga Hills. Hora (1921) reported only 2 species, viz. *Rasbora rasbora* (Hamilton-Buchanan) and *Rhynchobdella dhansiri* (Hora), from Nagaland. Hora and Mukherji (1935) reported 44 fish species from Naga hills, in which 17 species of it were collected from Tizu river and its tributaries. Hora (1936) and Menon (1954) have also reported the occurrence and distribution of fish species from Naga hills. Vishwanath and Kosygin (1998) reported 27 species under 19 genera and 7 families from Tizu river of Nagaland of which nine species were recorded for the first time from Nagaland. Karmakar and Das (2006) published a list of 108 fish species of Nagaland consisting of their own field collection of 81 species as well as 27 species from earlier ZSI records. Department of Fisheries, Nagaland (2005) reported 90 species from Nagaland. Bendangkokba and Ahmed (2007) have also described 65 species including 3 new species from Mokokchung district, Nagaland. Of late, Ao et al. (2008) accounted 149 species from Nagaland belonging to 64 genera and 22 families under 6 orders.

A satisfactory understanding of the aquatic life requires knowledge, not only of the organism themselves but also of those external influences which directly or indirectly affects them (Welch, 1952). Hawkes (1979) reported that the riverine water quality can be evaluated by the study of physico-chemical and biological condition of a river. As such, the limnological investigations in India were initiated by Prasad (1916) and were followed by the classical works of Pruthi (1933) and Sewell (1934) on the physico-chemical conditions and biota respectively of the tank in the Indian museum compound, Calcutta. Since then, there has been

notable proliferation of studies on different aspects of ecology from the diversified freshwater biotopes of India (Thangjam, 2010). Some notable works includes those of Pahwa and Mehrota (1966), Gulati and Wurtz-schultz (1980), Khan and Zutshi (1980), Michael (1980), Lal et al. (1986), Jhingran and Pathak (1988), Jhingran (1989), Sharma et al. (1989), Srivastava and Kulshrestha (1990), Sharma (1991), Khan et al. (1998), Singh et al. (1999), Kaur and Joshi (2003), Mishra and Tripathi (2003), Saxena et al. (2005), Zafar and Sultana (2008), Manikannan et al. (2011).

In Nagaland, there are good opportunities of riverine fishery potentials, which can be developed by giving proper attention to the fish habitat's limnological conditions and other capture fisheries. Sugunan (1998) highlighted the potential and constraints of fishery development in north eastern India. Limnological works of north eastern India showed that Dey and Sharma (1967) worked on the fish fauna and ecophysiological condition of the Beki river system of Assam. Singh et al. (1982) studied the seasonal and diurnal change in physico – chemical features of river Brahmaputra. Lal et al. (1986) did elaborative work on the ecology and fishery of river Ganga. Yadava et al. (1987) worked on the limnology and productivity in Dighali beel (Assam). Jhingran (1989) investigated the impact of environmental perturbations on the fishery ecology of river Ganga. Yadava and Dey (1990) studied the impact of physico-chemical complexes on plankton density in Dighali beel (Assam). Nath and Dey (1997) reported an outline ecological feature of the rivers of Arunachal Pradesh. Biswas and Baruah (2000) worked on the ecology of river Brahmaputra. Sharma (2000a, 2000b, 2004) extensively studied on the rotifers and phytoplanktons of the flood plains of Assam. Pathak et al. (2001) reported the ecological status and fish production potential of Siang, Dibang and Lohit, the three forerunners of river Brahmaputra. Gurumayum et al. (2001) did a detailed study on the ecology of river Subansiri in Arunachal Pradesh.

Gurumayum et al. (2002) reported seasonal distribution of phytoplanktons and zooplanktons in rivers of Meghalaya. Sharma and Sharma (2005, 2008, 2009) worked on faunal diversity of rotifers and Cladocera of Deepor beel, Assam and faunal diversity of Loktak lake, Manipur. Hazarika (2010) appraised the impact of flood in the wetlands of Assam. Evidently, most of the mentioned studies are seen to be limited to the different water bodies of Assam.

Despite these afore mentioned reports on the fish biodiversity and habitat ecology of few major river systems in north east India. No scientific investigation has been carried out so far on the ichthyofaunistic resources and ecology of different drainage system in Nagaland.

1.3 AIMS AND OBJECTIVES:

Doyang is the largest river of Nagaland and approximately lies between 25°40´44´´ and 26°13´74´´ N Latitude and between 94°14´31´´ and 94°0´54´´ E Longitude. The Doyang river is formed by two streams that runs parallel in the upper part of Doyang - The Dzülü and Sidzü rivers. The Doyang river flows through a length of about 152 km within the state of Nagaland, almost dividing the state into two equal halves, traversing different climatic and geomorphological terrains and receiving tributaries from the districts of Kohima, Zunheboto, Mokokchung and Wokha. On the riparian valleys, there are about 65 villages directly or indirectly availing its resources which makes it one of the most socially, culturally and economically important river of the state. Catchment characteristic influences the quality of water, as such, geomorphological surveys of the riparian zones are important to ascertain the extent of influence on the health of the river. In addition, studies on identification, categorization of cultivable, sports and ornamental fishes, endemic and endangered species,

threatened and vulnerable species etc. are very much essential for taking up any conservational measure of the fish germplasm resources in this river system.

The productivity of a river is generally determined by the nature of its limnological characteristics. So far, little is known about the limnology of Nagaland in general and particularly the status, composition, distribution and diversity of the physico-chemical and planktonic spectrum of the river system. As such, considering the ecological interest and importance and the dearth of research works in this facet, the present study is an attempt to establish information on the limnological aspects of this important river.

With the realization of the importance of these aspects, the present investigation on fish fauna and ecology was taken up. The whole plan of work is divided into four broad aspects and emphasis was given on the following objectives:

1. Study on geomorphology of the river Doyang.
2. Documentation of ichthyofauna in Doyang river system, Nagaland.
3. Physico – chemical and biological parameters such as air and water temperature, pH, water current, dissolved oxygen, total dissolved solids, free carbon-dioxide, alkalinity etc. were analyzed seasonally and station wise. Seasonal variations in phytoplankton and xooplankton communities were studied. In addition, the ichthyofaunal diversity in relation to different physico-chemical parameters and planktons were also analysed.
4. Fisheries of Doyang river system such as fish yield / unit catch of fishes in different fish landing centers, local fishing techniques and gears used in vogue were studied.

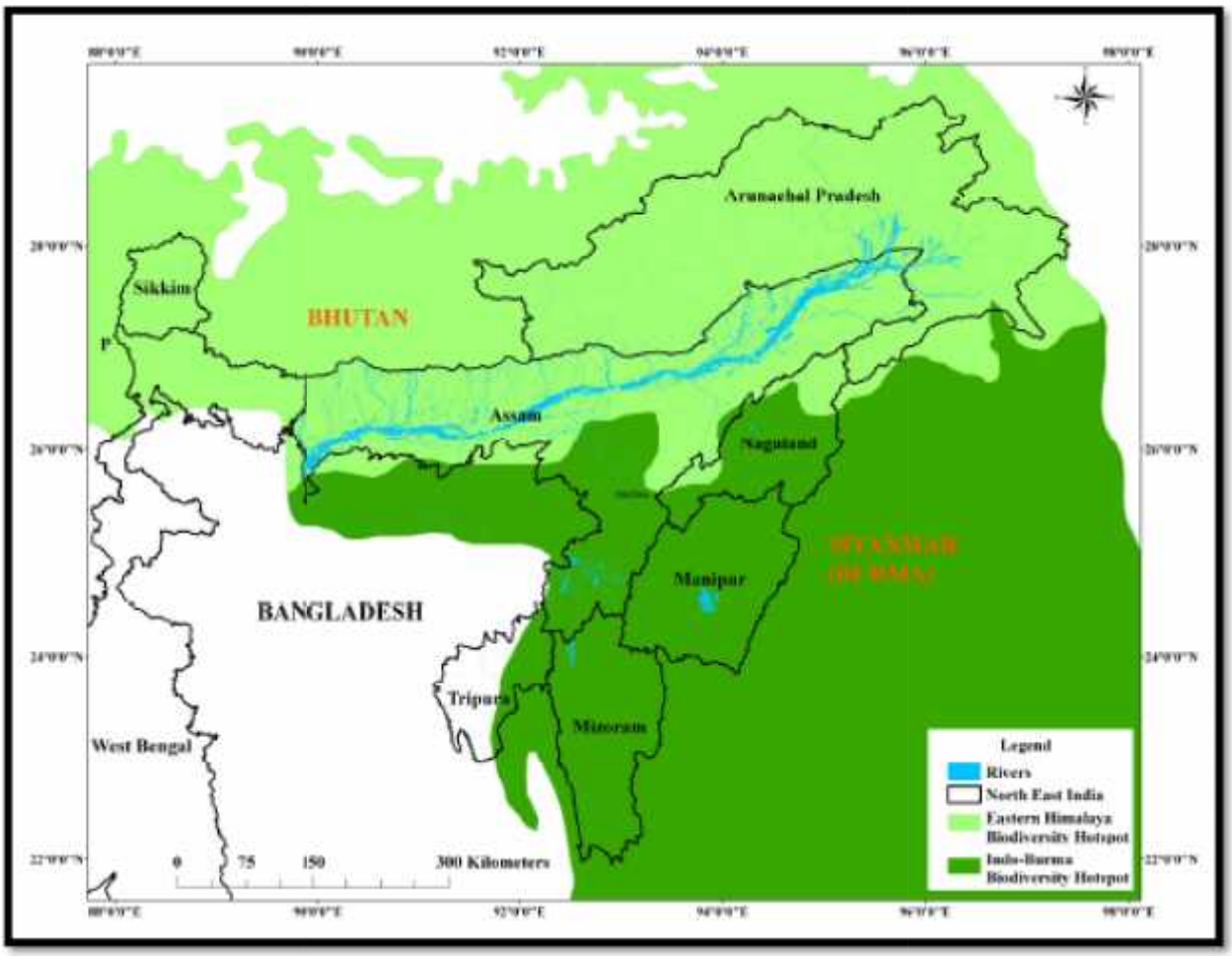

Fig. 1: The north eastern states bearing both Himalayan and Indo-Burma biodiversity hotspot zones (Goswami et al. 2012).

CHAPTER 2

MATERIALS AND METHODS

CHAPTER 2

2.1 MATERIALS AND METHODS:

In this chapter, the materials used and methodology followed in different aspects like geomorphology of the river, collection, preservation and identification of Ichthyofauna; sampling of physico -chemical parameters; qualitative and quantitative analyses of plankton samples; fishery aspects and prevalent fishing techniques and gears used along the study area were presented. Regular field trips were conducted in six selected stations at monthly intervals for a period of two years covering Pre-monsoon (January-April), Monsoon (May-August) and Post-monsoon (September-December) seasons during January 2008 to August 2010 for collection of Ichthyofauna, collection of water samples for physico-chemical and biological analysis and to study the fishing techniques and gears used in Doyang river system. The investigation was divided into four broad aspects viz.:

i) Geomorphology of the river Doyang.

ii) Documentation of Ichthyofauna in Doyang river system, Nagaland.

iii) Physico-chemical and planktonic analysis of water sample and their relationship with the abundance of ichthyofauna.

iv) Fishery of the river such as catch of the fish, use of local fishing gears and techniques.

2.1.1 Geomorphology of the river Doyang:

The geomorphological studies were carried out following the works of Dikshit (1990), Kumar et al (1990), Borah and Goswami (2006) and Prasad and Biswas (2011). The geomorphology of the Doyang river was evaluated by repeated visit, survey and scientific observations on the spot along the course of the river. Emphasis was given on the fluvial characteristics, river bed aggradation, degradation and instability of the river bank. Riparian vegetation in the catchment areas of the river was also recorded. The detailed course of the river passing through different regions and the riparian zone of the river was studied

2.1.2 Documentation of Ichthyofauna

2.1.2.1 Collection of Icthyofauna:

The collection of Icthyofauna of the river Doyang and its tributaries was made from six selected stations along the course of the river viz. Chakabama (25°40´44´´ N L and 94°14´31´´ E L, altitude 824m MSL), Kidzumetouma (25°49´26´´ N L and 94°22´35´´ E L, altitude 536m MSL), Mukhami (26°8´30´´ N L and 94°27´27´´ E L, altitude 337m MSL), Pangti (26°18´36´´ N L and 94°17´44´´ E L, altitude 262m MSL), Longtshung (26°6´28´´ N L and 94°2´27´´ E L, altitude 130m MSL) and Liphiyan (26°14´14´´ N L and 94°0´54´´ E L, altitude 106m MSL). Ichthyofauna were also collected from 8 tributaries viz. Sidzu, Dzülü, Tishi, Chubi, Nzü, Nrü, Baghty and Rengmapani river. The location map of all the selected stations is shown in fig.2. Field trips were conducted at regular intervals to collect the fish fauna from their natural habitat by employing local fishermen. Besides spot collections from six selected station, the fishes were also obtained from different fish landing centers, local fish

markets and fishermen along the rivers/ tributaries and from several approachable areas of the river by using different types of nets namely cast nets, gill nets, triangular scoop nets and a variety of locally made fishing traps. The best way to collect fish for scientific or taxonomic studies to catch them alive through fishing net, a trap or any other devices locally adopted except poisoning with toxic chemicals or dynamiting. After catching the specimen alive, some of the important characters e.g. colour of the fish, bands, spots or stripes if any was noted down in the field book prior to preservation of the specimen in formalin. The coloured photograph of all the live fish specimen was also taken in the field for preparation of an atlas of the fish germplasm resources of the river, since the samples gets discoloured after preservation.

At the time of collection of fishes, maximum care was taken to keep the external morphology intact for taxonomic studies. Collection from different place was packed separately. One field label was attached to each lot with detailed information indicating locality, altitude, name of the rivers / streams / water bodies, date, time, name of collector, fields collection number, etc. The labels were written on stout paper with the pencil. The permanent labels were written with ink after identification with registration number and deposited in the Nagaland University Fish Museum (NUFM).

2.1.2.2 Preservation of the specimen:

The live specimen collected in the field were fixed in a solution of dilute formalin .The small fishes were fixed and preserved in 4-5 % formalin solution. Whereas for larger fishes, 9-10 % formalin was used for better fixation as described by

Ayappan and Satyamurthi (1960). For fishes ranging from 10-30 cm length, an incision on the mid ventral line of the abdomen was made with a knife/scissor without damaging the alimentary tract. For fishes more than 30 cm length, undiluted concentrated formalin were injected in several places along the abdomen. In addition, depending on size 1 – 2 incision along the belly were also made. Where the abdomen is not rounded but sharp and keeled, the incision were made on the left side of the fish. Small sized fishes were immersed in the solution as it is. The live specimen immersed in solution die slowly expanding its fins and rays which helps during identification. The specimens were soaked in formalin solution for at least 4-5 hours. After bringing them in the laboratory this fishes were removed and put into fresh formalin solution. Formalin though a good preservative, yet, in the long run its acid content dissolves lime from bone and makes the specimens flabby. Further its fumes irritate the eyes. For permanent preservation in Fish Museum of the Department the specimen from the formalin solution were then only transferred to 70 % alcohol.

2.1.2.3 Identification:

For identification of fish species, standard measurements and counts were followed as described by Jayaram (1999). Measurements were made with a digital caliper to the nearest 0.1mm and body proportions were expressed as percentage of standard length (SL) and head length (HL). Different body measurements followed representing Cypriniformes and Siluriformes species are depicted in fig.3. Transverse scales were counted as scales between lateral line and dorsal fin origin and between lateral line and pelvic fin origin. For small specimens counting of fins and scales were made under binocular microscope, preferably after

using a temporary surface stain (pen ink). Measurements and counts were recorded in the Data sheet (Appendix-I).

Morphometric analysis for identifying the fishes was carried out generally with reference to Day (1978a), Menon (1987), Talwar and Jhingran (1991), Jayaram (1999) and Vishwanath (2002). For further confirmation the following literature were followed: Hamilton-Buchanan (1822), Pandey (1970), Mishra (1976a,76b),), Menon et al. (1977), Tilak & Hussain (1977), Day (1978b), Roberts (1980, 1994), Jayaram (1981, 1991), Sen & Jayaram (1982), Menon (1992), Nelson (1994), Needham (2000), Bendangkokba and Ahmed (2007) and Ao et al. (2008).

2.1.3 Ecological studies of the river:

It includes seasonal and station wise analysis of physico – chemical parameter of the river water and the variations of river biota both qualitatively and quantitatively. For ecological studies collection of samples was done fortnightly on 1st and 15th of every month from all the six selected stations between 8 to 10 a.m below 30 cm/ 1 foot below the water surface and about 2 meters away from the shore for a period of two years during January 2008 to August 2010.

2.1.3.1 Physico-Chemical parameters:

At each sampling sites various physical parameters of the river water such as air and

water temperature were measured using a mercury thermometer, velocity of water current by drifting colored float in a definite time, pH by pen type pH meter (ecotester pH1) and total dissolved solids (TDS) by pen type TDS meter. For chemical variables of water like dissolved oxygen, free Carbondioxide, total alkalinity and total hardness etc, the samples were collected in BOD bottles and analyzed in the laboratory following the standard method of APHA (2005) and Trivedy & Goel (1986). Dissolved oxygen was determined by Winkler's method after fixing the oxygen on the spot, while the remaining chemical parameters such as chloride, alkalinity, nitrate, nitrite and phosphate were estimated with the help of compact water analysis kit Aquamerck 1.11151.0001.

2.1.3.2 Planktons:

Collection of plankton samples was done by slowly filtering 50 liters of water samples collected from the six selected stations along the river (with 0.5 to 1 m depth) through the plankton net (silk cloth no. 25). The filtrate obtained in the plankton net test tube after separating the suspended particles and flock vegetation was preserved in 5% formalin solution in specimen tubes with proper labelling in the field. Planktons were collected from different stations in the morning and evening hours to avoid diurnal migration of most zooplanktons like Copepods, Cladocera and Rotifers.

For qualitative analysis of planktonic sample, phytoplankton and zooplanktons were stained with lugol's solution and Polyvinyl alcohol- glycerol eosin stains and identified under the compound microscope by dropping 4 to 6 drops of 5% formalin in a slide and identified. For identification the works of Edmondson (1959), Needham and Needham

(1972), Koste (1978), Michael and Sharma (1988) were followed. Other references that were espoused for the study and analysis of planktons includes Charkraborty et al. (1959), Dobriyal et al. (1983), Yosuf (1989) and Sharma and Sharma (1999, 2000,2001, 2009). For quantitative analysis of planktons, the filtrate was concentrated to 25 ml each time and preserved in 5% formalin solution. Quantitative analysis was done for both phytoplankton and zooplankton by using Sedgwick-Rafter counting cell and its density expressed in units per liter.

2.1.4 Fishery and Local fishing Techniques and Gears:

Under this section, the riverine fishing technique and gears used, catch per unit effort through different fishing seasons and fish landing centers were taken into account. An extensive survey was conducted for a period of two years (2008-2010) to study these aspects. Information on fish catching data at different stations of the river were recorded from questionnaires (Appendix-II), resource persons and local village people / fisherman on major captured fishes.

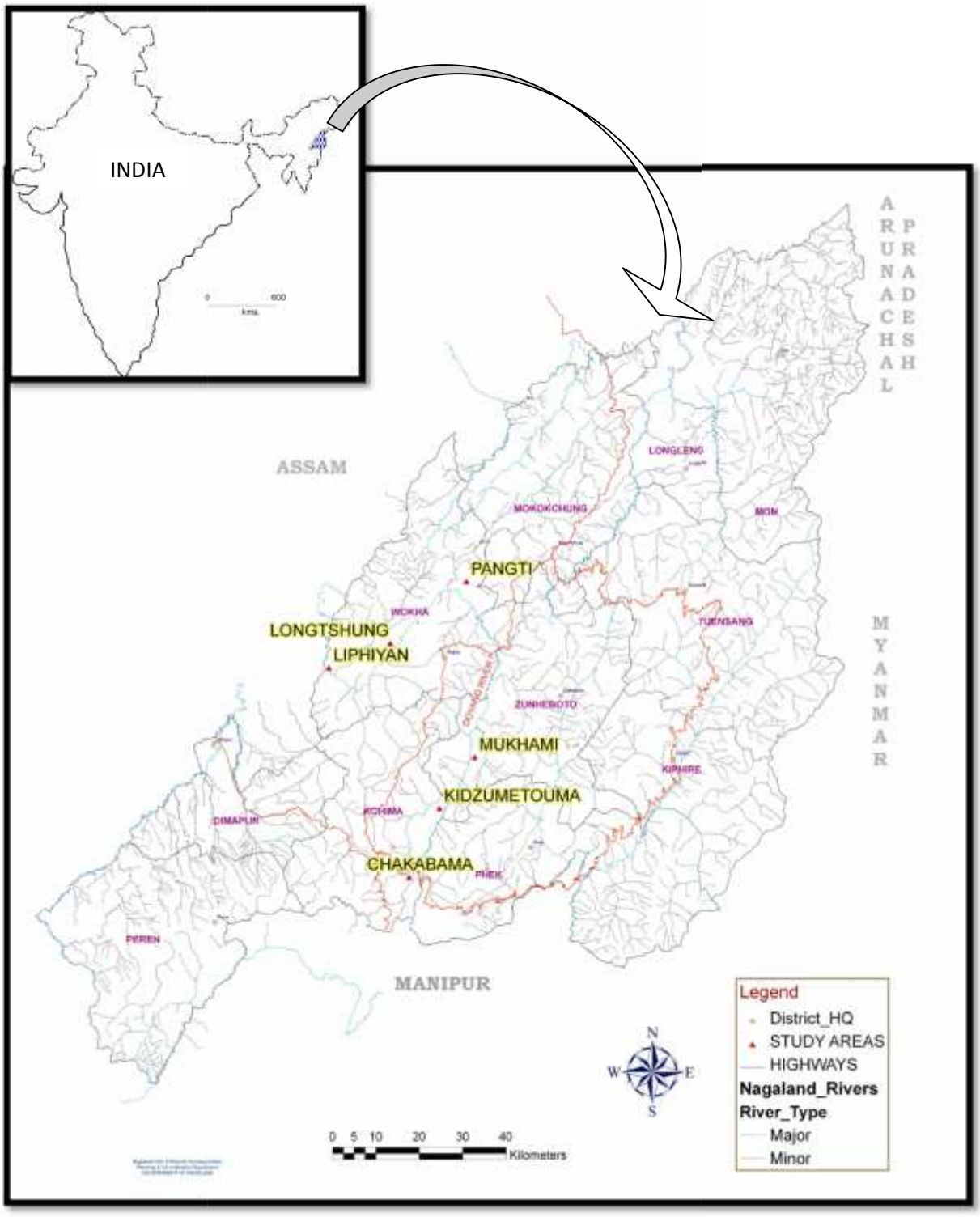

Fig.2 : Location Map of the study area (Doyang river, Nagaland)

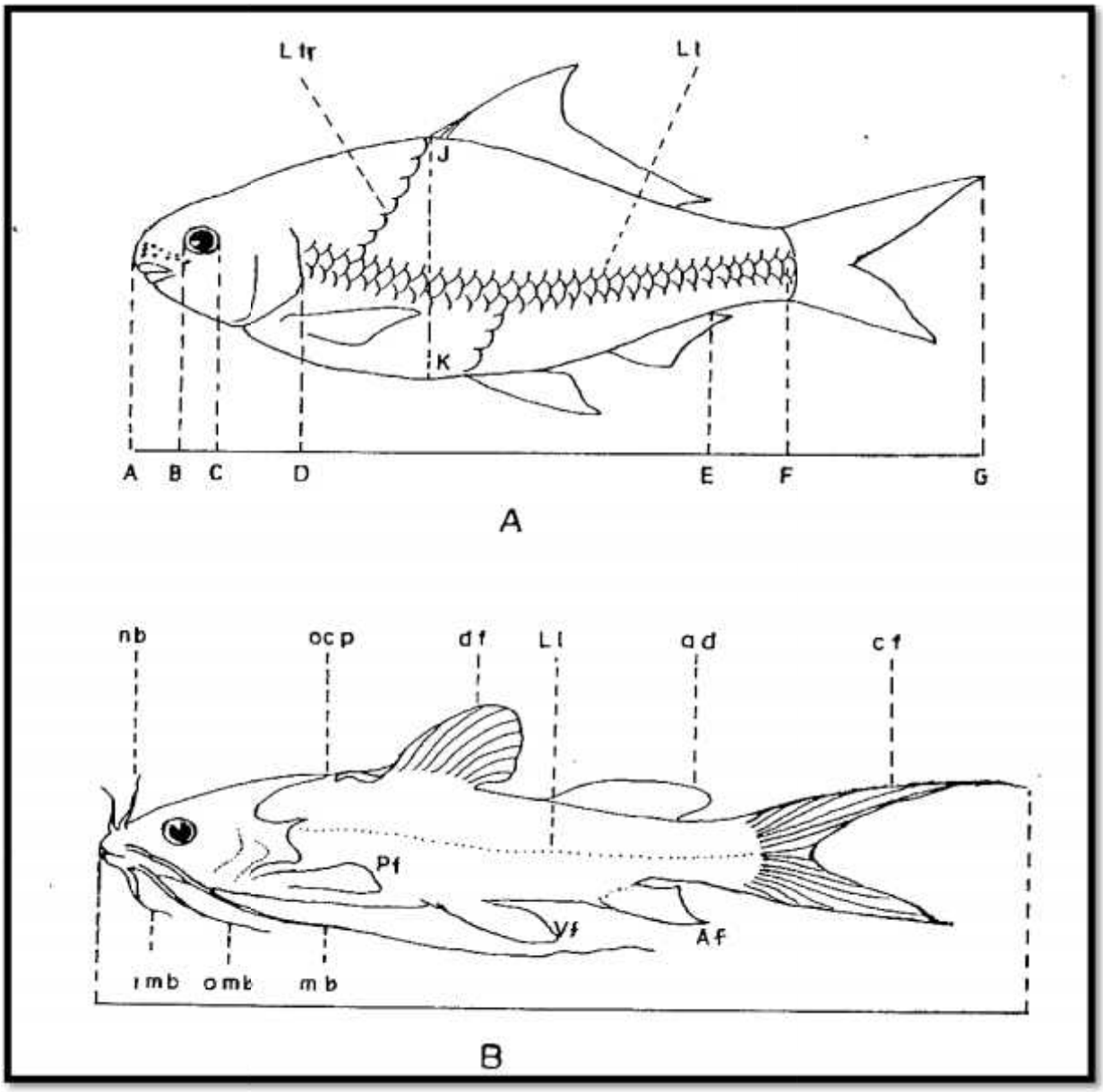

Fig. 3: Lateral view of fishes representing Cypriniformes (A) and Siluriformes (B), showing parts and measurements.

AB=Snout length, AC=Post orbital length, AD=Head length, AF=Standard length, AG=Total length, BC=Eye diameter, EF=Caudal peduncle length, JK=Body depth, ad=Adipose dorsal fin, af=Anal fin, cf=Caudal fin, df=dorsal fin, imb=Inner mandibular barbel, Ll=Lateral line, mb=maxillary barbel, nb=Nasal barbel, ocp=occipital process, omb=outer mandibular barbel, pf=Pectoral fin, vf=Ventral fin.

CHAPTER 3

RESULTS

CHAPTER 3

RESULTS
3.1 GEOMORPHOLOGY OF THE DOYANG RIVER

Doyang river is the largest perennial river of Nagaland and approximately lies between 25°40′44′′ and 26°13′74′′ N Latitude and between 94°14′31′′ and 94°0′54′′ E Longitude. The river is formed by two small rivers that run parallel in the upper part of Doyang - the Dzulu and the Sidzu rivers. The Dzulu river has its source from the Japfu peak (3048m asl) and flows towards the north where it is joined by a number of small tributaries before it joins the river Sidzu below Kijumetouma. The Sidzu river originated from Mao Gate and flows North - West towards Chakabama, later joining the Dzulu river. Henceforth, the combined rivers are known as the Doyang river. The river Doyang flows northwards and receives tributaries from Zunheboto and Mokokchung districts. It runs about 152 kilometers within the state of Nagaland.

The geomorphology of upper, middle and lower zone of the river along with mean gradient river bank and riparian zone etc were studied and depicted in table-2.

Table 2: Geomorphology of the river Doyang.

Parameter	Upper zone	Middle zone	Lower zone
River bed	Hard and rocky	Hard and rocky	Soft and mushy
Sediment type	Boulders, cobbles and gravels	Gravels, pebbles and sand	Fine sand, silt and clay
Mean gradient	8.2 m/km	2.4 m/km	1.95 m/km
River bank	Stable	Partly unstable	Partly unstable
Wood debris in river bank	Large and medium size	Medium and small	Medium and small
Riparian zone	Woody forest, shrubs and grass	Woody forest and shrubs	Sparse woody forest, shrubs and grass
Human habitation	Scanty on both sides	Moderate on both sides	Moderate on right bank and scanty on left bank

The river beds in the upper and middle zones were hard and rocky and mostly composed of boulders, cobbles and gravels etc. In the lower zone, the river bed was soft due to the presence of sand and clayey type of soil. These uneven distributions of the sediment were greatly influenced by the slope gradient of the river bed. The upper zone with a mean inclination of 8.2 m/km had fast flow regime hence the large boulders were dislodged and carried lower down the river. Similarly, the middle zone with a mean slope gradient of 2.4 m/km had a strong flow regime which powers the transfer of smaller rocks and gravels within it. While the lower zone of the river, with the reduction in the mean slope gradient 1.95 m/km of the river bed was mostly composed of sand, silt and clay. River bank was more stable in the upper zone of the river due to armoring by the rocky sediments, though in the middle and lower zone of the river, the river banks were partly stable. The river also carried and deposited large and medium wood debris on the riverbed and bank in the upper zone, while in the middle and lower zone of the river smaller wood debris were observed mostly. The Riparian zones were primarily composed of woody forest and shrubs in the upper and middle zone though it was sparse in the lower zone of the river. Human habitations on river banks were the main source of discharging the sewage, farmyard washings, agricultural waste, pesticides etc. into the river system. However, the human population size was found to be small in the upper zone and moderate and sparse in the middle and lower zones of the river respectively. Hence, major pollution of the river was not encountered and it was also evident from the physico-chemical analysis of water samples.

3.2 SYSTEMATIC ACCOUNT OF ICHTHYOFAUNA AND DESCRIPTION OF THE ICHTHYOFAUNA

3.2.1 Systematic account:

In the present Ichthyofaunal studies, 46 species belonging to 30 different genera under 14 families and 5 orders were recorded from the Doyang river of Nagaland during January 2008 to August 2010. The systematic list of Ichthyofauna along with their local names (in Ao), common names and their conservational status are delineated in Table 2. The order Cypriniformes was represented by a maximum number of 26 species (65%) followed by Siluriformes 7 species (17.5%), Perciformes 4 species (10%), Synbranchiformes 2 species (5%) and Beloniformes 1 species (2.5%). The protocol particulars of ichthyofauna preservation such as the photographs, locality, date of collection, local name, color of the fishes, habit and habitat etc. were recorded for all the species. The materials used and methodology followed for the collection, preservation and identification of the ichthyofauna were discussed in Chapter-2. The fish species constituting the number of families, sub-families and genera under different orders are provided in Table 3. The percentage composition of the species under the different orders is given in Fig. 4.

Table 3: Systematic list of Ichthyofauna of Doyang river system.

Sl. No.	Systematic Position	Local name (Ao)	Common name	Conservation status CAMP
	A. ORDER: CYPRINIFORMES **I. FAMILY: CYPRINIDAE** **i. SUB-FAMILY: RASBORINAE**			
1.	*Barilius bendelisis* (Hamilton Buchanan)	Tawa	Hamiltons barila	LR-nt
2.	*Barilius barila* (Hamilton Buchanan)	Zer	Barred baril	VU
3.	*Barilius barna* (Hamilton Buchanan)	Zer	Barna baril	LR-nt
4.	*Danio aequipinnatus* (McClelland)	Zer	Giant danio	LR-nt
5.	*Danio dangila* (Hamilton-Buchanan)	Zer	Dangila danio	NA
6.	*Esomus danricus* (Hamilton-Buchanan)	Zer	Flying barb	LR-lc
	ii. SUB-FAMILY: CYPRININAE			
7.	*Neolissochilus hexasticus* (McClelland)	Seben	McClelland bokar	NA
8.	*Neolissochilus hexagonolepis* (McClelland)	Seben	Katli	NA
9.	*Tor putitura* (Hamilton-Buchanan)	Tsuto zer	Putitor Mahaseer	EN
10.	*Puntius sophore* (Hamilton-Buchanan)	Tsuto zer	Spotfin swamp barb	LR-nt
11.	*Puntius ticto* (Hamilton-Buchanan)	Tsuto zer	Ticto barb	LR-nt
12.	*Puntius chola* (Hamilton-Buchanan)	Tsuto zer	Chola barb	NA
13.	*Bangana dero* (Hamilton-Buchanan)	Seben	Kalabans	VU
14.	*Labeo bata* (Hamilton-Buchanan)	Seben	Bata labeo	LR-nt
15.	*Labeo Pangusia* (Hamilton-Buchanan)	Seben	Pangusia labeo	LR-nt
16.	*Labeo fimbriatus* (Bloch)	Seben	Fringed lipped carp	LR-nt
17.	*Labeo rohita* (Hamilton-Buchanan)	Rohu	Rohu	LR-nt

18.	*Catla catla* (Hamilton-Buchanan)	Catla	Catla	VU
19.	*Cirrhinus mrigala* (Hamilton-Buchanan)	Mrigal	Mrigal	LR-nt
20.	*Cyprinus carpio* (Linnaeus)	C. carp	Common carp	NA
21.	*Ctenopharyngodon idellus* (Steindachner)	G. carp	Grass carp	NA
	iii. SUB-FAMILY: LEUCISINAE			
22.	*Hypopthalmichthys molitrix* (Valenciennes)	Silver carp	Silver carp	NA
	iv. SUB-FAMILY: GARRINAE			
23.	*Garra gotyla gotyla* (Gray)	Anget	Gotyla	VU
24.	*Garra naganensis* (Hora)	Anget	Naga garra	VU
25.	*Garra gravelyi* (Annandale)	Anget	Burmese garra	NA
26.	*Garra lissorhynchus* (McClelland)	Anget	Khasi garra	VU
27.	*Crossocheilus latius latius* (Hamilton-Buchanan)	Tongtsu	Gangetic latia	NA
	II. FAMILY: BALITORIDAE **v. SUB-FAMILY: NEMACHEILINAE**			
28.	*Schistura prashadi* (Hora)	Retong	NA	VU
29.	*Acanthocobitis botia* (Hamilton-Buchanan)	Sangsert	Mottled loach	NA
30.	*Neonoemacheilus assamensis* (Menon)	Retong	NA	NA
	vi. SUB-FAMILY: COBITINAE			
31.	*Lepitocephalichthys guntea* (Hamilton-Buchanan)	Retong	Guntea loach	NA

	III. FAMILY: PSILORHYNCHIDAE			
32.	*Psilorhyncoides homaloptera* (Hora & Mukherji)	Mern-ngo	Homaloptera minnow	VU

	B. ORDER: SILURIFORMES **IV. FAMILY: OLYRIDAE**			
33.	*Olyra kempi* (Chaudhuri)	Nenak	Kempi olyra	NA
34.	*Olyra longicaudata* (McClelland)	Nenak	Himalayan olyra	NA
	V. FAMILY: SILURIDAE			
35.	*Kryptopterus indicus* (Datta, Barman & Jayaram)	Lorng	NA	CR
	VI. FAMILY: AMPLYCIPITIDAE			
36.	*Amplyceps apangi* (Nath & Dey)	Nenak	Torrential cat fish	VU
	VII. FAMILY: SISORIDAE			
37.	*Glyptothorax telchitta* (Hamilton-Buchanan)	Ajang	Kotel	LR-nt
38.	*Glyptothorax cavia* (Hamilton-Buchanan)	Ajang	Catfish	EN
.	**VIII. FAMILY: CLARIDAE**			
39	*Clarius batrachus* (Linnaeus)	Magur	Magur	VU
	C. ORDER: PERCIFORMES **IX. FAMILY: CHANNIDAE**			
40.	*Channa punctatus* (Bloch)	Alopungo	Spotted snakehead	LR-nt
41.	*Channa orientalis* (Bloch & Schneider)	Alopungo	Asiatic snakehead	VU
	X. FAMILY: NANDIDAE **vii. SUB-FAMILY: Badinae**			
42.	*Badis badis* (Hamilton-Buchanan)	Ak ngo	Badis	NA
	XI. FAMILY: ANABANTIDAE			
43.	*Anabas testudineus* (Bloch)	Petitsung	Climbing perch	VU

	D. ORDER: SYNBRANCHIFORMES **XII. FAMILY: MASTACEMBILIDAE** **viii. SUB-FAMILY: MASTACEMBILINAE**			

44.	*Mastacembelus armatus* (Lacepede)	Mer	Tire track spiny eel	NA
	XIII. FAMILY: SYNBRANCHIDAE			
45.	*Monopterus albus* (Zuiew)	Kongsha	Rice swamp eel	NA
	E**. ORDER: SYNBRANCHIFORMES XIV. FAMILY: BELONIDAE**			
46.	*Xenentodon cancila* (Hamilton-Buchanan)	Rongsen ngo	Freshwater garfish	LR-nt

Table 4: Fish species representing the number of families, sub-families and genera under different orders

Sl.No.	Orders	No. of Families	No. of Sub-families	No. of Genera	No. of Species
1.	Cypriniformes	**3**	**6**	**20**	**32**
2.	Siluriformes	**5**	**-**	**5**	**7**
3.	Perciformes	**3**	**1**	**3**	**4**
4.	Synbranchiformes	**2**	**1**	**2**	**2**
5.	Beloniformes	**1**	**-**	**1**	**1**

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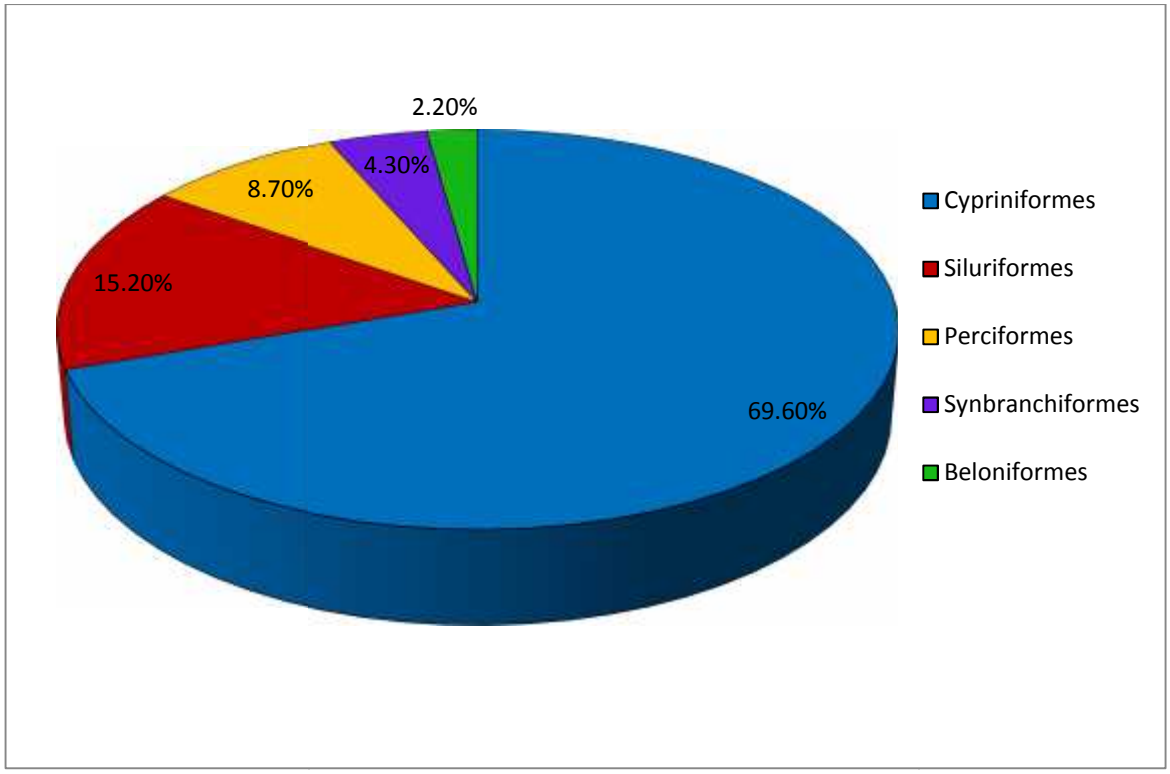

Fig. 4: Percentage composition of the fish species under 5 orders.

3.2.2 Description of the Ichthyofauna:

In the present treatise a total of 46 species belonging to 5 orders, 15 families, 8 sub-families and 31 genera were described. For convenience, the names of the species are arranged alphabetically under the different families and consequently the sub-families. The materials used and methodology followed for this investigation was followed after Talwar and Jhingran (1991).

Grade : Pisces

Class : Osteichthys

Sub-class : Actinopterygii

Sub-Division : Teleostei

3.2.2.1 ORDER: CYPRINIFORMES

FAMILY: CYPRINIDAE
SUB-FAMILY: RASBORINAE

Genus ***Barilius*** Hamilton-Buchanan, 1822

Barilius Hamilton-Buchanan, 1822, *Fishes of Ganges*, P. 266. 384 (type-species: *Cyprinus barila* Hamilton-Buchanan). Howes, 1980, *Bull. Br. Mus. Nat. Hist.*, (Zool.) **37** (3): 189-198 (Synopsis).

Key to the species of Genus Barilius Hamilton-Buchanan

1. a). Barbels absent, body with 7-9 vertical bars……..*B. barna*

   b). Barbels Present……..2

2. a). Anal fin short with 7-8 branched rays.

   Each scales with a black spot……....*B. bendelisis*

   b). Anal fin long with 10-11 branched rays.

   Scales plain…….....3

3. a). Body with 11-15 long vertical bars extending from

   back to lateral line……..*B. barila*

Barilius barila (Hamilton-Buchanan, 1822) [Plate I.2]

Cyprinus (Barilius) barila Hamilon-Buchanan, 1822, *Fishes of Ganges*, 127, 384 (type-locality: Rivers of Northern Bengal).
Barilius barila: Day, 1878, *Fishes of India*: 591, pl. 148. Fig.4; Day, 1889, *Fauna Br. India, Fishes,* **1**:348; Hora, 1921, *Rec. Indian Mus*., **22**(3): 190.

Local Name: Tawa

Material examined: NUFM 0601-0604, 4 exes., 42.3-53.6 mm SL, Chakabama station, 8.i.2008; NUFM 0605-0608, 4 exes., 42.3-53.7 mm SL, Kidzumetouma station, 15.v.2008; NUFM 0609-0613, 5 exes., 45.6-54.7 mm SL, Mukhami station, 21.x.2008; NUFM 0704-0707, 6 exes., 45.6-49.2 mm SL, Longtshung station, 25.iii.2009; NUFM 0755-0758, 3 exes., 44.2-45.7 mm SL, Kidzumetouma station, 16.xii.2009.

Diagnosis: A species of Barilius with 11-14 blue black bars on flanks. Anal fin long with 10-12 branched rays. Barbels present with two pairs.

Description: D. ii, 7; P. I, 12-13; V. I, 7-8; A. iii, 10-11; C. 9+8; L.1. 40-44. Body elongate, dorsal and ventral profile equally arched. Mouth moderate, terminal, jaws long. Barbels two pairs; one pair of rostral and one pair of maxillary. Dorsal fin inserted nearer to caudal fin base than to snout tip; placed in advance of anal fin. Pectoral fin shorter than head length. Pelvic fin shorter than pectoral fin, do not reach anal fin. Caudal fin forked; lower lobe slightly longer than upper lobe. Scales moderate, lateral line complete with 40-44 scales. Pre dorsal scales 22.

Proportional measurements:

(In % of SL): Body depth 23.3 (21.4-26.2); head length 25.4 (24.1-28.6); pre dorsal length 54.6 (49.7-59.2); post dorsal length 44.7 (40.8-52.1); dorsal fin height 20.7 (19.9-21.2); dorsal fin base length 14.1 (13.8-15.7); pectoral fin length 21.0 (19.7-22.5); Anal fin base length 13.2 (13.0-14.5); caudal fin height 16.5 (15.1-20.6).

(In % of HL): Head width 52.3 (49.7-55.3); head height at occiput 76.4 (72.1-80.1); snout length 35.4 (32.2-38.5); eye diameter 27.5 (24.5-31.3); inter orbital space 31.2 (28.9-36.8). Caudal peduncle height 75.5 (69.5-80.6) of its length.

Color: Back dark olivaceous, silvery beneath, body with 11-14 blue black bars on the sides. Fins with a reddish tinge. Operculum golden.

Distribution: India: throughout the country, Nepal, Bangladesh and Myanmar. Nagaland-Milak, Dikhu , Tsurang and Doyang river system.

Remarks: In the original description this species is stated to lack barbels. Day (1878) noted that it has two barbels which is an error consideration. Hora (1921) proved the presence of four barbels (two rostral and two maxillary), the barbels seems overlooked due to minute and thus gets hidden underneath the thick skin of the snout. Howes (1980) also observed that the species have four barbels. Hora and Mukerji (1935) noted that the morphological characteristic of this species is adaptation to life in hill streams. Talwar and Jhingran (1991) observed that the vertical blue bands on the body are better marked in young specimens than in adult. W. Vishwanath and L. Kosygin (1998) reported this species from Nagaland, Tizu river which flows into the Chindwin river.

Barilius barna (Hamilton-Buchanan, 1822) [Plate I.3]

Cyprinus (Barilius) barila Hamilon-Buchanan, 1822, *Fishes of Ganges*, 268, 384 (type-locality: Yamuna river and Brahmaputra river).
Barilius barna: Day, 1878, *Fishes of India*: 592, pl. 148. Fig.1&2; Day, 1889, *Fauna Br. India, Fishes*, **1**:350.

