

**STUDY ON FISHES OF MAHAKALI RIVER WITH
REFERENCE TO HILL-STREAM FISHES**

**A
Dissertation**

**Submitted by
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**For the fulfillment of M. Sc Degree
In Zoology (Fish and Fisheries)**

To

**Central Department of Zoology
Institute of Science and Technology
Tribhuvan University, Kirtipur
2010**

ABSTRACT

The present study “Study on fishes of Mahakali river with reference to hill-stream fishes” was carried out from October 2007 to October 2008. The Mahakali river flows in western region of Kanchanpur district of Mahakali zone of Nepal. The study was carried to provide baseline information on the hill-stream fishes of Mahakali river and also environmental factor, fishing implements and management policies. The sampling stations were established along the 10km stretch of this river and dividing into two section, each sampling station are 10km far from each other. Each sampling station was visited three times during the study period. A total of 16 samples were collected a total of 44 fish species including 19 hill stream fish species. This includes 5 order, 12 family, 29 genus. Among them, 5 species are exotic and 39 species are collected from Mahakali river and irrigation canal. The family Cyprinidae dominates with 21 species, followed by family Cobitidae with 5 species, Bagridae represented by 2 species, Claridae with 2 species, Channidae with 2 species, Mastacembelidae 2 species, Siluridae 1 species, Chandidae 1 species, Nandidae 1 species, Gobiidae 1 species and finally Anguillidae represent 1 species. Among them, altogether 19 species are hill-stream fishes. Among hill-stream *Labeo dero*, *Barilius barna*, *Barilius bendelisis*, *Barilius vagra*, *Raiamas bola*, *Brachydanio rerio*, *Esomus denricus*, *Garra annandalei*, *Garra gotyla*, *Tor tor*, *Crossocheilus latius*, *Schizothorax plagiostomus*, *Schizothoraichthys progastus*, *Botia lohachata*, *Lepidocephalus guntea*, *Acanthocobatis botia*, *Schistura rupecola*, *Schistura corica* and *Glossogobius giuris* were used.

The physico-parameter of Mahakali river is found as follows; the higher temperature is found to be 22°C in the month of June where as minimum temperature is found to be 12 °C in February. The water becomes hazy in October in rainy season and in that season the oxygen content measured to be 8.3 as high quantity. The CO₂ level is maximum as 5 in February. Total hardness is found to be high in October as 5. Besides these the P^H quantity is found to be higher in 7.6 in June.

Considering the conservation of hill stream fishes in the Mahakali river to be vital. The fishes of Mahakali river are used as food and ethno-medicine. Their economic importance are given and conservation and management principles are highlighted.

LIST OF CONTENTS

Latter of Recommendation	
Latter of Approval	
Acknowledgement	
Table of contents	
List of Table	
List of Photographs	
List of graphs	
Abstract	
	Page
CHAPTER-I	
1.1 Background	1
1.2 River System of Nepal	3
1.3 List of water resource and estimated surface area	6
1.4 Distribution of hill stream fishes in Nepal	7
CHAPTER-II	
Literature Review	9
Justification of the study	13
Aims and objectives	13
CHAPTER -III	
Methods and methodology	
The study area and potential sites	15
Study sites	18
CHAPTER - IV	
4.1 List of fishes collected from different water resources of Mahakali river	24
4.2 List of fishes with their systematic position and local names	27

4.3 List of hill stream fishes with their systematic position	32
4.4 Discription of hill stream fishes of Mahakali river	36
CHAPTER -V	
Result	44
CHAPTER-VI	
Economic importance	48
6.1. Fish as food	48
6.2 Sport and recreational fishery	49
6.3 Fish of decorative and academic values	49
6.4 Future opportunities for indigenious fish	50
CHAPTER–VII	
Conversation and management	51
Recommendation	53
CHAPTER-VIII	
Disscussion	54
References	57

LIST OF TABLE	Page No
Table 1: Water resources and estimated water surface Area.	7
Table 2: Showing annual rainfall (mm) of Kanchanpur District during 2006.	17
Table 3: Showing annual temperature (°c) and relative humidity (%) of Kanchanpur District during 2006.	18
Table 4: Physico-chemical parameter of Mahakali river.	21
Table 5: Showing fisheries survey of Kanchanpur District.	24
Table 6: Distribution of hill-stream fish at different Stations in the Mahakali river.	34
Table 7: Fish population composition by numbers and percentage in the Mahakali river.	35

LIST OF PLATES

Plate 1: List of hill-stream fishes collected from Mahakali river.

Plate 2: List of hill-stream fishes collected from Mahakali river.

Plate 3: List of hill-stream fishes collected from Mahakali river.

Plate 4: List of hill-stream fishes collected from Mahakali river.

Plate 5: List of hill-stream fishes collected from Mahakali river.

Plate 6: Photos of fishing gears used by fisherman of Kanchanpur Distric.

Plate7: List of hill-stream fishes showing the ecomorphological modification.

LIST OF MAP

Map 1: River system of Nepal.

Map 2: Map of Kanchanpur District.

Map 3: Map of geographic location of study sites in Mahakali river.

LIST OF GRAPH

Graph 1: Annual rainfall of Kanchanpur District.

Graph 2: Temperature and relative humidity of Kanchanpur District.

LIST OF ABBREVIATIONS

HMG - His Majesty's Government

DFD - Directorate of Fisheries Department.

IUCN - International Union for Conservation for Nature.

EIA - Environmental Impact Assessment.

FAO - Food and Agriculture Association.

NEA - Nepal Electricity Authority.

Cm - Centimeter.

Kg - Kilogramme.

⁰c - Degree centigrade

CHAPTER- I

1.1 Background

Nepal is small landlocked country with an area of 1, 47,181-sq km. It lies between India and China and stands between the latitude of 20⁰21' to 30⁰27' north and it's longitude between 80⁰4' to 38⁰12' east. It extends 885 km along the east-west with an average width of 193 km along the north side. Within this limited area exists a remarkable altitudinal variation, varying from the plain in the south with hot tropical climate to the mountain region of temperate climate and a very cold alpine in Himalayan region. The southern Terai region is an extension of Indo-Gangetic plains. To its north lies the Churia range, which along with the low land Terai contributes about 25 percent of the total area of Nepal. Its average elevation range between 300 to 500 m. At places, the elevation reaches about 1800m (Rao and Gupta, 1998). North of the Churia range lies the Mahabharat hills with rugged terrain, valleys and rivers with deep george. It contributes about 60 percent of the total area of Nepal. On the north of Mahabharat lies the snow-capped Himalayan. The Himalayan region contributes about 15 percent (22, 677 sq.km) of the total area of Nepal (Amatya, 1967).

Himalayan Mountain range lies along the northern border with Tibet, China. It contains world's 13 highest peaks including with its highest crest up to 8848m. Above 5000 m there is permanent snow. This together with the monsoon rainfall along the south facing slopes has resulted in compacting virtually all climatic zones found on the planet earth (Shrestha, 2003).

In Nepal rainfall occurs due to two types of monsoon, winter monsoon and summer monsoon. Winter monsoon is caused by the air stream blowing from the Arabic sea, and lasts from the month of

December to February. The summer monsoon lasts from month of June to September. The summer monsoon is caused by the humid air that blows from the Bay of Bengal. Heavy rainfall occurs when this air comes into contact with the tall mountain range of Nepal. Based on the rainfall record collected by the Department of Hydrology and Metrology, Nepal receives about 1500mm rainfall during a good monsoon regime.