Local name: Tawa

Material examined: NUFM 0614-0616, 3 exes., 44.4-45.2 mm SL, Chakabama station, 9.i.2008; NUFM 0617-0618, 2 exes., 41.2-42.5 mm SL, Mukhami station, 21.x.2008; NUFM 0701-0703, 3 exes., 40.1-42.8 mm SL, Liphiyan station, 19.xi.2009.

Diagnosis: A species of Barilius with 9-10 vertical black bands on side of body; a distinct longitudinal dark band on mid-dorsal streak from occiput to caudal fin base. 39-41 lateral line scales; pre-dorsal scales21. No barbels.

Description: D. ii, 7; P. I, 13-14; A. ii, 9; C. 10+9; L.l. 39-41; L.tr. 5/1/2. Body elongate, dorsal and ventral profile equally arched. Mouth slightly upturned. Cleft of mouth extends to middle of orbit. Eye large, equal to or slightly greater than snout tip. Dorsal fin almost reaching pelvic fin. Pelvic do not reach anal fin. Caudal fin forked; lower lobe longer than upper lobe. Scales moderate; lateral line complete with39-41 scales; pre-dorsal scales 21.

Proportional measurements:

(In % of SL): Body depth 25.5 (21.1-27.3); head length 20.1 (19.8-25.5); caudal peduncle length 13.3 (11.2-16.7); Pre dorsal length 54.4 (44.7-61.1); dorsal fin height 19.9 (15.6-22.4); pectoral fin length 17.2 (16.3-20.2); pelvic fin length 17.0 (12.2-16.4); anal fin length 15.9 (12.2-17.8); caudal fin length 23.6 (22.7-30.2).

(In % HL): Head width (maximum) 47.4 (43.4-55.0); head height at occiput 89.5 (66.2-89.3); head height at eyes 63.7 (59.8-81.7); snout length 31.6 (26.6-35.8); eye diameter 26.8 (26.1-35.9); inter orbital space 32.6 (28.2-36.8). Caudal peduncle height 65.9 (57.3-72.1) of its length.

Color: Greenish dorsally, silvery on sides and beneath with 9-10 well marked bluish vertical bands. A distinct longitudinal dark band on mid dorsal streak from occiput to caudal fin base. Pectoral, pelvic and anal fins yellow, dorsal and caudal fin edge black.

Distribution: India: Manipur, Assam, West Bengal; Nepal; Bangladesh and Myanmar. Nagaland-Milak , Tsurang, Zungki and Doyang river system.

Remarks: This bariline may prove to be an ideal aquarium fish due to its beautiful color pattern. This attains a length of 7.5 cm (Talwar and Jhingran, 1991).

Barilius bendelisis (Hamilton-Buchanan, 1807) [Plate I.1]

Cyprinus bendelisis Hamilton-Buchanan, 1807, *Journey in Mysore,* 3:345. Pl. 32 (type-locality: Vedawati stream, headwaters of Krishna river nr. Heriur, Mysore).
Barilius bendelisis: Tilak et al., 1984, *Rec. Zool. Surv. India,* 81(3/4): 280, figs 1&2

(Redescription).

Local name: Tawa

Material examined: NUFM 0619-0625, 7 exes., 53.4-63.5 mm SL, Chakabama station, 7.x.2008; NUFM 0626-0631, 5 exes., 55.2-60.7 mm SL, Kidzumetouma station, 13.iii.2008; NUFM 0631-0633, 3 exes., 55.6-59.7 mm SL, Mukhami station, 4.vi.2008; NUFM 0732-0739, 8 exes., 55.3-64.5 mm SL, Longtshung station, 4.iii.2009; NUFM 0740-0742, 3 exes., 64.0-64.4 mm SL, Kidzumetouma station, 15.ix.2009.

Diagnosis: A *Barilius* species with a dark spot at each scale. Pectoral fin very much extended and fan-shaped, the bases of which highly muscular. Anal fin short with 7-8 branched rays.

Description: D. ii, 7; P. i, 13-14; V. i, 8; A. ii, 7-8; C. 9+8; L.l. 41-43; pre dorsal scales 18-19. Body elongate, mouth moderate, upturned, maxilla reaches the anterior rim of orbit. Snout pointed. Eye moderate. Barbels two short pair; one rostral and one maxillary. Dorsal fin inserted in front of anal fin, it is nearer to the base of caudal fin than to snout tip. Pectoral fins do not reach the ventral, ventral fin not reaching the vent. Caudal fin forked, lower lobe slightly longer than upper lobe. Lateral line complete with 41-43 scales; pre dorsal scales 18-19; 8 scales from base of dorsal fin to lateral line and 3-4 scales from lateral line to base of pelvic fin.

Proportional measurements:

(In % of SL): Body depth 28.5 (25.3-31.2); head length 26.1 (23.2-29.4); predorsal length 59.8 (55.4-61.8); post dorsal length 45.2 (40.2-48.9); dorsal fin height 20.6 (18.7-22.8); pectoral fin length 21.3 (19.7-29.2); anal fin height 17.4 (15.5-19.1).

(In % of HL): Head height at occiput 80.2 (76.3-97.3); snout length 37.2 (34.1-43.5); eye diameter 28.1 (25.3-30.3); inter orbital space 36.2 (30.1-37.6); head width 55.3 (49.5-63.4).

Caudal peduncle height 83.7 (79.8-96.3) of its length.

Color: Silvery, grayish black dorsally. Body with 8-9 blue black transverse bars extending upto lateral line. Each scales with a black spot at its space and two on each scales forming the lateral line. Fins yellowish, tinged with orange.

Distribution: India; Pakistan; Nepal; Bangladesh and Sri Lanka. Nagaland- Dikhu, Milak, Tsurang, Intangki and Doyang river system.

Remarks: Tilak and Jaffer (1982) studied the sexual dimorphism of this species based on the pectoral girdle and the fins of both the sex. The paired fins in male are enlarged and fan like, especially the pectorals with the outer three rays thickened and extending slightly beyond the insertion of pelvic. The bases of pectorals and the region in front of them are highly muscular and thickened. The dorsal and anal fins are expanded. The dorso-lateral side of the body is rough due to the presence of fine tubercles on the scales. All these characters are absent in the case of females.

Genus ***Danio*** Hamilton-Buchanan

Danio Hamilton, 1822, *Fish. Ganges*: 321, 390 (type-species: *Cyprinus dangila* Hamilton-Buchanan): Hora and Mukerji, 1934, *Rec. Indian Mus*., **36**(1): 130-138 (Synopsis); Barman, 1985, *Bull. Zool. Surv. India*, **6**: 165 (key to species).

Key to the species of Genus **Danio** Hamilton-Buchanan

1. a). Barbels short, lateral line scales 32-34, several well marked and uniform along sides of body……..*D. aequipinnatus*

   b). Barbels very well developed, both pairs much longer than eye diameter, lateral line scales 37-38, body with dark lateral bands breaking anteriorly……....*D. dangila*

Danio aequipinnatus (McClelland, 1839) [Plate I.4]

Perilampus aequipinnatus McClelland, 1839, *Asiat. Res*., **19**(2): 393, Pl.60 fig. 1 (type-locality: Assam).
Danio aequipinnatus: Day, 1878, *Fishes of India*: 596, pl. 150. Fig. 6; Day, 1889, *Fauna Br. India, Fishes,* 1:356, fig. 111.

Local name: Zür

Material examined: NUFM 0634-0637, 4 exes., 53.9-66.1 mm SL, Chakabama station, 8.i.2008; NUFM 0638-0640, 3 exes., 66.2-68.4 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 0641-0643, 3 exes., 54.6-57.9 mm SL, Mukhami station, 11.viii.2008; NUFM 0725-0731, 7 exes., 55.7-63.8 mm SL, Pangti station, 7.vi.2010; NUFM 0644-0650, 7 exes., 59.2-61.4 mm SL, Longtshung station, 12.x.2009; NUFM 0752-0754, 3 exes., 60.2-63.1 mm SL, Kidzumetouma station, 15.ix.2009.

Diagnosis: A species of *Danio* with 32-34 lateral line scales; predorsal scales 14-15; branched dorsal fin rays 9-10; a well marked bluish lateral band which runs along the entire length from caudal fin base to the base of operculum.

Description: D. ii, 9-10; P. i, 11-12; V. I, 6-7; A. ii, 13-14; C. 10+9; L.l. 32-34; L.tr. 7/1/3; pre dorsal scales 14-15. Body elongate and compressed, abdomen rounded. Head conical, snout semi circular. Cleft of mouth shallow and directed obliquely upwards, eye in anterior half of head length. Barbels two pairs, not well developed, one each of maxillary and rostral. Dorsal fin moderately elongate. Pectoral fins slightly shorter than head length, not reaching pelvic fin origin. Anal fin long. Caudal forked. Scales moderate size, lateral line complete.

Proportional measurements:

(In % of SL): Body depth 32.0 (23.4-36.2); head length 26.0 (20.3-26.4); pre dorsal length 56.0 (50.2-58.4); dorsal fin height 22.4 (22.2-24.6); dorsal fin base length 19.6 (18.5-20.6);

pectoral fin length 22.0 (21.4-22.3); anal fin height 18.5 (18.0-22.2); anal fin base length 17.3 (17.0-18.5); caudal fin length 28.8 (28.8-30.0); caudal peduncle length 15.2 (13.4-16.7).

(In % of HL): Head width 49.2 (48.2-53.3); body width 52.3 (50.2-54.8); head height at occiput 83.3 (76.9-90.9); snout length 33.3 (30.7-35.4); eye diameter 27.6 (23.1-36.4); inter orbital space 38.5 (34.2-43.5); mouth gape width 30.8 (26.5-36.6).

Caudal peduncle height 81.6 (66.7-85.7) of its length.

Color: Body silvery white with blue and orange iridescent horizontal bands. A dark blue longitudinal band extending from base of caudal fin to the level of last insertion base of pectoral fin of the body on sides. Fins with bright orange.

Distribution: India; Myanmar; Bangladesh; Nepal; Thailand and Sri Lanka. Nagaland- Dikhu, Milak, Tsurang, Chate, Intangki and Doyang rivers (Brahmaputra drainage).

Remarks: In Nagaland, Hora and Mukerji (1935) reported this species for the first time from keleki stream (Emilomi), Sidzu river (Chakabama) and Rengma river (Mohumi village) and they stated that it is a widely distributed species. In Mokokchung district it is distributed in all the three major rivers. This species have a pre orbital backwardly directed spinous process which was pointed out by Vinciguerra (1889-90), confirmation was made by Myers (1937) and subsequently pointed out by barman (1984-85).

Danio dangila (Hamilton-Buchanan, 1822) [Plate I.5]

Cyprinus dangila Hamilton-Buchanan, 1822, *Fishes of Ganges*: 321, 390 (type-locality: Mountain streams of Mongher, Bihar)
Danio dangila, Day, 1878, *Fishes of India*: 596, Pl. 150, fig. 3; Day, 1889, *Fauna Br. India, Fishes,* 1: 356.

Local name: Zür

Material examined: NUFM 0651-0654, 4 exes., 43.6-49.9 mm SL, Chakabama station, 14.ii.2008; NUFM 0655-0658, 4 exes., 45.2-46.7 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 0708-0710, 3 exes., 39.8-43.9 mm SL, Mukhami station, 18.xi.2009.

Diagnosis: A species of *Danio* with barbels very well developed, both pairs much longer than eye diameter. Body with lateral dark bands which break up anteriorly to form a mottled pattern. Lateral line scales 37-38. Dorsal fin branched rays 9-10.

Description: D. ii, 9-10; P. i, 11; V. i, 7; A. ii, 12-13; L.l. 37-38; L. tr. 6/1/2; pre dorsal scales 13-14. Body elongate and laterally compressed. Head moderate, slightly shorter than body depth. Mouth small, upturned, lips thin; cleft extending to anterior margin of orbit; barbels two pairs, rostral and maxillary; rostral barbel shorter, maxillary barbels reaches the base of origin of pectoral fin. Dorsal fin inserted little advance to anal fin. Pectoral fin long, reaching the base of pelvic. Caudal fin slightly emarginated. Scales small; lateral line complete with 37-38 scales.

Proportional measurements:

(In % of SL): Body depth 26.8 (21.7-34.4); head length 21.9 (19.3-28.5); pre dorsal length 56.1 (48.2-60.5); dorsal fin height 22.4 (19.2-29.1); pectoral fin length 22.4 (20.0-29.4); anal fin base length 21.9 (16.5-25.5); anal fin height 19.5 (15.5-21.1); caudal fin length 36.1 (24.2-38.1).

(In % of HL): Head width 55.5 (44.8-64.2); head height at occiput 88.9 (76.1-90.6); head height at eyes 66.7 (62.3-74.2); snout length 33.3 (22.3-38.1); eye diameter 24.4 (22.2-31.2); inter orbital space 44.4 (34.0-50.3); caudal peduncle length 55.5 (45.9-62.5); caudal peduncle height 55.5 (47.0-62.4); rostral barbel length 50.3 (42.2-68.6); maxillary barbel length 94.4 (85.4-198.5). Caudal peduncle height 86.4 (74.6-102.2) of its length.

Color: Back olive, sides silvery with several narrow blue lines in the anterior half of the body form a beautiful network; a dark spot behind gill opening.

Distribution: India: throughout the country; Bangladesh; Nepal; and Burma. Nagaland- River Dikhu, Milak, Tsurang, Tesuru and Doyang rivers (Brahmaputra drainage).

Remarks: The species with an olivaceous silvery body with numerous and narrow blue lines forming a beautiful network which may prove to be a potential aquarium fish. This species has the longest pairs of barbels among the Danio which enables it to be easily separated (Talwar and Jhingran, 1991).

Genus ***Esomus*** Swainson

Esomus Swainson, 1839, *The natural history of fishes*, 2:185 (type-species: *Esomus vittatis* Swainson = *Cyprinus danrica* Hamilton); Hora and Mukherji. 1928, *Rec. India Mus*., **30**(1): 40-50 (revision).

Esomus danricus (Hamilton, 1822) [Plate I.6]

Cyprinus danricus Hamilton, 1822, *Fishes of Ganges*: 325, 390. Pl. 16, fig. 88. (type-locality: Ponds and ditches of Bengal).
Esomus danricus: Menon, 1974, *Indl. Fish Soc. India* (Spl. Pub): 18.

Local name: Zür

Material examined: NUFM 0659-0660, 2 exes., 34.7-39.9 mm in SL, Chakabama station, 17.iii.2009; NUFM 0661, 1 exes., 37.5 mm in SL, Kidzumetouma station, 25.vi.2008; NUFM 0743-0744, 2 exes., 38.9-39.3 mm in SL, Chakabama station, 2.ix.2009.

Diagnosis: A species of Esomus with a dark lateral band. Maxillary barbel half the length of pectoral fin. Lateral line 29-30. Mouth upturned.

Description: D. ii, 6; P. i, 10-11; V. i, 7; A. ii, 6; C. 10+9; L.l. 29-30; L. tr. 5/1/1; pre dorsal scales 29-30. Body elongate and compressed. Head small and pointed; its length shorter than

pectoral fin. Mouth small and upturned. Lips thin, lower jaw prominent. Barbels two pairs, one each of rostral barbel extends up to posterior margin of orbit and maxillary barbels almost reach pelvic origin. Eyes moderately large. Dorsal fins extend slightly beyond the base of ventral fins. Caudal fin forked. Scales moderate; lateral line incomplete with 29-30 scales.

Proportional measurements:

(In % of SL): Body depth 21.6 (18.9-36.8); head length 23.8 (19.1-27.4); caudal peduncle length 13.5 (12.9-16.6); its height 10.3 (7.3-12.5); pre dorsal length 67.6 (56.4-74.5); dorsal fin height 21.6 (18.4-23.2); pectoral fin length 32.4 (25.2-36.7); pelvic fin length 21.6 (19.8-25.4); anal fin height 18.9 (17.8-24.2); caudal fin length 35.1 (22.5-33.3); rostral barbel length 8.1 (7.0-9.1); maxillary barbel length 46.4 (38.8-50.2).

(In % of HL): Head width 56.8 (39.3-74.4); head height at occiput 59.1 (53.1-66.7); snout length27.3 (24.4-34.1); eye diameter 31.8 (25.1-31.8); inter orbital space 33.0 (31.9-36.7); dorsal fin base length 38.4 (36.2- 48.1); anal fin base length 40.4 (38.6-53.1) all in head length. Caudal peduncle height 76.0 (68.0- 81.0) of its length.

Color: Body olive green, ventral surface silvery white. A broad lateral band runs from eye to caudal base. Fins orange.

Distribution: India: throughout; Sri Lanka; Nepal and Myanmar. Nagaland- Dikhu, Milak, Tsurang and Doyang rivers.

Remarks: This species lives in shallow waters along the stretches of river. Day (1878) remarked that most of the specimens having maxillary barbels reaching beyond pectoral and certainly not up to ventral. In the Doyang river system this species was found to be present.

SUB-FAMILY: CYPRININAE

Genus ***Bangana*** Hamilton-Buchanan

Bangana Hamilton-Buchanan, 1822, *Fishes of Ganges*, 277, 385 (type-species: *Bangana dero* Hamilton-Buchanan); Nelson, 1994, *Fishes of the World* (genus recognised), Rainboth, 1996, *Fishes of Cambodiam Mekong*, 241 pp, PI XI (genus recognised).

Bangana dero (Hamilton-Buchanan) [Plate II.13]

Cyprinus dero Hamilton-Buchanan, 1822, *Fishes of Ganges:* 277, 385, Pl. 22, fig. 78 (type-locality: Brahmaputra river).
Labeo dero: Hora and Mukherji, 1936, *Rec. Indian Mus*., **38**(2): 142, fig. 3.

Local name: Seben

Material examined: NUFM 0678-0682, 5 exes., 132-164 mm SL, Pangti station, 18.iii.2008; NUFM 0683-0685, 3 exes., 144-169 mm SL, Pangti station, 18.vi.2009; NUFM 0716-0719, 4 exes., 157-172 mm SL, Pangti station, 7.x.2009.

Diagnosis: Body sub cylindrical, covered with medium sized cycloid scales. Dorsal fin with no spine. Smooth and entire upper lip separated from snout by a deep groove. Barbels of equal size.

Description: D. ii, 10; A. ii, 5; P. i, 16; V i, 8; L.l. 43-44; L.tr. 9/1/7. Body elongated with dorsal profile more convex than ventral. Head small. Snout prominent with a distinct groove across it and generally covered with pores. Eyes fairly small, not visible from underside. Mouth inferior, lips thick, lower lip papillated internally. Post-labial groove widely interrupted. Barbels small maxillary pair. Dorsal fin inserted almost midway between snout tip and caudal fin base. Pectoral fins shorter than head, caudal fin deeply forked. Scale moderate.

Proportional measurements:

(In % of SL): Body depth 28.0 (26.6-29.4); head length 25.4 (24.8-26.5); pre dorsal length 46.2 (43.2-48.7); dorsal fin height 31.1 (29.4-32.5); pectoral fin length 23.5 (22.7-24.3); pelvic fin length 21.2 (20.6-21.9); anal fin height 22.0 (21.9-24.8); caudal fin length 36.4 (35.6-38.5).

(In % of HL): Head width 55.7 (51.4-60.0); head height at occiput 75.4 (70.0-80.0); head height at eye 58.0 (57.5-60.0); snout length 42.5 (35.7-42.5); eye diameter 17.1 (15.0-17.5); inter orbital space 35.7 (34.3-40.0); dorsal fin base length 85.7 (79.4-90.5); anal fin base length 42.8 (40.0-47.6).

Color: Bluish black on back, bluish silvery on sides. Scales tinged red with red markings. Fins blackish, outer dorsal fin edge rather dusky.

Distribution: Pakistan; Nepal; Sri Lanka; Bangladesh; Myanmar and China; India: all along the Himalaya and Arunachal Pradesh; Nagaland- Doyang river system.

Remarks: The genus was considered valid by Rainboth (1996), Kullander (1998). However, Jayaram (1999) put it under *Labeo* Cuvier. Vishwanath (2002) also considered it under this genus as the group has a deep transverse groove across the snout and a widely interrupted post labial groove. Hence, it is also considered valid here.

Genus ***Catla*** Valenciennes

Gibelion Heckel, 1842, in: *Russegger, Reisen in Europa, Asien und Africa, etc*., **1**(1): 1014 (type-species: *Cyprinus catla* Hamilton-Buchanan).

Catla catla (Hamilton- Buchanan, 1822) [Plate III.18]

Cyprinus catla Hamilton- Buchanan, 1822, *Fishes of Ganges*: 287, 318, pl. 13, fig. 81 (type-locality: river and tanks of Bengal).
Catla catla: Jhingran, 1966, *FAO World Symposium On Warm-water Pond Fish Culture*: 18 (synopsis biological data).

Local name: Catla

Material examined: NUFM 0662-0665, 5 exes., 354-394 mm SL, Pangti station, 18.iii.2008; NUFM 0759-0763, 5 exes., 290-310 mm SL, Pangti station, 18.vi.2009; NUFM 0764-0768, 5 exes., 276-294 mm SL, Pangti station, 7.x.2008.

Diagnosis: A species of *Catla* with body deep, its depth 2.5 to 3 times in standard length. Head enormously large. Mouth wide and upturned with a prominent protruding lower jaw. Pectoral fins long, extend to pelvic fins. Scales conspicuously large; lateral line with 42 to 43 scales.

Description:

D. iii, 15-16; A. iii, 5; P. i, 18; V. i, 8.

Body short and deep, somewhat laterally compressed, its depth more than dorsal head length. Head enormously large, exceeds half body length; snout bluntly rounded. Eyes large and ventro-lateral in position, visible from under side of head. Mouth wide and terminal; upper lip absent, lower lip very thick. Barbels absent. Dorsal fin inserted slightly in advance of pelvic fins. Caudal fin forked. Scales large sized. Lateral line with 42-43 scales.

Proportional measurements:

(In % of SL): Body depth 37.3 (36.8-38.2); head length 41.5 (40.8-42.3); pre dorsal length 57.1 (56.2-58.4); dorsal fin height 27.4 (26.8-27.5); pectoral fin length 24.8 (22.9-24.8); pelvic fin length 24.9 (24.2-25.3) anal fin height 25.4 (24.6-25.8); caudal fin length 31.1 (30.6-32.2).

(In % of HL): Head width 53.1 (52.6-53.5); head height at occiput 75.5 (74.2-75.8); head height at eye 63.9 (62.4-64.5); snout length 36.7 (35.7-36.8); eye diameter 10.9 (10.6-11.4); inter orbital space 45.6 (44.7-45.9); dorsal fin base length 64.6 (63.5-65.8); anal fin base length 17.7 (16.3-17.8).

Color: In life, dark grey on back and flanks, silvery whitish below. Fins dusky.

Geographical Distribution: Pakistan: Indus plain and adjoining hills; India: Northern India; Bangladesh; Nepal; and Burma. Nagaland- Doyang river system.

Remarks: This species of fish has been transplanted in many rivers throughout India. Present observation of Catla in the Doyang river is due to its introduction specifically in Doyang reservoir. *Catla catla* thrives well in the present water body reflecting a suitable physico-chemical condition for its culture and propagation. However, at present the species is restricted only on the reservoir.

Genus ***Cirrhinus*** Cuvier

Cirrhinus Oken, 1817, *Isis*: 1833 (on *Les Cirrhines* Cuvier, 1817, Regne Animale, **2**: 193) (type-species: *Cyprinus cirrhosus* Bloch); Banarescu, 1983, *Rev. Roum. Biol*., (*Zool*.), **28**(1): 13-17 (Revision).

Cirrhinus mrigala mrigala (Hamilton-Buchanan, 1822) [Plate III.19]

Cyprinus mrigala Hamilton-Buchanan, 1822, *Fishes of Ganges*: 279, 386, pl. 6, fig. 79 (type-locality: ponds and freshwaters rivers of Gangetic provinces).
Cirrhinus chaudhryi Srivastava, 1968, *Fishes of Eastern Uttar Pradesh*: 30, fig. 17 (type-locality: Gorakhpur, Uttar Pradesh); Dutt and Murthy, 1976, *Mem. Soc. Zool. Guntur,* **1**: 17 (Status discussed).

Local name: Mrigal

Material examined: NUFM 0666-0669, 4 exes., 113-168 mm SL, Pangti station, 26.ii.2008; NUFM 0670-0674, 5 exes., 152-222 mm SL, Pangti station, 11.viii.2009; NUFM 0769-0772, 3 exes., 168-185 mm SL, Pangti station, 7.xii.2009.

Diagnosis: A species of *Cirrhinus* with dorsal fin short, inserted ahead of pelvic fin origin, last simple ray not osseous, scales on body hexagonal, lateral line scales 40-42.

Description:

D. iii, 13; A. ii, 5; P. i, 16-17; V. i, 8; L.tr. 6/1/6.

Body streamlined, its depth almost equal to length of head. Snout blunt, often with pores. Mouth broad; upper lip entire, lower lip indistinct. Barbels a single short pair of rostral only. Dorsal fin as high as body. Pectoral fins shorter than head. Caudal fin deeply forked.

Proportional measurements:

(In % of SL): Body depth 28.0 (26.0-28.3); head length 26.0 (25.6-28.3); pre dorsal length 49.4 (48.0-49.4); dorsal fin height 26.0 (24.4-28.3); pectoral fin length 20.2 (19.7-21.2); pelvic fin length 18.4 (17.8-19.1) anal fin height 18.4 (18.1-18.6); caudal fin length 31.5 (30.9-33.6).

(In % of HL): Head width 54.5 (50.0-59.5); head height at occiput 72.7 (69.8-74.4); head height at eye 42.4 (41.9-46.5); snout length 30.2 (28.1-33.3); eye diameter 19.1 (18.2-21.9); inter orbital space 37.5 (37.2-37.6); dorsal fin base length 71.9 (70.9-83.7); anal fin base length 28.1 (26.0-33.9).

Color: Dark grey along dorsum with a coppery tinge, flanks silvery with yellowish tinge and belly silvery white. Pectoral, pelvic and anal fins tipped with orange, especially during breeding season; dorsal and caudal fin blackish.

Geographical Distribution: Pakistan: Indus plain and adjacent hilly areas; Bangladesh; India: Punjab to West Bengal and Assam; Nagaland- Doyang river system.

Remarks: Present observation of Cirrhinus in the Doyang river is due to its introduction specifically in Doyang reservoir. Cirrhinus mrigal thrives well in the present water body

reflecting a suitable physico-chemical condition for its culture and propagation. However, at present the species is restricted only on the reservoir.

Genus **Ctenopharyngodon** Steindachner

Ctenopharyngodon Steindachner, 1866, *Verh. Zool. bot. Ges. Wien*., 16: 782 (type species: *Ctenopharyngodon laticeps* Steindachner = *Leuciscus idella* Valenciennes).
Howes, 1981, *Bull. Br. Mus. Nat. Hist*. (Zool.), 41(1): 40 (status and relatioonship).

Ctenopharyngodon idellus (Valenciennes) [Plate III.22]

Ctenopharyngodon Steindachner, 1866, Verh. zool. bot. Ges. Wien., **16**: 782 (type-species: *Ctenopharyngodon laticeps* Steindachner = *Leuciscus idella* Valenciennes); Wu, 1964, *The Cyprinid Fishes of China*, **1**: 13 (Review); Howes, 1981, *Bull. Br. Mus. Nat. Hist*. (Zool.), **41**(1): 40 (status and relationship).
Leuciscus idella Valenciennes, 1844, *Hist. nat. Poiss*., **17**: 362 (type-locality: China).
Ctenopharyngodon idellus: Howes 1981, *Bull. Br. Mus. Nat. Hist*. (Zool.), **41**(1): fig. 30a.

Local name: Grass carp

Material examined: NUFM 0686-0688, 3 exes., 290-298 mm SL, Pangti station, 18.ii.2009; NUFM 0689-0692, 4 exes., 300-308 mm SL, Pangti station, 19.vi.2008; NUFM 0779-0781, 3 exes., 290-306 mm SL, Pangti station, 8.xii.2008.

Diagnosis: A species of *Ctenopharyngodon* with large operculum almost square. Eyes large visible from underside, dorsal fin inserted nearer to tip of snout than to base of caudal fin.

Description:

D iii 7; A iii 7-8; P i 17; V i 8

Body stout and elongate, its depth 3.8 to 4.8 times in standard length, the dorsal and ventral profiles equally arched. Head broad, with a short rounded snout. Mouth sub-terminal; upper jaw slightly protractile. Dorsal fin inserted slightly nearer to snout tip than to base of caudal

fin. Pectoral fins fairly small. Caudal fin forked. Scales moderate sized. Lateral line with 38 to 40 scales.

Proportional measurements:

(In % of SL): Body depth 26.1 (25.6-27.2); head length 23.4 (22.4-25.2); pre dorsal length 52.4 (52.1-54.6); dorsal fin height 18.6 (17.9-22.0); pectoral fin length 21.2 (20.3-22.5); pelvic fin length 15.8 (15.7-17.6) anal fin height 16.7 (16.4-117.8); caudal fin length 26.8 (25.7-28.2).

(In % of HL): Head width 68.9 (66.2-75.8); head height at occiput 89.4 (86.3-90.5); head height at eye 45.9 (43.5-46.4); snout length 22.3 (20.4-24.5); eye diameter 14.4 (13.5-16.0); inter orbital space 55.2 (53.6-55.4); dorsal fin base length 54.2 (51.3-55.6); anal fin base length 38.1 (36.8-40.5).

Color: In life, dark brown along back, flanks coppery or dirty golden, base of each scale dark brown.

Geographical Distribution: Flatland rivers of China and the middle and lower reaches of river Amur in the USSR; introduced into many countries including India. Nagaland- Doyang river.

Remarks: Present observation of *Ctenopharyngodon* in the Doyang river is due to its introduction specifically in Doyang reservoir. *Ctenopharyngodon idellus* thrives well in the present water body reflecting a suitable physico-chemical condition for its culture and propagation. However, at present the species is restricted only on the reservoir.

Genus ***Cyprinus*** Linnaeus

Cyprinus Linnaeus, 1758, *Systema Naturae*, ed. 10, **1**: 320 (type-species: *Cyprinus carpio* Linnaeus); Kirpichnikov, 1967, *FAO Fish. Rep*., (44): 179-194 (Review); Holchik and Mihalik, 1970, *Freshwater Fishes*: 94-100 (Review).

Cyprinus carpio (Linnaeus, 1785) [Plate III.20]
Cyprinus carpio Linnaeus, 1758, *Systema Naturae*, ed. 10, **1**:320 (type-locality: Europe).
Cyprinus carpio intha Annandale, 1918, *Rec. Indian Mus*., **14**(1): 47, pl. 3, fig. 1 (type-locality: Southern Shan States, Burma).

Local name: Common carp

Material examined: NUFM 0675-0677, 3 exes., 163-172 mm SL, Pangti station, 26.ii.2008; NUFM 0773-0778, 6 exes., 174-208 mm SL, Pangti station, 20.v.2008; NUFM 0711-0715, 5 exes., 168-192 mm SL, Pangti station, 7.xii.2009.

Diagnosis: A species of *Cyprinus* with body robust, elongated and slightly compressed. Head, relatively small and asymmetrically tapered. Eyes moderate placed relatively high on head. Lips thick and fleshy. Dorsal spine stout and serrated behind. Scales large with 33-35 scales.

Description:

D. III, 20; A. III, 5; P. i, 15; V. i, 7-8

Body stout, slightly compressed. Head moderate, triangular; snout obtusely rounded. Mouth small and oblique, protrusible; lips thick and fleshy. Barbels two pairs; maxillary barbels twice as long as rostral pair. Dorsal fin inserted opposite to pelvic fin and slightly nearer to base of caudal fin. Anal fin trapezoidal. Pectoral fins large and rounded. Caudal fin deeply emarginate. Scales large; lateral line straight with 33 to 35 scales.

Proportional measurements:

(In % of SL): Body depth 43.2 (42.3-43.8); head length 34.6 (32.5-34.6); pre dorsal length 52.8 (50.7-54.3); dorsal fin height 22.7 (21.8-24.2); pectoral fin length 23.9 (22.9-25.6); pelvic fin length 21.6 (20.8-22.3) anal fin height 21.0 (20.7-21.9); caudal fin length 32.4 (30.6-32.6).

(In % of HL): Head width 65.6 (64.3-66.5); head height at occiput 82.0 (80.4-82.0); head height at eye 59.0 (57.7-60.1); snout length 34.4 (33.6-36.2); eye diameter 19.7 (19.2-19.7);

inter orbital space 36.7 (35.2-38.3); dorsal fin base length 106.6 (98.7-110.5); anal ***fin*** base length 24.6 (22.8-25.9).

Color: Dark olivaceous to grey with flanks silvery or golden. Fins yellowish or golden; anal and tips of caudal fins bright red during breeding seasons.

Geographical Distribution: The original natural distribution of common carp was probably restricted to a narrow belt in Central Asia within latitudes 35°-50° N and longitudes 30-135°E and altitude generally 300 m above mean sea level (Jhingran and Pullin, 1985). With its introduction in India, common carp thrives in almost all the states. During the present investigation it was also found in the Doyang river system.

Remarks: Present observation of the common carp in the Doyang river is due to its introduction specifically in Doyang reservoir. *Cyprinus carpio* thrives well in the present water body reflecting a suitable physico-chemical condition for its culture and propagation. However, at present the species is restricted only on the reservoir.

Genus ***Labeo*** Cuvier

Labeo Cuvier, 1817, Regne Animale, 2(ed. 1): 194 (type species: *Cyprinus niloticus* Forsskal = Cyprinus rufescens Hasselquist).

Key to the species of genus ***Labeo*** Cuvier.

1. a). Barbels 1 pair, Snout conical and projecting; lateral line scales less than 50…….……..…*L. bata*

   b). Barbels more than 1 pair, Snout not conical and projecting; lateral line scales less than 50…….……..……2

2. a). Dorsal fin ray less than 15…….*L.pangusia*

b). Dorsal fin ray more than 15…….3

3. a). Dorsal fin nearer to snout tip…….*L.fimbriatus*

b). Dorsal fin midway between snout tip and caudal fin base……*L.rohita*

Labeo bata (Hamilton-Buchanan) [Plate II.14]

Cyprinus bata Hamilton-Buchanan, 1822, *Fishes of Ganges*: 283, 386 (type-locality: Rivers and ponds of Bengal).
Labeo bata: Day, 1877, *Fishes of India*: 542, pl. 129, fig. 5.

Local name: Seben

Material examined: NUFM 0693-0695, 3 exes., 114-168 mm SL, Mukhami station, 19.ii.2008; NUFM 0782-0784, 3 exes., 149-170 mm SL, Pangti station, 18.vi.2009; NUFM 0812-0816, 5 exes., 164-183 mm SL, Liphiyan station, 23.xi.2009.

Diagnosis: The species is characterized with conical snout projecting slightly beyond mouth, often studded with pores, lateral line with 40-42 scales. An irregular black blotch present on anterior (fourth to sixth) scales of lateral line.

Description: D. ii, 10; P. i, 15; V. i, 8; A. ii, 5; L.l. 40-42; L.tr. 7/1/8. Body elongated with dorsal profile more convex than ventral. Snout projecting beyond mouth, studded with pores. Eyes large, not visible from ventral side. Mouth inferior, lips thin, lower lip slightly fringed and folded back and joined to isthmus by a narrow bridge. Barbels a pair of minute maxillary only. Dorsal fin inserted nearer snout tip than base of caudal fin. Pectoral fins as long as head extending to pelvic fins. Scales moderate. Pre dorsal scales 16-18.

Proportional measurements:

(In % of SL): Body depth 26.0 (24.7-27.2); head length 25.2 (24.6-25.9); pre dorsal length 43.3 (43.0-44.8); dorsal fin height 26.8 (25.4-29.2); pectoral fin length 19.7 (19.1-21.7); pelvic fin length 15.7 (15.6-18.6); anal fin height 19.0 (17.7-19.5); caudal fin length 32.8 (32.8-35.9).

(In % of HL): Head width 53.7 (53.6-57.8); head height at occiput 71.9 (71.9-75.3); head height at eye 56.2 (56.0-60.7); snout length 37.5 (35.7-38.6); eye diameter 16.2 (15.1-19.3); inter orbital space 31.9 (30.7-34.3); dorsal fin base length 81.9 (78.6-82.5); anal ***fin*** base length 34.4 (32.8-42.8).

Color: Bluish black on back, bluish silvery on sides. Scales tinged red with minute red markings. Fins blackish, outer dorsal fin edge rather dusky.

Distribution: India: all along the Himalaya, Arunachal Pradesh; Pakistan; Nepal; Sri Lanka; Bangladesh; Myanmar and China. Nagaland-Doyang river system.

Remarks: It is a savored medium sized fish caught by cast nets. This species is restricted to the upper reaches of Doyang river system.

Labeo fimbriatus (Bloch, 1795) [Plate II.16]

Cyprinus fimbriatus Bloch, 1795, *Naturgesch, ausland. Fische*, **12**: 50, pl. 409 (type-locality: "Malabarischen kueste" =? Madras).
Labeo fimbriatus: Day, 1877, *Fishes of India*: 536, pl. 126, fig.3; Day, 1889, *Fauna Br. India, Fishes*, 1: 258; Murthy, 1977, *Proc, Indian Acad. Sci*., 85B (3): 137, pl. 4, Fig. 3.

Local name: Seben

Material examined: NUFM 0696-0698, 3 exes., 244-262 mm SL, Mukhami station, 17.i.2008; NUFM 0817-0819, 3 exes., 268-305 mm SL, Pangti station, 28.vii.2008; NUFM 0820-0823, 4 exes., 282-300 mm SL, Mukhami station, 18.xi.2009.

Diagnosis: A species of *Labeo* with blunt and fairly swollen snout. Barbels two short pairs one rostral and one maxillary. Dorsal fin inserted nearer to snout tip than caudal fin base. Predorsal scales 13-18.

Description:

D. iii, 15; A. iii, 5; P. i, 16; V. i, 8; L.l. 42-43; L.tr. 7/1/6.

Body elongated its dorsal profile more convex than the ventral. Snout blunt and fairly swollen slightly overhangs mouth, devoid of lateral lobe, studded with minute pores. Eyes moderated, not visible from underside of head. Mouth moderate and sub inferior, lips thick and fringed, continuous, and having an inner fold above and below. Barbels two short pairs (rostral and maxillary). Dorsal fin inserted nearer to snout-tip than to base of caudal fin. Pectoral fins nearly as long as head. Caudal fin deeply forked. Scales moderate; lateral transverse scales-rows 6 or 7 between lateral line and pelvic fin base. Predorsal scales 17-18.

Proportional measurements:

(In % of SL): Body depth 35.1 (33.6-35.9); head length 22.3 (21.4-23.2); pre dorsal length 48.2 (45.7-49.6); dorsal fin height 30.5 (28.4-31.5); pectoral fin length 23.6 (22.8-24.2); pelvic fin length 25.2 (24.6-25.9); anal fin height 22.6 (22.1-22.6); caudal fin length 34.1 (33.6-34.8).

(In % of HL): Head width 75.7 (75.2-76.8); head height at occiput 81.8 (78.6-82.4); head height at eye 62.1 (58.5-62.1); snout length 43.9 (42.4-44.8); eye diameter 18.2 (18.2-20.4); inter orbital space 59.7 (58.2-60.4); dorsal fin base length 131.8 (128.5-133.6); anal ***fin*** base length 43.9 (41.8-44.2).

Color: Dark brown on back, silvery on lower flanks and abdomen; a red spot on each scales on about 8 to 10 horizontal rows of flanks, from behind tip of pectoral fin to above anal fin

(spots disappear in preserved specimens). Dorsal, pectoral and caudal fins dark; anal and pelvic fins black.

Geographical Distribution: India: West Bengal, Eastern Ghats, Manipur; Pakistan, Nepal and Myanmar. Nagaland- Doyang river system.

Remarks: This fish is recorded for the first time from Nagaland.

Labeo pangusia (Hamilton-Buchanan, 1822) [Plate II.15]

Cyprinus pangusia Hamilton-Buchanan, 1822, *Fishes of Ganges*, 285, 386 (type-locality: Kosi river, Uttar Pradesh).
Labeo pangusia: Day, 1877**,** *Fishes of India*: 541, pl. 131 fig.. 1; Day, 1889, *Fauna Br. India,* Fishes, 1: 266.

Local name: Seben

Material examined: NUFM 0905-0910, 6 exes., 98.6-136.2 mm SL, Mukhami station, 19.ii.2008; NUFM 0722-0724, 3 exes., 126.0-152.4 mm SL, Pangti station, 11.viii.2009; NUFM 0785-0789, 5 exes., 168.2-188.3 mm SL, Longtshung station,25.iii.2008; NUFM 0804-0807, 5 exes., 164.2-183.5 mm SL, Liphiyan station, 20.x.2009.

Diagnosis: The species is characterized with obtuse snout and overhang mouth with distinct lateral lobe; scales between lateral line and pelvic fin 6; circumpeduncular scales 22.

Description: D. iii, 10; P. i, 14; V. i, 8; A. ii, 5; C. 10+9; L.l. 41-42; L.tr. 8/1/6; pre dorsal scales 15. Body elongate, its dorsal profile more convex than the ventral. Snout obtuse, projecting over the jaws and having a very distinct lateral lobes and studded with large pores. Mouth small, thick lips with a distinct inner fold, which is not continued across the lower jaw. Eyes small, not visible from underside of head. Barbels a short maxillary pair. Dorsal fin inserted nearer to snout tip than base of caudal fin. Pectoral fins do not extend up to pelvic fins.

Caudal fin deeply forked. Scales moderate, lateral line complete with 41-42 scales.

Proportional measurements*:*

(In % of SL): Body depth 26.4 (22.4-28.7); head length 24.2 (23.9-26.4); pre dorsal length 44.9 (44.8-45.4); dorsal fin height 25.5 (25.0-25.9); pectoral fin length 19.7 (18.8-20.7); pelvic fin length 19.7 (18.8-20.7); anal fin height 20.4 (18.7-21.6); caudal fin length 32.2 (31.6-32.4).

(In % of HL): Head width 62.2 (59.0-63.9); head height at occiput 69.6 (68.7-70.9); head height at eye 60.2 (57.3-62.2); snout length 50.7 (47.0-52.2); eye diameter 16.6 (12.4-21.4); inter orbital space 42.7 (42.3-47.4); dorsal fin base length 72.6 (69.2-72.6); anal fin base length 33.2 (32.3-38.5).

Color: Greenish on back, lighter on the sides and beneath. Dorsal and caudal fins grey; pelvic and anal fins faint yellowish to hyaline.

Distribution: Pakistan and Bangladesh; India: Ganga and Brahmaputra drainage system of the Himalaya; Nagaland- Milak, Tsurang and Doyang river system.

Remarks: This species is a migratory to the hill-stream. It is found more abundantly in pre monsoon season. This fish serves as an excellent food fish and is caught in good numbers using various indigenous traps.

Labeo rohita (Hamilton- Buchanan) [Plate III.17]

Cyprinus rohita Hamilton- Buchanan, 1822, *Fishes of Ganges*: 301, 388, pl. 36, Fig. 85 (type-locality: Freshwater rivers of Gangetic provinces
Labeo rohita : Day, 1877, *fishes of India*: 538, pl. 127, fig.4; Day, 1889, *Fauna Br. India, Fishes,* 1:262; Macdonald, 1984, *J. Bombay nat. Hist. Soc*.,44: 527, fig. 9.

Labeo horai Fowler, 1924, *Proc. Acad. Nat. Sci. Philad*., 76:95, fig. 8 (type-locality: Sutlej river nr. Ludhiana, Punjab).

Local name: Rou

Material examined: NUFM 0790-0793, 4 exes., 302-314 mm SL, Pangti station, 18.iv.2008; NUFM 0794-0799, 6 exes., 290-316 mm SL, Pangti station, 18.vi.2009; NUFM 0808-0811, 4 exes., 264-298 mm SL, Pangti station, 7.x.2009.

Diagnosis: A species of *Labeo* with body cylindrical and elongated; abdomen rounded. Snout obtusely pointed, over hanging mouth, with a lateral lobe and studded with tubercles. Mouth subterminal. Lips thick, fringed and entire, covering both jaws continuous at corners of mouth forming a labial fold. Barbels one maxillary pair. Dorsal fin inserted anterior to origin of pelvic fin, devoid of a spine. Scales moderate; lateral line complete.

Description:

D iii-iv 12-14; A ii-iii 5; P i 16-18; V i 8

Body moderately elongated, its dorsal profile more arched than the ventral profile. Snout fairly depressed, projects beyond mouth, devoid of lateral lobe. Eyes large, not visible from underside of head, the diameter 4 to 6 times in head. Mouth small and inferior; lips thick and fringed, with a distinct inner fold to each lip. Barbels a pair of small maxillary barbels concealed in lateral groove. Dorsal fin inserted midway between snout-tip and base of caudal fin. Pectoral fins shorter than head. Caudal fin deeply forked. Scales moderate; lateral line with 40 to 44 scales; lateral transverse scales-rows 6 to 6 ½ between lateral line and pelvic fin base; predorsal scales 12 to 16.

Proportional measurements:

(In % of SL): Body depth 28.6 (28.2-30.8); head length 24.6 (23.8-25.8); pre dorsal length 48.4 (47.3-49.0); dorsal fin height 22.8 (21.7-24.2); pectoral fin length 19.4 (19.3-20.5);

pelvic fin length 19.8 (19.3-20.4); anal fin height 20.4 (18.8-20.5); caudal fin length 30.4 (29.5-32.8).

(In % of HL): Head width 63.6 (63.1-64.8); head height at occiput 76.3 (73.8-76.8); head height at eye 53.9 (52.3-55.8); snout length 42.4 (35.5-42.4); eye diameter 14.2 (13.1-16.2); inter orbital space 55.2 (52.4-56.6); dorsal fin base length 76.3 (76.078.2); anal fin base length 30.5 (28.9-32.6).

Color: In life, bluish along back, becoming silvery on the flanks and beneath; with a reddish mark on each scale during breeding season; eyes reddish. Fins grayish or dark; pectoral fins dusky. The body color tends to vary in fishes living among weeds, exhibiting greenish black on back.

Geographical Distribution: Pakistan; North and Central India; Bangladesh; Terai region of Nepal; and Burma. Nagaland- Doyang river system.

Remarks: This species of fish has been transplanted in many rivers throughout India. Present observation of rohu in the Doyang river is due to its introduction specifically in Doyang reservoir. *Labeo rohita* thrives well in the present water body reflecting a suitable physico-chemical condition for its culture and propagation. However, at present the species is restricted only on the reservoir.

Genus ***Neolissochilus*** Rainboth

Aerossocheilus (*nec* Oshima) Misra, 1962, *Rec. Indian Mus.*, 57:148.
Neolissocheilus Rainboth, 1985, *Beaufortia* **35** (3): 26 (type-species: *Barbus stracheyi* Day).

Key to the species of genus ***Neolissochilus*** Rainboth.

1. a). Mouth truncate, edge of lower jaw sharp; lateral line scales 27-28……..…….……*N.hexagonolepis*

   b). Mouth smoothly rounded, edge of lower jaw blunt……...2

2. a). Dorsal fin inserted nearer tip of snout than to caudal fin base…….*N.hexastichus*

Neolissochilus hexagonolepis (McClelland, 1839) [Plate I.8]

Barbus hexagonolepis McClelland, 1839, *Asiat. Res.*, **19**(2): 270, 340. pl. 41, fig.3 (type-locality: Upper Assam), Day, 1878, *Fishes of India*: 564, pl. 137, fig 4; Day, 1889, *Fauna Br. India*, Fishes, **1**: 305.
Barbus (Lissocheilus) hexagonolepis: Hora, 1940, J. Bombay nat. Hist. Soc., 42(1): 78, figs. 1-4 (Redescription).
Acrossocheilus hexagonolepis: Tilak and Sharma, 1982, Game Fishes of India and Angling: 56, fig. 13.

Local name: Seben

Material examined: NUFM 0699-0700, 2 exes., 298-310 mm SL, Chakabama station, 2.vii.2008; NUFM 0832-835, 4 exes., 282-298 mm SL, Mukhami station, 21.ix.2009; NUFM 0916-921, 6 exes., 354-378 mm SL, Pangti station, 25.ii.2010.

Diagnosis: A species of *Neolissochilus* with mouth truncate, its lower jaw edge sharp; tubercles scarcely present on check just below orbit; dorsal fin inserted nearer to tip of caudal fin than snout tip; last unbranched dorsal fin ray osseous and strong.

Description: D. iv, 9; A iii, 5-6; P i, 16-17; V. i, 8; L.l. 27-28; L.tr.4/1/3; pre dorsal scales 8.

Body graceful and moderately elongated, its depth 3 to 4 times in standard length. Head broad, its length 3.4 to 3.5 times in standard length. Eyes moderate. Mouth truncate, lower labial fold widely interrupted in middle. Barbels two pairs, longer than orbit. Dorsal fin

inserted nearer to the base of caudal fin; its last unbranched ray osseous and strong. Scales large; lateral line with 27-28 scales.

Proportional measurements:

(In % of SL): Body depth 31.5 (30.8-32.2); head length 29.6 (28.7-30.2); pre dorsal length 52.6 (50.7-52.6); dorsal fin height 22.5 (22.1-24.3); pectoral fin length 23.2 (22.9-23.8); pelvic fin length 18.8 (17.9-18.8); anal fin height 22.7 (21.6-22.8); caudal fin length 29.1 (28.9-30.3).

(In % of HL): Head width 51.8 (50.7-53.1); head height at occiput 59.8 (59.2- 60.4); that at eye 33.9 (32.5-34.2); snout length 31.2 (30.8-32.6); eye diameter 11.6 (10.9-11.8); inter orbital space 29.5 (28.6-32.1); dorsal fin base length 43.7 (42.0-45.3); pectoral fin length 78.6 (78.0-79.9).

Caudal peduncle height 66.7 (64.5-67.2) of its length.

Color: In life, dorsum dark olive green, scales above the lateral line coppery; scales pale slate colour fading to white on belly; iris coppery red.

Distribution: India: Eastern Himalaya and Assam; Bangladesh; Nepal; Burma; Thailand; Malaysia; Sumatra and China. Nagaland- Milak river and Doyang river system.

Remarks: This is a favored game fish which attains a length of over 60 cm on an average. In the present investigation this species was found to be mostly restricted to the Doyang reservoir.

Neolissochilus hexasticus (McClelland, 1839) [Plate I.7]

Barbus hexaticus McClelland, 1839, *Asiat. Res.*, **19**(2): 269, 33. (type-locality: Great rivers in the plains of India), Hora, 1924, *Rec. Indian Mus.*, **26**(1): 27.

Local name: Seben

Material examined: NUFM 0720-0721, 2 exes., 62.0-76.0 mm SL, Chakabama station, 2.vii.2008; NUFM 0824-827, 4 exes., 70.2-86.2 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 0828-0831, 4 exes., 82.2-92.4 mm SL, Mukhami station, 18.xi.2009; NUFM 0911-0915, 5 exes., 74.4-94.5 mm SL, Longtshung station, 15.vi.2010.

Diagnosis: A species of *Neolissocheilus* with rounded mouth; tubercles scarcely present on check just below orbit; dorsal fin inserted nearer to tip of snout than to base of caudal fin; last unbranched dorsal fin ray osseous and strong.

Description: D. iv, 10; P. i, 15; V. i, 5; C. 10+9; L.l. 26-27; L.tr. 4/1/2; pre dorsal scales 10. Body deep, elongate, it's dorsal and ventral equally arched. Head broad and rounded. Mouth subliminal; lips moderately thick, lower labial fold continues by a narrow groove. Two rows of irregularly scattered tubercles scarcely below orbit and a little beyond anterior rim of orbit. Eyes moderate and situated almost in anterior half of head. Barbels two pairs, longer than orbit, one each of maxillary ray osseous and strong. Pectoral fin shorter than head length. Ventral fin shorter than pectoral fin, not reaching anal fin. Anal fin not reaching caudal fin. Caudal fin forked. Scales large, pre dorsal scales 10, lateral line complete with 26-27 scales,

Proportional measurements:

(In % of SL): Body depth 29.3 (25.1-33.1); head length 27.5 (21.3-34.2); pre dorsal length 49.2 (42.6-55.7); dorsal fin height 28.9 (24.2-32.5); pectoral fin length 21.5 (18.6-27.9); pelvic fin length 17.3(15.1-25.6); anal fin height 16.2 (12.2-24.9); caudal fin length 30.5 (22.1-38.9). Caudal peduncle length 15.7 (13.4-18.2); caudal peduncle height 14.3 (12.8-18.1).

(In % of HL): Head width 59.3 (44.2-68.5); head height at occiput 80.0 (74.6- 95.3); that at eye 73.2 (66.5-96.2); snout length 35.2 (31.2-41.2); eye diameter 29.2 (21.4-32.0); inter orbital space 34.4 (28.6-41.8); dorsal fin base length 60.8 (49.8-70.2); pectoral fin length 77.2

(59.4-84.9).

Color: Body dark grey above the lateral line scales row and lighter below the lateral line scale row. Pectoral, ventral and anal fin tinged with orange color.

Distribution: India: Rivers from Kashmir to Sikkim and Assam along the Himalayan foothills; and Myanmar. Nagaland- Milak river and Doyang river system (Brahmaputra drainage).

Remarks: Hora and Mukerji (1935), considered *Barbus hexasticus* as synonym of Barbus *hexagonolepis.* They stated that thorough examination of the specimens has shown that *B. hexagonolepis* has a more slender body form, 28-30 scales along the lateral line and an interrupted groove behind the lower lip. Day (1878) differentiated it from *Neolissochielus hexagonolepis* by a continuous labial fold of the lower lip versus a widely interrupted labial fold. The fold is not distinct; it is only shallow labial fold. The present study, the specimens collected has a lower labial fold continuous by a narrow groove, and 26-27 scales along the lateral line.

Genus ***Puntius*** Hamilton-Buchanan

Puntius Hamilton-Buchanan, 1822, *Fishes of Ganges*: 310, 388 (type-species: *Cyprinus sophore* Hamilton-Buchanan).

Key to the species of Genus ***Puntius*** Hamilton-Buchanan

1. a). Barbels present…….. *P. chola*

   b). Barbels absent……2

2. a). Dorsal spine serrated on its posterior edge……..*P. ticto*

   b). Dorsal spine smooth……..……*P. sophore*

Puntius chola (Hamilton-Buchanan, 1822) [Plate II.12]

Cyprinus chola Hamilton-Buchanan, 1822, *Fishes of Ganges:* 312, 389 (type-locality: North eastern part of Bengal)
Puntius chola: Jayaram, 1991, Rec. Zool. Surv. India, Occ. Papers. No *135:52.*

Local name: Tsuto Zür

Material examined: NUFM 0800-0802, 3 exes., 42.2-44.5 mm SL, Pangti station, 28.vii.2008; NUFM 0836-839, 4 exes., 38.6-46.4 mm SL, Pangti station, 11.viii.2009; NUFM 0922-0924, 3 exes., 44.9-46.0 mm SL, Pangti station, 18.vi.2009.

Diagnosis: A *Puntius* species characterized by last simple dorsal ray moderately strong and smooth; a single maxillary pair of barbel present. Body marked with two conspicuous dark blotches. One at the caudal peduncle and another at the base of anterior dorsal fin ray. Lateral line complete.

Description: D. iii, 9; P. i, 13; V. i, 8; A. ii, 6; C. 10+9; L.l. 26; L.tr. 5/1/3; predorsal scales 10. Dorsal and ventral profile gently arched; fairly deep and compressed. Mouth moderate; lips continuous; barbels one short pair of maxillary. Eyes moderately large, situated nearer to the tip of snout than to the end of operculum. Dorsal fin inserted nearly at the middle of tip of snout and base of caudal fin, its last unbranched ray osseous, strong and smooth. Pectoral fin do not reach base of pelvic. Pelvic fin reaching up to the vent. Anal do not reach base of caudal. Scale moderate, lateral line complete with 26 scales.

Proportional measurements:

(In % of SL): Body depth 35.3(32.1-36.2); head length 28.6 (26.3-29.7); dorsal fin height

22.0 (21.6-22.8); dorsal fin base length 20.1 (19.3-21.4); caudal fin length 33.1 (31.8-34.3).

(In % of HL): Head width 54.2 (52.6-55.5); head height at occiput 85.2 (83.2-86.7); snout length 35.2 (33.7-36.9); eye diameter 29.4 (28.3-30.2); inter orbital space 38.2 (35.6-39.5); body

width at dorsal origin 55.2 (52.5-57.4); body width at anal origin 45.8 (43.5-46.7).

Caudal peduncle height 92.6 (88.6-94.4) of its length.

Color: Silvery, with olive green dorsally. Two dark blotches, one at the caudal peduncle and other at the base of anterior dorsal fin ray. Dorsal fin yellow to orange.

Distribution: India: throughout; Bangladesh; Myanmar, Pakistan; Sri Lanka and Nepal. Nagaland-Tsurang and Doyang river system.

Remarks: *Leuciscus thermalis* Valenciennes (1842) from Sri Lanka is considered synonymous with this species by Gunther (1868). *Thermalis* is synonymised with *P. chola*, although the former is bereft of any barbels unlike the latter possessing a pair. It has been shown by Hora and his workers that the presence or absence of the barbels is not binding criterion and it is a variable character. Day (1889) considered *P.thermalis* and *P.unimaculatus* are synonymised under *Chola* which are without barbels. The specimen under study has got one short pair of maxillary barbel.

Puntius sophore (Hamilton-Buchanan, 1822) [Plate II.10]

Cyprinus sophore Hamilton-Buchanan, 1822, *Fishes of Ganges:* 310, 389 (type-locality: Ponds and rivers of Gangetic provinces).
Puntius sophore: Jayaram, 1991, Rec, Zool. Surv. India, Occ. Pap., 135:15.

Local name: Tsuto Zür

Material examined: NUFM 0840-0848, 9 exes., 38.3-42.2 mm SL, Chakabama station, 14.ii.2008; NUFM 0849-0853, 5 exes., 36.8-46.2 mm SL, Kidzumetouma station, 13.iii.2008; NUFM 0925-0931, 7 exes., 36.2-43.8 mm SL, Mukhami station, 11.viii.2008; NUFM 0932-0936, 5 exes., 33.9-40.8 mm SL, Pangti station, 17.ix.2008; NUFM 1006-1012, 7 exes., 42.2-49.4 mm SL, Longtshung station, 14.xii.2009.

Diagnosis: A *Puntius* species with the last simple dorsal fin ray smooth. Barbels absent, lateral line complete with 24 scales. Two black blotches, one at the base of dorsal fin and another at the base of caudal fin.

Description: D. ii, 8; P. i, 12; V. i, 8; A. iii, 5; C. 9+8; L.l. 24; predorsal scales 9. Body comparatively deep, its dorsal profile more convex than ventral. Head short, much shorter than body depth. Mouth terminal; no barbels. Eye moderate, inter orbital space slightly convex. Dorsal fin inserted equidistant between tip of snout and base of caudal fin; its last unbranched ray osseous and smooth. Caudal fin forked. Scale medium; lateral line complete with 24 scales.

Proportional measurements:

(In % of SL): Body depth 36.2(32.6-48.1); head length 29.5(29.2-30.6); caudal peduncle length 16.6(16.3-17.1); pre dorsal length 49.8 (46.9-55.5; dorsal fin height 30.2 (29.5-30.9); pectoral fin length 19.3 (18.2-20.1); pelvic length 19.6(18.9-20.5); anal fin height 18.4 (17.2-19.1); caudal fin length 30.5 (29.1-33.3).

(In % of HL): Head width maximum 52.2 (50.0-53.3); that at eye 52.2 (50.0-53.3); head height at occiput 79.7 (73.3-80.6); head height at eye 59.4 (58.7-64.5); snout length 29.0 (25.8-33.3); eye diameter 30.6 (29.0-32.0); inter orbital space 34.8 (33.9-36.0).

Caudal peduncle height 72.0-85.0 of its length.

Color: Silvery, back grey-green to brownish; flanks with somewhat bluish lustre. A round black blotch at base of caudal fin and another at the base of anterior dorsal ray present.

Distribution: India: Nepal; Bangladesh; Myanmar, Pakistan and Yunnan (China). Nagaland-Tsurang and Doyang river system.

Remarks: Originally the name *Puntius sophore* was described from Sanskrit meaning 'a beautiful little fish' described by Hamilton (1822). It is a very plentiful shoaling fish, remaining appreciably smaller in the domestic aquarium and becoming mature at 7-8 cm in SL as remarked by Talwar and Jhingran (1991). This species is very similar to *P. chola* but it can be easily distinguished from the former by the absence of barbels.

Puntius ticto ticto (Hamilton-Buchanan, 1822) [Plate II.11]

Cyprinus ticto ticto Hamilton-Buchanan, 1822, *Fishes of Ganges*: pp. 314, 398, Pl. 8 fig. 87 (type-locality: South east part of Bengal)
Puntius ticto ticto: *Jayaram, 1982, Rec. Zool. Surv. India, Occ. Pap., No. 36:64.*

Local name: Tsuto Zür

Material examined: NUFM 0854-0860, 7 exes., 32.4-37.2 mm SL, Chakabama station, 8.i.2008; NUFM 0862-0866, 5 exes., 34.3-44.4 mm SL, Kidzumetouma station, 13.iii.2008; NUFM 0937-0941, 5 exes., 38.2-41.4 mm SL, Mukhami station, 4.vi.2008; NUFM 0942-0948, 7 exes., 35.6-39.7 mm SL, Pangti station, 17.ix.2008; NUFM 0949-0956, 8 exes., 39.2-48.5 mm SL, Longtshung station, 12.x.2009; NUFM 1013-1017, 5 exes., 36.8-47.5 mm SL, Liphiyan station, 12.vii.2010.

Diagnosis: This *Puntius* species is characterized by the last dorsal fin ray osseous and finely serrated. Two dark blotches, one near the gill opening another at the base of caudal fin.

Lateral line incomplete with 22-23 scales. Pre dorsal scales 10.

Description: D. iii, 8; P. i, 13-14; V. i, 8; A. ii, 5; C. 10+-9; L.l. 22-23; pre dorsal scales 9-10. Body elongate and compressed. Head short, mouth small and terminal, lips thin. Eyes moderate, snout plain. Dorsal fin inserted nearer caudal fin base than the tip of the snout; its last unbranched ray osseous, serrated posteriorly and moderately strong. Pectoral fins do not reach pelvic fin. Caudal fin forked. Circumpeduncular scales 11; scales moderate and lateral line incomplete with 22-23 scales.

Proportional measurements:

(In % of SL): Body depth 37.3 (34.4-38.2); head length 24.3 (23.5-25.7); pre dorsal length 51.2 (48.9-53.6); post dorsal length 49.2 (47.4-51.7); dorsal fin height 25.2 (24.2-26.7); dorsal fin base length 15.9 (14.7-16.9).

(In % of HL): Head width 56.4 (52.9-57.6); head height at occiput 93.9 (89.2-95.2); that at eye 74.6 (73.6-77.4); snout length 29.6 (27.4-30.1); eye diameter 29.1 (28.7-29.2); inter orbital space 33.1 (31.8-33.6); caudal peduncle length 65.7 (62.8-66.4); caudal peduncle height 55.2 (53.8-56.9).

Color: Body silvery with two black blotches, one at the base of caudal fin and another at the edge of operculum. Fins and flanks are reddish.

Distribution: India: widely distributed; Bangladesh; Sri Lanka; Pakistan; and Myanmar. Nagaland- Dikhu, Milak and Doyang river system.

Remarks: This Puntius species is found in the Doyang river system of Nagaland. It is also widely distributed in all the rivers of Nagaland. Talwar and Jhingran (1991) remarked that the arching reddish area in the dorsal fin of the male easily distinguishes the species; the dorsal fin of the female is pale, except for a faint pink at breeding season.

Genus ***Tor*** Gray

Tor Gray, 1834, *Illust. Indian Zoology*, 2: 196 (Type-species: *Cyprinus Tor* Hamilton); Sen and Jayaram, 1982, *Rec. Zool. Surv. India Occ. Paper*, (39) (Preliminary review).

Tor putitora (Hamilton-Buchanan, 1822) [Plate II.9]

Cyprinus putitora Hamilton-Buchanan, 1822, *Fishes of Ganges*: 303, 388 (Type-Locality: Eastern part of Bengal).
Barbus tor putitura, 1939, *J. Bombay Nat. Hist. Soc.*, 41(2): 77.
Tor putitura: Tilak and Sharma, 1982, *Game Fish. India Angling*: 39.

Local name: Seben

Material examined: NUFM 0867-0870, 4 exes., 96.4-10.8 mm SL, Mukhami station, 19.ii.2008; NUFM 0871-873, 3 exes., 91.2-121.2 mm SL, Pangti station, 20.v.2008; NUFM 0957-0960, 4 exes., 110.2-131.0 mm SL, Longtshung station, 12.x.2009; NUFM 1018-1020, 3 exes., 88.6-98.8 mm SL, Mukhami station, 20.vii.2010.

Diagnosis: A species of *Tor* with head broadly pointed; its length considerably greater than the body depth. 9 branched dorsal fin rays. Pre dorsal scales 9-10. Lateral line complete with 29-30 scales.

Description: D. iv, 9; P. i, 15-16; V. i, 8; A. iii, 5; C. 10+9; L.l. 29-30; L.tr. 4/1/2; pre dorsal scales 10. Body elongate and somewhat compressed. Head pointed and long, its length more than depth of body. Dorsal and ventral profile almost equally arched. Mouth moderate, lips thick and fleshy. Eye large, in anterior half of head. Barbels two pairs, one each of maxillary and rostral. Dorsal fin inserted equidistant between tip of snout and base of caudal fin, its last unbranched ray osseous and strong. Pectoral fin shorter than head length, not reaching pelvic fin. Pelvic fin do not reach the vent. Caudal fin forked, lower lobe slightly longer than upper lobe. Scales large, lateral line complete with 29-30 scales.

Proportional measurements:

(In % of SL): Body depth 28.6 (27.8-29.2); head length 30.0 (29.2-30.8); body width 14.5 (14.3-15.3); pre dorsal length 50.1 (50.0-51.6); dorsal fin height 29.7 (27.3-30.8); pectoral fin length 20.7 (19.7-22.0); pelvic fin length 18.5 (17.9-18.6); anal fin height 15.4 (14.8-20.87); caudal peduncle length 15.4 (14.9-16.3); caudal peduncle height 10.6 (9.9-11.2); caudal fin length 31.1 (30.3-34.1).

(In % of HL): Head width 44.2 (35.7-53.2); head height at occiput 55.8 (53.1-63.8); snout length 34.8 (33.6-36.8); eye diameter 18.2 (17.7-18.4); inter orbital space 26.5 (21.4-28.9); dorsal fin base length 47.1 (47.0-49.6); anal fin base length 38.7 (25.0-42.1); mouth gape width 21.3 (19.3-25.7); rostral barbel length 26.3 (18.2-29.8); maxillary barbel length 33.8 (27.4-38.2).

Caudal peduncle height 70.0 (64.3-75.5) of its length.

Color: Body greenish dorsally, silvery white ventrally. Distal part of the caudal fin orange; pectoral, pelvic and anal fins slightly yellow.

Distribution: India: Afghanistan; Pakistan; Nepal; and Bangladesh. Nagaland: River Tizu, Lanye (Chindwin drainage); Dikhu, Tsurang, Intangki and Doyang river system (Brahmaputra drainage).

Remarks: Hora and Mukerji (1936) remarked that the shape of the head of *Barbus putitura* and *barbus tor* shows considerable resemblance, but the former is more graceful (height of body considerably less then length of head), the head relatively longer, the snout more blunt and the eyes proportionately smaller. The median lobe of the lower lip is well developed even in the young of *putitura.* In the present specimens also head length is longer than the height of the body, the length of head is 30.0 % of SL and height of body is 28.6% of SL. They also noted that *B.putitura* is more carnivorous and voracious than *B. tor*. In the Dehra Dun hill the chief bait for *B.putitura* is *Barilius bendelisis* and *Labeo dero,* so it appears evident that the fish

feeds on smaller species. *B.putitura* is probably widely distributed in the sub mountainous streams of the Himalayas and the Assam hills. W.Vishwanath and L.Kosygin (1998) reported this species from Tizu river, Nagaland.

SUB-FAMILY: LEUCISINAE

Genus ***Hypopthalmichthys*** Bleeker

Hypopthalmichthys Bleeker, 1860, *Natuurk. Tijdschr.* Ned.-Indie, 20: 283 (type-species: *Leuciscus molitrix* Valenciennes); Howes, 1981, *Bull. Br. Mus. Nat. Hist. (Zool.)*, **41**(1): 1-48 (status and relationship).

Hypopthalmichthys molitrix (Valenciennes, 1844) [Plate ???]

Leuciscus molitrix Valenciennes, 1844, *Hist. nat. Poiss*., **17**: 360 (type-locality: China).
Hypopthalmichthys molitrix: Howes, 1981, *Bull. Br. Mus. Nat. Hist.* (Zool.), **41**(1):45, fig. 33a; Natarajan, 1984, *Bull. Cent. Inland Fish. Res. Inst*., (34): 1-12 (Biological notes).

Local name: Silver carp

Material examined: NUFM 0701-0703, 3 exes., 223-241 mm SL, Pangti station, 11.viii.2009; NUFM 0803, 1 exes., 238.2 mm SL, Pangti station, 7.x.2009.

Diagnosis: A species of *Hypopthalmichthys* with abdomen keeled from throat to vent. Eyes small set low on head. Dorsal fin inserted slightly behind pelvic fin origin. Scales small.

Description:

D. iii, 7; A. iii, 12; P. i, 17; V. i, 7; L.tr. 32/1/15.

Body stout and compressed; abdomen strongly compressed with a sharp keel from throat to vent. Head rather small, snout blunt, obtusely rounded anteriorly. Mouth terminal, lower jaw

slightly longer than upper. Dorsal fin short, inserted slightly behind pelvic fins. Scales small; lateral line with 112-114 scales.

Proportional measurements:

(In % of SL): Body depth 31.5 (29.1-32.8); head length 32.1 (30.5-33.6); pre dorsal length 53.5 (52.3-55.2); dorsal fin height 21.6 (20.5-21.8); pectoral fin length 22.8 (21.7-23.2); pelvic fin length 17.0 (17.0-17.8) anal fin height 14.9 (14.2-15.4); caudal fin length 29.9 (28.6-33.7).

(In % of HL): Head width 48.3 (48.2-48.9); head height at occiput 73.6 (72.4-74.4); head height at eye 45.2 (44.8-46.5); snout length 28.4 (28.1-30.5); eye diameter 12.9 (12.6-12.9); inter orbital space 40.0 (39.8-42.4); dorsal fin base length 32.3 (32.1-32.7); anal fin base length 51.7 (50.8-53.6).

Color: Silvery white with red spots on body especially on caudal peduncle. All Fins dark. Dorsum dark brownish, flanks coppery or dirty golden, base of each scale dark brown to black.

Geographical Distribution: South and Central China and in the Amur basin, also introduced into many countries including India. Nagaland- Doyang river.

Remarks: Present observation of *Hypophthalmichthys* in the Doyang river is due to its introduction in the Doyang reservoir and at present the species is restricted only on the reservoir.

SUB-FAMILY: GARRINAE

Genus *Crossocheilus* Kuhl et van Hasselt

Crossocheilus Kuhl et van Hasselt**,** 1823, *Algemeine. Kost. En Letter-Bode*, 2(35): 132 (Type-locality: *Crossocheilus oblongus* Kuhl et van Hasselt); Bamaresen 1986, *Trav. Mus. Hist. Natn. Antipa*, 28: 142-154 (Revision); Kottelat, 1987**,** *Jap. J. Ichtyol***.,** **33**(4): 371 (Generic and type species discussed).

Crossocheilus latius latius (Hamilton, 1822) [Plate IV.27]

Cyprinus latius Hamilton-Buchanan, 1822, *Fishes of Ganges:* 245, 393 (type-locality: Tista river at base of Darjeeling, Himalaya).
Crossocheilus latius: Hora and Misra, 1938. *J. Bombay Nat. Hist. Soc.,* 40(1): 31.

Local name: Tongtsü

Material examined: NUFM 0899-0904, 6 exes., 62.2-69.4 mm SL, Chakabama station, 2.vii.2008; NUFM 0983-0989, 6 exes., 62.6-76.0 mm SL, Kidzumetouma station, 9.xi.2009; NUFM 1045-1049, 6 exes., 82.2-93.8 mm SL, Liphiyan station, 26.viii.2008.

Diagnosis: A species of *Crossocheilus* with 8 branched dorsal fin rays. Mouth semi-circular and a narrow frenulum connecting upper lip with lower lip; lower lip without any suctorial disc. Maxillary barbel present. Lateral line complete with 40-41 scales; lateral transverse scales 6/1/4.

Description: D. ii, 8; P. i, 14; V. i, 8; A. ii, 5; C. 10+9; L.l. 40-41; L.tr. 6/1/4; pre dorsal scales 11, body elongate with rounded abdomen. Head small, flat and compressed; snout prominent and founded. Mouth inferior; a narrow frenulum connecting upper lip with lower lip; upper jaw slightly longer than lower jaw. Eyes moderate. Barbels only maxillary pair. Dorsal fin slightly in advance of pelvic fin and inserted to the tip of snout than to base of caudal fin. Pectoral fins well- developed. Pelvic fin do not reach the anal fin. Anal fin short, not reaching the caudal fin base, caudal fin deeply forked. Scales moderate; lateral line

complete with 40-41 scales.

Proportional measurements:

(In % of SL): Body depth 21.0 (13.9-22.7); head length 22.4 (16.6-24.1); pre dorsal length 43.4 (36.1-52.0); caudal peduncle length 13.1 (10.1-16.6); caudal peduncle height 10.0 (8.2-12.3); dorsal fin height 26.3 (21.2-32.5); pectoral fin length 21.0 (15.3- 21.8); pelvic fin length 19.7 (17.5-21.3); anal fin height 18.4 (14.5-20.7).

(In % of HL): Body depth 94.1 (68.8-96.4); head height at occiput 64.7 (58.5-72.9); snout length 47.0 (38.1-51.2); eye diameter 23.5 (26.1-29.4); inter orbital space 29.4 (27.4-34.6); head width 64.7 (47.0- 72.3**)**; dorsal fin base length 76.5 (64.7-81.7); anal fin base length 35.3 (26.7-42.4); mouth gape width 35.3 (32.6-43.2).

Caudal peduncle height 76.0 (56.6-82.5) of its length. Distance between vent to anal fin 55.0 (42.1-55.4) of distance between anterior origin of ventral fin to anal fin origin.

Color: In life, upper half of body grayish with irregular dark spots, lower half yellowish. Dorsal and caudal fins yellowish-grey; pectoral, ventral and anal fins orange.

Distribution: India: Drainages of the Ganga and Brahmaputra in Northern India; Mahanadi river drainage in Orissa; and Western Ghats, South to the headwaters of Krishna river. Nagaland- Dikhu, Milak, Tsurang and Doyang river system (Brahmaputra drainage).

Remarks: Mukerji (1934) reported *Crossocheilus latius* from Tizu river at Melon and conformed to the Siamese and Burmese form. Hora (1936) referred the species collected from Manipur valley; Tizu river, Naga Hills are Assamese and Burmese form. But, the species collected from the Naga Hills, however, belong to the typical form known from the Brahmaputra and the Gangetic drainage of the Himalayas. When, however, the distribution of the two forms is considered with regard to the various drainage systems, it is found that the form typical is restricted to the Brahmaputra and the Gangetic systems, where as the form

burmanicus is found in the various drainage systems of Burma - the Chindwin, the Irrawaddy, etc. The two forms differ mainly in their lepidosis and the relative length of the head.

Genus ***Garra*** Hamilton-Buchanan

Garra Hamilton-Buchanan, 1822, *Fishes of Ganges:* 343,393 (type-species: *Cyprinus lamta* Hamilton-Buchanan; Menon, 1964, *Mem. Indian Mus.,* **14**(4): 173-200 (Revision).

Key to the species of genus ***Garra*** Hamilton

1. a). Proboscis present…….……..…..2

   b). Proboscis absent……3

2. a). Proboscis weakly developed without lateral

   tubercular area……..*G. gravelyi*

   b). Proboscis well developed with well defined lateral

   tubercular area…….……..……..*G. gotyla gotyla*

2. a). Caudal fin with W shaped dark band

   Lateral line scales 33-34……..…….*G. lissorhynchus*

   b). Caudal fin with no W shaped dark band

   Lateral line scales 38-39……..…….*G. naganensis*

Garra gotyla gotyla (Gray, 1832) [Plate III.23]

Cyprinus gotyla Gray, 1832, *Illustr. Indian zool.,* 1**.** pl. 88. figs. 3, 3a, (type locality: Northern India); Hora, 1921, *Rec. Indian Museum,* **22**(5).653 (status discussed).
Garra gotyla gotyla: Menon. 1964, *Mem. Indian Museum,* **14**(4). 233, pl. 13, figs. 1-4.

Local name: Anget

Material examined: NUFM 0874-0877, 4 exes., 62.4-68.7 mm SL, Chakabama station, 14.ii.2008; NUFM 0878-0880, 3 exes., 66.5-98.6 mm SL, Kidzumetouma station, 13.iii.2008; NUFM 0961-0964, 4 exes., 86.5-90.4 mm SL, Mukhami station, 23.ii.2009; NUFM 0965-0968, 4 exes., 62.0-69.4 mm SL, Longtshung station, 4.xi.2008; NUFM 1021-1023, 3 exes., 69.8-72.4 mm SL, Liphiyan station, 20.x.2009.

Diagnosis: A species of Garra with single lobed proboscis on snout; branched dorsal fin rays 8; body depth 19.3% of SL; lateral line scales 33;distance between vent and anal fin origin 31.6% of the distance between pelvic and anal origin.

Description: D. ii, 8; P. i, 13-14; V. i, 8; A. ii, 5; C. 10+9; L.l. 33; L.tr. 4/1/3. Body elongate. Head much depressed; interorbital region slightly convex; snout with a well developed median proboscis and a transverse lobe at tip. Eyes fairly large. Mouth arched; mental disc well-developed. Barbels two pairs, one maxillary and one rostral. Dorsal fin inserted little ahead of ventral fin; it is nearer to tip of snout than to caudal fin base. Chest and belly scaled. Scales fairly large, predorsal scales 9 - 10. Lateral line complete with 33 scales. Caudal fin forked.

Proportional measurements:

(In % of SL): Body depth 19.3 (18.0-20.9); head length 22.9 (21.2-24.2); head width 19.0 (17.1-19.0); head height at occiput 15.2 (14.5-16.7); that at eye 13.9 (13.2-15.1); snout length 12.9 (12.9-13.6); caudal peduncle length 13.0 (12.9-13.2); caudal peduncle height 13.2 (12.6-13.6); predorsal length 45.7 (44.3-46.8); dorsal fin height 24.2 (22.8-24.2); dorsal fin base length 16.7 (15.2-17.7); pectoral fin length 22.6 (20.9-22.7); anal fin height 19.0 (18.1-19.7); caudal fin length 28.8 (27.1-29.0).

(In % of HL): Disc length 35.2 (31.2-36.8); Disc width 21.1 (18.7-26.3); Head width 81.2

(78.9-84.5); head height at occiput 63.4 (63.1-68.7); snout length 56.2 (53.7-56.3); eye diameter 18.9 (18.7-19.7); inter orbital space 43.7 (42.2-47.4).

Distance between anterior origin of pelvic and anal fin 54.0 (51.7-56.8) of distance between interior origin of pelvic and base of caudal fin. Distance between vent and anal fin origin 31.6 (26.7-35.0) of distance between pelvic and anal fin origin.

Color: Dark brown to greenish black and yellowish beneath. A black spot behind the upper angle of gill openings and a row of dark spots present along the base of the dorsal fin.

Distribution: India: All along the Himalaya, Chota Nagpur plateau and the Vindhya-Satpura mountain of the Indian peninsula; Bangladesh and upper Myanmar. Nagaland- Dikhu, Tesuru, Meguiki and Doyang river system.

Remarks: This species can be easily distinguished by the presence of a well-developed median proboscis without any lateral lobes on the snout. Male with prominent tubercles on snout. It attains a length of 14cm and having a minor interest to fisheries (Talwar and Jhingran, 1991). This species stays in the bottom of the river, and is caught by a technique called Tsüyok (river diversion or damming) during post monsoon period.

Garra gravelyi (Annandale, 1919) [Plate III.24]

Discognathus gravelyi Annandale, 1919, *Rec. Indian Museum,* **16** (1): 133, pl. 2, figs. 3,3a (type-locality: Inle lake and He-Ho stream, Southern Shan states, Burma).
Garra gravelyi: Hora, 1921, *Rec. Indian Museum, 22(5): 654;* Menon**,** *1964, Mem. Indian, Mus.*, **14**(4): 241; Vishwanath et *al., 1987. Indian J. Fish. 34 (3): 362 (*new record from India).

Local name: Anget

Material examined: NUFM 0881-0884, 4 exes., 60.3-66.8 mm SL, Chakabama station, 9.i.2008; NUFM 0885-0889, 5 exes., 66.0-70.4 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 0969-0971, 3 exes., 62.8-66.4 mm SL, Longkhung station, 12.x.2009; NUFM 1024-1029, 6 exes., 60.3.0-65.9 mm SL, Liphiyan station, 23.xi.2009.

Diagnosis: A species of *Garra* characterized with a single lobed incipient proboscis on snout; no lateral tubercular area; distance between vent and anal fin origin 31.2% of distance of pelvic and anal fin origin; disc width 76.5% of head width; disc length 71.8% of head length.

Description: D. ii, 8; P. i, 12; V. i, 8; A. ii, 5; C. 10+9; L.l. 33-34; L.tr. 4/1/3; pre dorsal scales 9-10. Body elongate. Head flattened beneath; snout rounded and convex, a transverse groove at its tip and weakly developed proboscis present. Mouth small, suctorial disc well developed. Barbels two pairs, one each of maxillary and rostral, shorter than eye diameter. Dorsal fin inserted nearer to snout tip than to caudal fin base. Pectoral fin longer than head length. Anal fin do not reach caudal fin base. Breast and belly scaled, scales moderate in size, lateral line complete with 33-34 scales. Caudal fin forked.

Proportional measurements:

(In % of SL): Body depth 21.8 (19.4-23.0); head length 22.9 (23.1-26.7); body width 16.7 (16.7-17.7); pre-dorsal length 47.4 (47.2-51.0); dorsal fin height 25.0 (24.6-29.0); pectoral fin length 22.2 (21.0-25.0); pelvic fin length 19.7 (19.4-25.0); anal fin height 20.5 (19.4-25.0).

(In % of HL): Head width 78.8 (68.7-83.3); head height at occiput 62.5 (62.2-64.8); Snout length 55.5 (54.5-56.2); eye diameter 18.2 (16.7-18.7); interorbital space 44.4 (43.7-47.3); anal fin base length 34.4 (31.5-43.7); disc length 37.5 (30.3-38.9).

Caudal peduncle height 97.8 (95.2-104.6) of its length. Distance between anterior origin of pelvic and anal fin 50.3 (48.5-56.7) of distance between anterior origin of pelvic and base of

caudal fin. Distance between vent and anal fin origin 31.2 (26.2-35.8) of distance between pelvic and anal fin origin of distance between interior origin of pelvic and base of caudal fin.

Color: Body dorsal dark gray, ventrally pale white. A few dusky dark spots are present at the base of dorsal branch fin rays. A minute black spot behind the upper angle of gill openings.

Distribution: India; Myanmar; Southern Shan States; Nagaland- Dikhu and Doyang river system.

Remarks: This species is ideal for use as an aquarium fish.

Garra lissorhynchus (McClelland, 1842) [Plate IV.26]

Platycara lissorhynchus McClelland, 1842, *Calcutta J. nat. hist. Calcutta. 2:587* (type-locality: Khasi Hills, Meghalaya).
Garra lissorhynchus. Hora, 1921, *Rec*. *Indian*. *Mus*. 22(5):662, pl. 26, figs 2, 2a.

Local name: Anget.

Material examined: NUFM 0893-0897, 5 exes., 59.6-60.3 mm SL, Chakabama station, 9.i.2008; NUFM 0980-0982, 3 exes., 62.8-70.9 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 1036-1039, 4 exes., 66.2-70.2 mm SL, Mukhami station, 18.xi.2009; NUFM 1040-1044, 5 exes., 57.6-70.2 mm SL, Liphiyan station, 23.xi.2009.

Diagnosis: A species of *Garra* with a 'W' shape band in the caudal fin and dorsal fin with a transverse black bar; no transverse groove and proboscis on snout; no scales on chest and belly. Distance between vent and anal fin origin 36.6% (35.8-37.4) of distance between pelvic and anal fin origin. Disc length 81.6% (59.5-101.1) of its width.

Description: D. ii, 6; P. i, 13-14; V. i, 7; A. i, 5; C. 10+9; L.l. 33-34; L.tr. 4*/1/3****;*** pre dorsal

scales 13-14. Body elongate and rounded; dorsal profile considerably elevated. Head small, snout somewhat rounded without transverse groove and proboscis. Inter orbital region slightly convex. Mouth semicircular, inferior. Barbels two pairs; rostral and maxillary, slightly smaller than eye diameter. Oral disc well developed. Dorsal fin inserted about midway between tip of snout and caudal fin base. Pectoral fin equal to head length. Pelvic fin not reaching the anal fin. Anal fin short, not reaching caudal fin. Scales moderate. Lateral line complete with 33-34 scales. Scales absent on chest and belly. Caudal fin slightly forked.

Proportional measurements:

(In % of SL): Body depth 20.4 (18.2-25.6); head length 24.2 (18.2-26.8); predorsal length 55.6 (46.2-66.4); dorsal fin height 18.6 (15.4-20.6); pelvic fin length 14.2 (12.5-16.0); anal fin height 15.0 (14.2-17.8).

(In % of HL): Head width 82.5 (62.2- 90.4); head height at occiput 64.2 (56.4-68.5***);*** inter orbital space 50.6 (48.5-52.6); Disc length 50.4 (42.6-58.8).

Disc length 81.6% (59.5-101.1) of its width. Distance between anterior origin of pelvic and anal fin 57.4 (52.8-60.4) of distance between anterior origin of pelvic and base of caudal fin. Distance between vent and anal fin origin 36.6% (35.8-37.4) of distance between pelvic and anal fin origin.

Color: Body dull greenish brown, lighter below. Dorsal fin with a broad transverse black bar near the free margin. Caudal fin with a "W" shaped band in the anterior half. A minute black spot behind the upper angle of gill opening and an indistinct black blotch near the base of caudal.

Distribution: India: Nagaland: River Tizu (Chindwin drainage); Dikhu, Milak, Chathe and Doyang river system (Brahmaputra drainage).

Remarks: Hora and Mukerji (1935) reported this species from Nagaland, the collection site

are Zhokami and Tekhubami a source of the Doyang river, Sakhai - Lizho stream and Emilomi - Keliki stream. W.Vishwanath and L.Kosygin (1998) also reported this species from Tizu river which flows into the Chindwin river. In color markings, the female specimens of *G.lissorhynchus* resemble *G.abhoyai* Hora, but the two species differ in general facies and lepidosis (Hora and Mukerji. 1935). *G.lissorhynchus* resembles *G.rupecula* in having a 'W' shaped black band on the anterior half of caudal fin. However, Menon (1964) separated it from *G.rupecula* by having the back and post pelvic regions covered with scales.

Garra naganensis (Hora, 1921) [Plate IV.25]

Garra naganensis Hora, 1921, *Rec. Indian Mus*., **22** (5): 667. (type-locality: near kirong, Naga hills, Nagaland); Vishwanath, 1993, *J. Freshwater Biol.* **5** (1):61.

Local name: Anget

Material examined: NUFM 0889-0892, 4 exes., 67.2-69.7 mm SL, Chakabama station, 14.ii.2008; NUFM 0972-0974, 3 exes., 68.5-78.2 mm SL, Kidzumetouma station, 15.v.2008; NUFM 0975-0979, 5 exes., 68.2-70.4 mm SL, Longtshung station, 12.x.2009; NUFM 1030-1035, 6 exes., 72.6-88.0 mm SL, Liphiyan station, 23.xi.2009.

Diagnosis: A species of *Garra* with no transverse groove and proboscis on snout; body width at dorsal fin origin ***18.6 (18.2-22.4)*** *%* of ***SL;*** Disc length ***78.4 (70.6-82.5)*** *%* of its width; disc width ***78.4 (68.2-92.8)*** *%* of head width; distance between vent and anal fin origin ***34.2 (30.6-35.2)*** % of distance between pelvic and anal fin origin. Branched dorsal fin rays 8.

Description: D.ii, 8; P.i, 13;V.i, 8;A.ii, 5; C.10+9; L.l. 38-39; L.tr. 5/l/3; pre dorsal scales 12.

Body elongate, sub cylindrical, dorsal profile arched or elevated from snout tip to base of dorsal fin, than slightly slopes down to caudal fin base. Head moderate size. Mouth semicircular, inferior; oral disc well developed Barbels two pairs; rostral and maxillary; both shorter than eye diameter. Dorsal fin inserted nearer to snout tip than to caudal fin base. Pectoral fin slightly shorter than head length, do not reach the base of caudal fin. Caudal fin forked with slightly longer upper lobe. Scales moderate, reduced on chest; lateral line complete with 38-39 scales.

Proportional measurements:

(In % of SL): Body depth 20.45 (19.0-25.2); head length 21.6 (20.4-23.5); head width 17.3 (16.8-19.2);body width 17.04 (16.3-17.9); caudal peduncle length 14.8 (14.2-17.3); caudal peduncle height 13.6 (12.8-14.1); predorsal length 47.7 (45.9-48.6); dorsal fin height 25.0 (24.8-25.9); pectoral fin length 22.7 (19.7-24.3); pelvic fin length 19.3 (18.2-20.4); caudal fin length 27.3 (26.8-28.2).

(In % of HL): Head width 80.0 (78.4-81.2); head height at occiput. 68.4 (67.3-69.1); snout length 53.7 (52.3-55.8); eye diameter 15.8 (15.2-16.1); inter orbital space 49.6 (48.7-50.2); Disc width 57.9 (56.1-59.2); disc length 36.8 (35.7-37.5).

Caudal peduncle height 92.3 (89.6-95.8) of its length. Disc length 63.6 (62.2-65.3) of its width. Disc width 72.4 (70.8-73.5) of head width. Distance between anterior origin of pelvic and anal fin 50.7 (50.2-51.6) of distance between anterior origin of pelvic and base of caudal fin. Distance between vent and anal fin origin 50.0 (49.1-55.2) of distance between pelvic and anal fin origin.

Color: Body dark brown above, pale white on ventral region. A black spot behind the upper angle of gill opening. And indistinct lateral band extends from behind gill opening to base of caudal fin.

Distribution: India: Nagaland- River Tizu (Chindwin drainage) and Dikhu, Meguiki and Doyang river system (Brahmaputra drainage).

Remarks: Unlike *G.gotyla* and *G.gravelyi* this species have no transverse groove and proboscis and scales on chest is also reduced. The species is distinguished from the *G.lissorhynchus* by its small transversely oval mental disc and by the fact that the oval opening is situated much nearer the commencement of the anal fin than that of the ventral fins (Hora and Mukerji, 1935). They reported this species from various streams and rivers, viz. Zhokami and Tekhubami - sources of the Doyang river, Purobami and Sahunyu — sources of the Tizu river, Melori — Tizu river, Leori and Phodung River - a tributary of the Tizu river, Laruri and Zhuzet stream - a tributary of Namteleik and Emilomi - Keleki stream.

FAMILY: BALITORIDAE
SUB-FAMILY: NEMACHEILINAE

Genus ***Acanthocobitis*** Peters

Acanthocobitis peters, 1861. *Konigl. Preuss. Acad. Wiss. Berlin*: 712 (type species: *Acanthocobitis longipinnis* Peters); Banarescu & Nalbant. 1995. *Trav. Mus. Hist. nat <<Grigore Anitpa>>*, 35: 432 (Generic classification).