Nepal has several sources of water, which includes the glaciers and the monsoon rain. The inland resources of Nepal total 818,500 (3% of Nepal's land area), of which irrigated paddy field covers the greatest area 398,000ha (49%). Marginal swamp cover 12,500ha (1.4%), river 395,000 ha (48%), lakes 5,000ha (0.60%), reservoir 1,500 (0.20%) and village ponds 6,500ha (0.80%) and marginal/swamps/Ghols cover (1.4%) (HMG, DFD, 2001/02). Such are the dimensions of the habitat in which fishes are distributed water resources of Nepal are represented by more than 6000 seasonal and perennial rivers belonging to four main drainage basin: Sapta Koshi, Gandaki, Karnali, and Mahakali and their tributaries (high altitude glacial lakes to low and oxbow lakes), Ghols, swamps, bogs, reservoir etc (Sharma, 1977).

Nepal has many streams or torrential rivers. The conditions of these hill streams are quite different in comparison to those of the plain rivers. The physico-chemical and biological conditions of water of these torrential rivers play an important role on the fish fauna inhabiting them. The fast flowing current of water (10m/10sec to 10m/3sec), the low temperature due to rapid and constant motion of water, plenty of oxygen, shelter rich food in the form of algae and shallow and clear water results in different structural modifications in the hill-stream fishes. On the basis of structural modifications the hill-stream fishes can be divided into three main groups:-

1. The first group with small fish like genus *Danio* and loaches which hide themselves under stone and rocks at the bottom for shelter.
2. The second group includes the migratory fishes like genus *Schizothorax*, *Tor*, *Neossocheilus*, *Barilius* and *Barbus* which migrate for feeding and breeding purpose. They live temporarily in hill streams so do not develop any types of adhesive organs for adhesion in the fast flowing water except in genus *Schizothorax*.
3. The third group comprises all highly specialized hill-stream fishes with different types of structural modifications of their body. eg. genus *Garra*, *Pseudechecheneis*, *Glyptothorax* etc.

The Complex ecological variation in water discharge, temperature and turbidity provide rich variation in ecological niches that satisfy the environmental requirement of a large number of fish species (Hora, 1839). Many fish exhibit morphological adaption in micro habitats occurring within the river. For instance genus *Schizothorax* has lips that form a suctorial disc, which facilitates swimming in swiftly flowing, water. Genus *Labeo* have well developed air bladder, which allow them to adjust their position in deep and slower flowing water (Edds, 1986).

1.2 River System of Nepal

Nepal, a Himalayan country is blessed by nature with a vast network of river and streams. There are 6000 rivers in Nepal. These rivers are classified into three categories in terms of their sources of dry season discharge. The first group of rivers has their sources in the snow and glaciers in the dry season. The Mahakali, The Karnali, The Gandaki and Sapta Koshi are the four rivers in the first category. The second group of rivers originates in the middle mountains, which are mostly have few water and low flow in dry season. Bagmati, west Rapti, Mechi, Kankai,

Kamala and Babai are the rivers in the second category. Rivers in the third categories originate in the Churia southern face of the Mahabharat or in the Terai. These rivers have small catchment areas. In dry season the discharge of these rivers becomes nominal, while several rivers dry up. Tilawe, Sirsia, Manusmara, Hadinath, Sunsari, Banganga are some of the river in this group (Sharma, 1997).

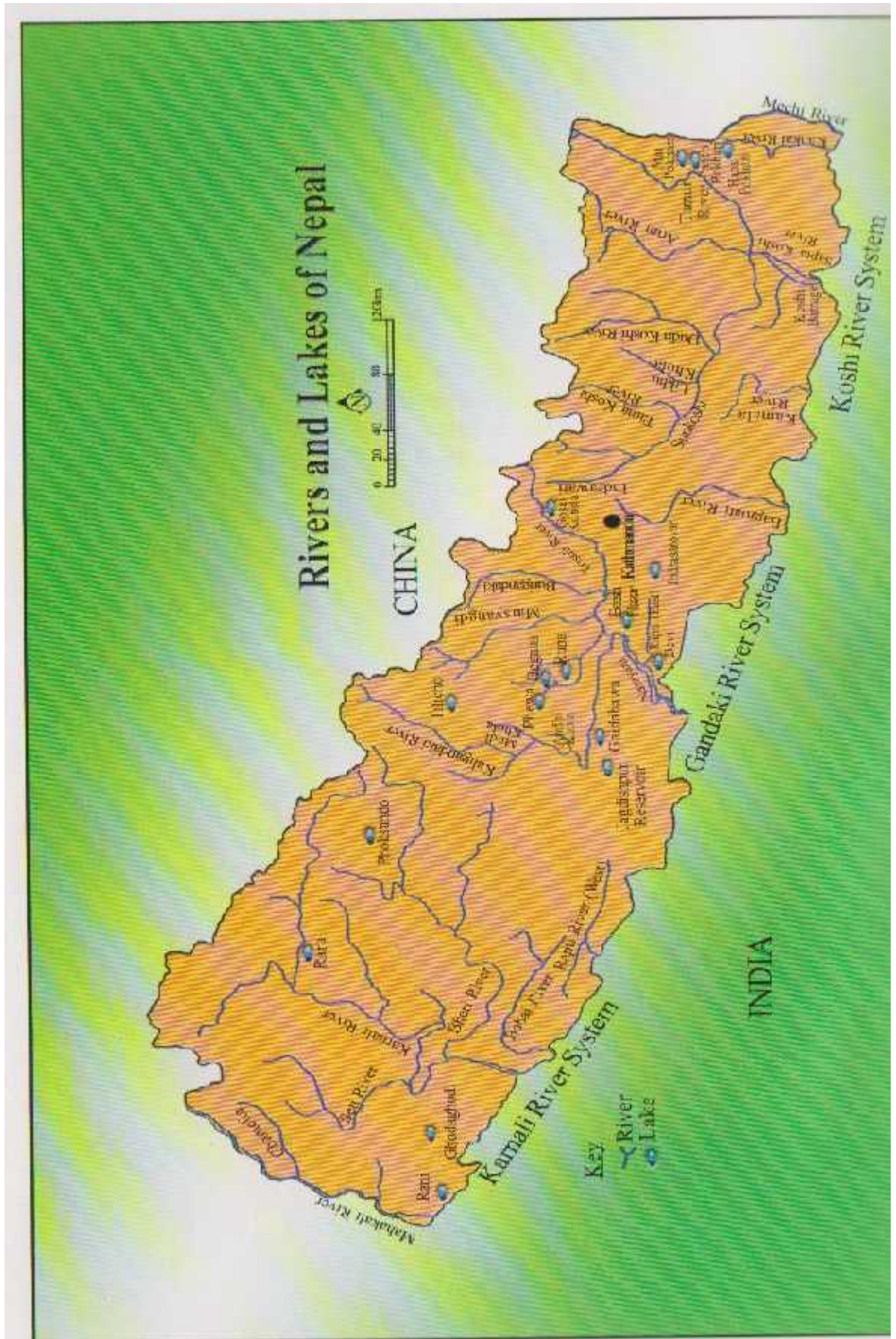
There are four major River systems in Nepal, which drain out the country. Sapta Koshi river in the east, Sapta Gandaki in the central, Kamalari in the west and Mahakali in the far west. Out of these i.e. Sapta Koshi, Sapta Gandaki, Sapta Karnali originate from the Tibetan plateau and crossed the Himalayas. Mahakali originate from the Greate Himalaya at Kalapani.