Acanthocobitis botia (Hamilton-Buchanan, 1822) [Plate IV.29]

Cobitis botia Hamilton-Buchanan, 1822, *Fishes of Ganges*: 350,394 (type-locality: rivers of north east Bengal*) Acanthocobitis botia*: Kottelat, 1990, Indo-chinese Nemacheilines: 35 (revision); Vishwanath and Juliana 2001. *J. Bombay nat. Hist Soc.* **98** (2): 200 (Manipur Nemacheilines).

Local name: Sangsert

Material examined: NUFM 0990-0994, 5 exes., 54.3-62.6 mm SL, Longkhung station, 17.viii.2009; NUFM 1050-1053, 4 exes., 65.0-76.8 mm SL, Longkhung station, 14.xii.2009.

Diagnosis: A species of *Acanthocobitis* with lateral line complete; no sub orbital flap but a sub orbital grove. A black spot at the upper base of caudal fin.

Description: D.iii, 10-11; P.i.11-12; V.i7; A.ii, 5½; C.9+8. Body robust with dorsal profile slightly convex anteriorly and concave posteriorly. Head moderate. Mouth arched, its gap about twice as wide as long; lips strongly papillated. Three pairs of barbels; inner rostral reaches base of maxillary barbel or a little beyond. Maxillary and outer rostral barbels reach about to the middle of the post orbital area. Doral fin inserted slightly ahead of middle of body; its distal margin convex. Pelvic fin origin below 3rd to 4th branched dorsal fin ray. Pelvis fin nearly reaches anus. Caudal fin slightly emarginated. Scales minute, covered the belly and body; lateral line complete.

Proportional measurements:

(In % of SL): Body depth 17.0 (15.4-18.2); Head length 22.4 (21.8-23.0); Predorsal length 47.9 (46.5-48.4); dorsal fin height 19.5 (18.2-20.2); Pectoral fin length 16.9 (16.6-17.2); pelvic fin length 15.6 (14.2-16.1); anal fin height 15.6 (15.2-16.2); caudal peduncle length 10.7 (10.2-11.2); caudal peduncle height 12.8 (12.4-13.4).

(In % of HL): Head width 63.9 (62.2-64.0); head height at occiput 58.1 (56.6-60.4); head height at eye 48.8 (44-2-53.3); snout length 48.8 (47.5-49.0); eye diameter 11.6 (11.2-13.3); inter orbital space 23.2 (23.0-26.7); head width at eye 52.3 (52.2-53.3).

Color: Body bright yellowish, a distinct thin dark line on lateral line; 8-10 elongate vertical blotches on body, shapes variable. 10-11 black patches (‘Saddles’ as mentioned by Kottelat,

1990) on back, extending towards lateral line alternate with the blotches. Dorsal fin with 5-6 horizontal series of black spots, caudal fin with 7-8 vertical series, V-shaped, pointed posteriorly.

Distribution: India; Pakistan; Thailand; and China. Nagaland- Dikhu and Doyang river system.

Remarks: In Nagaland, it is caught mostly when the volume of water gets receding and collected by the pangshi chali (gill net). It is a beautiful nemacheiline with body robust and a dorsal profile slightly convex anteriorly and concave posteriorly which has got a good ornamental value. Hora (1921) included this species in the list of fishes collected from Manipur; however, the collection site was Ghaspani, Nagaland, in the Brahmaputra basin.

Genus ***Neonoemacheilus*** Zhu & Guo

Neonoemacheilus Zhu & Guo, 1985. *Acta Zootax. Sinica*., **10**: 321 (type-species: Nemacheilus *labeosus Kottelat*). – Kottelat, 1990. *Indochinese Nemacheilines* (Revision). - Banarrescu & Nalbant, 1995. *Trav. Mus. Hist. nat*. <<*Grigore Antipa*>> 436 (generi classification).

Infundibulatus Menon, 1987. *Faun. India, Pisces* **4**: 177 (type-species: *Nemacheilus penguensis* Hora, new subgenus of *Nemacheilus* Bleeker).

Neonoemacheilus assamensis (Menon, 1987) [Plate IV.30]

Noemacheilus assamensis Menon, 1987, *Fauna of India*, Pisces, **4**: 179 (type-locality: Pagladia river, Assam).

Local name: Retong

Material examined: NUFM 1054-1057, 4 exes., 55.2-6.9 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 1115-1119, 5 exes., 72.0-89.0 mm SL, Longtshung station, 12.x.2009; NUFM 1120, 1 exes., 72.8 mm SL, Kidzumetouma station, 15.ix.2009.

Diagnosis: A species of Neonoemacheilus with hypertrophied lips. Interrupted lower lip in two thick pads; Dorsal fin with 8 branched rays. Lateral line complete.

Description: D. iii, 8; P. i, 11-12; V. i, 7; A. ii, 5; C. 9+8. Body elongate; Head moderately large. Eyes superior and small, in anterior part of head, not visible from ventral surface. Mouth inferior; lips hypertrophied, clearly conspicuous; lower lips in two thick pads. Barbels three pairs, well developed and thread like; maxillary extends to the posterior margin of the orbit. Dorsal fin inserted midway between snout tip and caudal fin base. Anus nearer to base of anal fin than base of pelvic fins. Caudal fin forked. Lateral line complete.

Proportional *measurements:*

(In % of SL): Body depth 17.2 (16.3-18.7); head length 25.4 (25.3-25.8); head depth 11.2 (10.5-12.1); head width 19.3 (18.6-19.7); body width 14.1 (13.5-16.1); pre dorsal length 50.7 (49.4- 51.6); dorsal fin height 17.7 (15.6-18.3); dorsal fin base length 16.1 (15.8-16.9); pelvic fin length 16.1 (15.6-16.9); anal fin base length 8.1 (6.8-8.4); anal fin height 14.5 (9.8-15.2); caudal peduncle length 11.5 (11.3-12.2).

(In % of HL): Head height at occiput 55.5 (46.7-56.2); snout length 50.0 (42.7-50.0); inter orbital space 22.2 (20.0-22.2); dorsal fin base length 62.5 (62.2-66.7); pectoral fin length 75.5 (68.0-75.5); pelvic fin length 62.5 (61.3-66.7); anal fin height 56.2 (38.9-60.0).

Caudal peduncle height 91.1 (87.5-102.8) of its length; ***eye*** diameter 22.5 (20.0-31.2) of snout length.

Color: In life, whitish- brown with 13-15 dark brown transverse bars extending from back

towards ventral side, though not reaching the ventral surface; Belly dully white. A dark transverse bar, smaller towards the middle is present in the caudal fin base. All fins are hyaline. A blackish spot present on the occiput.

Distribution: India; Pagladia river, Assam, Jiri river, Manipur. Nagaland- Doyang river system.

Remarks: Menon (1987) described *N. asssamensis* based on a single specimen. Kottelat (1990) distinguished *N. penguensis* by its smaller number of branched dorsal fin rays and slender peduncle. However, he could not describe the species due to paucity of material. Vishwanath & Laishram (2001) redescribed *N. assamensis* with 11 specimens from Jiri river, Manipur.

Genus ***Schistura*** McClelland

Schistura McClelland, 1838, *J. Asiat. Soc. Bengal*, **7**(2): Pl. 55.944, 947 (type-species: *S. rupecola*) McClelland, 1838, by subsequent designation of Jordan, 1919, *Indo-Chinese nemacheilines*, Verlag Dr. Friendrich pfeil, Munchen, 90; Banarescu & Nalbant 1995, *Trav. Mus. Hist. nat* <<Grigore Antipa>>, 438.

Schistura Prashadi (Hora, 1921) [Plate IV.28]

Nemacheilus prashadi Hora, 1921, *Rec. Indian Mus*., 22:203, Pl. 10 (type-locality: Thonagpal tank, Thoubal and sikmai streams, Manipur).
Schistura prashadi: Kottelat, 1990, *Indo-Chinese Nemacheilines*, Verlag Dr. Friedrich pfeil, Munchen, 191, fig. 142, 143 a-b; Banarescu & Nalbant, 1995, *Trav. Mus. Hist. Nat.* <<Grigore Antipa>>; 440.

Local name: Retong

Material examined: NUFM 0996-0997, 2 exes., 45.4-56.2 mm SL, Chakabama station, 8.i.2008; NUFM 1058-1062, 5 exes., 58.4-64.2 mm SL, Mukhami station, 21.x.2008; NUFM 1109-1114, 6 exes., 54.7-60.0 mm SL, Mukhami station, 19.i.2009.

Diagnosis: A species of *Schistura* with 9 branched dorsal fin rays; deeply forked caudal fin; body marked with 12-14 short black bands across lateral line on sides, dorsal surface reticulate black blotches.

Description: D.iii, 9; P.i, 10; V.i, 6; A. ii, 5; C. 10+9. Body moderately elongate and slightly elevated from head to dorsal fin origin. Mouth semi circular; lips moderately fleshy, upper lip uninterrupted, lower interrupted in middle. Eyes moderate, not visible from under surface. Nostril close to each other. Barbels three pairs well developed. Maxillary barbel reaches beyond posterior margin of orbit. Dorsal fin inserted in advance of pelvic fin origin, nearer to snout tip than to caudal fin base; distal margin of dorsal fin slightly concave. Caudal fin deeply forked with two V- shaped bands. Lateral line complete.

Proportional measurements:

(In % of SL): Body depth 19.4 (16.4-23.8); head length 23.6 (21.2-26.8); pre dorsal length 48.5 (42.6-52.5); dorsal fin height 22.3 (20.8-25.2); pectoral fin length 20.4 (17.5-24.6); pelvic fin length 18.2 (16.6-20.2); anal fin height 18.4 (15.8-22.4); caudal fin length 26.2 (23.5-27.9).

(In % of HL): Head width 66.5 (58.2-72.4); head height at occiput 65.3 (59.2-70.6); snout length 38.4 (35.2-41.7); caudal peduncle length 57.4 (52.6- 66.8).

Color: Body marked with 12-14 short black vertical bands across lateral line on flanks. ventral surface creamy yellow. Dorsal surface with numerous dark bands and blotches, dorsal fin with a black spot at base of first few rays and two black bars across the fin. Caudal fin

with a deep black bar.

Distribution: India: Manipur; Nagaland- River Tizu (Chindwin drainage); Dikhu, Milak, Tsurang and Doyang river system (Brahmaputra drainage).

Remarks: This species attains a length of 4.6 cm SL and have no interest in fisheries (Talwar and Jhingran, 1991). It differs from *S.multifasciatus* in having 12-14 bands vs. 16 vertical bands.

SUB-FAMILY: COBITINAE

Genus ***Lepidocephalichthys*** Bleeker

Lepidocephalus Bleeker, 1850, *Nat. Tijdschr. Ned. India*, 16:303 (type-species: *Cobitis macrochir* Bleeker); Tilak and Hussain, 1981, *Occ. Paper Rec. Zool. Surv. India*, (32): 3-28 (revision).

Lepidocephalichthys guntea (Hamilton-Buchanan, 1822) [Plate IV.31]

Cobitis guntea Hamilton-Buchanan, 1822, *Fishes of Ganges:* 353, 394 (type-locality: ponds and fresh water of Bengal)**.**
Lepidocephalichthys guntea: Day, 1878, *Fishes of India*: 609, pl. 155, fig. 4 (var. *balgara*) and pl. 156, fig. 12; Day, 1889, *Fauna Br. India*, Fishes, **1**: 220, fig. 80.

Local name: Retong

Material examined: NUFM 1112-1114, 3 exes., 48.3-54.6 mm SL, Chakabama station, 28.iv.2008; NUFM 1115-1119, 5 exes., 52.5-58.8 mm SL, Longtshung station, 17.viii.2009; NUFM 0998-01001, 4 exes., 50.4-58.0 mm SL, Longtshung station, 14.xii.2009.

Diagnosis: A species of *Lepidocephalichthys* with origin of dorsal fin slightly behind that of

pelvic fin origin. A patch of scales from below eye to upper part of operculum. A broad intensive dark band from end of snout to caudal fin base. One dark spot at the caudal fin.

Description: D. ii, 7; P. i, 6; V. i, 6; A. iii, 5; C. 8+8. Body elongate, moderately compressed, dorsal profile almost horizontal and ventrally slightly arched. Head small. Snout rounded. Eye rather small covered by skin the anterior half of head. Anterior nostrils with a raised tube. Mouth small; inferior with thick lips. Barbels 3 pairs, one each of rostral, maxillary and mandibular, all longer than orbit. Dorsal fin short, its height shorter than length of head; it is inserted nearer to caudal fin base than snout tip. Caudal fin truncate. Mental lobe with four pairs of barbel like projections. Lateral line absent, Scales very minute; scales on head in patches below and behind eye, and upper part of operculum. On ventral side of head, scales extended anteriorly beyond isthmus.

Proportional measurements:

(In % of SL): Body depth 17.8(16.2-20.2); head length 19.0 (15.6-20.5); pre dorsal length 54.3 (46.4-56.6); dorsal fin height 17.5 (16.0-17.8); pectoral fin length 16.4 (15.2-20.5); pelvic fin length 15.2 (14.4-19.6); anal fin 16.6 (14.8-18.8).

(In % of HL): Head width 47.8 (44.7-54.2); head height at occiput 72.3 (64.2-76.8); snout length 42.4 (40.6-48.2); eye diameter 20.4 (18.4-22.8); inter orbital space 23.7 (21.8-25.2); Caudal peduncle length 64.6 (50.2-76.2); Caudal peduncle height 59.4 (53.4-70.6).

Color: Body bright yellow with numerous black spots. Abdomen pale and spotless. 12-13 black blotches connected by a dark band along the lateral side of body. Dorsal and caudal fin with V-shaped bars; a black blotch at the upper base of caudal fin. Dorsal part of body with a row of spots from occiput to base of caudal fin.

Distribution: India; Bangladesh; Pakistan; Nepal; Burma and Thailand. Nagaland- Dikhu, Milak, Tizu and Doyang river system.

Remarks: Day (1878), differentiated a variety of *L.guntea balgara* (Hamilton) on the ground that its body is a little more elongated and the caudal fin sometimes cut rather more square. The origin of the ventral fin is sometimes in advance of the dorsal fin. Hora and Gupta (1941) have confused *L.annandale* (Chadhuri) with *L.guntea* (Hamilton) considering the former as a synonym of the latter (young stage) while recognizing at the same time that there is color variation in *L.guntea*. Rao and Yazdani (1978) reviewed the specific identity of *L.guntea* with respect to *L.thermalis.* According to Menon (1992), *L.guntea* more closely resembles to *L.berdmorei*. However, it can be easily separated from *L.berdmorei* by its distinctive coloration, the dark lateral band extending from snout to base of caudal and numerous rows of closely placed dark spots on the caudal fin (vs. a series of 10-18 brown spots on the sides of body and 4-7 'V' shaped black cross bands on caudal fin in *L.berdmorei*).

FAMILY: PSILORHYNCHIDAE

Genus ***Psilorhynchoides*** Yazdani, Singh and Rao.

Psilorhynchoides Yazdani, Singh and Rao, 1989, Matsya, 15 & 16 (type-species: *Psilorhynchus homaloptera* Hora and Mukerji, by original designation).

Psilorhynchoides homaloptera (Hora and Mukerji, 1935) [Plate IV.32]

Psilorhynchoides homaloptera Hora and Mukerji, 1935, *Rec. Indian Mus.,* **37**(3): 391 (type-locality: Emilomi, Naga hills, Nagaland).

Local name: Anget

Material examined: NUFM 1063-1068, 6 exes., 41.2-44.6 mm SL, Chakabama station, 28.iv.2008; NUFM 1069-1071, 3 exes., 42.2-52.4 mm SL, Kidzumetouma station, 29.iv.2009; NUFM 1120-1123, 4 exes., 42.6-47.8 mm SL, Mukhami station, 18.xi.2009; NUFM 1124-1127, 5 exes., 57.6-70.2 mm SL, Longkhung station, 12.x.2009.

Diagnosis: A species of *Psilorhynchoides* with dorsal profile evenly arched, ventral profile straight. Simple pectoral fin rays 7-8; lateral line scales 42-44. Abdomen smooth, caudal fin lunate.

Description: D. ii, 7-8; P. viii, 9; V. ii, 7; A. ii, 5; C.10+9; L.l. 42-44; predorsal scales 13-14. Body elongated, flattened ventrally. Head small, depressed and sub-triangular. Mouth inferior; both jaws with sharp rasping horny edge, bordered by thick and fleshy lips which are entire. Snout bluntly pointed. Eyes small, dorso-lateral in position, not visible from under side of head. Dorsal fin inserted in advance of pelvic fin, nearer the tip of snout than the base of caudal fm. Pectoral fin with adhesive pad which is fan shaped, does not reach pelvic fin. Caudal fin lunate, Scales moderate; lateral line complete with 42-44 scales.

Proportional measurements:

(In % of SL): Body depth 14.3 (11.8-15.2); head length 18.6 (17.4-22.1); pre dorsal length 45.7 (40.7-51.8); dorsal fin height 21.5 (18.4-22.5); pectoral fin length 16.5 (13.2-17.2); pelvic fin length 19.2 (18.2-22.4); anal fin height 12.8 (11.0-15.8); caudal fin length 25.6 (22.6-30.5); caudal peduncle length 12.0 (10.8-14.1); caudal peduncle height 7.2 (6.4-8.2).

(In % of HL): Head width 86.4 (78.4-90.8); head height at occiput 63.2 (57.2- 65.5); snout length 57.6 (48.2-64.6); eye diameter 25.4 (21.6-27.2); inter orbital space 48.4 (42.2- 56.6). Caudal peduncle height 63.7 (61.2-65.4) of its length.

Color: Pale yellow becoming olivaceous dorsally. Fine dark dots on the body. A dusky broad

band along the lateral line.

Distribution: India; Nepal and Myanmar; Nagaland - Dikhu, Chathe, Tesuru and Doyang river system.

Remarks: This species was first recorded by Hora and Mukerji (1935) from Keleki stream at Emilomi, Naga Hills, Nagaland. They stated that this species is not abundantly distinct in general facies and build, but can also be distinguished by its small, dorso-lateral eyes and the larger number of undivided rays in the pectoral fins. The absence of scales along the entire ventral surface in front of the anal fin is another distinguishing feature of this species. They also noted that this species has a greatly depressed and flattened body, naked ventral surface and large number (8) of undivided rays in the pectoral fins, which are pedunculate.

3.2.2.2 ORDER: SILURIFORMES

FAMILY: OLYRIDAE

Genus ***Olyra*** McClelland

Olyra McClelland, 1842, *Calcutta J. Nat. Hist.,* 2:588 (type-species: *Olyra longicaudata* McClelland); Jayaram, *Rec. Zool. Surv. India Occ. Pap*., (23): 17-21 (Synopsis).

Key to the species of genus ***Olyra*** Cuvier.

1. a). Body depth 9-11 times in SL, Anal fin rays 18-23……*O.longicaudata*

   b). Body depth 11-12 times in SL, Anal fin rays 17-18…….*O.kempi*

Olyra kempi (Chadhuri, 1912) [Plate V.33]

Olyra kempi Chadhuri, 1912, *Rec. Indian Mus.,* **7**:443, Pl. 41, figs. 4, 4a, 4b (type-locality: Mangaldai, Assam); Misra, 1976, *Fauna of India*, Pisces (2nd ed.), **3**:142.

Local name: Nenak

Material examined: NUFM 1072-1076, 5 exes., 61.3-74.5 mm SL, Chakabama station, 28.iv.2008; NUFM 1128-1131, 4 exes., 68.2-82.5 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 1132-1134, 2 exes., 76.9-86.8 mm SL, Mukhami station, 28.x.2008.

Diagnosis: A species of Olyra with 7 soft pectoral fin rays; Body depth 11-12 times in SL; Upper lobe of caudal fin twice as long as lower lobe; Anal fin rays 17-18.

Description: D. I, 7; P. I, 7; V. I, 5; A. 18; C. 6+7. Body elongate, abdomen sub-cylindrical. Head small, depressed. Snout obtusely rounded. Mouth terminal; teeth villiform on jaws, a

continuous Band on palate. Eyes superior, small, in anterior part of head, not visible from ventral surface. Lips thin, continuous, not fleshy. Jaws sub-equal, provided with a number of open pores. Four pairs of barbels, one each of maxillary, nasal and two of mandibular. Dorsal fin inserted above pelvic fin. Adipose dorsal fin forked, upper lobe much longer than lower. Lateral line complete.

Proportional measurements:

(In % of SL): Body depth 12.2 (11.2-12.8); head length 15.8 (12.6-16.5); head width 12.4 (10.2-13.8); body width 10.3 (8.2-12.7); pre-dorsal length 38.4 (30.5- 44.2); dorsal fin height 15.2 (10.3-18.6); dorsal fin base length 10.2 (8.4-11.2); pelvic fin length 12.3 (9.8-13.6); anal fin base length 24.8 (22.6-30.5); anal fin height 8.0 (6.6-8.8); caudal peduncle length 13.4 (10.4-17.4).

(In % of HL): Head height at occiput 62.4 (48.4-75.6); snout length 28.4 (26.7-33.5); inter orbital space 39.8 (32.8-48.4); dorsal fin base length 60.4 (48.8-74.6); pectoral fin length 66.4 (62.2-70.4); pelvic fin length 78.2 (72.4-86.8); anal fin height 50.6 (46.2-56.2).

Caudal peduncle height 62.5 (54.8-72.6) of its length; Eye diameter 42.6 (38.6-46.2) of snout length.

Color: Body chocolate brown with two pale longitudinal bands on each side of lateral line and a dark brown band along the lateral line. Fins dull white.

Distribution: India; Bangladesh. Nagaland- Dikhu, Milak and Doyang river system.

Remarks: Carl J. Ferraris, Jr (2007) pointed out that the *Olyra kempi* is treated in some literature as a synonym of *Olyra longicaudatus*.

Olyra longicaudata (McClelland) [Plate V.34]

Olyra longicaudata McClelland, 1842, Calcutta Jour. Nat. Hist., **2** :588, pl. 21, fig. 1 (type-locality: Khasi Hills, Meghalaya); Day, 1877, *Fishes of India*: 475; Day 1889, *Fauna Br. India, Fishes,* **1**: 121; Misra, 1976, *Fauna of India,* Pisces (2nd ed.), **3**:145.
Olyra elongata Gunther, 1883, *Ann. Mag. Nat. Hist*., (5) **11**: 140 (type-locality: Tenasserim, Burma).

Local name: Nenak

Material examined: NUFM 1077-1081, 5 exes., 66.9-75.7 mm SL, Chakabama station, 8.i.2008; NUFM 1082-1086, 5 exes., 98.2-115.2 mm SL, Kidzumetouma station, 15.v.2008; NUFM 1135-1139, 5 exes., 84.3-92.5 mm SL, Mukhami station, 10.ix.2008; NUFM 1140-1142, 3 exes., 69.8-79.2 mm SL, Mukhami station, 2.xii.2009.

Diagnosis: A species of Olyra with 5-6 soft pectoral fin rays; Body depth 9-11 times in SL; Upper lobe of caudal fin twice as long as lower lobe; Anal fin rays 18-23.

Description: D. i, 6-7; P. 4-6; V. i, 5; A. iii 15-20; C. 6+7. Body elongate; Head small, depressed. Eyes superior, small, in anterior part of head, not visible from ventral surface. Mouth terminal; a continuous band on palate. Barbels four pairs; maxillary extends to base of pectoral fins, pectoral spine strong, serrated on both edges. Caudal fins lanceolate. Lateral line complete.

Proportional measurements:

(In % of SL): Body depth 10.6 (8.9-11.2); head length 15.2 (14.9-19.7); head width 11.6 (11.3-13.1); body width 9.6 (8.0-10.2); pre-dorsal length 34.8 (33.0- 37.7); dorsal fin height 9.4 (8.7-9.8); dorsal fin base length 8.2 (7.8-8.2); pelvic fin length 11.0 (9.6-11.5); anal fin base length 26.5 (25.2-31.1); anal fin height 6.1(5.9-6.6); caudal peduncle length 11.8 (8.2-14.9).

(In % of HL): Head height at occiput 50.7 (50.0-51.2); snout length 25.7 (23.2-26.7); inter orbital space 34.3 (32.1-36.0); dorsal fin base length 47.8 (41.7-52.3); pectoral fin length 51.4 (50.0-52.3); pelvic fin length 60.7 (58.3-63.9); anal fin height 40.7 (33.3-42.8).

Caudal peduncle height 50.5 (50.5-52.6) of its length; eye diameter 30.4 (26.6-35.9) of snout length.

Color: In life, olivaceous brown with two pale longitudinal bands on each side of lateral line and a dark brown band along the lateral line; fins whitish; belly dully white.

Distribution: India; base of Darjeeling Himalaya, Meghalaya and Assam; Burma. Nagaland-Doyang river system.

Remarks: Talwar and Jhingran (1991) noted that, this species is generally found in small rocky streams at the base of hills; as such, *Olyra longicaudata* was found in the upper reaches of Doyang river system.

FAMILY: SILURIDAE

Genus ***Kryptopterus*** Bleeker

Kryptopterus Bleeker, 1858, *Ichthyol. Arch. Indici. Prodromos,* 1:283 (type-species: *Kryptopterus micropus* Bleeker=*Silurus Cryptopterus* Bleeker); Haig, 1951, *Rec. Indian Mus.*, 48: 93-110 (synopsis).

Kryptopterus indicus (Datta, Barman & Jayaram, 1987) [Plate V.35]

Kryptopterus indicus Datta, Barman & Jayaram, 1987, *Bull. Zool. Surv. India,* 8:29, fig.1 (type-locality: Namdapha river, Hornbill port. Arunachal Pradesh).

Local name: Longer

Material examined: NUFM 1002-1005, 4 exes., 90.8-96.4 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 1087-1088, 2 exes., 90.3-112 mm SL, Mukhami station, 21.x.2008; NUFM 1143-1145, 3 exes., 106-133 mm SL, Longkhung station, 14.xii.2009.

Diagnosis: A species of *Kryptopterus* is characterized by the dorsal fin, rudimentary and hair like with only two rays; gape of mouth short, not reaching beyond the anterior margin of eye.

Description: D. ii; P. i, 11; V. i, 6-7; A. iii, 80-83; C.17. Body elongate and laterally compressed, abdomen rounded Head small, depressed, dorso ventrally flattened Snout rounded Mouth subterminal, its gape very short, just reaching anterior margin of eye. Eyes small, Lips thin. Jaws subequal, maxilla overhanging. Two pairs of barbels; maxillary barbel tip filamentous reaching beyond posterior margin of pectoral fin, mandibular barbels half length of head, Rayed dorsal fin rudimentary with two minute rays. Adipose dorsal fin absent. Caudal fin rounded. Lateral line complete.

Proportional measurements:

(In % of SL): Body depth 15.2 (12.8-19.2); head length 15.4 (14.0-18.8); body width dorsal origin 13.1 (10.2-13.6); body width anal origin 10.4 (9.6-12.4); predorsal length 27.2 (24.1-28.8); dorsal fin height 3.2 (2.8-3.5); pectoral fin length 9.8 (8.8-12.2); Pelvic fin length 7.2 (6.5-8.6); anal fin height 6.6 (5.0-7.8).

(In % of HL): Head width 80.4 (77.2-96.4); head height at occiput 66.4 (57.8-73.6); snout length 41.2 (37.3-45.2); eye diameter 11.6 (10.3-11.8); inter orbital space 56.8 (49.2-66.3); mouth gape width 56.4 (49.4-70.2).

Distribution: India; Namdapha river, Namdapha wildlife sanctuary Arunachal Pradesh. Nagaland-Dikhu and Doyang river system.

Remarks: Talwar and Jhingran (1991) remarked that the fishes of the genus *Kryptopterus* Bleeker have a deeply forked caudal fin (Haig, 1951) and hence the generic placement of this species is clearly doubtful. The species under report have a caudal fin rounded and dorsal fin rays ii, anal fin rays iii, 80-83 vs. D. I and A. iii, 85 by Talwar and Jhingran (1991). The species was collected from Doyang river, Nagaland.

FAMILY: AMPLYCIPITIDAE

Genus ***Amblyceps*** Blyth

Amblyceps Blyth, 1858, *Proc. Asiat. Soc. Beng.,* **27**: 282 (type-species: *Amblyceps Caecutiens* Blyth = *Pimelodus mangois* Hamilton); Hora, 1933, *Rec. Indian Mus*., **35**(4): 607-621 (Revision).

Amblyceps apangi (Nath and Dey, 1989) [Plate V.36]

Amblyceps apangi, Nath and Dey, 1989, *J. Assam Sci. Soc*. (32) (1): 1-6 (type-locality: Dikrong river, Arunachal Pradesh)

Material examined: NUFM 1089-1091, 3 exes., 74.4-86.2 mm SL, Kidzumetouma station, 15.v.2008; NUFM 1146-1148, 3 exes., 75.6-89.3 mm SL, Mukhami station, 10.ix.2008; NUFM 1149-1152, 4 exes., 66.4-72.6 mm SL, Longkhung station, 14.xii.2009; NUFM 1153-1156, 4 exes., 76.8-90.5 mm SL, Liphiyan station, 12.vii.2010.

Diagnosis: A species of *Amblyceps* with lateral line complete; maxillary barbels longer than head length, caudal fin lunate; a prominent fold of skin in front of the pectoral fin.

Description: D. i, 5; P. i, 6; V. i, 5; A. ii, 7; C. 18. Body elongated and sub-cylindrical,

abdomen rounded. Head small, broad and dorso-ventrally flattened. Eye very small and covered by thin skin. Snout obtusely rounded. Mouth wide, transverse, sub-terminal. Jaws sub equal, upper jaw slightly longer than lower. Barbels four pairs, one pair each of maxillary and nasal, two pairs of mandibular. Dorsal fin inserted opposite above half of pectoral fin. Adipose dorsal low, originates a little behind anal. Caudal fin lunate. Lateral line with tubular openings, almost straight and complete.

Proportional measurements:

(In % of SL): Body depth 15.2 (13.5-16.2); head length 22.6 (18.2-26.6); body width 13.4 (11.8-15.1); pre dorsal length 27.4 (20.3-32.6); pre anal length 70.2 (58.6-80.2); pre anus length 55.7 (47.2-64.4); dorsal fin height 12.4 (10.6-15.2); pectoral fin length 11.4 (9.6-12.4); anal fin height 12.2 (10.0-14.4); caudal peduncle length 18.6 (16.2-22.5); caudal peduncle height 14.4 (12.4-16.6).

(In % of HL): Head width 75.2 (59.8-90.8); head height at occiput 49.2 ((42.5-66.84); snout length 33.2 (30.6-44.8); eye diameter 8.2 (7.0-9.8); inter orbital space 27.8 (22.8-34.2); mouth gap width 60.6 (42.3-86.2).

Caudal peduncle length 68.5 (50.6-74.3) of its height.

Color: Dark brown throughout the body.

Distribution: India: Nagaland – Dikhu and Doyang river system.

Remarks: This species shows resemblance with *A. mangois* but differs from it in having a complete lateral line with tubular openings vs. absent in *A. mangois*, maxillary barbels longer than head length vs. shorter and upper lip longer than lower vs. lower lip longer than upper in *A. mangois***.**

FAMILY: SISORIDAE

Genus ***Glyptothorax*** Blyth

Glyptothorax Blyth, 1861, *J. Asiat. Soc. Beng*. 29:154 (type-species: *Glyptothorax trilineatus* Blyth).

Key to the species of genus ***Glyptothorax*** Blyth.

1 a). Adhesive apparatus with distinct central pit……..*G.cavia*

b). Adhesive apparatus without distinct central pit……..…..2

2. Occipital process separated from basal bone of dorsal fin……..*G.telchitta*

Glyptothorax cavia (Hamilton-Buchanan) [Plate V.38]

Pimelodus cavia Hamilton-Buchanan, 1822, *Fishes of Ganges*: 188, 378 (type-locality: rivers of north Bengal).
Glyptothorax cavia: Hora and Menon, 1948, Rec. *Indian Mus*., **46**(1): 56, pl. 11, figs 4,6 (Redescription); Misra, 1976, *Fauna of India*, *Pisces* (2nd ed.), 3: 261, pl. 11, figs 3,4.

Local name: Ajang

Material examined: NUFM 1092-1095, 4 exes., 76.2-88.0 mm SL, Mukhami station, 21.x.2008; NUFM 1157-1160, 4 exes., 86.4-108.8 mm SL, Pangti station, 18.vi.2009; NUFM 1161-1164, 4 exes., 84.3-96.6 mm SL, Longtshung station, 12.x.2009.

Diagnosis: A species of Glyptothorax with occipital process not reaching basal bone of dorsal fin; skin on head and body smooth. Dorsal fin inserted equidistant between snout-tip and adipose fin.

Description: D. I, 6; P. I, 9; V. i, 5; A ii, 9-10. Body elongate, Head depressed, longer than broad; mouth inferior; lips papillated. Barbels four pairs; maxillary barbels extend posteriorly to slightly beyond pectoral fin base. Adhesive thoracic apparatus longer than broad, encircling a deep central pot. Dorsal fin inserted equidistant between snout tip and adipose; dorsal spine strong and smooth. Caudal fin forked. Skin on head and body smooth.

Proportional measurements:

(In % of SL): Body depth 19.3 (18.4-20.2); head length 28.4 (28.4-29.8); pre dorsal length 36.6 (36.1- 37.5); dorsal fin height 20.4 (18.8-21.1); pectoral fin length 21.1 (20.9-22.9); caudal fin length 23.6 (22.7-24.0).

(In % of HL): Head width 84.8 (80.0-87.1); eye diameter 6.8 (4.0-9.7); inter orbital space 20.0 (20.0-21.2); caudal peduncle length 60.0 (58.1-60.0); caudal peduncle height 24.0 (24.0-25.8); dorsal fin base length 41.4 (40.0-41.9); pelvic fin length 52.2 (51.6-52.5); mouth gape width 53.8 (52.0-54.8); adipose dorsal fin height 48.6 (47.5-50.2), adipose dorsal fin base length 45.4 (44.2-47.6).

Color: In life, olivaceous brown dorsally, dirty yellowish ventrally. Body mottled with dark spots. Fins with dark bands at their base.

Distribution: India: North Bengal and Assam; Pakistan; Bangladesh; Nepal and Burma; Nagaland- Doyang river system.

Remarks: Hora and Menon (1948) treated *G.burmanicus* as a synonym of *G. cavia*. They did not provide proper justification for the synonymy. Menon (1954a), Talwar and Jhingran (1991), Chu (1999), Menon (1999) also followed the same. Vishwanath and Linthoingambi (2007) clearly justifies the resurrection of the species from synonymy with *G. burmanicus*. As such, *G. cavia* is taken as a different species from *G. burmanicus.*

Glyptothorax telchitta (Hamilton-Buchanan) [Plate V.37]

Pimelodus telchitta Hamilton-Buchanan, 1822, *Fishes of Ganges*: 185, 378 (type-locality: Freshwater rivers of Bengal and Bihar).
Glyptothorax telchitta: Hora and Menon, 1947, *Rec. Indian Mus*., **46**(1): 57, Pl. 2, fig. 1, 2 & 3 (Redescription); Misra, 1976, *Fauna of India*, Pisces (2nd ed.), 3:281, pl. 12. Figs 2, 3 & 4.

Local name: Ajang

Material examined: NUFM 1096-1101, 6 exes., 67.2-83.0 mm SL, Mukhami station, 10.ix.2008; NUFM 1165-1167, 3 exes., 78.4-97.0 mm SL, Longtshung station, 29.vi.2009; NUFM 1168-1170, 3 exes., 82.6-90.2 mm SL, Mukhami station 17.ii.2010.

Diagnosis: A species of Glyptothorax with occipital process separated from basal bone of dorsal fin; skin on head and body tuberculated; and dorsal fin inserted nearer to adipose fin than to snout tip; maxillary barbel short.

Description: D. I, 6; P. I, 7; V. i, 5; A i, 10. Body spindle shaped. Head depressed, bluntly pointed anteriorly; occipital process separated from basal bone of dorsal fin. Eyes very small, mouth inferior, lips papillated. Four pairs of barbels, all the barbels shorter than head length. Adhesive thoracic apparatus much longer than broad, devoid *of* central pit. Dorsal fin inserted nearer to adipose fin than to snout tip; adipose dorsal fin length equal to dorsal fin length; anal fin inserted opposite to origin of adipose fin. Paired fins not plaited; caudal fin forked, lower lobe longer than upper. Skin on head and body tuberculated.

Proportional measurements:

(In % of SL): Body depth 17.2 (16.4-19.6); head length 22.5 (22.2-24.6); pre dorsal length 36.4 (34.6- 38.2); dorsal fin height 16.8 (15.2-17.4); pectoral fin length 16.8 (16.0-16.8); caudal fin length 25.8 (22.8-25.6).

(In % of HL): Head width 74.2 (72.8-75.6); body width 68.6 (66.2-68.4); head depth 73.4 (68.6-75.4); snout length 53.2 (50.8- 53.6); eye diameter 8.8 (8.4-9.2); inter orbital space 23.6

(23.2-25.4); caudal peduncle length 70.4 (66.0-72.6); caudal peduncle height 26.2 (22.6-26.8); dorsal fin base length 42.2 (40.8-42.5); pelvic length 56.8 (56.2-58.3); mouth gape width 34.2 (32.2-34.8); adipose dorsal fin length 43.2 (41.8-43.6), adipose dorsal fin height 36.2 (35.4-36.4).

Color: Body brown, grey on sides, and dirty yellow below. Dorsal, anal and paired fins with spotted bands.

Distribution: India; Pakistan; Bangladesh; Nepal. Nagaland- Dikhu, Tsurang and Doyang river system.

Remarks: Hora and Mukerji (1949) gave the reason for synonymy of *Pimelodus botia* Hamilton with this species. The difference between the two are in the skin and form of the pupil, which are within the range of variation of *G. telchitta,* which is rather common in North Bengal where *P. botius* is also reported to occur. Jayaram (1979) remarked that amongst all the species of *Glyptothorax* this is one of the most common species found in North Bengal. It is sold in markets in small quantities but the flesh content being not much; it fetches a poor price and is not much valued.

FAMILY: CLARIDAE

Genus ***Clarias*** Scopoli

Clarias Scopoli, 1777, *Introduction ad Historian Naturalem*: 455 (type-species: *Silurus anguillaris* Linnaeus); Teugela and Roberts, 1987, Zool. J. Linn. Soc., **90**: 95 (type-species designated).
Hora, 1936, Rec. Indian Mus., **38**(3): 347-350.

Clarias batrachus (Linnaeus) [Plate V.39]

Clarias batrachus Linnaeus, 1758, *Systema Naturae*, 1, ed. 10: 305 (type-locality: Asia and Africa).

Local name: Magur

Material examined: NUFM 1102-1105, 5 exes., 195-218 mm SL, Chakabama station, 2.vii.2008; NUFM 1171-1173, 3 exes., 164-172 mm SL, Kidzumetouma station, 23.ix.2008; NUFM 1174-1176, 3 exes., 108-124 mm SL, Liphiyan station, 23.xi.2009.

Diagnosis: Head moderately depressed, covered with osseous plates dorsally and laterally forming a cask over the gill cavity. Gill membranes free from isthmus. Base of dorsal and anal fins long. Pectoral fin with a very strong spine, finely serrated on both edges.

Description: D 66-70; A 43-45; P I 9; V i 5.

Body elongate and compressed. Head moderately depressed; occipital process angular and narrow. Mouth terminal; teeth in villiform bands on jaws. Barbels four pairs; the maxillary pair extends to gill-openings and the nasal pair equal to mental barbels. Dorsal fin inserted slightly anterior to tip of pectoral fins. Pectoral spine strong and well developed. Lateral line distinct.

Proportional measurements:

(In % of SL): Body depth 16.2 (15.5-17.4); head length 25.8 (25.5-25.8); pre dorsal length 34.0 (31.1- 34.0); dorsal fin height 8.4 (8.2-8.5); pectoral fin length 13.4 (13.2-14.2); caudal fin length 16.5 (16.4-18.4); Dorsal fin base length 66.5 (65.9-68.3); Anal fin base length 44.7 (43.8-45.4).

(In % of HL): Head width 79.1 (73.1-79.2); body width 60.3 (49.0-62.4); head depth 53.4

(50.4-58.8); snout length 30.2 (30.2-30.3); eye diameter 4.6 (4.3-5.7); inter orbital space 44.6 (44.6-46.2); pelvic length 40.2 (33.9-41.2).

Color: In life, brownish to dark grey; flanks and belly pale brown to dirty white. Dorsal and anal fins with reddish margins. The dorsal fin more yellowish.

Distribution: Pakistan, Nepal, Sri Lanka, Bangladesh, Burma, Indonesia, Singapore, Borneo and the Philippines, India. Nagaland: Doyang river.

Remarks: This is a highly variable species in form. The caudal fin occasionally gets fused with the dorsal and anal fins in some abnormal specimens. The catfish is abundant in ponds and rivers. It can live out of water for a short period of time as it has an accessory respiratory organ, as such it is a very hardy fish. It often migrates to nearby inundated pools and puddles for breeding during monsoon. Inundated paddy fields are most preferred spawning grounds.

3.2.2.3 ORDER: PERCIFORMES

FAMILY: CHANNIDAE

Genus ***Channa*** Scopoli

Channa Scopoli, 1777, *Introd. Hist. Nat*.: 459 (type-species: *Channa Orientalis* Bloch & Schneidar).

Key to species of genus ***Channa*** Scopoli

1 a). Pectoral fins with bluish vertical bands;

dorsal fin rays 32-33……*C,orientalis*

b). Pectoral fins plain, no vertical bands;

dorsal fin rays 29-30……*C.punctatus*

Channa orientalis (Bloch & Schneider, 1801) [Plate VI.41]

Channa orientalis Bloch & Schneider, 1801 *Syst. Ichth* : 496, Pl. 90, fig.2 (type-locality: India); Deraniyagala, 1929, *Spolia zeyl.*, **15** (2): 97, P1.27.

Local name: Alupongo

Material examined: NUFM 1106-1109, 4 exes., 90.4-152.2 mm SL, Chakabama station, 2.vii.2008; NUFM 1110-1114, 5 exes., 73.0-116.2 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 1177-1179, 3 exes., 86.4-135.3 mm SL, Mukhami station, 21.x.2008; NUFM 1180-1183, 4 exes., 116.4-152.6 mm SL, Longtshung station, 14.xii.2009.

Diagnosis: A species of *Channa* with pectoral fins bluish vertical bands; dorsal fin rays 32-33; length of pelvic fin less than 50% of pectoral fin length; pre dorsal scales 12.

Description: D. 32-33; P. 14; V. 6; A. 20-21; L.l. 42-44. Body elongated and sub cylindrical. Head long, about twice as long as body depth. Snout somewhat obtuse. Mouth terminal, fairly small, cleft hardly reaching anterior margin of orbit, teeth on vomer and palatines. Eyes large. Dorsal fin originates almost opposite to pectoral. Pectoral fin extent to anal fin; Pelvic fin less than 50% of pectoral fin length. Caudal fin rounded. Scales large; scales on summit of head large, rosette of head-scales situated behind orbit so that it touches frontal head-scale in front and basal head-scale behind. 4 or 5 scale rows between pre-opercular angle and posterior border of orbit Pre dorsal scales 12.

Proportional measurements:

(In % of SL): Body depth 16.5 (11.0-23.8), head length 22.0 (19.3-26.6); pre dorsal length 33.9 (23.8-42.5); dorsal fin length 6.4 (4.8-10.2); dorsal fin base length 59.7 (48.5-67.3); anal fin base length 36.5 (30.8-52.0); caudal peduncle length 10.4 (8.4-15.7); Caudal peduncle height 9.2 (7.3-14.7).

(In % of HL): Head width 66.4 (55.7-77.0), head height at occiput 55.2 (38.2-62.3); snout length 24.6 (22.8-34.3); eye diameter 16.6 (12.5-20.2); inter orbital space 42.9 (36.2-55.5); mouth gape width 56.25 (33.3-63.5).

Color: Body green in color. Pectoral with a black base; a large ocellus at the posterior end of dorsal; vertical band alternating each other at caudal and pectoral fins.

Distribution: India; Afghanistan; Iran; Pakistan; Nepal; Sri Lanka; Bangladesh; Myanmar; East indies. Nagaland- Dikhu, Milak and Doyang river system.

Remarks: Hora and Mukerji (1935) reported this species as *Ophiocephalus gachua* Hamilton from Zhakami- Doyang river, Melon- Tizu river, etc and remarked that this species

present in both the drainage basins of the Naga hills. They referred the specimens of this species collected in the Manipur valley to *O.barcourt-butleri* but latter they shown that the two species are synonymous. This species includes forms with and without pelvic fins, the latter being known from Sri Lanka, Burma and Java. Earlier, forms with ventral fins were designated as *Channa gachua* and forms without ventral fins as *Channa orientalis* until De witt (1960) considered the absence of ventral fins as an anomalous character.

Channa punctatus (Bloch, 1793) [Plate V.40]

Cephalo cephalus punctatus Bloch, *1793, Naturges. Ausland. Fische,* (7): 139, P1.358 (type-locality: River and lakes of Coromandel Coast); Deraniyagala, *1929, Spolia Zeyl.,* **15**(2): 90, Pl.26.

Local name: Alupongo

Material examined: NUFM 1184-1186, 3 exes., 64.8-88.5 mm SL, Chakabama station, 2.vii.2008; NUFM 1187-1188, 2 exes., 77.4-98.6 mm SL, Kidzumetouma station, 25.vi.2008; NUFM 1189-1191, 3 exes., 96.4-108.7 mm SL, Mukhami station, 23.ii.2009; NUFM 11248-1251, 4 exes., 102-118.5 mm SL, Pangti station, 18.vi.2009; NUFM 1252-1255, 4 exes., 84.8-94.6 mm SL, Longtshung station, 14.xii.2009.

Diagnosis: A species of *Channa* with length of pelvic fin more than 5% of pectoral fin length ; pectoral fins plain; dorsal fin ray 29-30; 5 scale rows between pre opercular angle and posterior border of orbit.

Description: D.29-30; P.16-17; V.6; A.20; L.l.37-38. Body elongate and sub cylindrical. Mouth moderately wide, cleft reaching to anterior margin of orbit; villiform teeth on vomer

and palatines. Pectoral fins extend to anal fin. Dorsal fin originate almost opposite to pectoral. Caudal fin rounded. Scales large; 5 scale row between pre opercular angle and posterior border of orbit. Pre dorsal scales 13; lateral line scales 29-30.

Proportional measurements:

(In % of SL): Body depth 20.4 (16.9-25.2); head length 34.3 (28.4-40.2); pre dorsal length 38.2 (31.6-44.2); dorsal fin height 11.5 (9.2-12.8); dorsal fin base length 56.2 (50.7-62.5); anal fin base length 33.7 (29.5-40.3); anal fin height 11.3 (9.8-13.1); caudal peduncle length 7.4 (6.6-9.1); caudal peduncle height 9.3 (8.8-13.1).

(In % of HL): Head width 52.4 (48.3-65.8); head height at occiput 51.5 (42.0-60.7); snout length 21.6 (18.1-25.2); eye diameter 14.2 (12.0-15.8); inter orbital space 27.0 (21.3-31.1); mouth gape width 22.3 (25.9-30.7).

Color: Body black to light green on dorsal side, ventral side white to pale yellow. Deep black bands passes from dorsal to ventral, caudal fin with alternate black bands. Dorsal and anal fin dark grey.

Distribution: India; Afghanistan; Pakistan; Sri Lanka; Nepal; Bangladesh; Myanmar and Yunnan (China). Nagaland-Milak, Intangki and Doyang river system.

Remarks: This spotted snake head is found mostly in ponds, muddy streams and under rocks and inside holes when the water levels recedes during post monsoon.

FAMILY: CHANNIDAE
SUB-FAMILY: BADINAE

Genus ***Badis*** Bleeker

Badis Bleeker, 1853, Verh. Bat. Genootsch., 25, Pl. 106. (type-species: *Labrus buchanini* Bleeker = *Labrus badis* Hamilton-Buchanan).

Badis badis (Hamilton-Buchanan, 1822) [Plate VI.42]

Labrus badis Hamilton-Buchanan, 1822, *Fishes of Ganges*: 70, 368. Pl. 25, fig. 23 (type-locality: Gangetic provinces).
Badis badis: Talwar and Jhingran, 1991, *Inland Fish*. 2: 882.

Local name: Petitsung

Material examined: NUFM 1192-1194, 3 exes., 32.4-43.6 mm SL, Chakabama station, 2.vii.2008; NUFM 1237-1239, 3 exes., 38.8-48.9 mm SL, Kidzumetouma station, 23.ix.2008; NUFM 1240-1244, 5 exes., 46.2-53.5 mm SL, Mukhami station, 19.i.2009; NUFM 1245-1247,3 exes., 30.8-45.3 mm SL, Longtshung station, 28.vii.2009.

Diagnosis: The species is characterized with small protusible mouth; operculum distinctly triangular, some indistinct vertical bands along lateral side from operculum to caudal fin base and bluish dark spot behind the gill opening.

Description: D.XVI-XVIII, 8; P.i, 11-12; V.i, 5; A.III, 6; L.l 27-30; L.tr. 3/1/8; pre dorsal scales 12-14. Body moderately elongated and compressed. Head moderate size, compressed. Snout obtusely pointed. Mouth slightly upturned, superior. Jaws sub equal, lower jaw longer than upper. Dorsal fin inserted nearer the caudal fin base than to snout; spinout dorsal fin longer than soft portion. Pectoral fin extends far beyond the ventral fin base. Anal fin with three spines. Caudal fin truncate. Lateral line interrupted.

Proportional measurements:

(In % of SL): Body depth 31.3 (26.4-36.8); head length 31.4 (26.4-36.9); predorsal length 31.2 (28.1-38.2); dorsal fin length 18.2 (16.3-19.4); pectoral fin length 24.4 (19.7-28.2); pelvic fin length 21.3(18.9-23.4); anal fin base length 19.6 (17.5-22.5); anal fin length 18.2 (16.3-19.4); caudal peduncle length 13.0 (9.2-17.0); caudal peduncle height 14.1 (11.2-17.8).

(In % of HL): Head width 45.7(40.6-55.8); head height at occiput 85.4 (72.4-93.4); snout length 26.2 (22.4-35.7); eye diameter 26.4 (20.4 -31.2); inter orbital space 25.4 (21.7-28.2); dorsal fin height 55.6 (50.2-62.4); anal fin height 58.4 (53.7-60.2); mouth gape width 26.5 (20.2-29.4).

Caudal peduncle length 70.4 (67.8-73.4) of its height.

Color: Blackish to brown with numerous black spots on the body. Indistinct bands on lateral side of body extending from operculum to caudal, the bands run from mid-dorsal to ventral surface. Two black spots, one at caudal base and other at operculum behind orbit.

Distribution: India; Pakistan; Nepal; Bangladesh; and Myanmar. Nagaland- Dikhu, Milak, Tsurang, Dhansiri, Intangki and Doyang river system (Brahmaputra drainages).

Remarks: Talwar and Jhingran (1991) remarked that this is the most beautifully colored of all of the Nandidae, and it has an amazing range of pigmentation. This is a solitary fish spending much of its time motionless. It shows no special color when feeding other than being cryptically marked (Barlow et al., 1968); the adult males are highly territorial.

FAMILY: ANABANTIDAE

Genus **Anabas** Cuvier & Cloquet

Anabas Cuvier & Cloquet, 1816, *Dictionnaire des Sciences naturelles* (ed. 2), 2, Suppl.: 35 (type-species: *Perca scandens* Daldoff= *Anthias Testudineus* Bloch).

Anabas testudineus (Bloch, 1795) [Plate VI.43]

Anabas testudineus Bloch, 1795, *Naturges. Ausland. Fische,* (6): 121. Pl. 322 (type-locality: Java).
Anabas testudineus Thakur and Dus, 1968, *Bull. Cent. Inland Fish. Res. Inst.,* (40): 1-47 (Biological data).

Local name: Ak ngo

Material examined: NUFM 1196-1197, 2 exes., 48.4-58.8 mm SL, Kidzumetouma station, 19.v.2009; NUFM 1233-1236, 4 exes., 52.5-61.2 mm SL, Mukhami station, 2.xii.2009.

Diagnosis: A species of *Anabas* with a distinct dark spot on the base of caudal fin and a black spot 4 the base of pectoral fin, lateral line incomplete with 25 scales.

Description: D.XVI, 8; P. i, 13; V. 1, 5; A. X, 9; C.16. Body oblong, compressed. Head fairly small, compressed. Snout obtusely pointed. Mouth oblique, terminal. Eye large. Spinous portion of dorsal fin longer than soft portion. Dorsal fin inserted opposite to anterior half of pectoral. Caudal fin rounded. Lateral line interrupted at the posterior half of the body. Lateral line scale 25.

Proportional measurements:

(In % of SL): Body depth 37.3 (33.5-40.3); head length 36.1 (34.3-44.2); predorsal length 42.4 (36.8-44.9); dorsal fin height 13.5 (10.2-16.9); dorsal fin base length 49.1 (43.6-52.5); pectoral fin length 21.0 (19.3-23.1); pelvic fin length 14.9 (13.5-16.4); anal fin height 11.5

(10.3-14.2); anal fin base length 37.3 (35.8-40.1); caudal peduncle length 5.1 (4.2-5.8); caudal Peduncle height 13.5 (10.4-17.5).

(In % of HL): Head width 60.0 (56.1-63.2); head height at occiput 86.0 (79.8-88.2); snout length 25.0 (22.0-28.4); eye diameter 25.0 (21.8-29.5); inter orbital space 30.0 (26.2-32.6). Mouth gape width 40.0 (35.3-46.2).

Color: Body grayish black, a distinct dark spot at the base of caudal fin another black spot at the base of pectoral fin.

Distribution: India; Pakistan; Bangladesh; Sri Lanka; Myanmar; Malay archipelago; Singapore; Philippines. Nagaland- Milak, Tzürang, Doyang river systems.

3.2.2.4 ORDER: SYNBRANCHIFORMES

FAMILY: MASTACEMBELIDAE
SUB-FAMILY: MASTACEMBELINAE

Genus ***Mastacembelus*** Scopoli

Mastacembelus scopoli, 1777, *Intro. Hist. nat*.: 458 (type-species: *Ophidium Mastacembelus*)

Mastacembelus armatus (Lacepede, 1800) [Plate VI.44]

Mastacembelus armatus Lacepede, 1800, *Hist. nat. Poirs*., 2:286
Mastacembelus armatus: Talwar and Jhingran, 1991, *Inland fishes*, 2: 1031.

Local name: Mer

Material examined: NUFM 1198-1201, 4 exes., 112-126 mm SL, Kidzumetouma station, 16.xii.2008; NUFM 1202-1204, 3 exes., 124-145 mm SL, Mukhami station, 11.viii.2008; NUFM 1205-1208, 4 exes., 380-312 mm SL, Pangti station, 8.iv.2009; NUFM 1228-1232, 5 exes., 240-258 mm SL, Longtshung station, 14.xii.2009.

Diagnosis: A species of Mastacembelus with anal and dorsal fins confluent with the caudal fins: body eel like; dorsal spines 36-38 and dorsal fin branched rays 74-78.

Description: D. XXXVI – XXXVIII, 74-78; P. i, 22-24; A.III, 65-67; C.16. Body relatively slender, eel like tapering to head and tail. Mouth small, extending to below, posterior nostril, sharp teeth in bands on both jaws, ending with trilobed structure; both jaws equal in length. Pre-opercle with 2-3 spines usually conspicuous but one or two embedded skin; pre orbital

spine strong and usually piercing skin. Snout trilobed at anterior extremity. Spinous dorsal fin inserted above middle of pectoral fin, last dorsal spine small and hidden beneath skin. Eyes small, superior, in middle of head. Dorsal and anal fin confluent with the caudal fin. Ventral fin absent. Lateral line complete.

Proportional measurements:

(In % of SL): Body depth 8.6 (5.2-12.7); head length 16.4(9.2-22.8); body width 6.2 (4.2-9.8); pre dorsal length 16.6 (11.4-22.8); dorsal fin base length 78.9 (55.8-110.8); pectoral fin length 5.2(3.4-8.2); anal fin base length 41.2(25.7-54.5).

(In % of HL): Head width 18.7 (16.5-25.9); head height at occiput 18.7 (14.6-30.8); snout length 16.6(11.2-25.4); eye diameter 4.6 (3.2-7.2); inter orbital space 5.4 (3.6-6.8); mouth gape width 8.9 (5.2-12.6).

Color: Body light brownish gray, fainter on the abdomen. 21-23 rounded dark spots present along base of dorsal fin. Body with irregular blackish bands. Dorsal and anal fin banded dark. Caudal fin with dark bands and spots.

Distribution: India; Pakistan; Sri Lanka; Nepal; Myanmar; Thailand; Malaya to Southern China. Nagaland- Likhimro and Lanye rivers (Chindwin drainage). Dikhu, Milak, Dhansiri, Intangki and Doyang river system (Brahmaputra drainage).

Remarks: It is widely distributed in both the drainage basin of Nagaland. Vishwanath and Kosygin (1998) reported this species from Tizu river, Nagaland. It is the largest among the spiny eel. Day (1878) reported that it may grow up to two feet or more. It is a hardy fish and can tolerate extreme draught situation by keeping itself buried inside the mud and silt for months together till the onset of monsoon rains (Sen, 1985). In the present collection the largest specimen recorded is 32.2 cm.

FAMILY: SYNBRANCHIDAE

Genus ***Monopterus*** Lacepede

Monopterus Lacepede, 1880, *Hist. nat. Poiss*., **2**: 139 (type-species: *Monopterus javanensis* Lacepede = Muraena alba Zuiew); Rosen and Greenwood, 1976, *Bull. Am. Mus.. nat. Hist.*, **157**(1): 56-66 (Revision).
Fluta Bloch and Schneider, 1801, *Syst. Ichth*.: 565 (type-species: *Monopterus javanensis* Lacepede).

Monopterus albus (Zuiew, 1793) [Plate VI.45]

Muraena alba Zuiew, 1793, *Nova Acta Acad. Sci. Petropolitanae*, **7**: 299, pl. 7, fig. 2 (type-locality: Asiatic Russia).
Monopterus javanensis Lacepede: Day, 1878, *Fishes of India*: 656, pl. 169, fig. 1; Day, 1889, *Fauna Br. India*, Fishes, **1**: 70, fig. 28.
Monopterus albus: Hora, 1921, *Rec. Indian Mus*., **22**: 177.

Local name: Kongsha

Material examined: NUFM 1209-1211, 3 exes., 364-382 mm SL, Kidzumetouma station, 15.v.2008; NUFM 1226-1227, 2 exes., 341-366 mm SL, Mukhami station, 21.ix.2009.

Diagnosis: A species of Monopterus with robust eel-like body; Gill opening triangular without lateral folds. Scales absent in skin.

Description: D. i, 6-7; P. 4-6; V. i, 5; A. iii 15-20; C. 6+7. Body elongated not whip-like; Head moderate, its upper profile descending abruptly towards the snout; Eyes small. Teeth minute and conical, in a band tapering towards angle of mouth. Palatine teeth biserial. Gill opening internally attached to isthmus; gills greatly reduced. Adults devoid of pectoral and pelvic fins. Dorsal and anal fin folds indistinct.

Proportional measurements:

(In % of TL): Body depth at maximum 6.02 (5.9-6.8); body depth at anus 5.0 (4.8-5.3); head length 10.5 (9.5-12.2); head width 5.07 (5.6-7.1); body width 5.5 (5.33-5.5); pre anus length 67.5 (64.7-68.2);

(In % of HL): Head height at occiput 44.0 (43.5-45.1); Head height at eye 25.0 (24.7-26.8); snout length 20.0 (18.7-22.3); inter orbital space 15.0 (14.8-16.2); eye diameter 7.5 (7.3-7.8); gape width 33.5 (31.6-34.7).

Color: In life, consistently dark brown to dark red, ventrally pale; body usually with dark spots.

Distribution: India: Northeastern region; Bangladesh; Burma; the East Indies; Indo-Malayan archipelago; China; and Japan. Nagaland-Doyang river.

Remarks: Talwar and Jhingran (1991) noted that the rice swamp eel is able to survive in deep mud pockets during dry season when the waters in the ponds dry up; as such the present observation of *Monopterus albus* in the Doyang river is probably due to entry from the adjacent paddy fields where the rice swamp eels are cultured in particular pockets along the river.

3.2.2.5 ORDER: BELONIFORMES

FAMILY: BELONIDAE

Genus ***Xenentodon*** Regan

Xenentodon Regan, 1911, *Ann. Mag. Nat. Hist.,* (8)7: 332 (type-species: *Esox cancila* Hamilton); Roberts, 1989, *Fresh water fishes of Western Borneo*: 152-153. (Review).

Xenentodon cancila (Hamilton-Buchanan, 1822) [Plate IV.46]

Esox cancila Hamilton-Buchanan, 1822, *Fishes of Ganges*: 231, 380, Pl. 27, fig 70 (type-locality: Gangetic provinces).
Xenentodon cancila Talwar and Jhingran, 1991, *Inl. Fishes India*, 2: 743.

Local name: Rongsen ngo

Material examined: NUFM 1211-1215, 5 exes., 312.4-352.8 mm SL, Mukhami station, 27.v.2009; NUFM 1222-1225, 4 exes., 286.5-305.2 mm SL, Pangti station, 17.x.2009.

Diagnosis: This species is characterized with upper and lower jaw extended into long beaks armed with sharp teeth to their tip; a silvery lateral band extends on flank of the body.

Description: D.ii, 16-17; P.i, 10; V. I, 5; A.ii, 16-17; C. 16. Body elongated and slightly compressed, both the dorsal and ventral profile almost equally straight. Head small. Eyes fairly large, placed almost in dorsal region. Mouth moderate; extends upto anterior half of orbit. Upper and lower jaw area provided with a raw of sharp widely spaced teeth and external row of fine teeth which ate mote on the lower jaw; lower jaw slightly longer. Dorsal fin

originates almost opposite to anal fin. Caudal fin truncate or slightly emarginated. Scales small. Lateral line straight, visible only at the posterior half of the body.

Proportional measurements:

(In % of SL): Body depth 7.1 (6.5-9.3); head length 40.0 (36.1- 48.3); pre dorsal length 80.9 (69.3-86.3); post dorsal length 18.9 (15.0-24.4); dorsal fin height 10.6 (8.5-11.9); dorsal fin base length 15.6 (12.2-18.6); pectoral fin length 7.6 (6.5-9.4); anal fin base length 15.6 (12.8-16.6); anal fin height 9.7 (8.2-12.6).

(In % of HL): Head width 15.0 (12.3- 18.1); head height at occiput 15.5 (14.1-20.2); snout length 65.4 (59.8-70.3); eye diameter 8.8 (7.6- 11.2); inter orbital space 9.7 (8.4-11.9); Caudal peduncle length 10.7 (8.5-13.7); Caudal peduncle height 6.6 (5.1-7.9).

Caudal peduncle height 63.2 (51.3-80.***2)*** of its length.

Color: Silvery, greenish dorsally and whitish along abdomen. A silvery streak having a dark margin extends on flank of body from the orbit and runs up to the middle of the caudal fin. Dorsal and anal fin dark edge.

Distribution: India; Pakistan; Bangladesh; Sri Lanka; Burma; and Thailand. Nagaland-Tsurang and Doyang river system.

3.3 OCCURRENCE AND SEASONAL ABUNDANCE OF ICHTHYOFAUNA IN DOYANG RIVER SYSTEM

Occurrence and seasonal abundance in different monsoon periods: pre-monsoon (January-April), monsoon (May- August) and post monsoon (September to December) showed a great variations of Ichthyofauna in different selected stations of the river. The details of the materials used and methodology followed for these studies were described in Chapter-2. Out of the 46 species recorded from Doyang river system, 25 species were recorded from Station-I, 27 species were collected from station-II, maximum of 31 species from station-III, 19 species from station IV, 22 species from station-V and 15 species were recorded from station-VI (Table 5). The predominant species in station I were *Barilius bendelisis, Danio aequipinnatus, Puntius sophore, Bangana dero, Garra gravelyi, Psilorhynchoides homaloptera* and *Olyra longicaudata*. In station II, the prevalent species were *Barilius bendelisis, Danio aequipinnatus, Danio dangila, Puntius sophore, Puntius ticto, Garra gravelyi, Garra naganensis* and *Psilorhyncoides homaloptera.* In station III, the preponderant species were *Danio aequipinnatus, Neolissocheilus hexastichus, Labeo bata, Labeo pangusia, Garra gotyla, Schistura prashadi* and *Glyptothorax cavia*. The dominant species in station IV were *Puntius sophore, Catla catla, Labeo rohita, Neolissocheilus hexagonolepis* and *Cyprinus carpio.* In station V most common species were *Danio aequipinnatus, Tor putitura, Puntius ticto, Labeo pangusia, Garra gravelyi, Amplceps apangi* and *Channa punctatus*; while in station VI, *Barilius bendelisis, Danio aequipinnatus, Neolissocheilus hexagonolepis, Puntius ticto, Labeo bata Crossocheilus latius latius* and *Channa punctatus* were more commonly found.

From the 8 different tributaries covered during the present study viz. Sidzü, Dzülü, Tishi, Chubi, Nzü, Nrü, Bagthy and Rengmapani rivers, varying records of ichthyofauna was observed. However, the predominant species in all the tributaries belonged to Cypriniformes followed by Siluriformes, Perciformes, Synbranchiformes and Beloniformes. The Sidzü river registered a total of 22 species, while Dzülü river recorded 21 species, Tishi river recorded 16 species, Chubi river recorded the maximum with 24 species while Nzü river recorded 20 species, 21 species were collected from Nrü river, 22 species from Bagthy river while 15 species were collected from Rengmapani river (Table 6).

With respect to the seasonal abundance, 30 species was found abundantly during pre monsoon period namely, *Barilius bendelisis, Danio aequipinnatus, Tor putitura, Labeo pangusia, Catla catla, Puntius sophore, Puntius ticto, Garra gravelyi, Garra lissorhynchus* and *Badis badis*. During monsoon period 42 species were copiously found such as, *Danio aequipinnatus, Puntius sophore, Catla catla, Labeo rohita, Cyprinus carpio, Schistura prashadi, Glyptothorax cavia, Channa punctatus, Badis badis* and *Mastacembelus armatus*. The maximum seasonal abundance of 46 species was registered during post monsoon period and the predominant species during this period were *Barilius bendelisis, Danio aequipinnatus, Labeo bata, Catla Catla, Garra gravelyi, Crossocheilus latius latius, Schistura prashadi, Glyptothorax telchitta, Mastacembelus armatus* and *Badis badis*. The seasonal abundance of ichthyofauna of the Doyang river system are presented in Table 7.

Table 5: Occurrence of Ichthyofauna in Doyang river system.

Sl. No.	Name of the species	Occurrence					
		Site-I	Site-II	Site-III	Site-IV	Site-V	Site-VI
1.	*Barilus bendelisis* (Hamilton-Buchanan)	√	√	√	–	√	√
2.	*Danio aequipinnatus* (McClelland)	√	√	√	√	√	√
3.	*Danio dangila* (Hamilton-Buchanan)	√	√	√	–	–	–
4.	*Esomus danricus* (Hamilton-Buchanan)	√	√	–	–	–	–
5.	*Barilius barila* (Hamilton-Buchanan)	√	√	√	–	√	√
6.	*Barilius barna* (Hamilton-Buchanan)	√	–	√	–	–	√
7.	*Neolissochilus hexastichus* (McClelland)	√	√	√	–	–	√
8.	*Neolissochilus hexagonolepis* (McClelland)	√	–	√	√	–	–
9.	*Tor putitura* (Hamilton-Buchanan)	–	–	√	√	√	–
10.	*Puntius sophore* (Hamilton-Buchanan)	√	√	√	√	√	–
11.	*Puntius ticto* (Hamilton-Buchanan)	√	√	√	√	√	√
12.	*Puntius chola* (Hamilton-Buchanan)	–	–	–	√	–	–
13.	*Bangana dero* (Hamilton-Buchanan)	√	√	√	–	–	–
14.	*Labeo bata* (Hamilton-Buchanan)	–	–	√	√	–	√
15.	*Labeo pangusia* (Hamilton-Buchanan)	–	–	√	√	√	√
16.	*Labeo fimbriatus* (Bloch)	–	–	√	√	–	–
17.	*Labeo rohita* (Hamilton-Buchanan)	–	–	–	√	–	–
18	*Catla catla* (Hamilton-Buchanan)	–	–	–	√	–	–
19.	*Cirrhinus mrigala mrigala* (Hamilton-Buchanan)	–	–	–	√	–	–
20.	*Cyprinus carpio* (Linnaeus)	–	–	–	√	–	–
21.	*Ctenopharyngodon idellus* (Steindachner)	–	–	–	√	–	–
22.	*Hypopthalmichthys molitrix* (Valenciennes)	–	–	–	√	–	–
23.	*Garra gotyla gotyla* (Gray)	√	√	√	–	√	√
24.	*Garra naganensis* (Hora)	√	√	–	–	√	√

25.	*Garra gravelyi* (Annandale*)*	√	√	–	–	√	√
26.	*Garra lissorhynchus* (McClelland)	√	√	√	–	–	√
27.	*Crossocheilus latius* (Hamilton-Buchanan)	√	√	–	–	–	√
28.	*Schistura prashadi* (Hora)	√	–	√	–	–	–
29.	*Acanthocobitis botia* (Hamilton-Buchanan)	–	–	–	–	√	–
30.	*Neonoemacheilus assamensis* (Menon)	–	√	–	–	√	–
31.	*Lepitocephalichthys guntea* (Hamilton-Buchanan)	√	–	–	–	√	–
32.	*Psilorhyncoides homaloptera* (Hora & Mukherji)	√	√	√	–	√	–
33.	*Olyra kempi* (Chaudhuri)	√	√	√	–	–	–
34.	*Olyra longicauda* (McClelland)	√	√	√	–	–	–
35.	*Kryptopterus indicus* (Datta, Barman & Jayaram)	–	√	√	–	√	–
36.	*Amplyceps apangi* (Nath & Dey)	–	√	√	–	√	√
37.	*Glyptothorax telchitta* (Hamilton-Buchanan)	–	–	√	–	√	–
38.	*Glyptothorax cavia* (Hamilton-Buchanan)	–	–	√	√	√	–
39.	*Clarias batrachus* (Linnaeus)	√	√	–	–	–	√
40.	*Channa punctatus* (Bloch)	√	√	√	√	√	–
41.	*Channa orientalis* (Bloch & Schneider)	√	√	√	–	√	–
42.	*Badis badis (*Hamilton-Buchanan*)*	√	√	√	–	√	–
43.	*Anabas testudineus* (Bloch*)*	–	√	√	–	–	–
44.	*Mastacembelus armatus* (Lacepede)	–	√	√	√	√	–
45.	*Monopterus albus* (Zuiew)	–	√	√	–	–	–
46.	*Xenentodon cancila* (Hamilton-Buchanan)	–	–	√	√	–	–

– = Absent

√ = Present

Table 6: Occurrence of Ichthyofauna in the tributaries of Doyang river system, Nagaland.

Sl. No.	Name of the species	Occurrence in the tributaries							
		Sidzu	Dzulu	Tishi	Chubi	Nzu	Nru	Baghty	Rengma Pani
1.	*Barilus bendelisis* (Hamilton-Buchanan)	√	√	√	√	√	√	√	√
2.	*Danio aequipinnatus* (McClelland)	√	√	√	√	√	√	√	√
3.	*Danio dangila (*Hamilton-Buchanan)	√	√	-	-	-	-	√	-
4.	*Esomus danricus* (Hamilton-Buchanan)	√	√	√	-	√	√	√	-
5.	*Barilus barila* (Hamilton-Buchanan)	√	√	-	-	-	-	-	-
6.	*Barilus barna* (Hamilton-Buchanan)	√	√	-	-	-	-	-	-
7.	*Neolissochilus hexasticus* (McClelland)	√	√	√	-	√	√	-	√
8.	*Neolissochilus hexagonolepis* (McClelland)	√	-	-	√	-	√	-	-
9.	*Tor putitura* (Hamilton-Buchanan)	-	-	-	-	√	√	√	√
10.	*Puntius sophore* (Hamilton-Buchanan)	√	√	-	√	√	√	√	√
11.	*Puntius ticto* (Hamilton-Buchanan)	√	√	-	√	-	√	√	√
12.	*Puntius chola* (Hamilton-Buchanan)	-	-	-	√	-	√	-	√
13.	*Bangana dero* (Hamilton-Buchanan)	√	-	-	-	-	-	-	-
14.	*Labeo bata* (Hamilton-Buchanan)	-	√	√	√	-	-	-	-
15.	*Labeo Pangusia* (Hamilton-Buchanan)	-	-	-	√	√	√	-	-
16.	*Labeo fimbriatus* (Bloch)	-	-	-	-	-	-	-	-
17.	*Labeo rohita* (Hamilton-Buchanan)	-	-	-	-	-	-	-	-
18	*Catla catla* (Hamilton-Buchanan)	-	-	-	-	-	-	-	-
19.	*Cirrhinus mrigala mrigala* (Hamilton-Buchanan)	-	-	-	√	-	-	-	-
20.	*Cyprinus carpio* (Linnaeus)	-	-	-	-	-	-	-	-
21.	*Ctenopharyngodon idellus* (Steindachner)	-	-	-	-	-	-	-	-
22.	*Hypopthalmichthys molitrix* (Valenciennes)	-	-	-	√	-	-	-	-

Sl. No.	Name of the species	Occurrence in the tributaries							
		Sid zu	Dzulu	Tishi	Chubi	Nzu	Nro	Baghty	Rengma Pani
23.	*Garra gotyla gotyla* (Gray)	√	√	-	-	-	-	√	-
24.	*Garra naganensis* (Hora)	√	√	√	√	-	-	√	√
25.	*Garra gravelyi* (Annandale)	√	√	-	-	√	√	√	√
26.	*Garra lissorhynchus* (McClelland)	√	√	√	√	√	√	√	-
27.	*Crossocheilus latius latius* (Hamilton-Buchanan)	√	√	-	√	√	√	√	√
28.	*Schistura prashadi* (Hora)	√	-	√	√	√	√	√	√
29.	*Acanthocobitis botia* (Hamilton-Buchanan)	-	-	√	√	-	-	-	-
30.	*Neonoemacheilus assamensis* (Menon)	-	-	√	-	-	-	-	-
31.	*Lepitocephalichthys guntea* (Hamilton-Buchanan)	-	-	√	√	-	-	√	-
32.	*Psilorhyncoides homaloptera* (Hora & Mukherji)	-	√	-	-	√	√	√	-
33.	*Olyra kempi* (Chaudhuri)	-	√	√	√	√	-	-	-
34.	*Olyra longicaudata* (McClelland)	-	√	-	-	-	-	-	-
35.	*Kryptopterus indicus* (Datta, Barman & Jayaram)	-	√	√	-	-	-	-	-
36.	*Amplyceps apangi* (Nath & Dey)	√	-	-	√	√	√	-	√
37.	*Glyptothorax telchitta* (Hamilton-Buchanan)	-	-	√	-	√	√	√	-
38.	*Glyptothorax cavia* (Hamilton-Buchanan)	-	-	-	-	√	√	√	-
39.	*Clarias batrachus* (Linnaeus)	√	-	-	-	-	-	-	-
40.	*Channa punctatus* (Bloch)	√	-	√	√	√	√	√	√
41.	*Channa orientalis* (Bloch & Schneider)	√	-	-	√	-	√	√	-
42.	*Badis badis* (Hamilton-Buchanan)	√	√	√	√	√	√	√	√
43.	*Anabas testudineus* (Bloch)	-	√	-	√	-	-	-	-
44.	*Mastacembelus armatus* (Lacepede)	-	-	-	√	√	√	√	√
45.	*Monopterus albus* (Zuiew)	-	√	√	-	-	-	-	-
46.	*Xenentodon cancila* (Hamilton-Buchanan)	-	-	-	√	-	-	√	-

Table 7: Seasonal abundance of Ichthyofauna in Doyang river system, Nagaland.

Sl. No.	Name of the species	Seasons		
		Pre Monsoon	Monsoon	Post Monsoon
1.	*Barilus bendelisis (*Hamilton-Buchanan)	+	+	+++
2.	*Danio aequipinnatus* (McClelland)	++	+++	+++
3.	*Danio dangila* (Hamilton-Buchanan)	++	+	++
4.	*Esomus danricus* (Hamilton-Buchanan*)*	+	+	++
5.	*Barilius barila* (Hamilton-Buchanan*)*	–	++	++
6.	*Barilius barna* (Hamilton-Buchanan)	–	+	+
7.	*Neolissochilus hexastichus* (McClelland)	++	+	+
8.	*Neolissochilus hexagonolepis* (McClelland*)*	++	++	++
9.	*Tor putitora* (Hamilton-Buchanan)	++	+	++
10.	*Puntius sophore* (Hamilton-Buchanan)	–	+	–
11.	*Puntius ticto* (Hamilton-Buchanan)	++	+++	++
12.	*Puntius chola* (Hamilton-Buchanan)	+++	+++	+++
13.	*Bangana dero* (Hamilton-Buchanan)	+	+++	+
14.	*Labeo bata* (Hamilton-Buchanan)	+	+++	++
15.	*Labeo pangusia* (Hamilton-Buchanan)	+	++	+
16.	*Labeo fimbriatus* (Bloch)	–	+	+
17.	*Labeo rohita* (Hamilton-Buchanan)	++	–	++
18	*Catla catla* (Hamilton-Buchanan)	+	+	++
19.	*Cirrhinus mrigala mrigala* (Hamilton-Buchanan)	++	+	+++
20.	*Cyprinus carpio* (Linnaeus)	++	+	+++
21.	*Ctenopharyngodon idellus* (Steindachner)	+	+	++
22.	*Hypopthalmichthys molitrix (*Valenciennes)	+	–	+++
23.	*Garra gotyla gotyla* (Gray)	–	+	++

24.	*Garra naganensis* (Hora)	–	++	++
25.	*Garra gravely* (Annandale)	–	+	++
26.	*Garra lissorhynchus* (McClelland)	+	–	++
27.	*Crossocheilus latius* (Hamilton-Buchanan)	–	+	+
28.	*Schistura prashadi* (Hora)	+	–	+
29.	*Acanthocobitis botia* (Hamilton-Buchanan)	–	+	++
30.	*Neonoemacheilus assamensis* (Menon)	–	+	++
31.	*Lepitocephalichthys guntea* (Hamilton-Buchanan)	+	++	+++
32.	*Psilorhyncoides homaloptera* (Hora & Mukherji)	–	++	++
33.	*Olyra kempi* (Chaudhuri)	–	+	+
34.	*Olyra longicauda* (McClelland)	+	++	++
35.	*Kryptopterus indicus* (Datta, Barman & Jayaram)	–	++	+
36.	*Amplyceps apangi* (Nath & Dey)	+	++	++
37.	*Glyptothorax telchitta* (Hamilton-Buchanan)	–	+	+
38.	*Glyptothorax cavia* (Hamilton-Buchanan)	+	++	+++
39.	*Clarias batrachus* (Linnaeus)	–	++	+
40.	*Channa punctatus* (Bloch)	–	++	++
41.	*Channa orientalis* (Bloch & Schneider)	+	+	+++
42.	*Badis badis (*Hamilton-Buchanan)	++	+++	+++
43.	*Anabas testudineus* (Bloch)	++	+	++
44.	*Mastacembelus armatus* (Lacepede)	+	+	++
45.	*Monopterus albus* (Zuiew)	–	++	++
46.	*Xenentodon cancila* (Hamilton-Buchanan)	–	+	+

+ = Rare ++ = Common +++ = Very Common

3.4 CATEGORIZATION OF ICHTHYOFAUNA

3.4.1 Ornamental Ichthyofauna:

Ornamental fishes maybe defined as fishes which are reared as pets and not for consumption. In a broader sense, the term ornamental fishes includes those fishes which are generally attractive, colorful, peaceful and nature, small in size that can be kept as pets in confined spaces and exhibit graceful movements in the glass aquarium. They are also called the living jewels for their beautiful color and graceful behavior in the aquarium.

Ornamental fishes are generally classified into two distinct categories:

i. Classified ornamental fishes and

ii. Non-classified ornamental fishes.

Those species with attractive locomotion, beautiful color patterns, smaller in size which can be used as aquarium fish throughout their life span are termed as classified ornamental fishes. Those species with less coloration but peculiar body morphology, uncommon locomotion, rare occurances are termed as non-classified ornamental fishes. Even some food fishes with beautiful coloration maybe considered as non-classified ornamental fish at their juvenile stage. Based on these definitions, the ornamental ichthyofauna of Doyang river system were categorized into 18 species as classified ornamental fishes and 28 species as non-classified ornamental fishes. The checklist of the ornamental ichthyofauna are provided in Table 8.

Table 8: A Check list of Ornamental ichthyofauna of Doyang river system

Classified ornamental fishes	Non-classified ornamental fishes
Barilius bendelisis (Hamilton-Buchanan)	*Garra gotyla gotyla* (Gray)

Barilius barila (Hamilton-Buchanan)	*Garra gravelyl* (Annandale)
Barilius barna (Hamilton-Buchanan)	*Garra lissorhynchus* (Mc Clelland)
Danio aequipinnatus (McClelland)	*Garra naganensis* (Hora)
Danio dangila (Hamilton-Buchanan)	*Psilorhynchoides homaloptera* (Hora & Mukerji)
Esomus danricus (Hamilton-Buchanan)	*Kryptopterus indicus* (Datta,Barman & Jayaram)
Puntius chola (Day)	*Amblyceps apangi* (Nath & Dey)
Puntius sophore (Hamilton-Buchanan)	*Glyptothorax telchitta* (Hamilton-Buchanan)
Puntius ticto (Hamilton-Buchanan)	*Glyptothorax cavia (*Hamilton-Buchanan)
Acanthocobitis botia (Hamilton -Buchanan)	*Olyra kempi* (Chaudhuri)
Schistura prashadi (Hora)	*Olyra longicauda (*McClelland)
Lepidocephalichthys guntea (Hamilton-Buchanan)	*Clarias batrachus* (Bloch)
Mastacembelus armatus (Lacepede)	*Xenentodon cancila* (Hamilton-Buchanan)
Anabas testudineus (Bloch)	*Bangana dero* (Hamilton-Buchanan)
Channa orientalis (Schneider)	*Labeo bata* (Hamilton-Buchanan)
Channa punctatus (Bloch)	*Labeo pangusia* (Hamilton-Buchanan)
Crossocheilus latius (Hamiton-Buchanan)	*Labeo fimbriatus* (Hamilton-Buchanan)
Neonoemacheilus assamensis (Menon)	*Labeo rohita*(Hamilton-Buchanan)
	Catla catla(Hamilton-Buchanan)
	Cirrhinus mrigala(Hamilton-Buchanan)
	Cyprinus carpio (Linnaeus)
	Ctenopharyngodon idellus (Steindachner)
	Hypopthalmichthys molitrix (Valenciennes)
	Monopterus albus (Zuiew)
	Tor putitora (Hamiton-Buchanan)
	Badis badis (Hamilton-Buchanan)
	Neolissochilus hexastichus (Mc Clelland)
	Neolissochilus hexagonolepis (Mc Clelland)

3.4.2 Food and Sport Fishes:

Any fish used primarily as a commercial source of food is termed as food fish. However, even the small size fish because of their flavor and taste are consumed by the local people and therefore considered under food fishes. While, those fishes that provides sport for the anglers are termed as sport fish/game fish. As regards to food fish, except for a few species like *Badis badis, Esomus danricus* etc. all the fishes occurring in the Doyang river system has potential as food fish. Even the small size fishes are considered under food fishes due to their flavor and taste. As such, out of the total 46 ichthyofauna species of Doyang river system 44 species (95.65%) were classified as food fishes, while 11 species (23.91%) as sport fishes. The checklist of the food and sport fishes are depicted in Table 9.

Table 9: List of Ichthyofauna as food and sport fishes of Doyang river system, Nagaland.

Sl. No.	SCIENTIFIC NAME	POTENTIAL VALUE	
A I i	ORDER: CYPRINIFORMES FAMILY: CYPRINIDAE SUB-FAMILY: RASBORINAE	FF	SF
1.	*Barilius bendelisis* (Hamilton-Buchanan)	√	√
2.	*Barilius barila* (Hamilton-Buchanan)	√	
3.	*Barilius barna* (Hamilton-Buchanan)	√	
4	*Danio aequipinnatus* (McClelland)	√	
5.	*Danio dangila* (Hamilton-Buchanan)	√	
6.	*Esomus danricus* (Hamilton-Buchanan)	X	
ii	SUB FAMILY: CYPRININAE		
7.	*Neolissochilus hexastichus* (McClelland)	√	√
8.	*Neolissochilus hexagonolepis*(McClelland)	√	√
9.	*Tor putitora* (Hamilton-Buchanan)	√	√
10.	*Puntius sophore* (Hamilton-Buchanan)	√	
11.	*Puntius ticto* (Hamilton-Buchanan)	√	
12.	*Puntius chola* (Hamilton-Buchanan)	√	
13.	*Bangana dero* (Hamilton-Buchanan)	√	
14.	*Labeo bata* (Hamilton-Buchanan)	√	
15.	*Labeo pangusia* (Hamilton-Buchanan)	√	
16.	*Labeo fimbriatus* (Bloch)	√	
17.	*Labeo rohita*(Hamilton-Buchanan)	√	
18.	*Catla catla*(Hamilton-Buchanan)	√	
19.	*Cirrhinus mrigala* (Hamilton-Buchanan)	√	
20.	*Cyprinus carpio* (Linnaeus)	√	
21.	*Ctenopharyngodon idellus* (Steindachner)	√	
iii	SUB FAMILY: LEUCISINAE		

22.	*Hypopthalmichthys molitrix* (Valenciennes)	√	
iv	SUB FAMILY: GARRINAE		
23.	*Garra gotyla gotyla* (Gray)	√	
24.	*Garra naganensis* (Hora)	√	
25.	*Garra gravely* (Annandale)	√	
26.	*Garra lissorhynchus* (McClelland)	√	
27.	*Crossocheilus latius* (Hamilton-Buchanan)	√	√
II v	FAMILY: BALITORIDAE *SUB FAMILY: NEMACHEILINAE*		
28.	*Schistura prashadi* (Hora)	√	
29.	*Acanthocobitis botia* (Hamilton-Buchanan)	√	
30.	*Neonoemacheilus assamensis* (Menon)	√	
III vi	FAMILY: COBITIDAE SUB FAMILY: COBITINAE		
31.	*Lepitocephalichthys guntea* (Hamilton-Buchanan)	√	
IV	FAMILY: PSILORHYNCHIDAE		
32.	*Psilorhyncoides homaloptera* (Hora & Mukherji)	√	
B I	ORDER: SILURIFORMES FAMILY: OLYRIDAE		
33.	*Olyra kempi* (Chaudhuri)	√	
34.	*Olyra longicauda* (McClelland)	√	
II	FAMILY: PSILORHYNCHIDAE		
35.	*Kryptopterus indicus* (Datta, Barman & Jayaram)	√	√
III	FAMILY: AMPLYCIPITIDAE		
36.	*Amplyceps apangi* (Nath & Dey)	√	
IV	FAMILY: SISORIDAE		
37.	*Glyptothorax telchitta* (Hamilton-Buchanan)	√	
38.	*Glyptothorax cavia* (Hamilton-Buchanan)	√	

V	FAMILY: CLARIIDAE		
39.	*Clarius batrachus* (Linnaeus)	√	√
C I	ORDER: PERCIFORMES FAMILY: CHANNIDAE		
40.	*Channa punctatus* (Bloch)	√	√
41.	*Channa orientalis* (Bloch & Schneider)	√	√
II i	FAMILY: NANDIDAE SUB FAMILY: BADINAE		
42.	*Badis badis* (Hamilton-Buchanan)	X	
III	FAMILY: ANABANTIDAE		
43.	*Anabas testudineus* (Bloch)	√	√
D I i	ORDER: SYNBRANCHIFORMES FAMILY: MASTACEMBELIDAE SUBFAMILY: MASTACEMBELINAE		
44.	*Mastacembelus armatus* (Lacepede)	√	√
II	FAMILY: SYNBRANCHIDAE		
45.	*Monopterus albus* (Zuiew)	√	
E I	ORDER: BELONIFORMES FAMILY: BELONIDAE		
46.	*Xenentodon cancila* (Hamilton-Buchanan)	√	

FF=Food fishes SF=Sport fishes

3.5 ECOLOGICAL STUDIES OF THE RIVER

Ecological studies includes seasonal and station wise analysis of physico – chemical parameter and the variations of the planktons both qualitatively and quantitatively in the Doyang river system. For physico-chemical studies altogether 14 parameters were considered viz. Air temperature, Water temperature, Total Dissolved Solids, Water current, Dissolved oxygen, pH, Free Carbon-dioxide, Alkalinity, Total Hardness, Chloride, Phosphate, Nitrate, Nitrite and ammonium. The materials used and methodology followed are detailed in chapter-II.

3.5.1 Physico-Chemical parameters:

3.5.1.1 Air temperature

The mean seasonal and station wise variations of air temperature are depicted in Table 10. The mean air temperature ranged from 10°C-29°C. The maximum air temperature 29°C was observed in the month of August (fig.5) during monsoon period in station V and that of minimum 10°C was found in the month of January (station II & IV), February (station I & II) and March (station II) during pre monsoon period. Annual mean value was calculated to be 18.4°C±5.80.

Table 10: Mean air temperature (°C) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(10-16) 12.25±2.63	(10-16) 11.5±3.0	(11-17) 12.75±2.87	(10-17) 12.25±3.20	(12-17) 13.75±2.36	(11-17) 13.25±2.63	(10-29) 18.4±5.80
Monsoon	(13-21) 17.33±4.04	(20-26) 23.75±2.63	(22-27) 24.75±2.06	(21-26) 23.75±2.22	(23-29) 26.5±2.64	(20-28) 24.5±3.41	
Post monsoon	(17-29) 24.33±6.43	(12-23) 17.25±4.79	(12-23) 17.25±5.12	(12-24) 19.0±5.60	(13-26) 19.5±5.69	(14-24) 19.25±4.27	

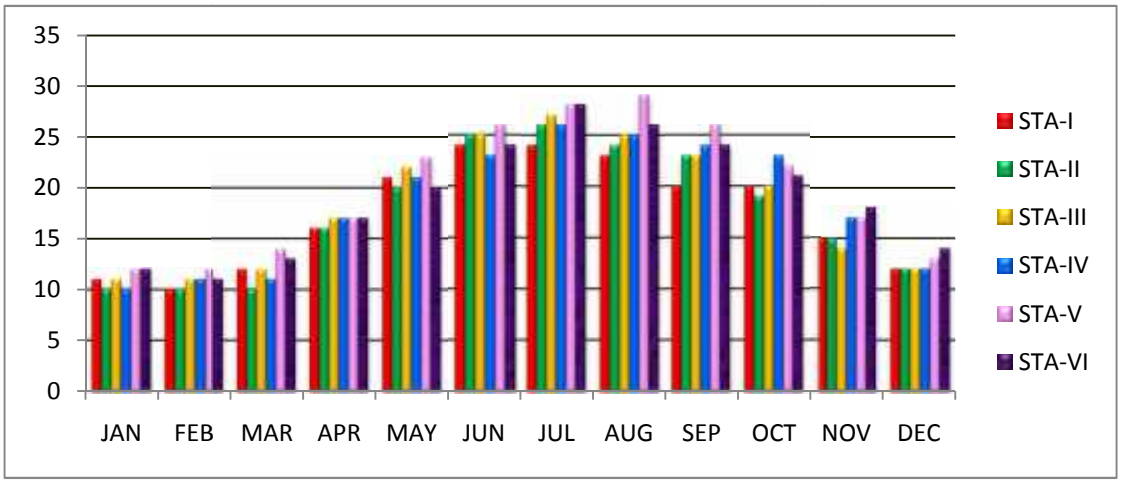

Fig 5: Monthly variation of mean Air temperature (°C).