The Sapta Gandaki River System:

This river arises from the Muktinath area and it flows between Dhaulagiri and Gosainthan. Burhi (Badi Gad), Marsyangdi, Seti and Trisuli Ganga join it in the midlands. It then flows through the Churia hill making its way to Tribenighat before appearing in the plains, where it is known as the Narayani River. The seven tributaries of Gandaki river system are Burhi Gandaki, Kali Gandaki, Madi, Myagdi, Marsyangdi, Seti and the Trisuli.

The Sapta Koshi River System:

From the point of view of catchment area the Koshi is the largest river system in Nepal. It flows in eastern Nepal, east of Gosainthan and west of Kanchanjunga area. The seven tributaries of Koshi river system are the Arun koshi, Dudh koshi, Indrawati, Likhu, Sunkoshi, Roshi and Tamor.



Map 2: River system of Nepal

Karnali River System:

The Karnali rises in the Tibetan region of China near Limpiya dhura pass between India and Tibet. It flows south-easterly through the Tibetan plateau and then enters Nepal in a george through the Lipa lekh. It is the major river system of western Nepal. The rivers course through Nepal is marked irregular. The seven tributaries of Karnali river system are Karnali, Burhi Ganga, Humla Karnali, Mugu Karnali, Seti Karnali, Sani Bheri, Thuli Bheri and Tila.

The River Mahakali:

The River Mahakali originates in high mountains of Himalaya of Nepal and it flows south forming western international boundary between Nepal and India. In the upper region of the river, it flows in deep george. The river basin has a total drainage area of 15,640 km². The river has three major tributaries; rivers Chamelia, Surnayagad and Rongun Khola (Sharma, 1997). From the river, Nepal gets 1000 qusec water for irrigation purpose.

1.3 List of water resource and estimated surface area

Type of potential water Resources Area (ha)	Estimated Area (ha)	Percentage(%)
Natural waters	401500.0	48.8
Rivers	395000.0	48.0
Lakes	5000.0	0.6
Reservoirs	1500.0	0.2
Village ponds	6700.0	0.8
Marginal Swamps	1250.0	1.4
Irrigated rice field	398000	49.0
Total	818500.0	100.0

Table 1: Water resources and estimated water surface Area

(Source: ADB/N, 1982 and APROSC 1986)

1.4 Distribution of hill-stream fishes in Nepal

No fish species has yet been officially listed as protected by Government of Nepal. The leaflet on "Endangered Wildlife Nepal's Threatened Animals" in the IUCN Red list, 1994, as well as "Nepal's Flora and Fauna" in the current CITES list, 1995, have not shown a single fish species under alarming status. So far no specific study has been conducted to assess this issue. An EIA study on Ilam hydroelectric project has reported 14 fish species from Puwa Khola out of which 2 species (*Neolissocheilus hexagonolepis* and *Tor tor*) and one species (*Anguilla bengalensis*) has been claimed as endangered and threatened fish species, respectively (Chaudhary, 1994). Shrestha (1994) has not listed any fish under threat in her book "Fishes, Fishing Implements and Methods of Nepal", but she has expressed a potential threat to genus *Tor*, *Neolissocheilus* and *Schizothorax* from the increasing number of hydropower projects. Shrestha (1995) study on "Enumeration of the Fishes in Nepal" under the Bio-diversity Profile Project. She concluded that 34 fish species (about 18 % of the total reported fish species) are threatened (endangered -1, rare - 24 and vulnerable - 9). The study has further recommended legal protection for ten fish species: *Tor tor* as endangered, *Neolissocheilus hexagonolepis*, *Chagunius chagunio*, *Tor putitora*, *Danio rerio*, *Schizothorax plagiostomus*, *Schizothorax richardsonii*, *Schizothoraichthys progastus*, *Psilorhynchus pseudecheneis* and *Anguilla bengalensis* as vulnerable. Shrestha (1995) in his book "Fish catching in the Himalayan Waters of Nepal" has described 22 species as rare and 26 species as pristine rare fish species. Most of the listed fish are from the cold waters of high Himalaya. A study on the "Conservation Status of the Inland Fish Fauna of Nepal" has not spelled out any fish

under threat or alarm conditions. However, Rajbanshi (1995) endorses the general view of sharp depletion of fish stocks in many water bodies around densely populated areas and development projects. The deteriorating environment, increased industrial activities with a consequent draining of the industrial waste in rivers and lakes, construction of hydropower dams without any appropriate and adequate provision for fish migrations, and indiscriminate killing of indigenous fish using illegal fishing methods are considered to be responsible for the depletion of the indigenous fish.

CHAPTER- II

Literature Review

The oldest report of fish of Nepal dates back to the year 1793, however, the credit of scientific record goes to Hamilton for his work of 1822. In the 19th century a number of other ichthyologists, including McClelland (1839), Gunther (1861), Beaven (1877) and Day (1889) studied the fish fauna of Nepal. In the 20th century, Regan (1907) studied seven fish species sent to him by Dr. N. Annadalei, India, out of which five species were reported from Nepal. These fish were collected by Hodgard on behalf of the Indian Museum, with the support of the then British Legation in Nepal in 1906. The fish samples were collected from Kathmandu and adjacent areas like Sundarijal and Pharping. Out of the reported fish species, one species *Diptichus annandalei sp. nov.* was found then new to science (it is now considered as synonymous to *Schizothorax richardsonii*). Hora (1937) also studied 158 fish species from Hulchowk, Mugling, Nagarkot and Sundarijal collected on his request by the Resident, British Legation in Nepal. A list of 52 fish species was made for the River Koshi, Eastern Nepal, by Menon (1949).

After 1951 fish and fisheries were studied by a number of people, e.g. Taft (1955), DeWitt (1962), Menon (1962), Thapa and Rajbanshi (1968), Majpuria and Shrestha (1968), Bhatt (1970), and Atkinson (1974). Shrestha (1978) studied the fish fauna of Nepal and reported 118 fish species out of which she described two new species and one sub-species (*Barilius jalkapoorei sp. nov.*, *Lepidocephalichthys nepalensis sp. nov.*, and *Pseudeutropius murius batarensis sub sp. nov.*). Shrestha et al. (1979) have reported 82 fish species from downstream of the River Bagmati. Ferro and Badagami (1980) reported 22 fish species from lakes Begnas and Rupa in Pokhara valley while McGladdery et al. (1980)

reported 62 fish species from the Gandak River system of Chitwan valley. Robert (1980, 1982) studied the genera *Macrognaathus* and *Wallago*. Jayaram (1981) reported 106 species under 61 genera, 21 families and 8 orders from Nepal of which one species *Myersglanis blythi* Day has been specified as being endemic in Nepal. The first compilation of the reported fish fauna for the Central or Nepal Himalaya within the boundary of the Kingdom of Nepal for the period 1793-1982 was prepared, and it contained 171 fish species, of which 164 were indigenous and 7 exotic (Rajbanshi, 1982). Terashima (1984) reported three new species endemic to Mahendra Tal (Lake Rara). Edds (1985) has further reported a list of 111 and 113 native fish species from the River Kali Gandak/Narayani River and the waters of the Royal Chitwan National Park, Chitwan, respectively. Jha and Shrestha (1986) have studied fish fauna of the River Karnali and have reported 57 fish species under 38 genera, 19 families and 9 orders from the River Rapti and the River Narayani.