3.5.1.2 Water temperature

The mean seasonal and station wise variations of air temperature are depicted in Table 11. The mean water temperature ranged from 9°C-26°C. The maximum air temperature 26°C was observed in the month of July (fig.6) during monsoon period in station IV and that of minimum 9°C was found in the month of January (station II), February (station I & II) and March (station II) during pre monsoon period. Annual mean value was computed to be 15.7°C±4.92.

Table 11: Mean water temperature (°C) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(9-13) 10.5±1.73	(9-13) 10.0±2.0	(10-14) 11.5±1.73	(11-14) 12.5±1.29	(10-12) 11.25±0.96	(10-14) 11.5±1.91	(9-26) 15.7±4.92
Monsoon	(17-18) 17.5±0.58	(16-22) 19.75±2.63	(18-24) 21.25±2.5	(19-26) 23.5±3.32	(15-24) 20.75±4.03	(17-25) 21.75±3.59	
Post monsoon	(12-16) 14.25±2.06	(11-19) 14.25±3.59	(11-19) 14.75±3.86	(12-23) 17.0±4.69	(11-21) 15.75±4.57	(11-22) 16.25±5.12	

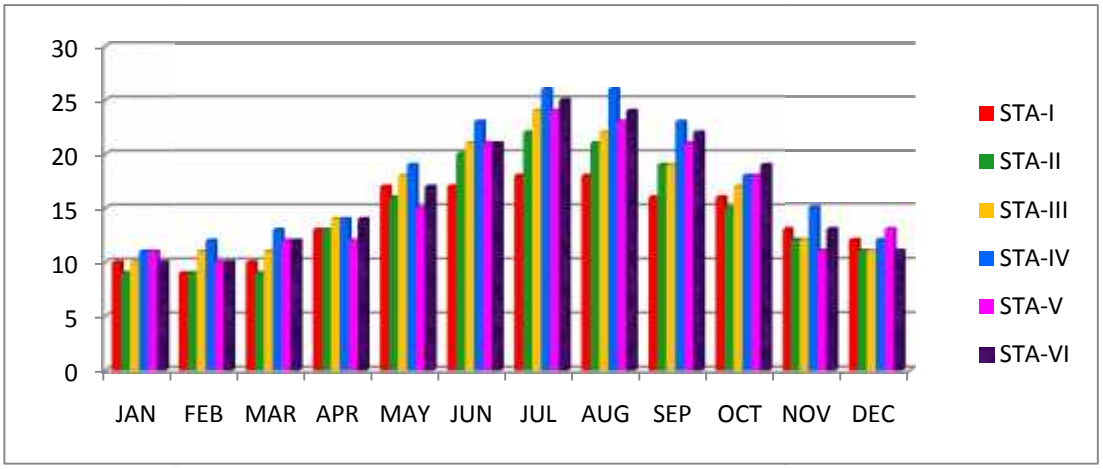

Fig 6: Monthly variation of mean Water temperature (°C).

3.5.1.3 pH

The pH of Doyang river was found to be almost neutral and the seasonal variations were observed within a narrow range. It ranged from pH 6.4 to a maximum of pH 7.8, with an annual mean of 7.1±0.303 (Table 12). The highest value of pH 7.8 (fig.7) was recorded in the month of February during pre monsoon in station III and the minimum value of 6.4 was recorded in the month of July during monsoon period in station III.

Table 12: Mean pH values of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(6.8-7.2) 6.97±0.21	(6.9-7.3) 7.07±0.17	(7.1-7.8) 7.5±0.29	(7.2-7.6) 7.47±0.19	(6.9-7.5) 7.3±0.28	(7.5-7.7) 7.57±.0.09	(6.4-7.8) 7.1±0.303
Monsoon	(6.7-7.1) 6.87±0.17	(6.9-7.0) 6.95±0.058	(6.4-7.7) 7.12±0.54	(6.9-7.4) 7.12±0.22	(6.5-7.0) 6.75±0.21	(6.9-7.4) 7.1±0.22	
Post monsoon	(6.7-7.0) 6.82±0.12	(6.7-7.0) 6.85±0.13	(6.9-7.0) 6.95±0.058	(6.8-7.1) 6.95±0.13	(7.0-7.2) 7.12±0.09	(6.9-7.4) 7.12±0.22	

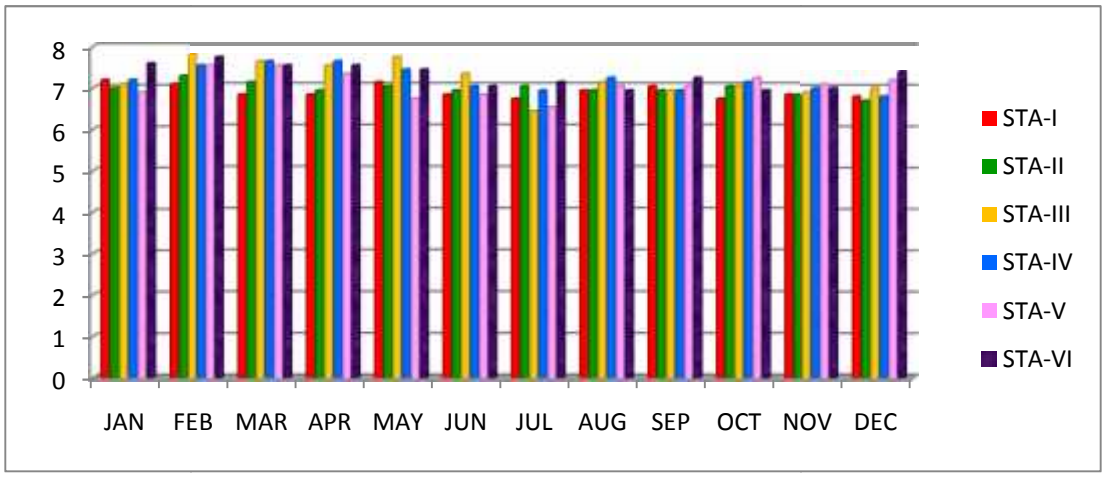

Fig 7: Monthly variation of pH value

3.5.1.4 Water Current

A wide variation of water current from 0.303 m/sec to 0.966 m/sec was observed during the study period with an annual mean of 0.611 m/sec ±0.175. The seasonal and station wise variations are given in Table 13. The maximum mean water current (0.966 m/sec) was recorded in August (fig.8) during monsoon period in station I and that of minimum of 0.303 m/sec in April during pre monsoon period in station IV.

Table 13: Mean water current (m/sec) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(0.491-0.497) 0.494±0.002	(0.476-0.530) 0.505±0.022	(0.465-0.541) 0.493±0.033	(0.303-0.408) 0.356±0.051	(0.425-0.445) 0.431±0.009	(0.405-0.410) 0.407±0.002	(0.303-0.966) 0.611 ±0.175
Monsoon	(0.467-0.966) 0.794±0.227	(0.661-0.931) 0.834±0.127	(0.662-0.945) 0.824±0.126	(0.422-0.737) 0.611±0.136	(0.470-0.871) 0.726±0.179	(0.550-0.837) 0.729±0.135	
Post monsoon	(0.535-0.947) 0.712±0.186	(0.513-0.738) 0.624±0.109	(0.521-0.768) 0.632±0.130	(0.515-0.720) 0.637±0.088	(0.476-0.817) 0.637±0.150	(0.448-0.713) 0.552±0.127	

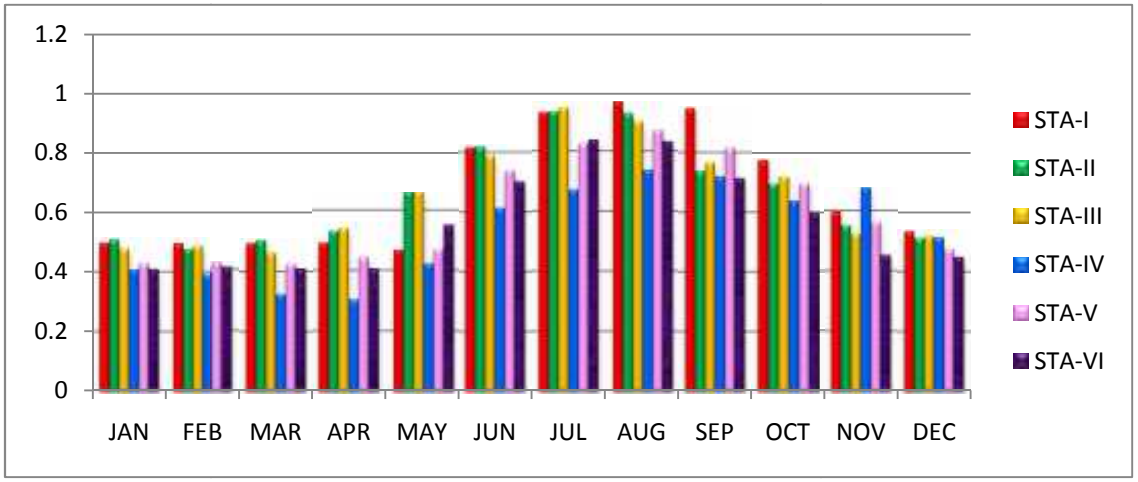

Fig 8: Monthly variation of Water current

3.5.1.5 Dissolved oxygen

The concentration of dissolved oxygen of the river was fluctuated in different seasons and in different collection sites as given in Table 14. The maximum value of 13.0 mg/l was recorded during pre monsoon period in the month of January (fig. 9) in station III and again in the month of December during post monsoon period in station IV. The minimum value of 8.0 mg/l was observed during monsoon period in the months of May (station V), June (station VI) and July (station II & VI). The annual mean value calculated was 10.25± 1.32.

Table 14: The mean dissolved oxygen content (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(10-12) 11.5±1.0	(10-12) 11.0±0.82	(11-13) 11.75±0.96	(10-12) 10.75±0.96	(9-12) 10.0±1.41	(10-12) 10.75±0.96	(8-13) 10.25 ±1.32
Monsoon	(9-11) 9.75±0.96	(8-9) 8.75±0.5	(8-9) 8.75±0.5	(9-11) 9.5±1.0	(8-9) 8.5±0.58	(8-10) 8.75±0.96	
Post monsoon	(11-12) 11.25±0.50	(10-12) 11.25±0.96	(9-11) 10.25±0.96	(10-13) 11.0±1.41	(9-12) 10.0±1.41	(9-12) 10.75±1.26	

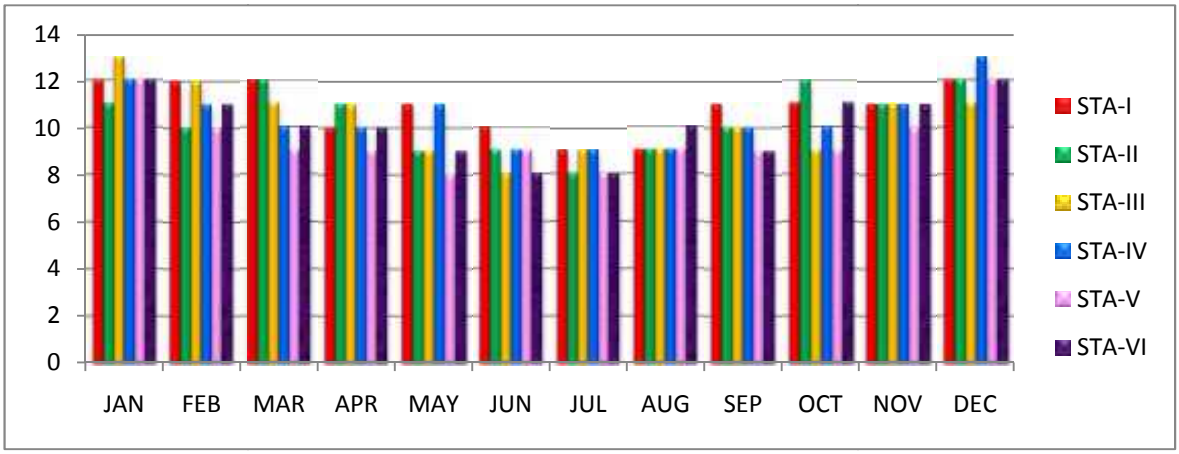

Fig 9: Monthly variation of Dissolved oxygen content

3.5.1.6 Free Carbondioxide

The river Doyang exhibited maximum free Carbondioxide 5.9 mg/l and minimum of 4.1 mg/l, with an annual mean of 4.9 mg/l ± 0.40 (Table 15). The higher value was found in August during monsoon period (fig. 10) in station V and lower value was observed in December in station I during post monsoon period.

Table 15: The mean values of Free Carbondioxide (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(4.4-4.6) 4.5±0.10	(4.6-4.9) 4.8±0.15	(4.6-4.9) 4.7±0.13	(4.8-5.4) 5.2±0.27	(4.6-5.1) 4.8±0.21	(4.9-5.1) 5.0±0.09	(4.1-5.9) 4.9±0.70
Monsoon	(4.6-4.8) 4.7±0.10	(4.6-4.8) 4.7±0.10	(4.6-5.1) 4.9±0.22	(5.0-5.3) 5.17±0.15	(5.2-5.9) 5.6±0.30	(4.8-5.7) 5.3±0.38	
Post monsoon	(4.1-4.3) 4.2±0.08	(4.2-4.6) 4.4±0.17	(4.3-4.6) 4.4±0.13	(5.0-5.2) 5.1±0.08	(4.8-5.5) 5.2±0.29	(5.1-5.8) 5.4±0.30	

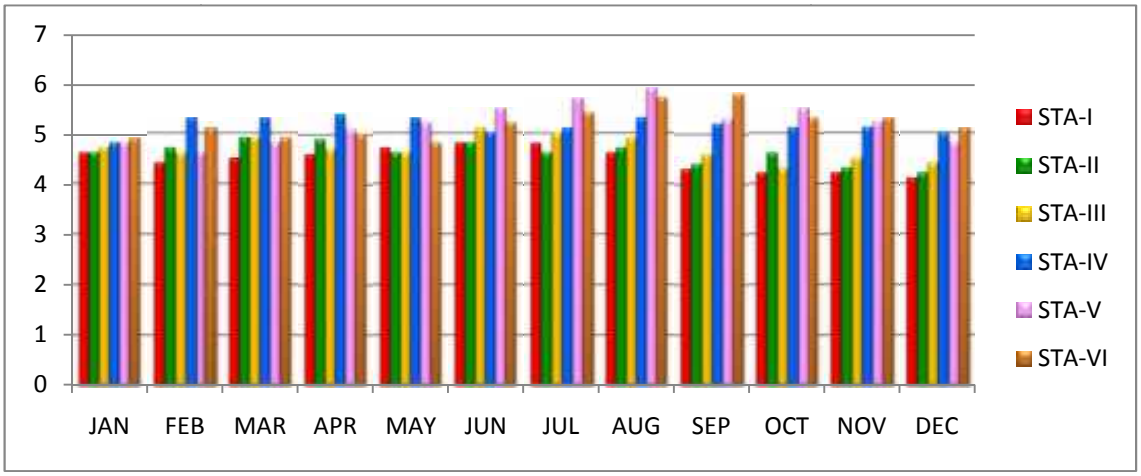

Fig 10: Monthly variation of Free carbondioxide

3.5.1.7 Total Alkalinity

The mean total alkalinity of the river fluctuated from 46.7 mg/l to 58.7 mg/l, with an annual mean of 52.55 mg/l ± 2.93 (Table 16). The maximum value of Alkalinity was recorded during post monsoon period in the month of November (fig.11) in station III, while that of minimum value was recorded in station I during monsoon in the month of August.

Table 16: The mean Total Alkalinity (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(51.0-52.3) 51.6±0.53	(50.9-57.1) 53.6±2.74	(51.7-55.4) 53.6±1.55	(51.5-58.1) 56.0±3.08	(56.9-58.5) 57.6±0.68	(55.1-56.4) 55.8±0.58	(46.7-58.7) 52.55 ±2.93
Monsoon	(46.7-50.6) 49.1±1.74	(48.9-51.3) 49.8±1.09	(48.9-52.7) 50.7±1.62	(48.7-51.8) 50.3±1.33	(48.2-50.2) 49.2±0.83	(50.1-52.3) 51.3±0.95	
Post monsoon	(48.7-50.7) 49.9±0.96	(50.5-52.6) 51.5±0.90	(50.7-58.7) 54.2±3.41	(50.9-56.1) 52.5±2.42	(48.4-54.3) 51.7±2.60	(50.9-58.0) 54.7±3.30	

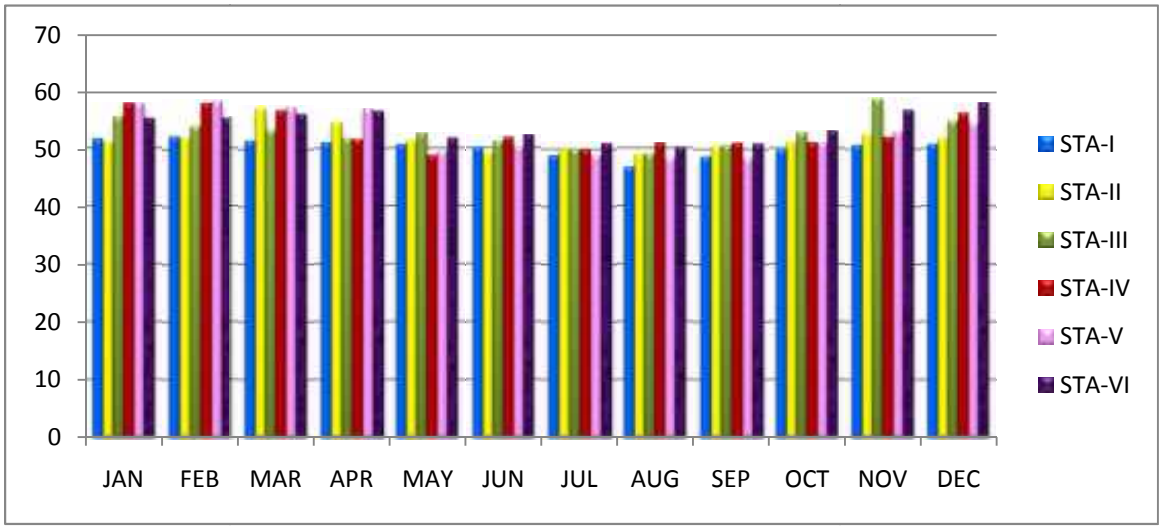

Fig 11: Monthly variation of Total alkalinity

3.5.1.8 Total Hardness

The variations of total hardness are provided in Table 17. In the present study, total hardness ranged from 47.9 mg/l to 60.6 mg/l, with an annual mean of 54.96 mg/l ± 3.56. Total hardness was comparatively found higher during pre monsoon period with a maximum value of 60.6 mg/l (fig.12) in the month of April in station VI, whereas, minimal value was recorded in August during monsoon period in station II.

Table 17: The mean Total Hardness (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(55.4-58.7) 56.9±1.45	(55.8-57.7) 56.8±0.78	(55.5-57.9) 56.4±1.07	(55.7-57.3) 56.4±0.68	(57.5-58.9) 58.0±0.64	(56.7-60.6) 58.6±1.65	(47.9-60.6) 54.96 ±3.56
Monsoon	(48.3-52.3) 49.9±1.75	(47.9-55.1) 50.7±3.12	(48.4-54.0) 50.6±2.61	(49.5-52.5) 50.6±1.43	(50.4-55.4) 52.1±2.28	(49.9-54.6) 51.5±2.13	
Post monsoon	(51.3-55.6) 53.4±1.76	(52.1-56.8) 54.1±2.01	(55.4-60.3) 57.0±2.27	(59.0-60.1) 59.6±0.48	(57.4-60.3) 58.3±1.33	(56.8-60.4) 58.1±1.57	

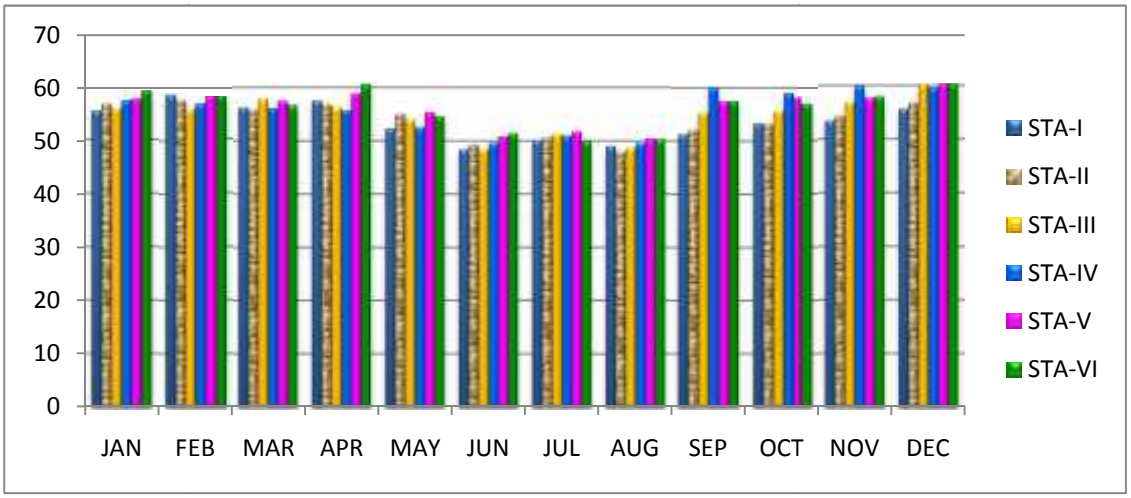

Fig 12: Monthly variation of Total hardness

3.5.1.9 Total dissolved solids

Total dissolved solids (TDS) were fluctuated between 58.3 mg/l to 186.7 mg/l, with an annual mean of 113.5 mg/l ± 29.09 (Table 18). The minimum 58.3 mg/l was recorded in the month of January during pre monsoon in station I, while the maximum 186.7 mg/l (fig. 13) was found in the month of August in station III during monsoon period.

Table 18: The mean Total dissolved solids (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(58.3-81.0) 65.7 ±10.39	(79.0-90.7) 84.2 ±4.86	(104.0-117.3) 108.8 ±5.83	(90.3-111.3) 103.1 ±9.07	(86.7-138.0) 105.8 ±22.57	(85.0-97.0) 89.5 ±5.20	(58.3-186.7) 113.5 ±29.09
Monsoon	(103.7-126.7) 116.3 ±10.08	(113.3-142.0) 128.5 ±11.95	(152.7-186.7) 166.0 ±15.23	(133.3-156.0) 145.8 ±11.75	(122.7-167.3) 141.7 ±20.90	(119.7-161.7) 137.7 ±19.19	
Post monsoon	(63.3-98.7) 77.1 ±15.65	(83.0-122.0) 97.0 ±17.94	(93.3-160.0) 127.5 ±29.87	(94.7-150.7) 117.8 ±23.93	(95.3-152.7) 118.2 ±25.74	(91.7-144.7) 112.3 ±23.22	

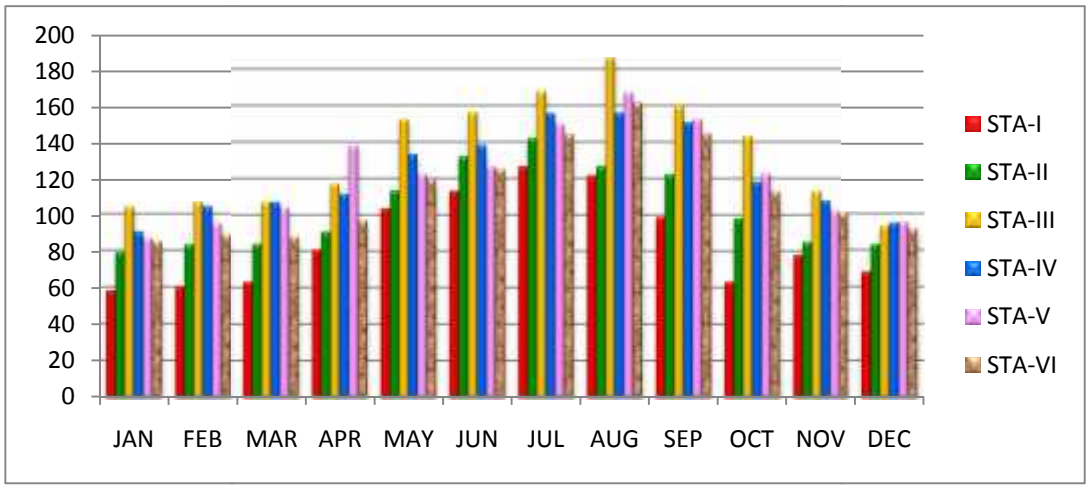

Fig 13: Monthly variation of Total dissolved solids

3.5.1.10 Chloride

The Chloride content ranged between 7.7 mg/l to 13.3 mg/l, with an annual mean of 10.18 mg/l ± 1.31. The seasonal and station wise variations are provided in Table 19. In the present study, Chloride content showed an ascending trend from the minimum value of 7.7 mg/l during monsoon in station IV to pre monsoon period. However, the maximum value was recorded in the month of October (fig 14) in station I during post monsoon season.

Table 19: Mean Chloride values (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(9.5-10.5) 10.1±0.45	(9.7-13.2) 11.1±1.48	(9.9-12.6) 11.7±1.23	(9.5-11.8) 10.5±0.97	(9.2-12.2) 10.9±1.27	(10.5-12.7) 12.0±1.04	(7.7-13.3) 10.18 ±1.31
Monsoon	(8.8-9.7) 9.3±0.39	(8.9-9.6) 9.4±0.33	(8.3-9.7) 8.8±0.66	(7.7-9.7) 8.6±0.85	(8.2-9.1) 8.7±0.38	(8.9-9.8) 9.25±0.43	
Post monsoon	(9.7-13.3) 11.0±1.60	(9.8-11.5) 10.5±0.83	(8.9-12.4) 10.4±1.56	(9.5-11.7) 10.4±1.0	(9.1-10.5) 9.8±0.70	(9.3-12.5) 10.7±1.43	

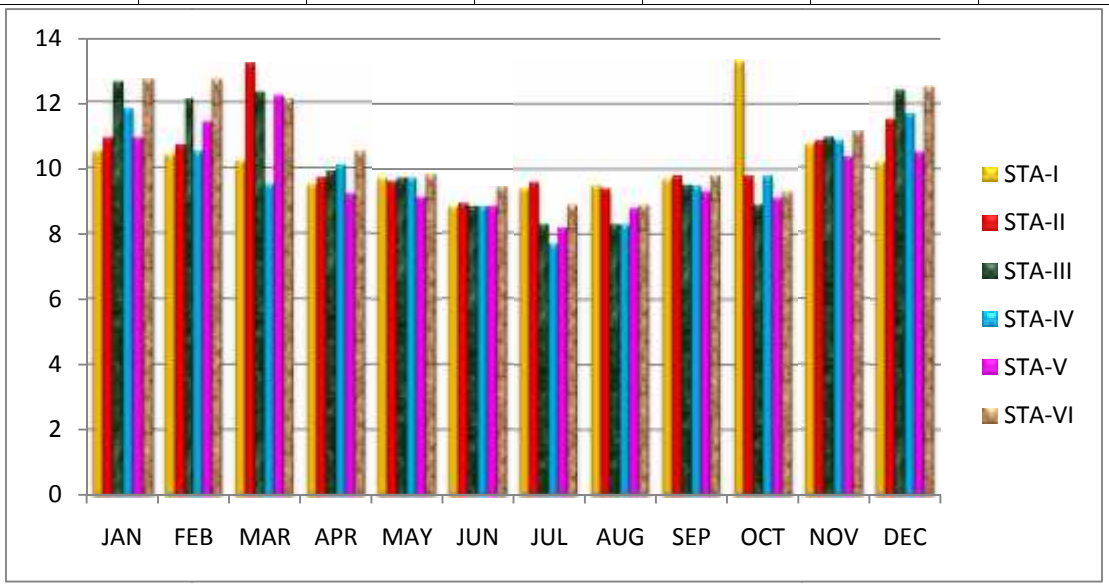

Fig 14: Monthly variation of Chloride

3.5.1.11 Phosphate

The mean values and standard deviation of phosphate recorded at different seasons and stations are presented in Table 20. During the present investigation phosphate content was found to be ranged between 0.01-0.09 mg/l. The highest concentration of phosphate 0.09 mg/l was found during monsoon period in station II and III in the month of June and again in station V and VI in the month of July (fig. 15). The minimal value 0.01 mg/l was recorded in almost all stations during the month of December and January in post monsoon and pre monsoon periods respectively. Besides, the minimal value was also observed in October (stations III & V), November (stations II, III & VI), February (stations I-IV) and twice during the month of May in station III and IV.

Table 20: The mean Phosphate values (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(0.01-0.03) 0.02±0.009	(0.01-0.02) 0.01±0.006	(0.01-0.02) 0.01±0.005	(0.01-0.02) 0.01±0.005	(0.01-0.02) 0.02±0.005	(0.01-0.03) 0.02±0.008	(0.01-0.09) 0.028 ±0.024
Monsoon	(0.02-0.08) 0.05±0.024	(0.04-0.09) 0.06±0.024	(0.01-0.09) 0.04±0.034	(0.01-0.07) 0.04±0.025	(0.02-0.09) 0.05±0.033	(0.02-0.09) 0.07±0.032	
Post monsoon	(0.01-0.03) 0.02±0.009	(0.01-0.02) 0.01±0.006	(0.01-0.02) 0.01±0.005	(0.01-0.02) 0.02±0.005	(0.01-0.03) 0.02±0.009	(0.01-0.02) 0.01±0.005	

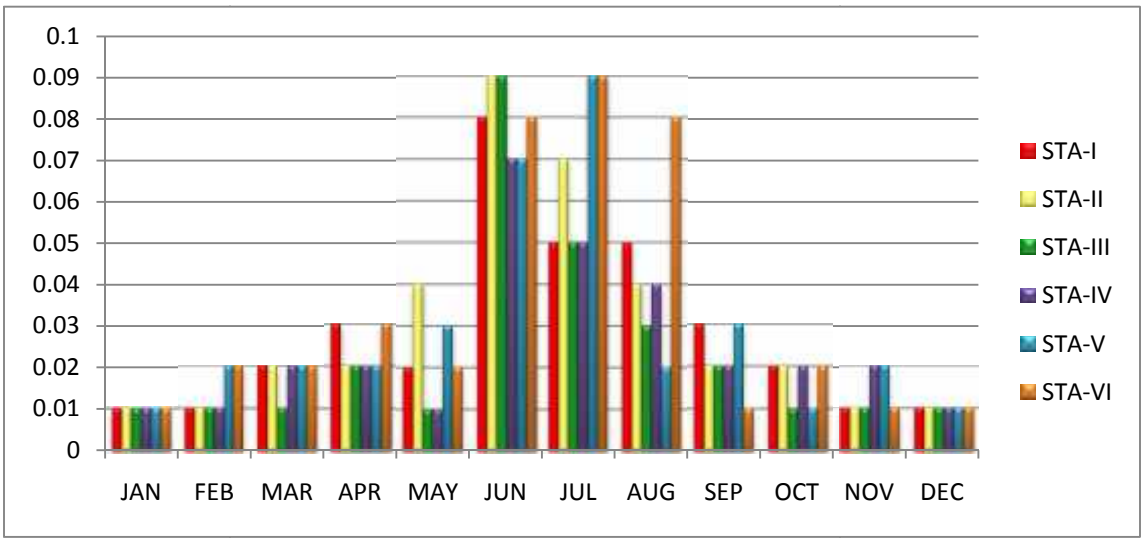

Fig 15: Monthly variation of Phosphate

3.5.1.12 Nitrate

In the present study, a small amount of Nitrate (NO_3) in the range of 0.01 mg/l to 0.6 mg/l, was recorded in Doyang river, with an annual mean of 0.11mg/l ± 0.147 (Table 21). Nitrate content was found maximum with 0.6 mg/l (fig. 16) during monsoon period in the month of July in station II. The minimum value of 0.01 mg/l was observed characteristically in pre monsoon period during the months of January (station II & V), February (station II, III & VI) and March (station III). However, minimal value was also inferred discretely in November (station II & III).

Table 21: Mean Nitrate values (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(0.02-0.05) 0.03±0.012	(0.01-0.02) 0.01±0.006	(0.01-0.02) 0.01±0.006	(0.02-0.03) 0.03±0.005	(0.01-0.03) 0.02±0.008	(0.01-0.03) 0.02±0.008	(0.01-0.6) 0.11 ±0.147
Monsoon	(0.07-0.4) 0.29±0.156	(0.04-0.6) 0.33±0.233	(0.02-0.5) 0.33±0.227	(0.01-0.2) 0.09±0.08	(0.04-0.5) 0.31±0.198	(0.06-0.2) 0.13±0.073	
Post monsoon	(0.02-0.1) 0.04±0.037	(0.01-0.06) 0.03±0.022	(0.01-0.1) 0.04±0.039	(0.03-0.1) 0.06±0.030	(0.02-0.2) 0.87±0.083	(0.02-0.1) 0.05±0.038	

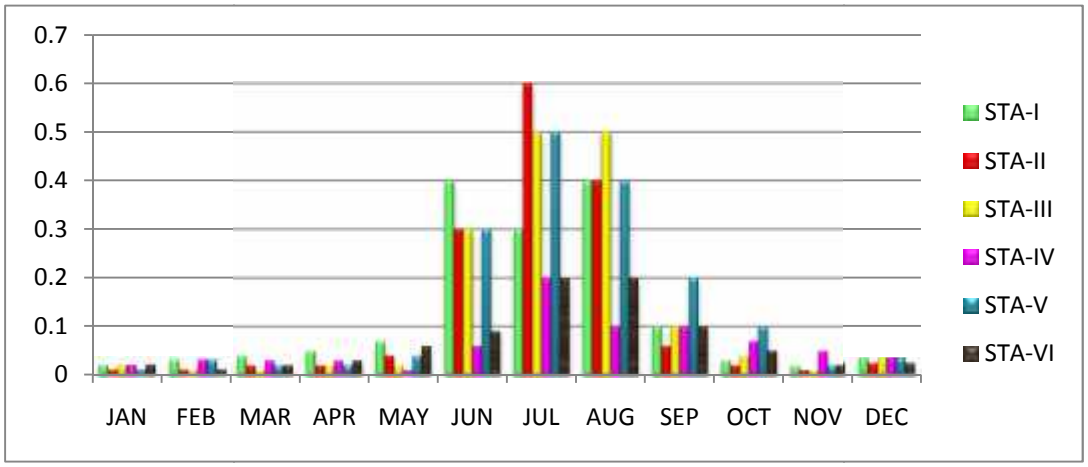

Fig 16: Monthly variation of Nitrate

3.5.1.13 Nitrite

The range of nitrite in Doyang river was found to be within a very narrow range and varied from 0.01 mg/l to 0.05 mg/l, with an annual mean of 0.022 mg/l ± 0.012 (Table 22). The peak values of nitrite 0.05 mg/l was observed during the monsoon period in the month of June (fig. 17) in station II. The minimum value of 0.01 mg/l was observed predominantly during the pre monsoon months and discretely during monsoon in the months of May (station II & VI) and

June (station V) and during post monsoon season in the months of September (station V & VI), October (station II & IV) and December (station III).

Table 22: Mean Nitrite values (mg/l) in Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(0.01-0.02) 0.01±0.006	(0.01-0.02) 0.01±0.005	(0.01-0.03) 0.01±0.010	(0.01-0.03) 0.01±0.010	(0.01-0.02) 0.01±0.006	(0.01-0.02) 0.01±0.005	(0.01-0.05) 0.022 ±0.012
Monsoon	(0.02-0.05) 0.04±0.012	(0.01-0.05) 0.04±0.019	(0.02-0.04) 0.03±0.009	(0.02-0.04) 0.03±0.009	(0.01-0.04) 0.03±0.015	(0.01-0.04) 0.03±0.012	
Post monsoon	(0.02-0.03) 0.02±0.005	(0.01-0.04) 0.02±0.012	(0.01-0.02) 0.02±0.005	(0.01-0.02) 0.02±0.005	(0.01-0.02) 0.02±0.005	(0.01-0.02) 0.02±0.005	

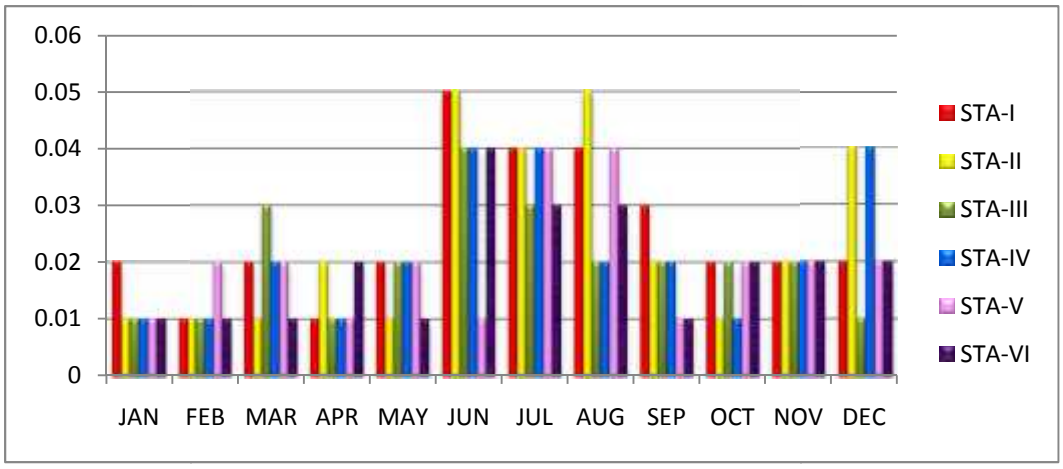

Fig 17: Monthly variation of Nitrite

3.5.1.14 Ammonia

In the present study, the variation of ammonia content was found very narrow ranging from 0.01 mg/l to 0.06 mg/l, with an annual mean of 0.023 mg/l ± 0.14 (Table 23). A marginal fluctuation of ammonia was also recorded in different seasons and stations of the river.

Maxima reading of 0.06 mg/l was observed during monsoon period in the month of July (fig. 18) in station III and V, while minima values of 0.01 mg/l was observed predominantly during the pre monsoon months and discretely during post monsoon period in the months of September (station II), November (I-IV) and December (station I-VI).

Table 23: The mean values of Ammonia (mg/l) of Doyang river

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(0.01-0.02) 0.01±0.005	(0.01-0.02) 0.01±0.005	(0.01-0.02) 0.01±0.005	(0.01-0.02) 0.01±0.005	(0.01-0.02) 0.01±0.005	(0.01-0.03) 0.02±0.008	(0.01-0.06) 0.023 ±0.014
Monsoon	(0.01-0.04) 0.03±0.012	(0.01-0.04) 0.03±0.012	(0.04-0.06) 0.05±0.009	(0.03-0.05) 0.04±0.009	(0.03-0.05) 0.04±0.009	(0.03-0.05) 0.04±0.009	
Post monsoon	(0.01-0.02) 0.02±0.005	(0.01-0.02) 0.02±0.005	(0.01-0.03) 0.02±0.008	(0.01-0.02) 0.01±0.006	(0.01-0.02) 0.01±0.005	(0.01-0.02) 0.02±0.005	

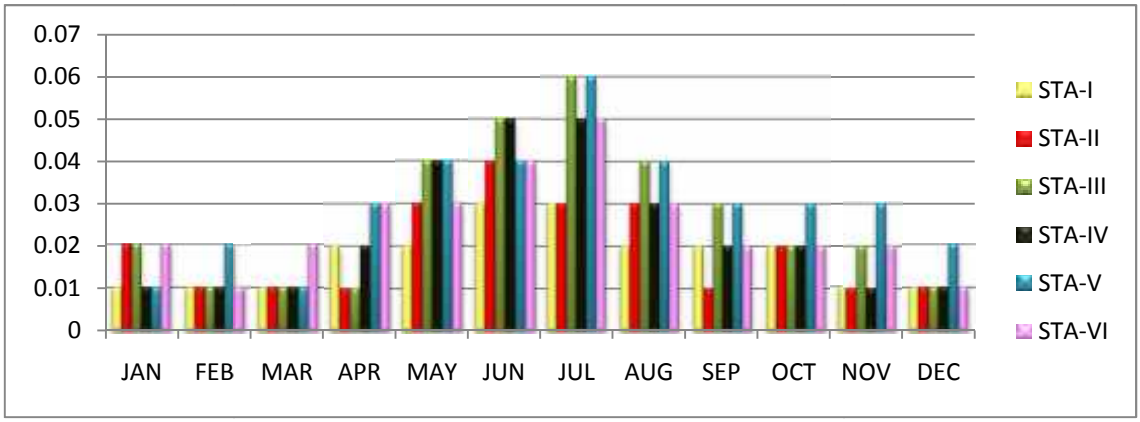

Fig 18: Monthly variation of Ammonia

3.5.2 Planktons:

Plankton is part of aquatic life, which is composed of microscopic living organisms, drifting in the direction of water current. It acts as the main source of food for most fauna, both in lotic and lentic water ecosystems (Negi and Rajput, 2011). Planktons are classified as phytoplanktons and zooplanktons. Of these the phytoplanktons includes organisms with chlorophyll as well as non-photosynthetic plants like bacteria and fungi. They are the primary producers of water bodies, serving as the main source of food directly or indirectly for various animal groups. The productivity of any aquatic water body depends on the amount of plankton present in the said water body (Guy, 1992). The zooplanktons are minute animals like the protozoans, rotifers, crustaceans like the copepods, ostracods etc. Zooplanktons form important groups as most of them feed upon and incorporate the primary produces into their bodies and make them available to higher organisms in food chain. In most of the aquatic ecosystem different zooplankton groups acts as primary consumer as a result their diversity abundance and seasonality affects the other biotic components (Thirupathaiah et al, 2011).

3.5.2.1 Qualitative composition of Phytoplankton:

During the present study, a total of 21 species of phytoplankton were recorded. Four major groups of phytoplankton viz. Chlorophyta represented by 12 species, Bacillariophyta

represented by 6 species, Cyanophyta represented by 2 species and Dinophyta represented by 1 species were found in the different stations along the Doyang river. The list of phytoplankton diversity is given in the following Table 24.

Table 24: Phytoplankton diversity in Doyang river system.

Sl. No.	Name of the species	Sl. No.	Name of the species
	Chlorophyta		**Bacillariophyta**
1	*Cloisterium acerosum*	*13*	*Asterionella sp.*
2	*Cloisterium abruptum*	*14*	*Cyclotella sp.*
3	*Cosmarium botrytis*	*15*	*Gomphonema sp.*
4	*Gonatozygon aculeatum*	*16*	*Diatoma elongatum*
5	*Gonatozygon. pilosum*	*17*	*Melosira varians*
6	*Pediastrum duplex*	*18*	*Surirella sp.*
7	*Mougeotia sp.*		**Cyanophyta**
8	*Chaetophora sp*	*19*	*Oscillatoria sp.*
9	*Cladophora sp.*	*20*	*Gloecapse compacta*
10	*Spirogya sp.*		**Dinophyta**
11	*Volvox sp.*	*21*	*Ceratium hirudinella*
12	*Zygnema sp.*		

Amongst the phytoplankton 5 species was found to occur in all the six stations. They are *Pediastrum duplex, Mougoetia sp., Chaetophora sp. Oscillatoria sp. and Gloecapse compacta*. *Ceratium hirudinella* was found to occur in 5 stations (II-VI). *Cloisterium abruptum*, *Gomphonema sp*. and *Diatoma elongatum* was found to occur in 4 stations (III-VI), whereas, *Asterionella sp.* occurred in stations I-IV. *Cyclotella sp*. occured in 4 stations (I-III &

VI). *Cloisterium acerosum* and *Zygnema sp*. was observed in 3 stations (IV-VI), *Gonatozyon pilosum* occurred in stations III,IV & V while, *Cladophora sp*. was observed in 3 stations (I,II & IV). *Cosmarium botrytis, Spirogyra sp*. and *Surirella sp.* was found to be present in 2 stations each (I & IV; III & VI and IV & V respectively). *Gonatozygon aculeatum* was observed only in station IV while *Volvox sp*. also occurred only in station III.

The mean seasonal and station wise variations of phytoplanktons are depicted is Table 25. The mean qualitative richness of phytoplankton ranged from 3.0-15.0 species, with an annual mean of 6.83 ±2.35. The maximum phytoplankton richness 15.0 species (fig. 19) was collected in the post monsoon months of November (station III & IV) and December (station IV). The minimum phytoplankton 3.0 species was predominantly observed during the months of monsoon period.

Table 25: Mean qualitative richness of phytoplankton in Doyang river system.

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(4.0-6.0) 5±0.82	(4.0-8.0) 5.5±1.91	(5.0-11.0) 8.75±2.63	(8.0-14.0) 11±2.94	(6.0-11.0) 7.5±2.38	(5.0-10.0) 6.5±2.38	(3.0-15.0) 6.83±2.35
Monsoon	(3.0-5.0) 3.75±0.96	(3.0-4.0) 3.7±0.50	(5.0-7.0) 5.75±0.96	(3.0-8.0) 5.25±2.22	(4.0-5.0) 4.5±0.58	(4.0-8.0) 5.75±1.71	
Post Monsoon	(4.0-9.0) 6.25±2.22	(4.0-8.0) 6±1.82	(7.0-15.0) 10.25±3.59	(9.0-15.0) 12.7±2.87	(4.0-12.0) 7.5±3.41	(6.0-10.0) 7.75±1.71	

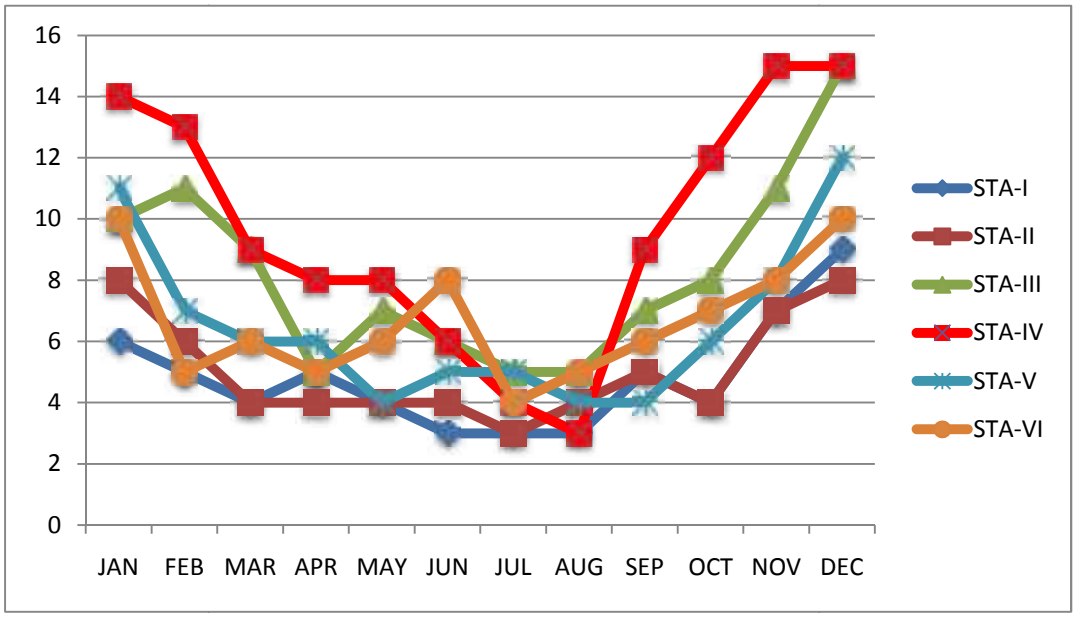

Fig. 19: Monthly qualitative variation of phytoplankton

3.5.2.2 Qualitative composition of Zooplankton:

During the present study, a total of 13 species of zooplanktons belonging to four categories of zooplankton viz. Cladocera represented by 6 species, Rotifera represented by 4 species, Copepoda represented by 2 species and Rhizopoda represented by 1 species was collected from the Doyang river. The list of Zooplankton diversity is given in the following Table 25.

Table 26: Zooplankton diversity in Doyang river system.

Sl. No.	Name of the species	Sl. No.	Name of the species
	Cladocera		**Copepoda**
1	*Diaphanosoma excisum*	*11*	*Cyclops sp.*

2	*Bosmina longirostris*	*12*	*Mesocyclops sp.*
3	*Alona sp.*		**Rhizopoda**
4	*Alona quadrangularies*	*13*	*Arcella sp.*
5	*Chydorus sphericus*		
6	*Pleuroxus denticulatus*		
	Rotifera		
7	*Cephalodella gibba*		
8	*Trichocerca rattus*		
9	*Asplanchna priodonta*		
10	*Polyartha vulgaris*		

Among the zooplankton, a total of 6 species was observed in all the six stations, which are *Asplanchna priodonta, Bosmina longirostris, Alona quadrangularies, Chydorus sphaericus, Cyclops sp.* and *Mesocyclops sp*. Two species, *Polyartha vulgaris* and *Diaphanosoma excisum* was found in 5 sites each (I, III-VI and I-V respectively). *Trichocerca rattus* was found in 4 stations (I-IV), while *Arcella sp.* was observed in stations III-VI. *Pleuroxus denticulatus* was ascertained in 3 stations (II-IV), *Cephalodella gibba* was collected only from station VI while *Alona sp*. was found only in station IV.

The mean seasonal and station wise variations of zooplanktons are depicted is Table 27. The mean qualitative richness of zooplankton ranged from 3.0-10.0 species, with an annual mean of 4.86 ±1.43. The maximum zooplankton richness 10.0 species (fig.20) was collected in the post monsoon month of December (station IV). The mean minimum zooplankton 3.0 species was predominantly observed during the monsoon months and

discretely during March, April, September and October in station VI.

Table 27: Mean qualitative richness of zooplankton in Doyang river system.

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(4.0-8.0) 5.25±1.89	(3.0-4.0) 3.5±0.58	(4.0-8.0) 5.75±2.06	(5.0-8.0) 6.25±1.50	(3.0-7.0) 5.0±1.82	(3.0-6.0) 4.5±1.73	(3.0-10.0) 4.86±1.43
Monsoon	(3.0-4.0) 3.75±0.5	(3.0-3.0) 3.0±0.00	(3.0-4.0) 3.5±0.58	(3.0-5.0) 3.75±0.96	(3.0-4.0) 4.0±0.82	(3.0-4.0) 3.5±0.578	
Post Monsoon	(5.0-7.0) 5.75±0.96	(4.0-8.0) 5.25±1.89	(4.0-8.0) 5.75±1.71	(6.0-10.0) 8.0±1.63	(4.0-7.0) 5.5±1.29	(3.0-8.0) 4.75±2.36	

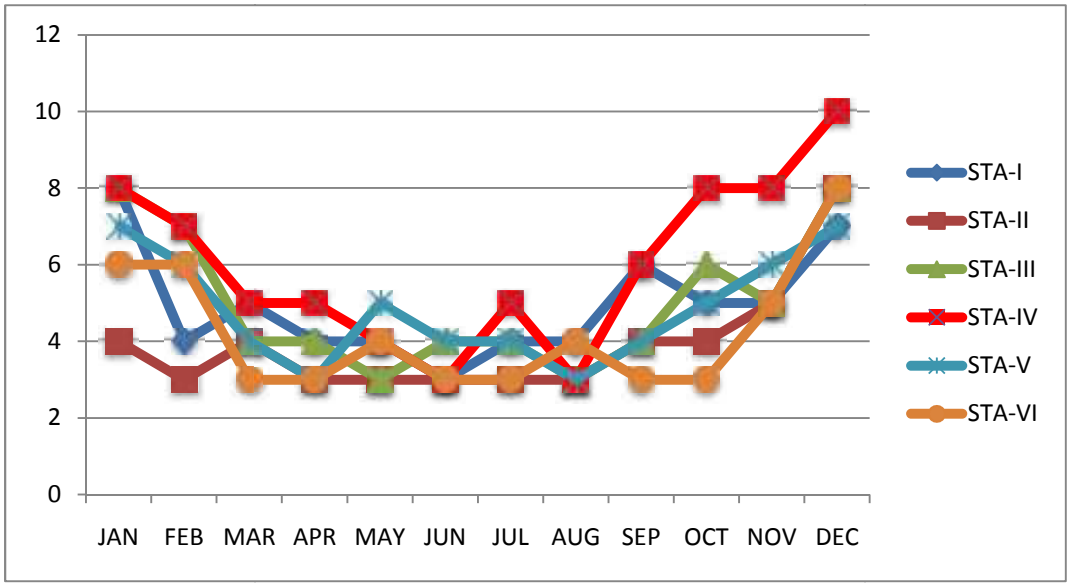

Fig. 20: Monthly qualitative variation of Zooplankton

3.5.2.3 Quantitative composition of Phytoplankton:

Seasonal and station wise variation of phytoplanktons are given in Table 28. Analysis indicated that density of phytoplankton was highest 110.0 ul^{-1} during pre monsoon period in the month of February in station IV, while the minimum was 20.0 ul^{-1} in the month of July in station II during the monsoon period. Annual mean value was found to be 55.57 ±12.15.

TABLE 28: Mean density of phytoplankton (ul^{-1}) in Doyang river system.

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(36-49) 40.5±5.92	(36-43) 39.2±3.30	(51-67) 59.2±6.55	(77-110) 95.2±13.65	(64-69) 67.5±2.38	(63-89) 76.2±10.81	(20-110) 55.57 ±12.15
Monsoon	(21-29) 24.2±3.40	(19-28) 23.7±4.92	(34-42) 37.0±3.55	(41-72) 56.2±14.24	(34-48) 42.5±6.81	(49-52) 54.4±6.14	
Post Monsoon	(25-38) 32.5±6.14	(30-47) 39.0±6.98	(52-60) 55.7±3.86	(82-109) 94.5±11.27	(63-77) 68.5±6.19	(81-103) 90.7±10.14	

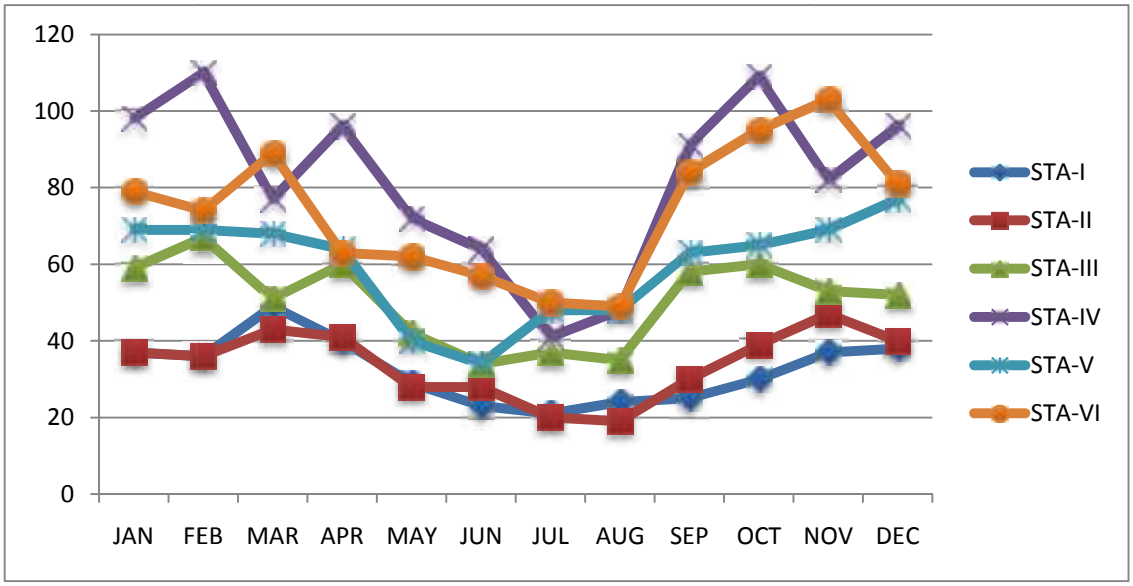

Fig. 21: Monthly quantitative variation of Phytoplankton

Among the phytoplankton categories, Chlorophyta recorded the highest value of 57.5 ±3.70 during post monsoon period in station VI while the lowest value was 11.75±2.5 in station II during the monsoon period (Table 29). Bacillariophyta registered maximum of 20.75±4.35 in station IV during pre monsoon while the minimum was 7.0±2.58 in station II during the monsoon period. Cyanophyta showed a maximum of 17.0±2.94 in station V during pre monsoon season while minimum was 5.00±1.82 in station I during monsoon. Dinophyta recorded maximum of 7.75±3.40 during post monsoon in station VI, while minimum recorded was 1.75±2.20 station V during monsoon period.

Table 29: Mean density of phytoplankton categories (ul^{-1}) in Doyang river system.

CATEGORIES	SEASON*	SITE-I	SITE-II	SITE-III	SITE-IV	SITE-V	SITE-VI
CHLOROPHYTA	1	18.75±2.99	16.75±2.5	31.5±5.07	56.25±13.77	33.5±6.03	46.0±7.83
	2	12.00±2.16	11.75±2.5	16.5±3.11	30.75±8.99	19.75±2.50	33.75±4.35
	3	11.76±2.63	15.5±2.08	29.75±2.5	53.25±11.26	34.5±4.20	57.5±3.70
BACILLARIOPHYTA	1	14.25±4.57	12.5±3.87	14.75±3.95	20.75±4.35	13.75±2.22	14.0±2.45
	2	7.25±1.71	7.0±2.58	10.25±2.06	16.5±3.51	9.0±1.41	11.0±2.58
	3	12.25±5.12	13.75±1.89	14.75±3.3	20.5±5.20	15.25±2.22	13.0±2.58
CYANOPHYTA	1	7.50±3.11	8.25±2.22	9.5±2.38	13.75±2.22	17.0±2.94	12.5±1.29
	2	5.00±1.82	5.25±2.22	8.0±2.16	9.0±2.16	12.0±2.58	7.0±1.41.00
	3	8.25±2.50	7.25±2.75	6.5±2.08	11.5±4.2	16.5±4.04	12.5±2.08
DINOPHYTA	1	-	1.76±2.62	3.5±1.73	4.5±2.09	4.0±2.64	3.75±3.85
	2	-	-	2.25±1.26	-	1.75±2.20	2.75±3.40
	3	-	2.5±3.22	4.75±2.22	6.75±5.86	2.25±2.80	7.75±3.40

*1=Premonsoon; 2=monsoon; 3=post monsoon

3.5.2.4 Quantitative composition of Zooplankton:

Seasonal and station wise variations of zooplankton are given in Table 30. Results indicated that density of zooplankton was recorded highest 39.0 ul^{-1} during post monsoon period in the month of September in station IV (fig. 21), while the minimum was 3.0 ul^{-1} preponderantly in station II during the monsoon months. Annual mean value was found to be 13.08 ±4.21.

TABLE 30: Mean density of zooplankton (ul^{-1}) in Doyang river system.

Season/ period	STATIONS						Annual Mean
	I	II	III	IV	V	VI	
Pre monsoon	(9.0-15.0) 11.5±2.52	(4.0-12.0) 9.2±3.59	(6.0-15.0) 10.2±4.03	(29.0-35.0) 32.2±2.75	(7.0-17.0) 11.7±4.57	(20.0-29.0) 23.0±4.24	(3.0-39.0) 13.08 ±4.21
Monsoon	(5.0-10.0) 7.2±2.22	(3.0-8.0) 4.2±2.50	(3.0-9.0) 6.0±2.45	(9.0-14.0) 11.2±2.22	(5.0-9.0) 7.2±1.71	(6.0-15.0) 9.7±3.86	
Post Monsoon	(9.0-16.0) 11.7±3.09	(4.0-9.0) 6.5±2.08	(10.0-15.0) 12.5±2.08	(34.0-39.0) 36.0±2.16	(10.0-16.0) 13.7±2.63	(6.0-15.0) 11.2±4.11	

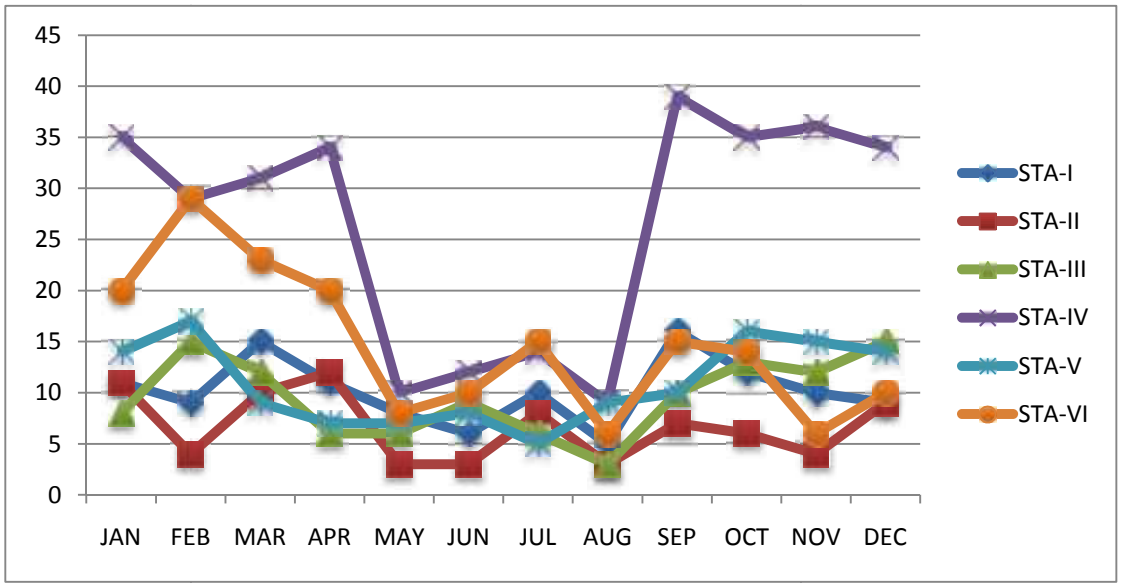

Fig. 22: Monthly quantitative variation of Zooplankton

The mean density of zooplankton groups exhibited variations (Table 31) with Rotifera recording a maximum density of 20.75 ±3.5 in station IV during post monsoon while minimum was 1.75 ±1.5 in station II during the monsoon period. Cladocera exhibited maximum value in stations III and VI with 4.00 ±1.41 and 4.00 ±1.82 respectively during post monsoon and a minimum of 1.75 ±0.96 in station III during the monsoon period. Copepoda depicted a maximum of 7.25 ±2.75 in station IV during pre monsoon while minimum values were registered mostly during the monsoon seasons in stations II, III and VI. Rhizopoda was recorded only from station V and VI with a maximum of 2.75 ±1.89 during post monsoon and minimum recorded value of 1.00 ±1.58 during the pre monsoon period.

Table 31: Mean density of zooplankton groups (ul^{-1}) in Doyang river system.

GROUPS	SEASON*	SITE-I	SITE-II	SITE-III	SITE-IV	SITE-V	SITE-VI
ROTIFERA	1	4.5±2.64	4.75±2.22	5±2.16	16±3.37	5±1.82	10.75±2.75
	2	2.5±1.73	1.75±1.5	3±1.82	4.75±1.71	3.5±1.91	6±2.16
	3	5.75±1.71	3.25±1.71	6.75±2.22	20.75±3.5	6±1.63	5±1.82
CLADOCERA	1	3±0.82	2.5±1.29	3.5±2.38	9±2.16	3.75±1.71	7.5±2.64
	2	2.25±1.26	1.25±0.5	1.75±0.96	3.75±1.71	2.5±1.29	2.5±1.29
	3	3.75±2.99	1.5±0.58	4±1.41	10±1.82	3.25±1.71	4±1.82
COPEPODA	1	3.25±1.5	2±1.41	1.75±0.96	7.25±2.75	2±0.82	4.75±2.22
	2	2.5±1.91	1.25±0.5	1.25±0.5	2.75±1.5	1.25±0.5	1.25±1.25
	3	2.25±1.26	1.75±0.96	1.75±0.96	5.25±2.5	1.75±0.96	2.25±0.96
RHIZOPODA	1	-	-	-	-	1±1.58	-
	2	-	-	-	-	-	-
	3	-	-	-	-	2.75±1.89	0.25±0.59

*1=Premonsoon; 2=monsoon; 3=post monsoon

7.3 Correlationship of physico-chemical parameters and planktons on ichthyofaunal distribution

Biological production in any aquatic body gives direct correlation with its physico-chemical states which can be used as trophic status and fisheries resource potential (Jhingran et al 1969). Life in aquatic environment is largely governed by physico-chemical characteristics and their stability. Analysis of biological materials along with chemical characteristics of water forms a valid method of water quality assessment (Cairns and Dickson, 1971). However, It is also pertinent to note that hilly streams or rivers does not support a strong planktonic community, and that those present are carried out by currents from sheltered bays into the main stream (Lauterborn. 1893). The station wise variation of water quality parameters of the river has a marked influence on the numerical abundance of planktons and the fish fauna. Hence, the physico-chemical characteristics, planktonic and ichthyofaunal abundance in different stations along the course of the river are correlationally discoursed.

As given in table-32, station –I was characterized by mean readings of 17.3°C and14.0°C for air and water temperature respectively, water current 0.66 m/sec, pH 6.9, dissolved oxygen 10.9 mg/l, free Carbondioxide 4.5mg/l, TDS 86.4 mg/l, total alkalinity 50.2mg/l, total hardness 53.4 mg/l, chloride 10.1 mg/l, phosphate 0.03 mg/l, nitrate 0.12 mg/l, nitrite 0.026 mg/l and ammonium 0.02 mg/l. The mean planktonic abundance was 4.83 and 4.92 for phytoplanktons and zooplanktons respectively and the predominant species of zooplankton were *trichocerca rattus and Cyclops sp.* while phytoplanktons were *Mougeotia*, *Pediastrum* and *Cyclotella spp.* Correspondingly, in station-I a maximum of 25 species was found within this physico-chemical ranges with dominant fish species such as *Barilius bendelisis, Danio aequipinnatus, Puntius sophore, Bangana dero, Garra gravelyi, Psilorhynchoides homaloptera* and *Olyra longicaudata*.

TABLE 32: Correlationship of the mean values of physico-chemical parameters and planktons with the ichthyofaunal distribution.

Sl. No	Parameters	STATIONS*					
		I	II	III	IV	V	VI
I.	**Physico-chemical**						
1.	Air temp. (°C)	10-24 (17.3±5.28)	10-26 (17.5±6.16)	11-27 (18.2±6.11)	10-26 (18.3±6.08)	12-29 (19.9±6.64)	11-28 (19±5.75)
2.	Water temp. (°C)	9-18 (14±3.27)	9-22 (14.7±4.89)	10-24 (15.8±4.95)	11-26 (17.7±5.63)	10-24 (15.9±5.18)	10-25 (16.3±5.66)
3.	Water current (m/sec)	0.535-0.966 (0.66±0.202)	0.476-0.931 (0.65±0.168)	0.465-0.945 (0.65±0.170)	0.303-0.737 (0.53±0.161)	0.425-0.871 (0.60±0.176)	0.407-0.837 (0.563±0.164)
4.	pH	6.7-7.2 (6.9±0.17)	6.7-7.3 (6.9±0.16)	6.4-7.8 (7.2±0.40)	6.9-7.6 (7.2±0.27)	6.5-7.5 (7±0.31)	6.9-7.7 (7.3±0.29)
5.	Dissolved oxygen (mg/l)	9-12 (10.9±0.996)	8-12 (10.3±1.37)	8-13 (10.2±1.48)	9-13 (10.4±1.24)	8-12 (9.50±1.31)	8-12 (10.1±1.38)
6.	Free carbondioxide (mg/l)	4.1-4.8 (4.5±0.23)	4.2-4.9 (4.6±0.22)	4.3-5.1 (4.7±0.24)	4.6-5.9 (5.2±0.40)	4.8-5.8 (5.2±0.31)	4.7-5.4 (4.9±0.70)
7.	TDS (mg/l)	58.3-126.7 (86.4±25.24)	79-142 (103.2±22.62)	93.3-186.7 (134.3±30.57)	90.3-156 (122.2±23.63)	86.7-167.3 (121.9±26.06)	85-161.7 (113.7±26.03)
8.	Total alkalinity (mg/l)	46.7-52.3 (50.2±1.53)	50.5-57.1 (51.6±2.30)	48.9-58.7 (52.8±3.06)	49.9-58.1 (53.0±3.55)	48.2-58.5 (53.5±3.43)	50.1-58.0 (54.3±3.04)
9.	Total Hardness (mg/l)	48.3-58.7 (53.4±3.35)	47.9-57.7 (53.9±3.24)	48.4-60.3 (54.7±3.56)	49.5-59.9 (54.7±4.09)	50.4-60.3 (56.1±3.33)	49.9-60.6 (56.1±3.75)
10.	Chloride (mg/l)	8.8-13.3 (10.1±1.13)	8.9-13.2 (10.3±1.17)	8.3-12.6 (10.3±1.65)	7.7-11.8 (9.8±1.24)	8.2-12.2 (9.8±1.22)	8.9-12.7 (10.6±1.51)
11.	Phosphate (mg/l)	0.01-0.05 (0.03±0.022)	0.01-0.09 (0.03±0.026)	0.01-0.09 (0.02±0.025)	0.01-0.07 (0.02±0.019)	0.01-0.09 (0.03±0.025)	0.01-0.09 (0.03±0.032)
12.	Nitrate (mg/l)	0.02-0.4 (0.12±0.150)	0.01-0.6 (0.13±0.197)	0.01-0.5 (0.13±0.191)	0.01-0.2 (0.061±0.053)	0.01-0.5 (0.14±0.170)	0.02-0.2 (0.07±0.068)
13.	Nitrite (mg/l)	0.01-0.05 (0.026±0.012)	0.01-0.05 (0.024±0.016)	0.01-0.04 (0.019±0.010)	0.01-0.04 (0.022±0.012)	0.01-0.04 (0.021±0.011)	0.01-0.04 (0.020±0.010)
14.	Ammonium (mg/l)	0.01-0.03 (0.02±0.008)	0.01-0.04 (0.02±0.011)	0.01-0.06 (0.03±0.018)	0.01-0.05 (0.02±0.015)	0.01-0.06 (0.03±0.014)	0.01-0.05 (0.02±0.012)
II	**Planktons**						
1.	Phytoplanktons distribution	3-9 (4.83±1.80)	3-8 (5.08±1.72)	5-15 (8.25±3.08)	3-15 (9.67±4.14)	4-12 (6.50±2.64)	4-10 (6.67±1.97)
2.	Zooplanktons distribution	3-8 (4.92±1.44)	3-8 (3.92±1.44)	3-8 (5.00±1.81)	3-10 (6.00±2.21)	3-7 (4.83±1.40)	3-8 (4.25±1.66)
III	**Ichthyofaunal distribution**	25	27	31	19	22	15

*Stations: I. Chakabama, II. Kidzumetouma, III. Mukhami, IV. Pangti, V. Longtshung, VI. Liphiyan.

Station-II was characterized by mean readings of 17.5°C and 14.7°C for air and water temperature respectively, water current 0.65 m/sec, pH 6.9, dissolved oxygen 10.3 mg/l, free carbondioxide 4.6 mg/l, TDS 103.2 mg/l, total alkalinity 51.6 mg/l, total hardness 53.9 mg/l, chloride 10.3 mg/l, phosphate 0.03 mg/l, nitrate 0.13 mg/l, nitrite 0.024 mg/l and ammonium 0.02 mg/l. The mean planktonic species abundance was 5.08 and 3.92 for phytoplanktons and zooplanktons respectively and the predominant species of zooplankton were *Asplanchna priodonta,Chydorus sphericus* and *Cyclops* etc and *Mougeotia sp., chaetophora sp.* and *cyclotella sp* etc for the phytoplanktons. Correspondingly, in station-II a maximum of 27 species was found within this physico-chemical ranges with dominant fish species such as *Barilius bendelisis, Danio aequipinnatus, Danio dangila, Puntius sophore, Puntius ticto, Garra gravelyi, Garra naganensis* and *Psilorhyncoides homaloptera.*.

Station-III was characterized by mean readings of air temperature 18.2°C and 15.8°C for water temperature, 0.65 m/sec for water current, 7.2 for pH, dissolved oxygen 10.2 mg/l, free carbondioxide 4.7 mg/l, TDS 134.3 mg/l, total alkalinity 52.8 mg/l, total hardness 54.7 mg/l, chloride 10.3 mg/l, phosphate 0.02 mg/l, nitrate 0.13 mg/l, nitrite 0.019 mg/l and ammonium 0.03 mg/l. The mean planktonic species abundance was 8.25 and 5.00 for phytoplanktons and zooplanktons respectively and the preponderant species of zooplankton were *Polyartha vulgaris, chydorus sphericus* etc. and *Mougeotia sp., Pediastrum duplex, Chaetophora sp, Oscillatoria* etc for the phytoplanktons. In station-III a maximum of 31 species was found within this physico-chemical ranges with dominant fish species such as *Danio aequipinnatus, Neolissocheilus hexastichus, Labeo bata, Labeo pangusia, Garra gotyla gotyla, Schistura prashadi* and *Glyptothorax cavia*.

Station-IV was featured by mean values of air temperature 18.3°C and 17.7°C for water temperature, 0.53 m/sec for water current, 7.2 for pH, dissolved oxygen 10.4 mg/l, free carbondioxide 5.2 mg/l, TDS 122.2 mg/l, total alkalinity 53.0 mg/l, total hardness 54.7 mg/l, chloride 9.8 mg/l, phosphate 0.02 mg/l, nitrate 0.061 mg/l, nitrite 0.022 mg/l and ammonium 0.02 mg/l. The mean planktonic species abundance was 4.83 and 4.92 for phytoplanktons and zooplanktons respectively and the preponderant species of zooplankton were *Asplanchna priodonta, Polyartha vulgaris, Bosmina longirostris, chydorus sphericus and Cyclops sp* etc. and *Mougeotia sp., Pediastrum duplex, Zygnema sp, Gomphonema sp and Gloecapse sp* etc for the phytoplanktons. In station-IV a maximum of 19 species was found within this physico-chemical ranges with dominant fish species such as *Puntius sophore, Catla catla, Labeo rohita, Neolissocheilus hexagonolepis* and *Cyprinus carpio.*

Station-V was characterized by mean readings of air temperature 19.9°C and 15.9°C for water temperature, 0.60 m/sec for water current, 7.0 for pH, dissolved oxygen 9.50 mg/l, free carbondioxide 5.2 mg/l, TDS 121.9 mg/l, total alkalinity 54.3 mg/l, total hardness 56.1 mg/l, chloride 9.8 mg/l, phosphate 0.03 mg/l, nitrate 0.14 mg/l, nitrite 0.021 mg/l and ammonium 0.03 mg/l. The mean planktonic species abundance was 6.50 and 4.83 for phytoplanktons and zooplanktons respectively and the preponderant species of zooplankton were *Polyartha vulgaris* and *chydorus sphericus* etc. while for phytoplanktons the preponderant species were *Mougeotia sp., Pediastrum duplex, Chaetophora sp, Oscillatoria* etc. As such, in station-V a maximum of 22 species was found within this physico-chemical ranges with dominant fish species such as *Danio aequipinnatus, Tor putitura, Puntius ticto, Labeo pangusia, Garra gravelyi, Amplceps apangi* and *Channa punctatus.*

Station-VI was featured by mean values of air temperature 19.0°C and 16.3°C for water temperature, 0.56 m/sec for water current, 7.3 for pH, dissolved oxygen 10.1 mg/l, free carbondioxide 4.9 mg/l, TDS 113.7 mg/l, total alkalinity 54.3 mg/l, total hardness 56.1 mg/l, chloride 10.6 mg/l, phosphate 0.03 mg/l, nitrate 0.07 mg/l, nitrite 0.020 mg/l and ammonium 0.02 mg/l. The mean planktonic species abundance were 6.67 and 4.25 for phytoplanktons and zooplanktons respectively and the preponderant species of zooplankton were *Polyartha vulgaris and Cyclops sp* etc. while dominant phytoplanktons were *Mougeotia sp., Pediastrum duplex, Cyclotella sp, Oscillatoria sp* and *Ceratium hirudenella* etc for the phytoplanktons. In station-VI a maximum of 15 species was found within this physico-chemical ranges where dominant fish species were *Barilius bendelisis, Danio aequipinnatus, Neolissocheilus hexagonolepis, Puntius ticto, Labeo bata, Crossocheilus latius latius* and *Channa punctatus.*

3.6 FISHERIES AND LOCAL FISHING TECHNIQUES AND GEARS

3.6.1 Fisheries of Doyang river system:

In Doyang river system, Small scale or artisanal capture fishery is the only fishing system prevailing which is widely scattered and unorganized. In the whole stretch of the river system only a lesser number of fishermen are actively involved in subsistence fishery except around station IV which covers the Doyang Dam reservoir area, where a good number of regular fishermen are actively engaged. Being a torrential hill stream Doyang river though abounding a diversity of fishes, supports mainly small hill stream fishes. In the present investigation, abundantly captured fishes in the different stations included *Barilus bendelisis, Danio aequipinnatus, Neolissochilus hexagonolepis, Tor putitura, Puntius sophore, Puntius ticto, Labeo bata, Labeo pangusia, Labeo rohita, Catla catla, Garra gotyla gotyla, Garra naganensis, Garra gravelyi, Garra lissorhynchus, Crossocheilus latius latius, Psilorhyncoides homaloptera, Glyptothorax telchitta, Channa punctatus, Badis badis* and *Mastacembelus armatus.*

During the present study, it was also found that except the Doyang reservoir there was no permanent fish landing centers. As such, fish landing could not be estimated accurately in the different stations due to inconsistencies in the catch of the fishes. Hence, with respect to the fish landing, the Doyang reservoir fishery was covered during the present travail.

3.6.1.1 Doyang reservoir fishery:

The Doyang reservoir is located between 26°13’10” N L and 94°18’ 30’’ E L and has a reservoir area of 3,407.73 ha with a catchment area of 2,606 ha. The major fish species caught from Doyang reservoir was the Indian major carps especially *Catla catla* and *Labeo rohita* and exotic carps predominantly *Cyprinus carpio* rather than the natural stock of fishes. This dominance is because of stocking of fingerlings of IMC and exotic carps into the reservoir at the rate of catla (30%), rohu (25%), mrigal (20), grass carp (10%), silver carp (5%) and common carp (10%). The Doyang reservoir fishery serves as a source of livelihood subsistence for many fishermen (200-400 persons) and as an employment generation avenue for the 19 villages surrounding it. During the study period from January 2008- August 2010, it was found that there are 5 fish landing centers (FLC) viz. Luxio FLC, Janbemo FLC, Saliu FLC, Jentsü FLC and Jenthungo FLC around the reservoir which procures the fishes caught by the fishermen every day. From data analysis it was inferred that Luxio FLC accounted the highest landing with 28.6%, Saliu and Janbemo FLC’s with 23.8% each, while Jentsü FLC accounted 16.7% and Jenthungo FLC accounted the lowest landing with 7.1%. The consolidated monthly landing of fishes from the different FLC’s around the Doyang reservoir is given in the following Fig. 5. In Doyang reservoir, the peak fishing season was found to be during the monsoon period while the lean fish production was during the pre monsoon period. The calculated annual total fish production during the study period was found to be 2,09,000 – 2,10,000 kg/ha. Thus, the productivity of Doyang reservoir was calculated to be 61.48 kg/ha/yr.

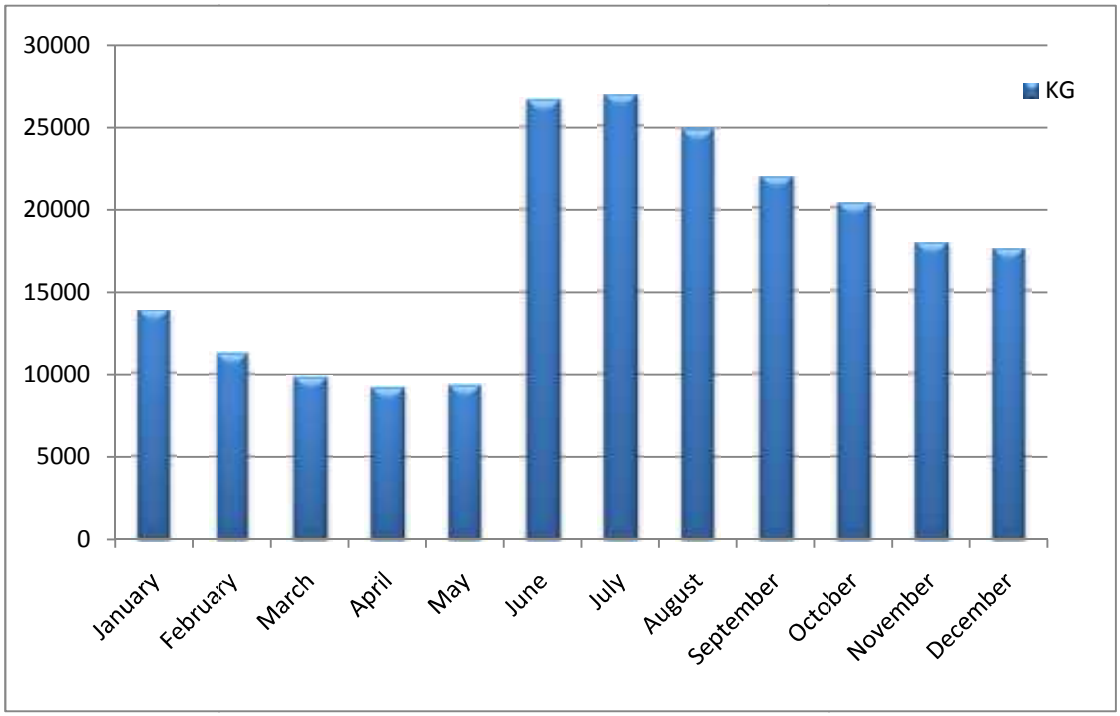

Fig. 23: Consolidated monthly fish landing in the FLC's

3.6.2 Local fishing techniques and gears

Selection of fishing methods and gears are influenced by various factors such as physiographic of the water body, nature of fish stock, characteristics of the raw material from which gear are fabricated and standard of living (Choudhury, 1992). Therefore, variation in application of gear can be observed in different rivers, which have characteristic of their own due to unique nature of the water resources of the region (Gurumayum and Choudhury, 2009). As such, the different techniques and gears prevalently used along the length of Doyang river system are described herewith. The pictorial representations of various fishing gears are given in Plates XI & XII.

3.6.2.1 Asetdang (diversion of river channel):

This technique is highly prevalent throughout the river and is used for catching all species of fishes within a target area. During dry season when the water volume is reduced, the shallow part of the river is bifurcated by constructing a dam using bamboo mats, large tarpaulins, stones, clay and mud to prevent leakage of water. Fish traps are placed downstream in the dammed side of the river to prevent escape of fish. As the water flow gradually stops, the river bed dries up and the fishes are easily harvested. In this way most fishes within the target area are caught. This method can be successfully implemented by a group of 10 persons and above. However, this method is considered destructive as there is wanton harvesting of all aquatic fauna in that area.

3.6.2.2 Etsük (Cast netting):

Cast net is a stringed, meshed bell shaped net made of strong cotton threads or nylon. It is thrown in the river to catch fish. This cast net has varying mesh size ranging from 0.5 to 2.0 cm covering an area of 4.5m^2 when fully spread and thrown into the river. This cast net is

operated by an individual. Small hill stream fishes such as *Barilius, Danio, Esomus, Garra spp* etc. are mostly caught by it. Cast netting is generally considered not a destructive method however netting during breeding season may cause loss of brood fishes.

3.6.2.3 Pangshi chal (Gill netting):

Gill net is a rectangular mesh net usually made of strong nylon with strings attached at the corners to attach the net in the river or usually across a river below the water surface. The mesh size of this gill net varies from 1.0 – 15.0 cm and depending on the fish the mesh size is accordingly used. Fishes moving up and down the river get entangled in the net by their gills. After a certain time the nets are checked and the attached fishes are collected from it. This gill net accounts for most fishes caught in Doyang reservoir. Gill netting is usually considered not a destructive method but netting during breeding season causes loss of brood fishes.

3.6.2.4 Tsüteptsü (Scoop netting):

Scoop net consists of a rectangular, triangular or rounded wooden or metallic frame with a handle. Attached to the frame is an ovoid meshed net of varying size from 0.5 – 2.0 cm. this fishing net scoops out the fishes from the water. It is used when fishes are cornered or together with other techniques like river poisoning, liming, river diversion and electro-fishing. Scoop netting is not itself a destructive gears though it can be destructive when used with other techniques.

3.6.2.5 Porki (Hooks and lines/Angling):

Angling is a popular sport fishing method to catch fishes with a fishing rod. It consist of a slender rod where a fine strong nylon or cotton thread is tied to the tip of the rod and to the

other end of the thread a hook is attached. Just above the hook, a small lead piece or stone is attached to sink the hook into the water. Bait (usually earthworm, small fishes, piece of meat) is attached in the tip of the hook and immersed in prospective sites in the river. Fishes while eating the bait are caught by their palate and are fished out of the water. Fishes like Tor, Mastacembelus, and Neolissocheilus spp. are usually caught by this method. This method is not considered destructive.

3.6.2.6 Rock striking/hammering:

This process of fishing is done with the help of a sledge hammer. Large prospective flat rocks are selected in the shallow waters of the river and are struck with the sledge hammer. The intensive vibrations and sound produced shocks and paralyses the fishes hiding below the rocks and the fishes slides out into the open water during which the fishes are caught. Fishes such as Barilius, Garra, Tor, Neolissocheilus, Channa spp. are mostly caught by this hammering. This method is considered moderately destructive as it kills all the fishes hiding beneath the rock.

3.6.2.7 Electro-fishing:

Electro-fishing contraption consist of a back pack in which a 12 volt battery is carried. Attached to the battery are two poles with metal wires attached, serving as electrodes (cathode and anode) provided with a switch to regulate the current flow. Fishes are caught by passing an electric current via the electrodes into the water near the fishes. The current emitted stuns the fishes which becomes disoriented or electrocutes the fishes and are easily captured by a scoop net. By this method all types of small fishes are caught and hence considered very destructive.

3.6.2.8 River poisoning (Liming, bleaching powder, plant extracts):

In this method, a certain stretch of river is poisoned by pouring lime or bleaching powder or plant extract poisons (*Diospyros, Juglans spp.* etc) into the river which kills all aquatic fauna. The dead fishes float along the whole stretch on the water during which it is collected before the fishes get swept away by the current. This method is considered very destructive as it causes wanton destruction of all aquatic life and further pollutes the river.

3.6.2.9 Explosives:

In this method, gelatine sticks or dynamites are used for getting the fishes. Potential deep pools or certain areas in the river are selected and short pieces 2.5-3.0 cm of dynamites tied to a small rock for quick sinking, attached with a fuse are lighted and hurled into the selected site of the river. During which the explosion stuns and paralyses or in most cases kills the fishes which starts floating on the water. The fishes are then collected by a scoop net or swimmers are engaged to collect the fishes from the river. This method is considered destructive as it kills all aquatic fauna in the target area.

3.6.2.10 Indigenous traps

i. Longr kago:

Literally the word longr kago means Kryptopterus trap. It is a rectangular trap made of split bamboos sticks which are closely tied together with nylon threads or cane strings forming a cuboid shaped structure. Except on one side, the entire side walls are made in the same way. In the opened side, another small spirally twisted funnel shaped piece is fixed at its mouth, which served as an entry point for the fishes but cannot escape out. This trap is generally placed near

boulders and rocks in the river. Some heavy object is placed on the top of the trap to hold against the water current. Fish species of the genus *Kryptopterus, Mastacembelus, labeo etc* are caught by this trap.

ii. Atep Kago:

Atep kago is made of split bamboo meshed together. It is a two piece trap, a smaller funnel shaped with a long pole towards the narrow end which is placed above and inside the larger wide mouthed dumbbell shape piece. The trap is fixed with its wide mouth set against the water current in slightly steep slopes. Stones and rocks are put inside the larger piece to hold the trap in position in the river. Small to medium sized fishes of genus like *Danio, Esomus, Schistura, Badis, Barilius spp*. etc. travelling with the water current are carried into the trap. This is a very common technique practiced not only by fishermen but by most farmers cultivating near the riparian areas.

iii. Talu-Tatu kago:

This trap is somewhat rectangular or box type in shape, made of split bamboo sticks tied with the help of nylon thread or cane strings. On two sides placed oppositely, two openings are made laterally. One opening faces in one direction and the other faces in the opposite direction. In the openings, conical structure made of the split bamboos are placed to deter the fishes from escaping once they are inside. In the trap, bait such as chicken or animal entrails are kept to lure the fishes into the trap. In this way fishes are caught by this trap. Bi-directionally fishes are caught by this trap, those fishes going upstream and those that go downstream.

iv. Kongti Kago:

This trap is similar to Atep kago. It is also a two piece trap made of tender split bamboo meshed together and fastened by nylon threads or cane string with a pole attached on the distal

part of the larger piece. Both the two piece are funnel shaped except that one is larger than the other so that the smaller piece can be kept on top of the other. Stones or rocks are put between them to hold the trap in position when placed in the river. This trap is commonly used during monsoon when the water volume is big and the water is turbid. Usually, 4-5 traps are fixed in the river supported by a long bamboo placed across the river. By this technique a good amount of fishes are caught. Species like *Barilius, Danio, Neolissocheilus, Tor, Labeo spp.*etc. are generally caught by this trap.

v. Kago:

This trap is cuboidal in shape and made of commonly used split bamboo sticks which are fastened together with nylon threads or cane strings. The size is usually 1.5 X 2.0 ft. on one side there is an opening which is devised to allow fishes into the trap but prevent fishes from escaping out of the trap. This trap is usually positioned in deeper waters with an enclosed bait such as flour dough to lure the fishes. Fishes such as *Labeo, Catla, Cypinus spp.* etc. are commonly caught by this trap.

vi. Paa:

This is an on-the-river built structure, the shape and materials used vary according to the builders but the principle and purpose remains the same. Wooden poles measuring about 3-5 ft are tied to each other in the shape of a rectangle and tied with ropes or cane strings. This frame is placed in the river against the water flow and allowed to position upright using stones or rocks available in the area. A wire mesh or nylon net is carefully placed, with one side of the mesh attached to the upper part of the wooden frame and the middle part of the mesh allowed to hang loosely. The other end of the mesh net is attached strongly in the river bed with the

help of stones or sometimes with poles. The water flows through the mesh net and the fishes gets stranded in the wire mesh or net. This structure is usually built in shallower part of the riverbed. This technique is also used in concurrence with river diversion technique and river poisoning. A huge amount of fishes are caught by this method.

CHAPTER 4

GENERAL DISCUSSION

CHAPTER 4

GENERAL DISCUSSION

Geomorphology of the river Doyang:

Geomorphologically, the dynamic relationship between the river and the land is shaped by the river's fluvial characteristics and involves the interconnected processes of erosion, transportation of materials and deposition. In natural condition, aquatic environment and river system adapts with each other and keeps a balance between them. The present geomorphologic studies of Doyang river system revealed that in upper zone the erosion process was found predominated, with mean gradient of 8.2 m/ km. The middle region was characterized by a gradient of 2.4 m/km with reduced velocity of water current. In the lower zone of the river, sedimentation and river bed aggradation were observed, with an average gradient of 1.95 m/km. Large bed forms or sand bar formations on the bed of the river due to siltation's were observed along the course of the river system, which are more pronounced in winter due to reduce water level. River meandering due to ongoing bed and bank deformation by the river flow is also observed which increases the width and sinuosity of the river bank. Especially, on the upstream of the Doyang dam, river bank erosion due to the action of the flooded river flow on the new and non-cohesive soils eroding the river bank was observed during the present study. The vegetation of riparian zone was predominantly covered by woody forest and shrubs on both sides of the river banks. Human habitations on river banks were the main source of discharging the sewage, farmyard washings, agricultural waste, pesticides etc. into the river system. The geomorphological study of different drainage system

of Assam and Meghalaya were made by a few workers namely Dikshit (1990), Kumar et al. (1990), Borah and Goswami (2006), Prasad and Biswas (2011), which are in accordance with the present investigation on Doyang river system of Nagaland.