Shrestha (1990) has recorded 108 fish species from the River Koshi, 102 fish species from the Gandak, 74 fish species from the Karnali, 82 fish species from the Bagmati (downstream reach near Karmaiya), 34 fish species from the Trishuli and 69 fish species from the Mahakali. Shrestha (1990) has also stated that 130 species of fish occur in the snow-fed rivers and mountain lakes of the Nepalese highlands. Talwar and Jhingran (1991) have reported 96 fish species representing 19 families and 5 orders from Nepal in their book "Inland Fishes of India and Adjacent Countries". A number of other workers including Kadga (1989), Shrestha (1991) and Shah et.al. (1992) have explored the lower stream of the River Arun in eastern Nepal and have reported 46 fish species from there. Ormedo et. al. (1994) has assessed the hydrobiological changes along an altitudinal transect of eighteen to

twenty three tributaries in 600 - 3750 m altitude. In adjacent river systems (six streams of Likhu Khola valley) of central Nepal they reported *Neolissocheilus hexagonolepis* (McClelland), *Puntius conchoni* (Hamilton), *Schistura rupecola*(McClelland), *Ophiocephalus gachuwa* (Hamilton), genus *Barilius* and *Garra*. Chaudhury (1994), studied on the Ilam Hydroelectric Project and reported 14 fish species in Puwa Khola of Ilam .The Mountain Institute (1995) studied Biodiversity Conservation in Nepal and reported a total of 179 fish species. Shrestha (1994) has reported a total of 188 fish species from Nepal, out of which 179 indigenous and 9 exotic. But in 1985 Shrestha, (1995) listed only 185 species, representing 11 orders. Shrestha (1995) records a total of 183 species, out of which 173 indigenous and 10 exotic fish species. Out of the reported exotic fish, two species - *Oncorhynchus rhodurus* Jordan et Mcgregor and *Salmo trutta* L. do not exist presently in the country. Subba (1995) has reported a new record on the occurrence of a hill stream fish *Olyra longicaudata* McClelland from a tributary of the River Trijuga, a tributary of the Koshi River, Saptari District, Eastern Nepal.

Shrestha (1996), studied the fishes of Kali Gandaki river and reported 57 species. Subba and Ghosh (1996) have reported a new record of the pigmy barb - *Puntius phutunio* (Hamilton) from the Koshi Tappu Wildlife Reserve's lowland catchment area. Smith et. al. (1996) have studied aquatic biodiversity in the Karnali and Narayani River basins of Nepal and have recorded 141 fish species (including *Glyptothorax ribeiroi* synonymous to *Laguvia ribeiroi*), of which 121 and 134 fish species have been reported from the Karnali and Gandaki rivers, respectively. Shrestha (1997) made an Environmental Impact Assessment Study of the Upper-Karnali Hydropower project and reported 48 fish species. Shrestha (1999), studied on 'Cold Water Fish and Fisheries in

Nepal' and reported 59 indigenous and 2 exotic fish species. Pokharel, 1999 studied on the "Fish Bio-diversity of the Lakes of Pokhara Valley" and reported 25 fish species from the seven lakes of Pokhara. Shrestha, (1999) studied on the Bheri - Babai Hydroelectric Project and reported 46 fish species out of which 21 fish species for the River Bheri and 19 fish species for the River Babai. Rai (2000) reported 13 fish species from West - Seti Hydroelectric Project. Jayaram (1999) explain in his recent book "The Fresh Water Fishes of the Indian Region", 108 fish species from Nepal. Nath and Day (2000) contributed fish and fisheries of north eastern India. Menon (2004) highlighted threatened fishes of India and their conservation. Rahman (2005) contributed on "Fresh water fishes of Bangladesh". Karmaker and Das (2005) contributed on "Endemic Freshwater fishes of India". Recently, Shrestha (2008) enumerate the fishes of Nepal and describe the 232 species of fish in his book entitled "Fish diversity and potentiality of indigenous fishes for the future development of aquaculture".

CHAPTER-III

Methods and Methodology

Justification of the study

Very little work has been done in the Mahakali river. Being a large river and nature of its course from Himalayan region to Terai region, it has divergent fish species. Among them most of fishes are found on low land courses as well as its nearest wetlands. They have some adaptational features, and are adapted in the high hill regions. But most of the fishes of hill-stream are seen to be distributed on low land and also found on canals, natural lakes and Ghols of Terai region. Now, my study is tended towards the study of hill-stream fishes of Mahakali river and their adaptive nature and also on their economic importance.

Aims and objective

1. To explore the different fish species available in the Mahakali river with their distribution and ecological habits etc.
2. To study the adaptational features of hill-stream fishes.
3. Conservation and management of these hill-stream fishes.
4. To study the economic importance of hill-stream fishes together with ecological, food and recreation value.

Materials and methods

The present investigation was started from the year at 2007 October to 2008 October, series of collection were made from the Mahakali river. Fishes are also collected from ponds, swamplands, ditches and paddy fields. Fishes were collected in three seasons namely summer, monsoon and winter to determine fish stocks in these seasons. Fish collection were made with the help of local fishermen using various nets. For fish sampling cast nets and scoop nets were used. Fishes were also collected from local fish markets.

Regular visits were made at field sites and fish markets. The ecological variation of size and color of the fishes were noted down in the field. Local names of fishes were also noted down in the field with the assistance of local fisherman. Fishes were caught, from rivers, ponds and muddy water and preserved in 4 to 8 percent formalin solution. Observations were also made in the field to know the natural habits, adaptive features and modification on the body structures of fishes.

Different types of fishes collected and identified in situ and brought to zoological laboratory of Tribhuvan University, Kirtipur for confirmation. During visits to the various fish markets and fishing sites, information's were gathered from the fishermen on the maximum size weight, months of maximum and minimum catch. Observations were also focus in the field to know the natural habits and habitats of the fishes.

Various kinds of fishing techniques and fishing gears were noted. The methods were photographed and catch composition were recorded.

The study area and potential sites

Geographical location:-

Kanchanpur District lies in the far western part of Nepal. Its average north south length is about 44km and East west breadth is 34km and altogether it covers an area of 164,400 hector. It is situated between the $28^{\circ}32^1$ to $29^{\circ}30^1$ north latitude and $80^{\circ}4^1$ to $80^{\circ}23^1$ east longitude. It is surrounded by Kailali from east side, north side by Dadeldhura District, west side by Nainital District of India and south by Lakhimpur and Pilibit District of India. Besides, it is separated with Kailali by Mohana river in the east and in the west by Mahakali and Jogbudha river. Seventy five percent of land lies on Terai Zone of this district. The altitude of this district lies 159 to 288km from the sea level. The climate of Kanchanpur Distric is tropical marked by monsoonal rain fall pattern. According to Department of Hydrology and Meteorology, Babarmahal, Kathmandu, Nepal (2007), the maximum temperature of atmosphere is 36.1°c and minimum is 6.8°c and there is heavy rainfall during June to September and minimum in February to April The maximum rain fall is 426.5mm and minimum is 1.0mm in July and Janaury respectively.