Systematic account and description of the fishes:

In the present ichthyofaunal studies, a total of 46 species belonging to 5 orders, 15 families, 8 subfamilies and 31 genera were identified from Doyang river system, Nagaland during January 2008 – August 2010. Order Cypriniformes was represented by a maximum number of 32 species (69.60%) followed by Siluriformes 7 species (15.20%), Perciformes 4 species (8.70%), Synbranchiformes 2 species (4.30%), Beloniformes 1 species (2.20%). The complete description of the ichthyofauna based on the morphometric and meristic account was presented and the colored photographs of all the ichthyofauna were also depicted in Plate-I-VI exhibiting morphological characteristics of the species in live condition. Jayaram (1999) reported that the major percentage of freshwater fish species in India belonged to 3 orders viz. Cypriniformes (51%), Siluriformes (19%), Perciformes (15%). Similar observations were also made by Borah and Goswami (2006) and Bendangkokba and Ahmed (2007) on percentage wise distribution of ichthyofauna in Assam and Mokokchung district of Nagaland respectively which were in conformity with the present findings.

Occurrence and seasonal abundance of ichthyofauna in Doyang river system:

Occurrence and seasonal abundance in different stations namely station-I (Chakabama), station-II (Kidzumetouma), station-III (Mukhami), station-IV (Pangti), station-V (Longtshung) and station-VI (Liphiyan), along with the 8 major tributaries and in different seasons viz. Pre-monsoon (January-April), Monsoon (May-August) and Post monsoon (September-December) showed a great variation of Ichthyofauna during the present investigation. Out of the 46 species recorded from Doyang river system, 25 species were recorded from Station-I, 27 species were collected from station-II, maximum of 31 species from station-III, 19 species from station IV, 22 species from station-V and 15 species were registered from station-VI. From the 8 different tributaries covered during the present study viz. Sidzü, Dzülü, Tishi, Chubi, Nzü, Nrü, Bagthy and Rengmapani rivers, varying records of ichthyofauna was observed. Sidzü river registering a total of 22 species, while Dzülü river recorded 21 species, Tishi river recorded 16 species, Chubi river recorded the maximum with 24 species while Nzü river recorded 20 species, 21 species was collected from Nrü river, 22 species from Bagthy river while 15 species was collected from Rengmapani river. With respect to the seasonal abundance 30 species was found abundantly during pre monsoon period, 42 species during monsoon period and the maximum seasonal abundance of 45 species was registered during post monsoon period in the river system. Similarly, the occurrence and seasonal abundance of fish species in various drainage systems in North East region were recorded by several workers (Sugunan, 2001, Sen, 2000 and Bendangkokba and Ahmed, 2007) which were also in accordance with the present findings.

Categorization of Ichthyofauna:

The ichthyofaunal diversity of Doyang river system, Nagaland were further evaluated as ornamental fishes because of their colour pattern, size, unusual body morphology, strange locomotive deportment and rare occurrences of the species. They were categorized as classified (16 species) and non-classified (30 species) ornamental fishes. Bendangkokba and Ahmed (2007) while studying the ichthyofaunal distribution in the river of Mokokchung district, Nagaland also categorized 44 species as classified ornamental fishes and 21 species as non-classified ornamental fishes. Similarly, Ao et al (2008) had also categorized the fishes found in Nagaland into 70 species as classified ornamental fishes and 48 species as non-classified ornamental fishes. Similar observations on fish fauna of Nagaland were also made by Sarmah (2002).

As regards to food fish, except for a few species like *Badis badis, Esomus danricus* etc. all the fishes occurring in the Doyang river system has potential as food fish. Even the small size fishes are considered under food fishes due to their flavor and taste. Out of the total 46 species, 44 species were classified as food fishes while a total of 11 species were classified as sport fishes. This categorization of ichthyofauna were in accordance with the earlier findings of Sarker and Ponniah (2000) who categorized 38 fishes of Nagaland into 13 species as food and aquarium fishes, 3 species as food and sports fishes, 8 species as food fishes, 13 species as sole aquarium fishes and 1 species in uncategorized status. Bendangkokba and Ahmed (2007) had also categorized the ichthyofauna found in Mokokchung district into 61 species as food fish, 11 species as commercially important and 14 species as sport fishes.

During the present study, the conservational status of the ichthyofauna was also analyzed based on the CAMP report (Molur and Walker, 1998). The 46 species of Doyang river system

were thus classified into 14 species under Low risk- Near threatened (Lr-nt), 12 species under Vulnerable (VU), 2 species under Endangered (EN), 1 species as Critically endangered (CR) while 17 species were not evaluated. Similarly, Sarker and Ponniah (2000) also categorized 38 fish species into 8 as endangered, 13 as vulnerable, 5 species as low risk near threatened, 1 species as low risk least concerned, 9 species and 2 species as not evaluated and data deficient respectively. Accordingly, Ao et al (2008) has also reported that out of the 149 species found in Nagaland, 29 species of fish were considered as higly endangered, 44 species as vulnerable while near threatened status constituted 30 species.

Physicochemical parameters:

The physico-chemical parameters of water depend upon several factors including location of water bodies, type of sewage and domestic waste disposal, localized human population and their activities. The enrichment of nutrients also occurred due to disposal of domestic and industrial effluents, which supports the growth of variety of microphytic vegetation and microbes in the aquatic system (Rao et al, 2003). During the present undertaking, seasonal and station wise variations of the 14 physico chemical parameters were comprehensively studied.

Temperature is one of the important physical parameter which plays an important role in distribution of fish species. The maximum air temperature 29°C was recorded in August during monsoon and that of minimum 10°C was recorded in January during pre monsoon period, with an annual mean of 18.4°C ± 5.80. The range of water temperature of the river Doyang was varied from 9°C in pre monsoon period to 26°C during monsoon period, with an annual mean of 15.7°C ± 4.92. The minimum and maximum water temperature of the river showed a clear correlation with atmospheric temperature. Air and water temperature plays

important role in the physico-chemical and physiological behavior of biotic components of aquatic ecosystem (Sawant et al., 2010). In the present study, the water temperature was found to be directly influenced by air temperature and hence showed a downward trend from September to march, followed by an upward trend during the hot months. Similar seasonal trend in respect of air and water temperature were also reported by several workers (Kaur & Joshi, 2003; Mishra & Tripathi, 2003; Zafar & Sultana, 2008; Ganai et al., 2010; Patil et al., 2011).

pH is an important factor that governs the survival and growth of the fishes. The pH of Doyang river was found to be almost neutral and the seasonal variations were observed within a very narrow range. It ranged from pH 6.4 to a maximum of pH 7.8, with an annual mean of 7.1 ± 0.303. No marked difference in pH values was observed during pre monsoon and post monsoon periods. The highest value of 7.8 was recorded in the month of February during pre monsoon and the minimum value of 6.4 was recorded in the month of July during monsoon period. The lower values of pH in monsoon period were also observed by Riddhi et al., 2011. The pH of natural waters is due to available nitrogen concentrations and mostly it lies within the range of 6.5 to 8.5 (Webber & Stumm, 1963). In NE region the pH of water was found to be slightly acidic in relatively high altitude system (Gupta et al, 1992; Mukhopadhyay, 1996). The pH value 6.5 to 8.5 usually indicates good water quality and this range is typical of most major drainage basins of the world (Carr & Neary, 2008). The observed pH of Doyang river indicates good water quality as it falls within the normal range of pH 6.5 to 8.5.

The water current is a major controlling factor in lotic habitat which controls the occurrence and abundance of species (Upadhya & Verma, 2004). A wide variation of water current from 0.303 m/sec to 0.966 m/sec, was observed during the study period, with an

annual mean of 0.611m/sec ± 0.175. The maximum mean water current (0.966 m/sec) was recorded in August during monsoon period and that of minimum of 0.303 m/sec in April during pre monsoon period. The minimum water current during pre monsoon period could be due to flat nature of the basin and also because of low discharge in dry season. The findings of the present study are in agreement with that of Singh (1999) and Singh et al. (2009).

The dissolved oxygen (DO_2) is one of the most important parameters of water quality assessment. It plays an important role on the biotic life of a river system and this can be used as an index of water quality for pollution studies (Thirumala et al., 2011). The concentration of dissolved oxygen of the river was fluctuated in different seasons and also different collection sites. Mean values and standard deviation of dissolved oxygen recorded during pre monsoon, monsoon and post monsoon periods were 11.0 mg/l ± 1.08, 9.04 mg/l ± 0.86 and 10.7 mg/l ± 1.1 respectively. The maximum value of 13 mg/l was recorded during pre monsoon period in the month of January and again in the month of December during post monsoon period when the water temperature was low. The minimum values of DO_2 8.0 mg/l were observed during monsoon in the months of May-July when the water temperature and river flow was high. These findings about dissolved oxygen are in conformity with George et al. (1966), Saxena et al. (1966), Zafar and Sultana (2008). Variations of DO_2 in different water bodies were also observed by several workers (Singhal et al., 1986; Kant & Raina, 1990; Shastree et al., 1991; Kaushik et al., 1991 and Siddiqui & Ahmed, 2010) which are in accordance with our present study.

The river Doyang exhibited maximum free Carbondioxide (CO_2) 5.9 mg/l and minimum of 4.1 mg/l, with an annual mean of 4.9 mg/l ± 0.40. The higher values were found in August during monsoon and lower values were observed in October during post monsoon

periods. In the present study free CO_2 was found to be inversely proportional to the dissolved oxygen of the river. The same negative correlation between CO_2 and DO_2 was also reported earlier by Ray et al. (1966), Prakash et al. (1978), Saxena et al. (2005) and Patil et al. (2011).

The alkalinity of the river fluctuated from 46.7 mg/l to 58.7 mg/l, with an annual mean of 52.55 mg/l ± 2.93. The range of alkalinity in Indian waters varies from 40 mg/l to over 1000 mg/l. The maximum value of Alkalinity was recorded during post monsoon period in the month of November while that of minimum value was recorded during monsoon in the month of August. The alkalinity values tend to increase from monsoon to post monsoon. As such, low values were recorded during rainy seasons. Similar observations in respect of alkalinity in riverine waters were also made by previous workers (Pahwa & Mehrota, 1966; Singh et al., 2009; Hazarika, 2010).

Hardness in water is due to the natural accumulation of salts of mainly Calcium and Magnesium. According to Kannan (1991), water with the hardness having values more than 180 mg/l is very hard. In the present study, total hardness ranged from 47.9 mg/l to 60.6 mg/l, with an annual mean of 54.96 mg/l ± 3.56. Total hardness was comparatively found higher (57.2 ± 1.31) and lower values (50.9 ± 2.05) during pre monsoon and monsoon periods respectively. The lower values of total hardness of the river could be due to the high rate of precipitation during monsoon period which diluted the salt content of the water. On the contrary, natural accumulation of salts and decrease in water volume during post and pre monsoon period might be the reasons for increase in the total hardness of the river. Similar trend in total hardness of the riverine water was also observed by several workers (Sharma et al., 1989; Sahu et al., 1995, Chandra et al., 1996; Singh et al., 2009).

Total dissolved solids (TDS) were fluctuated between 58.3 mg/l to 186.7 mg/l, with an

annual mean of 113.5 mg/l ± 29.09. The minimum 58.3 mg/l was recorded in the month of January during pre monsoon, while the maximum 186.7 mg/l was found in the month of August during monsoon period. Total dissolved solids depend on various factors such as geological character of the water shed, rainfall and amount of surface runoffs. High value of TDS recorded during monsoon period could be related to increase in the load of soluble salts, mud, increase in the surface runoff and erosion of river banks. Lower value of TDS recorded in pre monsoon period might be due to sedimentation of suspended solids and slow decomposition rate during pre monsoon period. The load of TDS varies greatly in different seasons. Similar results were also reported by Chauhan (2002), Ganai et al. (2010) and Thirumala et al. (2011).

The Chloride content ranged between 7.7 mg/l to 13.3 mg/l, with an annual mean of 10.18 mg/l ± 1.31. In the present study Chloride content showed an increasing trend from post monsoon (10.5 mg/l ± 1.15) to pre monsoon (11.11 mg/l ±1.19) period. The low chloride content 9.02 mg/l ± 0.57 was recorded in rainy season during monsoon period , which could be due to an increase in the amount of water level of the river. Similar to our present observation, Jana (1973); Mishra & Tripathi (2003) and Zafar & Sultana (2008) also reported low chloride during the rainy, but high during winter season. The most important source of chloride in the water is the discharge of domestic sewage (Trivedi & Goel, 1986). The high content of chloride maybe due to storage of the accumulated sewage during monsoon coupled with decaying process that accomplished by the microbes (Kumar et al., 2005).

Phosphate is an essential nutrient for the growth and development of flora in any ecosystem. The major sources of PO_4 in natural waters are domestic sewage, detergents, agricultural effluents with fertilizers and industrial waste. Phosphate in small quantities in

water is not harmful to the organism. However, the prime concern to organism is above 50μ/l, which will increase the growth of nuisance algae and eutrophication (Trivedy & Goel, 1986). In the present investigation highest concentration of phosphate was found during monsoon (0.05 mg/l ± 0.027) period and the lowest value (0.01 mg/l ± 0.006) were recorded during post monsoon and pre monsoon period. This may probably be due to high rate of decomposition of waste material or due to surface runoff from the surrounding crop fields fertilized with phosphate during the monsoon period, which increase the level of phosphate. In accordance with our findings similar observations were also made by Nagarathna & Leelavathi (2008) and Manikannan et al. (2011). The result of low phosphate during the pre monsoon/post monsoon may be attributed to the limited rate of precipitation and utilization of phosphate by planktons (Rajasegar, 2003; Manikannan et al., 2011).

A small amount of Nitrate (NO_3) in the range of 0.01 mg/l to 0.6 mg/l, was recorded in Doyang river, with an annual mean of 0.11mg/l ± 0.147. In the present study, Nitrate content was found low (0.022 mg/l ± 0.05) during pre monsoon which tends to increase (0.025 mg/l ± 0.093) in monsoon and (0.052 mg/l ± 0.045) in post monsoon period . The increase in level of nitrate therefore be attributed due to precipitation and terrestrial runoff during the monsoon period (Karuppasamy & Perumal, 2000; Manikannan et al., 2011). The most important source of nitrate in the natural water is domestic and industrial sewage which contains very high amount of nitrogenous compounds. Runoff from agricultural fields is also high in nitrate. Katavkar et al. (1989) observed that sewage entry into the water body is the major factor responsible for the enrichment of nitrate.

There are no mineral sources of this ion in natural waters. Nitrite (NO_2) is less stable and usually present in much lower amount than nitrate. The range of nitrite varies from 0.01

mg/l to 0.05 mg/l, with an annual mean of 0.022 mg/l ± 0.012. Nitrite is a very unstable ion and gets converted into either ammonia or nitrate depending upon the conditions prevailing in the water (Trivedy & Goel, 1986). However, the peak values of nitrite observed during the monsoon (0.031 mg/l ± 0.013) period maybe attributed to the influence of seasonal rainfall, whereas the low value of nitrite recorded in post monsoon / pre monsoon maybe due to the lesser amount of freshwater inflow . Similar trend of nitrite level during different seasons were also observed by previous workers (Satpathy, 1996; Prabhu et al., 2008; Damotharan et al., 2010).

Ammonia of mineral origin is rare in natural waters. It is one of the most important pollutants in the aquatic environment because of its relatively high toxic nature in surface water systems. In the present study, the variation of ammonia content was found very narrow ranging from 0.01 mg/l to 0.06 mg/l, with an annual mean of 0.023 mg/l ± 0.14. In accordance with our findings, seasonal variations of ammonia content in the wetlands of Assam were also reported by Hazarika (2010). The most important source of ammonia is the ammonification of organic matter. Sewage has large quantities of nitrogen matter, thus its disposal tends to increase the ammonia content of the water (Trivedy & Goel, 1986). Therefore, slightly higher values of ammonia 0.039 mg/l ±0.011 during monsoon period could be related to increase load of domestic sewage carried by the surface runoff during high precipitations rate in monsoon.

The present study provides first hand information on the seasonal and station-wise variations of the water quality of the Doyang river system, Nagaland. It was observed that the different physico-chemical parameters of the river were elevated during the monsoonal rains. Hence, the disposal of farmyard washings, domestic sewage including agricultural waste/pesticides, human excreta etc. need to be properly checked to maintain a good river

health. A continuous monitoring of the water quality variables covering all the seasons over a period of time is necessary for management practices of this important lotic freshwater resource of the state that supports a lucrative abode of ichthyofaunal diversity.

Planktons:

The overall plankton collected during the present study in Doyang river system was represented by 36 species, phytoplankton comprised of 21 species belonging to 4 groups viz. Chlorophyta represented by 12 species, Bacillariophyta represented by 6 species, Cyanophyta represented by 2 species and Dinophyta represented by 1 species; while zooplanktons comprised of 13 species belonging to 4 categories viz. Cladocera represented by 6 species, Rotifera represented by 4 species, Copepoda represented by 2 species and Rhizopoda represented by 1 species.

Phyoplankton are important among aquatic flora and are ecologically significant as they form the basic link in the food chain of aquatic animals (Kortnicker & Shon, 1971) and also serves as ecological indicators (Puri et al., 1964). The mean qualitative richness of phytoplankton ranged from 3.0-15.0 species, with an annual mean of 6.83 ±2.35. The maximum phytoplankton richness 15.0 species was collected in the post monsoon months of November and December. The minimum phytoplankton 3.0 species was predominantly observed during the months of monsoon period. Zooplankton occupies an intermediate position in the foodwebs, many of them feed on algae and bacteria and in turn are fed by numerous invertebrates and fish (Trivedy et al., 1986). The mean qualitative richness of zooplanktons ranged from 3.0-10.0 species, with an annual mean of 4.86 ±1.43. The maximum zooplankton richness 10.0 species was collected in the post monsoon month of

December. The mean minimum zooplankton 3.0 species was predominantly observed during the monsoon months. The nature and properties of river water controls the planktons in their establishment. Increased flow velocities and turbulence may also lead to increased turbidity in waterholes and reduce the production (Lakhi, 2012). As such, during the present study, the decreased level of planktons during monsoon months maybe due to the stronger current flow and increased turbidity. While increasing trends during pre monsoon and monsoon periods maybe attributed to the decrease in water current and turbidity which augments the growth of planktons. Plankton production was also observed to be positively correlated to dissolved oxygen and inversely related to free carbondioxide, air temperature and water temperature. Similar observations of the impact of hydrological factors on the distribution of planktonic organism have been studied by several workers (Rai, 1974, Bilgrami & Dutta, 1979).

Quantitative analysis indicated that density of phytoplankton was highest 110.0 ul^{-1} during pre monsoon period in the month of February in station IV, while the minimum was 20.0 ul^{-1} in the month of July in station II during the monsoon period. In case of zooplanktons the density was recorded highest 39.0 ul^{-1} during post monsoon period in the month of September in station IV, while the minimum was 3.0 ul^{-1} preponderantly in station II during the monsoon months. The phytoplankton abundance is followed by zooplankton peak (Mazhar & Kapoor, 1992), which is congruent with the present findings. The retarded photosynthetic acitivity and large scale consumption of oxygen by dissolved organic matter in turbid water and the increase amount of water in the river which dilutes the concentration of oxygen and acts as a limiting factor of plankton (Shivani & Tripathi, 2003; Balsre, 2008), similarly, the density of planktons were reduced during the monsoon period and showed increasing trend during post monsoon and pre monsoon periods.

Correlationship of Physico-chemical parameters, plankton and Ichthyofaunal distribution:

During the present investigation, the variations of physico-chemical parameters and occurrence and seasonal distribution of ichthyofauna in the different stations portrayed a correlational trend between them. As such, inference drawn from the resultant data depicted that higher values of air and water temperature which were observed in station IV and V comparatively with the other stations showed that the predominant species available in these sites were *Labeo, Tor, Catla, Cirrhinus, Hypopthalmichthys, Ctenopharyngodon, Cyprinus spp.* which are mostly considered as warm water fishes and hence are found more abundantly than other species of fishes. With respect to the physico-chemical parameters prevailing in station IV and V, the dominant zooplanktons were *Asplanchna priodonta, Polyartha vulgaris, Bosmina longirostris, Chydorus sphericus, Chaetophora sp, Oscillatoria sp and Cyclops sp* etc. while available phytoplanktons were *Mougeotia sp., Pediastrum duplex, Zygnema sp, Gomphonema sp and Gloecapse sp*.

Higher values of water current was found in station I and II which are located at a more higher altitude than the other stations. As such, the mean gradient in these stations was 8.2 m/km, hence the water current was more faster. The predominant species of zooplankton were *Chydorus sphericus, Trichocerca rattus, Cyclops* etc and *Mougeotia sp., Pediastrum duplex, Chaetophora sp. Cyclotella sp* etc for the phytoplanktons. Preponderantly found fish species were *Garra, Psilorhynchus, Barilius, Danio, Esomus, Puntius, Olyra spp.* These fishes are seen to have structural modifications or adaptations in their body to adjust, with the fast flowing current.

pH was found to be slightly more in station III and IV, where fishes such as *Glypthothorax,*

Xenetodon, Labeo and *Puntius spp.* was found preponderantly. The commonly found species of zooplankton were *Polyartha vulgaris, Chydorus sphericus, Bosmina longirostris*, etc. and the commonly available phytoplanktons were *Mougeotia sp., Pediastrum duplex, Zygnema sp, Chaetophora sp, Oscillatoria, Gomphonema sp* etc.

Higher values of dissolved oxygen was found in station I and II which can also be strongly correlated to the swifter current flow. The predominant species of zooplankton were *Chydorus sphericus, Trichocerca rattus, Cyclops sp* etc and *Mougeotia sp., Pediastrum duplex, Chaetophora sp. Cyclotella sp* etc for the phytoplanktons. The fish species found commonly were *Psilorhynchus, Barilius, Danio, Esomus, Puntius, Amplyceps, Olyra, Mastacembelus spp.*

Higher free Carbondioxide values was observed in station IV and V, where the commonly found species were *Garra, Clarias, Channa, Crossocheilus, Puntius, Labeo spp.* The preponderant species of zooplankton were *Asplanchna priodonta, Polyartha vulgaris, Bosmina longirostris, chydorus sphericus and Cyclops sp* etc. while common phytoplankton were *Mougeotia sp., Pediastrum duplex, Zygnema sp, Chaetophora sp, Oscillatoria* etc.

Higher values of alkalinity and total hardness was observed in stations V and VI, where the predominant species of zooplankton were *Polyartha vulgaris, Cyclops sp* and *Chydorus sphericus* etc. while for phytoplanktons the preponderant species were *Mougeotia sp., Pediastrum duplex, Cyclotella sp, Chaetophora sp, Ceratium sp and Oscillatoria sp* etc. The the predominant species found was *Labeo, Crossocheilus, Clarias, Channa, Badis spp.*

As regards to the other physico-chemical parameters like Nitrate, Nitrite, ammonia and phosphate fluctuated within a narrow range in the different stations; hence no distinct inference could be made.

Fisheries of Doyang river system:

In the present investigation, fishes captured abundantly in the different stations in Doyang river system included *Barilus bendelisis, Danio aequipinnatus, Neolissochilus hexagonolepis, Tor putitura, Puntius sophore, Puntius ticto, Labeo bata, Labeo pangusia, Labeo rohita, Catla catla, Garra gotyla gotyla, Garra naganensis, Garra gravelyi, Garra lissorhynchus, Crossocheilus latius latius, Psilorhyncoides homaloptera, Glyptothorax telchitta, Channa punctatus, Badis badis* and *Mastacembelus armatus.* From the various observations, inquires and field visits during the present study, it was found that except around the Doyang reservoir there was no permanent fish landing centers. Therefore, the fisheries of Doyang reservoir was studied thoroughly. The major fish species caught from Doyang reservoir was the Indian major carps especially *Catla catla* and *Labeo rohita* and exotic carps such as Cyprinus carpio rather than the natural stock of fishes. This dominance is because of annual stocking of fingerlings of IMC and exotic carps into the reservoir. The Doyang reservoir fishery serves as a source of livelihood subsistence for many fishermen (200-400 persons) and as an employment generation avenue for the 19 villages surrounding it. During the study period from January 2008- August 2010, it was found that there are 5 fish landing centers (FLC) viz. Luxio FLC, Janbemo FLC, Saliu FLC, Jentsü FLC and Jenthungo FLC around the reservoir which procures the fishes caught by the fishermen every day. From data analysis it was inferred that Luxio FLC accounted the highest landing with 28.6%, Saliu and Janbemo FLC's with 23.8% each, while Jentsü FLC accounted 16.7% and Jenthungo FLC accounted the lowest landing with 7.1%. In Doyang reservoir, the peak fishing season was found to be during the monsoon period while the lean fish production was during the pre monsoon period. Harvesting of fishes in Doyang reservoir was largely done using plank-built boats and Gill

nets contributing maximum to the total fish catch. The calculated annual total fish production during the study period was found to be 2,09,000 – 2,10,000 kg/ha and the productivity of Doyang reservoir was calculated to be 61.48 kg/ha/yr. The overall national production rate for Indian reservoirs is 20.1 kg/ha/yr while stocking of small impoundments in India could yield within a range of 63 – 316 kg/ha/yr (Sugunan, 1995).

Fishing techniques and gears:

The methods used in this region are results of experiences gained over a period of time and are related to the topography of the fishing ground, ecomorphology and behavior of fish (Sharma , 2001). To some extent, the style of living and nature of consumption have also influenced fishing practices. Many people of this region like to eat the fry stage of the medium size fishes like *Barilius sp*. and accordingly, catching methods also varies. Some specific fishing methods are very effective to catch a particular fish species even though the method practiced maybe primitive (Gurumayum & Choudhury, 2009). Most traditional methods of fishing had no adverse effects on other biota of the ecosystem. The various fishing techniques and gears used in Doyang river system, Nagaland, included: Asetdang (diversion of river channel), Etsük (cast netting), Pangshi chal (gill netting), Tsüteptsü (Scoop netting), Porki (Hooks and lines), Rock striking and a number of indigenous traps (Longr kago, Atep kago, Talu-tatu kago, Kongti kago, Kago, Paa). Highly destructive methods or illegal techniques of fishing such as electro-fishing, river poisoning (Liming, bleaching powder, plant extracts of *Diospyros*, *Juglans spp.* etc), use of explosives/Dynamite. Fishing gears like Longr kago, Atep kago, Kongti kago, Tsüteptsü and techniques like paa and rock striking were mostly used in the

upper regions of Doyang river system, while fishing gears like Talu-tatu kago, various fishing nets, hooks and lines etc were commonly used throughout the river system.

During the present comprehensive studies of Doyang river system it was observed that the ichthyofauna of Doyang river system is unfortunately dwindling due to over exploitation and lack of conservational measures. Use of illegal fishing techniques like electric fishing, fish poisoning etc which are prevalent in some areas could be one of the reasons of depleting the fish germplasm resources of the river. The government, non-governmental organizations, village councils and related institutions should therefore conserve the rich diversity of fishes in their natural habitat by means of legislation and regulation, which will bring about awareness among the village people. This will help in conserving the rich fish germplasm in the state.

CHAPTER 5

SUMMARY AND CONCLUSION

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Doyang river, the largest perennial river of Nagaland approximately lies between 25°40´44´´ and 26°13´74´´ N Latitude and between 94°14´31´´ and 94°0´54´´ E Longitude and is formed by two rivers that runs parallel in the upper part of Doyang- the Dzülü and Sidzü rivers, which originates from the Japfu peak (3046m MSL) and Mao gate area respectively. The river Doyang receives 8 perennial tributaries from the districts of Kohima, Zunheboto, Mokokchung and Wokha, traversing centrally across Nagaland almost dividing into two equal halves. The river offered lucrative abode of diversified ichthyofauna comprising of ornamental, food and sport fishes. However, the survey of literature revealed that so far no efforts have been made to assess the rich fish germplasm resources of the river system. Hence, the present investigation was taken up to study the fish fauna and ecology of Doyang river system. The whole plan of work is divided into four broad aspects and emphasis was given on the following objectives:

1. Study on geomorphology of the Doyang river.
2. Documentation of fish fauna in Doyang river system, Nagaland
3. Physico – chemical and biological parameters such as air and water temperature, Ph, water current, dissolved oxygen, total dissolved solids, free carbon-dioxide, alkalinity etc. were analyzed seasonally and station-wise. Besides, variations in phytoplankton and zooplankton communities and the relationship between physico-chemical parameters, planktons nd ichthyofaunal distribution were also analysed.

4. Fisheries of Doyang river system such as fish yield / unit catch of fishes in different fish landing centers, local fishing techniques and gears used in vogue etc.

The present geomorphologic studies of Doyang river system revealed that in upper zone the erosion process was found predominated, with mean gradient of 8.2 m/ km. The middle region was characterized by a gradient of 2.4 m/km with reduced velocity of water current. In the lower zone of the river, sedimentation and river bed aggradation were observed, with an average gradient of 1.95 m/km. The vegetation of riparian zone was predominantly covered by woody forest and shrubs on both sides of the river banks. Human habitations on river banks were the main source of discharging the sewage, farmyard washings, agricultural waste, pesticides etc. into the river system.

During the present investigation, as many as 46 fish species belonging to belonging to 5 orders, 15 families, 8 subfamilies and 31 genera were identified from Doyang river system, Nagaland during January 2008 – August 2010. The colored photographs of all the ichthyofauna were portrayed in plate I-VIII, exhibiting their morphological state in live conditions. The systematic account based on their morphometric and meristic characteristics of the species were described. Station-wise occurrence of the diversified ichthyofauna, seasonal abundance, preferred habitat of the fish fauna were presented. Out of the 46 species recorded from Doyang river system, 25 species were collected from Station-I, 27 species were ascertained from station-II, maximum of 31 species from station-III, 19 species from station IV, 22 species from station-V and 15 species was recorded from station-VI. From the 8 different tributaries covered during the present study, Sidzü registered a total of 22 species, while Dzülü recorded 21 species, Tishi recorded 16 species, Chubi recorded the maximum with 24 species while Nzü recorded 20 species, 21 species was ascertained from Nrü, 22 species from Bagthy while 14 species was collected from Rengmapani. With respect to the

seasonal abundance 30 species was found abundantly during pre monsoon period, 42 species during monsoon period and the maximum seasonal abundance of 45 species was registered during post monsoon period in Doyang river system.

All the fish species, recorded during the present study were found to have ornamental value, of which 16 species were categorized as classified ornamental fishes and 30 species as non-classified ornamental fishes. Further, Out of the total 46 species, 44 species were classified as food fishes while a total of 11 species were classified as sport fishes. These categorization of the species are very essential for taking up conservational measures of the fish germplasm resources.

During the present study, the conservational status of the ichthyofauna was also analyzed based on the Conservation Assessment and Management Plan report (1998). Of the 46 species documented from Doyang river system, the ichthyofauna were categorised as 14 species under Low risk- Near threatened (Lr-nt), 12 species under Vulnerable (VU), 2 species under Endangered (EN), 1 species as Critically endangered (CR) while 17 species were not evaluated.

During the present study, analysis of various water quality variables of the river were conducted at six selected sites in pre monsoon, monsoon and post monsoon seasons. The range, mean annual values and standard deviation recorded for physical parameters were : Air temperature 10-29 °C (18.4±5.80), water temperature 9-26 °C (15.7±4.92), velocity of water current 0.303-0.966 m/sec (0.611±0.175), total dissolved solids 58.3-186.7 mg/l (113.5±29.09) and chemical parameters included: dissolved oxygen 8-13 mg/l (10.25±1.32), free

Carbondioxide 4.1-5.9 mg/l (4.9±0.40), total alkalinity 46.7-58.7 mg/l (52.55±2.93), pH 6.4-7.8 (7.1±0.303), total hardness 47.9-60.6 mg/l (54.96±3.56), chloride 7.7-13.3 mg/l (10.18±1.31), phosphate 0.01-0.09 mg/l (0.028±0.024), ammonia 0.01-0.06 mg/l (0.023±0.014), nitrate 0.01-0.6 mg/l (0.11±0.147) and nitrite 0.01-0.05 mg/l (0.022±0.012) during the period of investigation. The present study also reflected seasonal variations in water quality variables of Doyang river which exhibited considerable seasonal and spatial variations of different parameters (Table 10-23).

The planktons collected during the present study in Doyang river system was represented by 36 species which comprised, phytoplankton 21 species belonging to 4 group viz. Chlorophyta, Bacillariophyta, Cyanophyta and Dinophyta**,** while zooplanktons comprised of 13 species belonging to 4 categories viz**.** Cladocera, Rotifera, Copepoda and Rhizopoda. Quantitative analysis indicated that density of phytoplankton was highest during pre monsoon, while the minimum was during the monsoon period. Similarly, the density of zooplanktons was recorded highest during post monsoon period, while the minimum was preponderantly observed during the monsoon period.

The correlationship of physico-chemical parameters, planktons and ichthyofaunal distribution were also studied. Higher values of Air and water temperature reflected occurrence of few predominant fish species such as *Labeo rohita, Tor putitora, Catla catla, Cirrhinus mrigala, Hypopthalmichthys molitrix, Ctenopharyngodon idellus, Cyprinuscarpio* and zooplankton species such as *Asplanchna priodonta, Polyartha vulgaris, Bosmina longirostris, Chydorus sphericus, Chaetophora sp, Oscillatoria sp* and *Cyclops sp,* while available phytoplanktons were *Mougeotia sp., Pediastrum duplex, Zygnema sp, Gomphonema*

sp and *Gloecapse sp*. Higher values of water current supported predominant fish species such as, *Garra, Psilorhynchus, Barilius, Danio, Esomus, Puntius, Olyra spp* and common zooplankton species such as *Chydorus sphericus, Trichocerca rattus* and *Cyclops sp.* while preponderant phytoplanktons were *Mougeotia sp., Pediastrum duplex, Chaetophora sp.* and *Cyclotella sp.* The species such as *Glypthothorax telchitta, Glypthothorax cavia, Xenentodon cancila, Labeo rohita* and *Puntius spp* preferred a little higher pH than other species, while the preponderant zooplanktons found were *Chydorus sphericus, Trichocerca rattus, Cyclops spp* and predominant phytoplanktons were *Mougeotia sp., Pediastrum duplex, Chaetophora sp* and *Cyclotella sp*. Higher values of dissolved oxygen was strongly correlated to the swifter current flow and the fish species found commonly were *Psilorhynchus, Barilius, Danio, Esomus, Puntius, Amplyceps, Olyra, Mastacembelus spp*. while common zooplanktons were *Chydorus sphericus, Trichocerca rattus, Cyclops sp.* and phytoplanktonic species were *Mougeotia sp, Pediastrum duplex, Chaetophora sp* and *Cyclotella sp*. In stations with higher free Carbondioxide values the commonly found species were *Garra spp, Clarias batrachus, Channa orientalis and Channa punctatus, Crossocheilus latius, Labeo and Puntius spp.* while preponderant zooplanktons were *Asplanchna priodonta, Polyartha vulgaris, Bosmina longirostris, chydorus sphericus* and *Cyclops sp* while more commonly found phytoplanktons were *Mougeotia sp., Pediastrum duplex, Zygnema sp, Chaetophora sp, Oscillatoria* etc. Higher values of alkalinity and total hardness supported the species like *Crossocheilus, Clarias, Channa, Badis, Labeo spp.* which are considered as hardy species, while preponderant zooplanktons were *Polyartha vulgaris, Cyclops sp* and *Chydorus sphaericus* and those common phytoplanktons were *Mougeotia sp., Pediastrum duplex, Cyclotella sp, Chaetophora sp, Ceratium sp* and *Oscillatoria sp*.

Fisheries aspects of Doyang river system was taken up to study the river fishing technique and gears used, major fish species caught and the different fish landing centers present along the river system. In the present investigation, Small scale or artisanal capture fishery was found to be the only fishing systems prevailing, which were widely scattered and unorganized. In the whole stretch of the river system only a lesser number of fishermen were actively involved in subsistence fishery except in the Doyang Dam reservoir, where a good number of regular fishermen numbering 200-400 were actively engaged depending on the seasons. In the Doyang reservoir the major fish species caught included, the Indian major carps especially *Catla catla* and *Labeo rohita* and exotic carps such *Cyprinus carpio* rather than the smaller natural stock of fishes. The calculated annual total fish production during the study period was found to be 2,09,000 – 2,10,000 kg/ha. The productivity when calculated accordingly was calculated to be 61.48 kg/ha/yr.

The different fishing techniques and gears used along the river system were studied. Most of the traditional methods of fishing and the indigenous gears used in vogue had no adverse effect on other biota of the ecosystem except the target fishes. However, illegal fishing techniques like electric fishing, poisoning by using lime, bleaching powder, plant extract poisons, Dynamites etc. were found to be prevalent in certain pockets of the river system. As per the various data collected and observations made, revealed that the ichthyofauna was gradually dwindling away due to over exploitation and lack of awareness among the local populace to conserve the ichthyofauna in their natural habitat.

Recommendations:

The assessment of ichthyofaunistic resources of Doyang river system and further categorization of the species in the present investigation will definitely provide an important baseline date for conservation of the fish species in their natural habitat. The database of the fish and fisheries with the information embodied in the thesis will offer good opportunities to the conservationist, policy makers, entrepreneurs and fish culturist to take up appropriate measures for conservation of fish species in their natural habitat, so that the rich fish germplasm resources of the river system can flourish unabated. With this premise, few recommendations could be forwarded for insitu conservation of the dwindling ichthyofauna.

1. The Government, Non Governmental Organization, village council and related institutions, entrepreuneurs should conserve the rich diversity of fishes in the river through policies and action programmes aimed at protecting the natural habitat of the fish germplasm resources.
2. Regulatory measures should be adopted as enforced by the state government to prohibit use of non-scientific and illegal fishing practices.
3. Participatory programmes to create awareness among the fishing communities should be organized at regular intervals at different block levels.
4. The insitu ranching programmes to replenish the depleted stocks of ichthyofauna should be established and promoted.
5. The analysis of physico-chemical parameters showed a slightly increasing trend of nutrients levels during monsoon period. hence, appropriate measures needs to be taken up by properly managing waste and monitoring human activities to avoid eutrophication in the river system.
6. The present work may also serve as a model representation for further assessment of rich ichthyofaunal diversity and ecology of other drainage system of the state.

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R E F E R E N C E S

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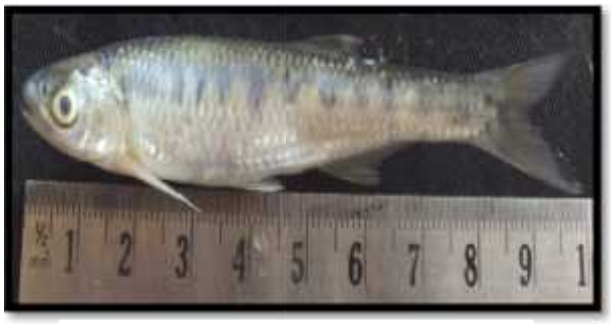
P L A T E S I - XVI

PLATE-I

1. *Barilius bendelisis*



2. *Barilius barila*

3. *Barilius barna*

4. *Danio aequipinnatus*

5. *Danio dangila*

6. *Esomus danricus*

7. *Neolissocheilus hexastichus*

8. *Neolissocheilus hexagonolepis*

PLATE-II

9. *Tor putitora*

10. *Puntius sophore*

11. *Puntius ticto*

12. *Puntius chola*

13. *Bangana dero*

14. *Labeo bata*

15. *Labeo pangusia*

16. *Labeo fimbriatus*

PLATE-III

17. *Labeo rohita*

18. *Catla catla*

19. *Cirrhinus mrigala mrigala*

20. *Cyprinus carpio*

21. *Hypopthalmichthys molitrix*

22. *Ctenopharyngodon idellus*

23. *Garra gotyla*

24. *Garra gravelyi*

PLATE-IV

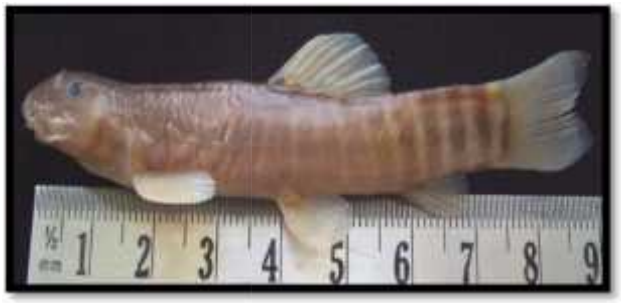
25. *Garra naganensis*

26. *Garra lissorhynchus*

27. *Crossocheilus latius latius*

28. *Schistura prashadi*

29. *Acanthocobitis botia*



30. *Neonemacheilus assamensis*

31. *Lepidocephalichthys guntea*

32. *Psilorhynchoides homaloptera*

PLATE-V

33. *Olyra Kempi*

34. *Olyra longicaudata*

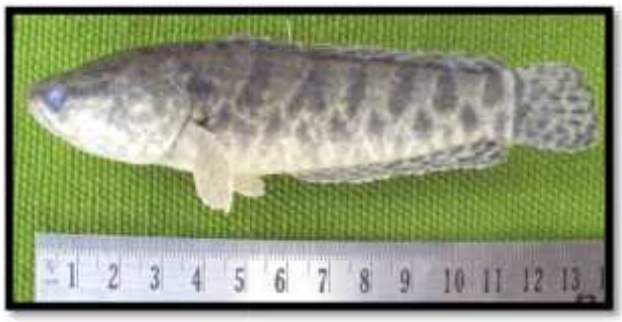
35. Kryptopteris indicus

36. *Amplyceps apangi*

37. *Glyptothorax telchitta*

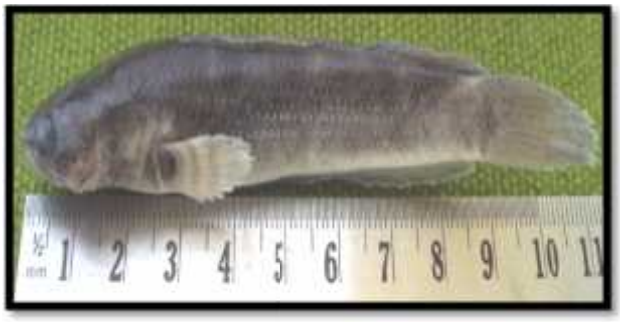
38. *Glyptothorax cavia*

39. *Clarias batrachus*



40. *Channa punctatus*

PLATE-VI



41. *Channa orientalis*

42. *Badis badis*

43. *Anabas testudineus*

44. *Mastacembelus armatus*

45. *Monopterus albus*

46. *Xenentodon cancila*

Plate-VII

Panoramic views of the study area

1. Sidzü river, Chakabama

2. Sidzü river, Kidzümetouma

3. Dzülü river, Chakabama

4. Dzülü river, kidzümetouma

5. Confluence of Sidzu and Dzülü rivers

6. Upper stretches of Doyang river

Plate-VIII

Panoramic views of the survey stations

1. Chakabama Station

2. Kidzumetouma Station

3. Mukhami Station

4. Pangti station

5. Longtshung station

6. Liphiyan station

Plate-IX

Panoramic views of the Tributaries

1. Tishi river

2. Chubi river

3. Nrü river

4. Nzü river

5. Baghty river

6. Rengmapani river

Plate-X

Geomorphological variations in the river

1. Bar formation in river bed

2. River meandering

3. Increased sinuosity of river bank

4. River Bank erosion

5. Erosion of surface soil

6. River bed quarrying

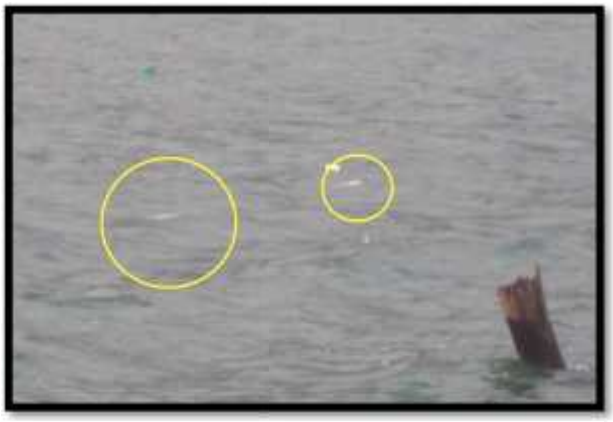
Plate-XI

Fishing techniques and gears

1. Asetdang (River diversion)

2. Putting up Gill net across a river

3. Operating a Cast net



4. Fishes caught in a gill net

5. Tsüteptsü (Scoopnet)

6. Gelatine sticks

Plate-XII

Fishing techniques and gears

7. Electro-fishing contraption

8. Kago (trap) & an plank boat

9. Talu-Tatu kago

10. Atep Kago

11. Longr kago

12. Paa (Trap)

A P P E N D I X

A P P E N D I X

I. Research Paper published /communicated in National and International Journals:

1. IMNATOSHI AND SHARIF U. AHMED .2010. "Ichthyofaunal diversity of Doyang river system, Nagaland". *Nat. J. of Lif. Sci.* Vol.7(3): 01-06.*****

2. IMNATOSHI AND SHARIF U. AHMED .2012. "Geomorphology and seasonal variations of physico-chemical parameters of Doyang river, Nagaland". *The Ecoscan*, 6(1&2): 05-09, 2012.*****

II. National/International conference/workshop participated:

1. International conference on "*Recent trends in Life Science researches vis-à-vis natural resource management, sustainable development and human welfare* " held on 27th – 29th June 2009, Vinoba Bhave University, Hazaribagh, Jharkhand.******

2. ICAR sponsored short course on "*Application of Molecular techniques in cold water fishes*" held from 14th – 23rd July 2009, Directorate of Coldwater Fisheries Research, Bhimtal, Nainital, Uttarkhand.******
3. UGC sponsored National conference on *"Advances in environmental research: An interdisciplinary approach" AERIA'11, held on 11th and 12*th March 2011, Annamalai University, Chidambaram, Tamil Nadu. Presented a research paper entitled '*Diversity of Ichthyofauna in Doyang river system of Nagaland' Abstract No.* R.303.******

4. Nagaland University Research poster competition, held on 6th September 2009, Lumami campus.******

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