Climate: This district is situated on tropical climate zone of west Terai. Here, the winter season is dry and hot with hot dry air on summer season. The maximum temperature of this district is 36.1°c and minimum is 6.8°c . The monsoon starts on June and ends on October. The average rainfall is 87.95mm and maximum relative humidity is 95.7%.



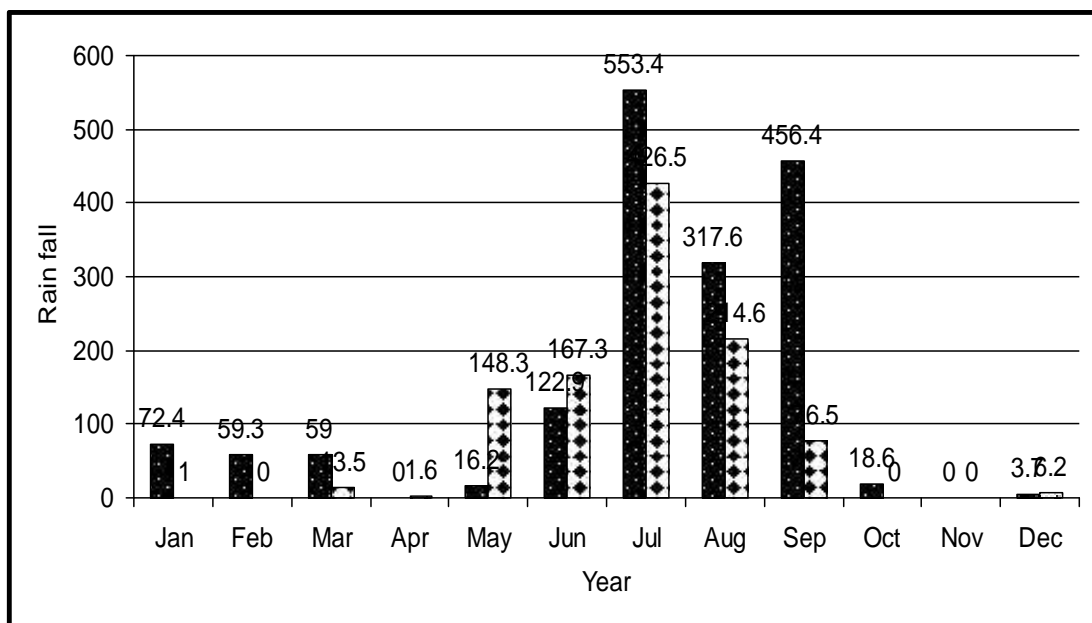
Map 2: Map of Kanchanpur District

Rain fall (in mm)

Table 2: Showing Annual Rainfall (mm) of Kanchanpur District during 2006.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	72.4	59.3	59.0	0.0	16.2	122.9	553.4	317.6	456.4	18.6	0.0	3.7
2007	1.0	0.0	13.5	1.6	148.3	167.3	426.5	214.6	76.5	0.0	0.0	6.2

Source: MG, Department of Hydrology and Meteorology, Babarmahal, Kathmandu, Nepal.



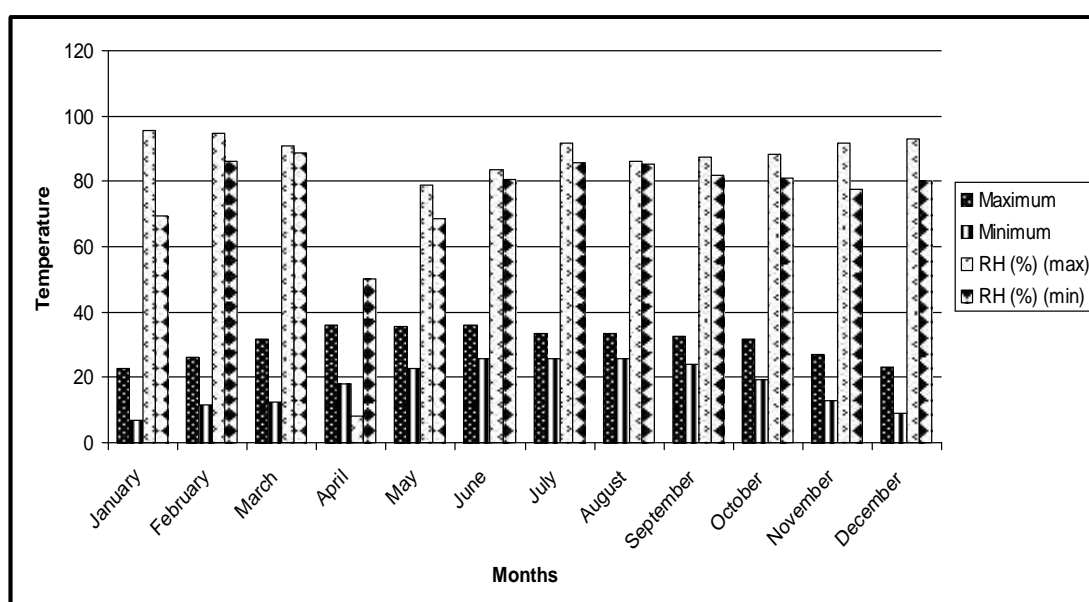
Graph 1: Showing the annual rainfall of Kanchanpur District 2006/2007

Temperature

Table 3: Showing Annual Temperature (°c) and Relative Humidity (%) of Kanchanpur District during 2006.

Month (2006)	Maximum	Minimum	RH (%) (max)	RH (%) (min)
January	22.7	6.8	95.7	69.6
February	26.3	11.7	94.6	86.1
March	31.7	12.3	90.8	88.7
April	36.0	18.0	8.0	50.0
may	35.6	22.8	79.0	68.6
June	36.1	25.9	83.5	80.6
July	33.4	25.7	91.6	85.6
August	33.5	25.8	86.3	85.2
September	32.7	24.0	87.3	82.0
October	31.6	19.5	88.5	80.8
November	26.9	12.8	91.7	77.4
December	23.1	8.8	93.1	80.3

Source: Department of Hydrology and Meteorology, Babarmahal, Katmandu, Nepal.



Graph 2: Showing the maximum and minimum temperature and relative humidity of Kanchanpur District.

Study sites

The water bodies of Kanchanpur District is broadly divided into two groups i.e. running (lotic environment) such as rivers and streams and standing water (lentic environment) such as ponds, swamplands (Ghols) etc. Among the river most of the rivers are drought, only flooded in the rainy season. The Mahakali, Mohana, Bahanama, Chaudhar river are perennial rives of Kanchanpur District but Mahakali river is prime river of the district.

The Mahakali river:- The Mahakali river is an interesting and important river in Nepal and plays a great role in the development of reverine fisheries and constitute one of the principal source of fish seed. The volume of Mahakali river changes with season reaching maximum during monsoon and minimum during winter. Fishes of the Mahakali river are biologically diverse during my observation. Field visits were conducted in different time of year. Fish faunas were identified and their ecological features and habitat conditions were also noted. The study area was divided in two section for the study:-

Locality 1: Upper section of Mahakali river (Sarada barrage).

Lacality2: Lower section of the Mahakali river i.e. Suspension bridge of Dodhara and Chadani.

Locality 1:- Upper section (Sarada barrage section)

This section lies near the Gaddachowki Bhansar office of Nepal. It is south-west side of Tanakpur barrage. This section is very old barrage established in 1920s under an agreement signed between British India and Nepal. Nepal get 1000 qusec water in average form this river for irrigation purpose and runs along the Mahendranagar and other VDCs of Kanchanpur District.

This section is an ideal habitat of fishes. The dominant fishes are the Buduna (*Garra annandalei*), Baghi (*Botia lohachata*), Asla (*Schizothorax plagiostomus*) etc. The important game fish are Sahar (*Tor tor*). The fishes sampled in this section are Sahar (*Tor tor*), Rohu (*Labeo rohita*), *Labeo dero*, *Botia lohachata*, *Crossocheilus latius*, *Chanda nama*, Asla (*Schizothorax plagiostomus*), *Garra annandalei*, Raj Bam (*Anguilla bengalensis*), Sidre (*Puntius sarana*) etc. These fishes are caught by regular casting nets, drift nets and scoop nets etc except *Barilius bendelisis*, *Macrognathus pancalus* .

Locality 2: Lower section i.e. Suspension bridge of Dodhara and Chadani

This section is 10km far from Sarada barrage. The Piparia is the nearest village in east and Dodhara is the adjoining village in the west. The length of pool is 1450m. In this section, the river is totally lies on Nepal's area and south west from Sarada barrage. The Rajbam (*Anguilla bengalensis*) caught from this area. The game fishes found in this section are Sahar (*Tor tor*), Asla (*Schizothorax richardsoni*), *Crossocheilus latius*. Except these Baghi (*Botia lohachata*), Buduna (*Garra annandalei*), *Garra gotyla*, Nata channa (*Chanda nama*), Bulla (*Glossogobius giuris*) are also abundantly found. Bam (*Amphimnous cuchia*), Tengra (*Mystus tengara*), Gadella (*Acanthocobatis botia*) are rarely found.

Most of the game fishes are caught by nets and hook line (Balchi) where other species of fishes are caught by nets and lift nets. Some where fishing takes place by hand.

Table 4: Physico-chemical parameter of Mahakali river.

S.N	Month	Appear	Temperature	Oxygen Content	Carbon-dioxide Content	PH	Total Hardness
1.	October	Hazy	21	8.3	4.3	7.2	5
2.	February	Transparent	12	7.5	5	7.3	3
3.	June	Transparent	22	8	4	7.6	4



Photo 1: Researcher standing at the side of Mahakali river near Sarada barrage. This river contains large amount of water in the rainy season.



Photo 2: Researcher standing at lower section (Suspension bridge of Dodhara and Chadani) area .



Photo3: Researcher seeing the fisher of Mahakali river at lower section area of Dodhara. Fisherman fishing by placing hooks on long rope.



Photo4: Fisherman of Mahakali river. Fishing by mosquito net.

CHAPTER - IV

4.1: List of fishes collected from different water resources of Kanchanpur District.

During the survey period, data on maximum length, weight, catching method, economic value and status of fishes were collected and result were tabulated as shown in (table 5).

Table 5: Showing fisheries survey and use of fish diversity in Kanchanpur District.

S.N.	Fish fauna	Max. length	Max. weight	Catching value	Economic value	Status
1.	<i>Catla catla</i> (Hamilton-Buchanan)	29cm	400g	cast net	Used as Food.	Cultivated in pond
2	<i>Cirrhinus mrigala</i> (Hamilton-Buchanan)	20 cm	300g	Cast net	Tasty fish	Cultivated in pond.
3.	<i>Ctenopharyngodon idella</i> (Valenciennes)	50cm	2kg	Cast net	Tasty fish	Cultivated in pond.
4.	<i>Labeo calbasu</i> (Hamilton-Buchanan)	30 cm	400g	Cast net Drift net	Used as food	Mahakali river
5.	<i>Labeo dero</i> (Hamilton-Buchanan)	30 cm	500g	Cast net	Used as food	Mahakali river
6.	<i>Labeo rohita</i> (Hamilton-Buchanan)	30cm	500g	Gill net Cast net	Used as food	Mahakali river
7.	<i>Puntius chola</i> (Hamilton-Buchanan)	10 cm	30g	Cast net Scoop net	Sudried as food	Canal
8.	<i>Puntius sarana</i> (Hamilton-Buchanan)	8cm	50g	Scoop net Cast net	Sundrid	Canal,Ghols
9.	<i>Puntius sophore</i> (Hamilton-Buchanan)	7 cm	25g	Cast net	Used as food	Found in calal
10.	<i>Cyprinus carpio</i> (Linnaeus)	50 cm	2.5kg	Cast net	Used as food	Cultivated in pond
11.	<i>Tor tor</i> (Hamilton-Buchanan)	20 cm	300g	Gill net Cast net	Used as food	Mahakali river
12.	<i>Hypophthalmichthys molitrix</i> (Valenciennes)	40 cm	2 kg	Cast net Scoop net	Used as food	Cultivated in pond
13.	<i>Aristichthys nobilis</i> (Richardson)	70 cm	2.5 kg	Cast net	Used as food	Cultivated in pond

14.	<i>Barilius vagra</i> (Hamilton-Buchanan)	10 cm	20g	Scoop net Cast net	Used as food	Canal
15.	<i>Barilius barna</i> (Hamilton-Buchanan)	9 cm	25g	Scoop net	Used as food	Canal
16.	<i>Barilius bendelisis</i> (Hamilton-Buchanan)	12cm	20g	Scoop net Cast net	Used as food	Canal
17.	<i>Esomus danricus</i> (Hamilton-Buchanan)	5 cm	20g	Cast net Scoop net	Sundried used	Canal
18.	<i>Raiamas bola</i> (Hamilton-Buchanan)	20cm	100g	Drift net	Food fish	Mahakali river
19.	<i>Brachydanio rerio</i> (Hamilton-Buchanan)	3.6 cm	25g	Scoop net Cast net	Sun dried	Canal
20.	<i>Rasbora daniconius</i> (Hamilton-Buchanan)	10cm	30g	Scoop net Cast net	Sun dried	Canal
21.	<i>Oxygaster bacaila</i> (Hamilton-Buchanan)	8cm	25g	Scoop net Cast net	Sun dried	Canal
22.	<i>Schizothoraichthys progastus</i> (McClelland)	25 cm	200g	Drag net	Excellent for eating	Mahakali river, canal
23.	<i>Schizothorx plagiostomus</i> (Heckel)	15 cm	200g	Drag net	Used as food	Mahakali river, canal
24.	<i>Crossocheilus latius</i> (Hamilton-Buchanan)	20cm	200g	Drag net Cast net	As food	Mahakali river
25.	<i>Garra annandalei</i> (Hora)	10 cm	25g	Cast net Scoop net	As food Sun dried	Mahakali river
26.	<i>Garra gotyla gotyla</i> (Gray)	8 cm	35g	Cast net Scoop net	As food	Canal
27.	<i>Acanthocobatis botia</i> (Hamilton-Buchanan)	8.4 cm	30g	Cast net	Used as food	Canal
28.	<i>Schistura corica</i> (Hamilton-Buchanan)	5.5cm	10g	Scoop net	Sun dried	Canal
29.	<i>Schistura rupecola</i> (McClelland)	8.5cm	25g	Cast net	Used as food	Canal, swamp lands,
30.	<i>Lepidocephalus guntea</i> (Hamilton-Buchanan)	7.6 cm	29g	Scoop net	Sun dried	Canal, pond
31.	<i>Botia lohachata</i>			Cast net	Used as	Canal

	(Chaudhuri)	8 cm	20g	Scoop net	food	Mahakali river
32.	<i>Mysus vittatus</i> (Bloch)	9.6cm	25g	Scoop net	Used as food	Mahakali river
33.	<i>Mystus tengara</i> (Hamilton-Buchanan)	12 cm	30g	Cast net Scoop net	Sun dried, As food	Canal, swampland
34.	<i>Wallago attu</i> (Schneider)	30cm	300g	Cast net	Used as food	Mahakali river
35.	<i>Clariasbatrachus</i> (Linnaeus)	40 cm	1kg	Cast net Scoop net	Very tasty	Cultivated in pond
36.	<i>Heteropneustes fossilis</i> (Bloch)	12 cm	100g	Scoop net	As food	Jhilmilataal, canal
37.	<i>Macragnathus pancalus</i> (Hamilton-Buchanan)	11.6 cm	25g	Cast net, Scoop net	As food	Mahakali river
38.	<i>Macragnathus aculeate</i> (Bloch)	12cm	26g	Cast net	As food	Mahakali river
39.	<i>Chanda nama</i> (Hamilton-Buchanan)	5cm	26g	Scoop net	Sun dried	Mahakali river
40.	<i>Badis badis</i> (Hamilton-Buchanan)	10cm	20g	Scoop net	Sun dried	Swamp land
41.	<i>Glossogobius giuris</i> (Hamilton-Buchanan)	6cm	28g	Scoop net	Sun dried	Mahakali river
42.	<i>Channa marulias</i> (Bloch)	20cm	300g	Hand pickling	Medicinal value, as food	Canal
43.	<i>Channa striatus</i> (Hamilton-Buchanan)	20cm	125g	Hand pickling	Used as food	Canal
44.	<i>Anguilla bengalensis</i> (Gray)	103.5 cm	2.75 Kg	Hook line	Very tasty food	Mahakali river

4.2 List of fishes with their systematic position and local names

I- Order-Cypriniformes

Family- Cyprinidae

Sub family- Cyprinini

Genus - *Calta* (Hamilton) 1822

1. *Calta calta* (Hamilton-Buchanan) 1822, Bhakur

Genus-*Cirrhinus* (Bleeker)1859

2. *Cirrhinus Mrigala Mrigala* (Hamilton-Buchanan) 1822, Naini

Genus –*Cyprinus* (Heckel) 1838

3. *Cyprinu carpio* (Linnaeus) 1758, Common carp

Genus- *Labeo* (Cuvier) 1817

4. *Labeo rohita* (Hamilton-Buchanan) 1822, Rohu

5. *Labeo dero* (Hamilton-Buchanan) 1822, Gurdi

6. *Labeo calbasu* (Hamilton-Buchanan) 1822, Salabata

Genus- *Ctenopharyngodon* (Steindachner) 1866

7. *Ctenopharyngodon idella* (Valenciennes) 1842, Grass carp

Genus-*Puntius* (Hamilton) 1822

8. *Puntius sarana sarana* (Hamilton-Buchanan) 1822, Sidre

9. *Puntius sophore* (Hamilton-Buchanan) 1822, Pothi

10. *Puntius chola* (Hamilton-Buchanan) 1822, Sidre

Genus-*Tor* (Gray) 1833

11. *Tor tor*(Hamilton-Buchanan) 1822, Mahaseer

Sub family-Leuciscinae

Genus -*Hypophthalmichthys* (Bleeker) 1959

12. *Hypophthalmichthys molitrix* (Valenciennes) 1842, Silver carp
Genus-*Aristichthys* (Oshima)
13. *Aristichthys nobilis* (Richardson) 1845, Bighead carp
Subfamily-Danioninae
Genus- *Barilius* (Hamilton) 1822
14. *Barilius vagra* (Hamilton-Buchanan) 1822, Faketa
15. *Barilius barna* (Hamilton-Buchanan) 1822, Poti
16. *Barilius bendelisis* (Hamilton-Buchanan) 1822, Gurdi
Genus-*Esomus* (Swainson) 1839
17. *Esomus denricus* (Hamilton-Buchanan) 1822, Dedhawa
Genus- *Brachydanio* (Weber de Beaufort) 1916
18. *Brachydanio rerio* (Hamilton-Buchanan) 1822, Zebra fish
Genus-*Rasbora* (Hamilton) 1822
19. *Rasbora daniconius* (Hamilton-Buchanan) 1822, Dedhaura
Genus-*Oxygaster* (Van.Hasselt) 1823
20. *Oxygaster bacaila* (Hamilton-Buchanan) 1822, Chalwa
Genus-*Raiamas* (Jordan) 1919
21. *Raiamas bola* (Hamilton-Buchanan) 1822, Bhutte, Chalwa
Sub family- Schizothoracinae
Genus- *Schizothoraichthys* (Misra) 1959
22. *Schizothoraichthys progastus* (McClelland) 1839, Chuche Asla
Genus- *Schizothorx* (Heckel) 1838
23. *Schizothorx plagiostomus* (Heckel) 1838, Buche Asla
Sub family-Garrinae
Genus-*Crossocheilus* (van Hasselt) 1823

24. *Crossocheilus latius* (Hamilton-Buchanan) 1822, Buduna
Genus- *Garra* (Hamilton) 1822
25. *Gurra annandalei* (Hora) 1921, Buduna
26. *Garra gotyla gotyla* (Gray) 1831, Buduna
Family- Balitoridae
Subfamily-Nemacheilinae
Genus- *Schistura* (McClelland) 1839
27. *Schistura corica* (Hamilton-Buchanan) 1822, Natwa
28. *Schistura rupecola* (McClelland) 1839, Bhote gadelo
Genus- *Acanthocobatis* (Peters) 1861
29. *Acanthocobatis botia* (Hamilton-Buchanan)1822
Sub family- Cobitinae
Genus-*Lepidocephalus* (Bleeker) 1859
30. *Lepidocephalus guntea* (Hamilton-Buchanan) 1822, Guntea
Sub family-Botinae
Genus-*Botia* (Gray) 1831
31. *Botia lohachata* (Chaudhuri) 1912, Baghi
- II. Order- Siluriformes**
Family-Bagridae
Genus-*Mystus* (Scopoli) 1777
32. *Mystus vittatus* (Bloch) 1786, Tengra
33. *Mystus tengara* (Hamilton-Buchanan) 1822, Tengra
Family-Siluridae
Genus-*Wallago* (Bleeker) 1859
34. *Wallago attu* (Bloch and Schneider) 1801, Buhari

Family-Claridae

Genus-*Clarias* (Scopoli) 1777

35. *Clarias batrachus* (Linnaeus) 1758 Mangur

Family-Heteropneustidae

Genus- *Heteropneustes* (Muller) 1840

36. *Heteropneustes fossilis* (Bloch) 1794

III. Order-Synbranchiformes

Suborder- Mastacembeloidei

Family- Mastacembelidae

Genus- *Macrognathus* (Lacepede) 1800

37. *Macrognathus aculeate* (Bloch) 1786

38. *Macrognathus pancalus* (Hamilton-Buchanan) 1822

IV. Order-Perciformes

Suborder-Percoidae

Family- Chandidae

Genus -*Chanda* (Hamilton) 1822

39. *Chanda nama* (Hamilton-Buchanan) 1822, Gurda

Family-Nandiadae

Subfamily - Badinae

Genus- *Badis* (Bleeker) 1859

40. *Badis badis* (Hamilton-Buchanan) 1822, Pasari

Sub order-Gobiodei

Family -Gobiidae

Subfamily - Gobiinae

Genus-*Glossogobius* (Gill)

41. *Glossogobius giuris* (Hamilton-Buchanan) 1822, Bulla

Suborder-Ophiocephaliformes

Family-Ophiocephalidae

Genues-*Channa* (Scopoli) 1777

42. *Channa marulias* (Bloch and Schneider) 1801, Bhote

43. *Channa striatus* (Bloch) 1786, Hile

V. Order -Anguliformes

Family-Anguillidae

Genus-*Anguilla* (Gray) 1831

44. *Anguilla bengalensis* (Gray) 1831, Raj bam

4.3 List of hill-stream fishes found in Mahakali river with their systematic position

Order -I Cypriniformes

Family-Cyprinidae

Subfamily- Cyprinini

Genus- *Tor* (Gray) 1833

1. *Tor tor* (Hamilton-Buchanan) 1822, Mahaseer
Genus- *Labeo* (Cuvier) 1817
2. *Labeo dero* (Hamilton-Buchanan) 1822, Gurdi
Subfamily-Danioninae
Genus- *Barilius* (Hamilton) 1822
3. *Barilius vagra* (Hamilton-Buchanan) 1822, Faketa
4. *Barilius barna* (Hamilton-Buchanan) 1822, Poti
5. *Barilius bendelisis* (Hamilton-Buchanan) 1822, Gurdi
Genus-*Brachydanio* (Weber de Beaufort) 1916
6. *Brachydanio rerio* (Hamilton-Buchanan) 1822, Zebra fish
Genus-*Esomus* (Swainson) 1839
7. *Esomus denricus* (Hamilton-Buchanan) 1822, Dedhawa
Genus-*Raiamas* (Jordan) 1919
8. *Raiamas bola* (Hamilton-Buchanan) 1822, Bhutte, Chalwa
Sub family- Schizothoracinae
Genus- *Schizothoraichthys* (Misra) 1959
9. *Schizothoraichthys progastus* (McClelland) 1839, Chuche Asla
Genus- *Schizothorx* (Heckel) 1838
10. *Schizothorx plagiostomus* (Heckel) Buche Asla
Sub family-Garrinae
Genus-*Crossocheilus* (van Hesselt) 1823
11. *Crossocheilus latius* (Hamilton-Buchanan) 1822, Buduna
Genus- *Garra* (Hamilton) 1822
12. *Garra annandalei* (Hora) 1921, Buduna
13. *Garra gotyla gotyla* (Gray) 1832, Buduna

Family- Balitoridae

Subfamily-Nemacheilinae

Genus- *Acanthocobatis* (Peters) 1861

14. *Acanthocobatis botia* (Hamilton-Buchanan) 1822, Natwa

Genus- *Schistura* (McClelland) 1839

15. *Schistura corica* (Hamilton-Buchanan) 1822, Baghe

16. *Schistura rupecola* (McClelland) 1839, Bhote gadelo

Sub family- Cobitinae

Genus-*Lepidocephalus* (Bleeker) 1859

17. *Lepidocephalus guntea* (Hamilton-Buchanan) 1822, Guntea

Sub family-Botinae

Genus-*Botia* (Gray) 1831

18. *Botia lohachata* (Chaudhuri) 1912, Baghi

II. Order-Perciformes

Sub order-Gobiodei

Family -Gobiidae

Subfamily - Gobiinae

Genus-*Glossogobius* (Gill)

19. *Glossogobius giuris* (Hamilton-Buchanan) 1822, Bulla

Table 6: Distribution of hill-stream fish at different stations in the Mahakali river

Family	Species	Local name	St.I	St.II	
Cyprinidae	<i>Labeo dero</i>	Gurdi	+	+	
	<i>Barilius barna</i>	Poti	+	+	
	<i>Barilius bendelisis</i>	Gurdi	+	-	
	<i>Barilius vagra</i>	Faketa	+	+	
	<i>Raiamas bola</i>	Chalwa	+	+	
	<i>Brachydanio rerio</i>	Zebra fish	+	-	
	<i>Esomus denricus</i>	Dedhawa	+	+	
	<i>Garra annandalei</i>	Buduna	+	+	
	<i>Garra gotyla gotyla</i>	Buduna	+	-	
	<i>Tor tor</i>	Mahseer	+	+	
	<i>Crossocheilus latius</i>	Buduna	+	+	
	<i>Schizothorax plagiostomus</i>	Buche Asla	+	+	
	<i>Schizothoraichthys progastus</i>	Chuche Asla	+	+	
	Balitoridae	<i>Botia lohachata</i>	Baghe	+	+
		<i>Lepidocephalus guntea</i>	Guntea	+	-
		<i>Schistura corica</i>	Gadela	+	-
<i>Acanthocobatis botia</i>		Gadela	+	+	
<i>Schistura rupecola</i>		Gadela	+	-	
Gobiidae	<i>Glossogobius giuris</i>	Bulla	+	-	

Where, 'St.' = Station; - = absence; and + = present.

Table 7: Fish population composition by numbers and percentage in the Mahakali river

Fish genus/species	Total no.in (St. I)	Total no in (St.II)	Percentae number in (St.I.) (%)	Percentae number in (St.II.) (%)
<i>Labeo dero</i>	25	20	4.5	8.40
<i>Barilius vagra</i>	15	19	2.7	7.50
<i>Barilius barna</i>	4	16	0.72	6.71
<i>Barilius bendelisis</i>	16	0	2.8	0
<i>Raiamas bola</i>	1	0	0.18	0
<i>Brachydanio rerio</i>	40	0	7.2	0
<i>Esomus denricus</i>	6	5	1.08	2.10
<i>Garra annandalei</i>	50	34	9.02	14.2
<i>Garra gotyla</i>	70	35	12.6	14.70
<i>Tor tor</i>	17	17	3.06	7.14
<i>Crossocheilus latius</i>	16	5	2.88	2.10
<i>Schizothorax plagiostomus</i>	20	25	3.61	10.50
<i>Schizothoraichthys progastus</i>	20	27	3.61	11.34
<i>Botia lohachata</i>	80	25	14.44	10.50
<i>Lepidocephalus guntea</i>	40	0	7.22	0
<i>Acanthocobatis botia</i>	40	9	7.22	3.78
<i>Schistura rupecola</i>	60	0	10.80	0
<i>Schistura corica</i>	30	0	5.41	0
<i>Glossogobius giuris</i>	4	1	0.72	0.42
Total	554	238	99.79	99.92

4.4 Description of hill-stream fishes of Mahakali river

Genus –*Tor* (Gray)

1. *Tor tor* (Hamilton-Buchanan) Sahar

It is one of the endemic fish of Nepal. This species found on major rivers like Koshi, Gandaki, Karnali and Mahakali rivers of Nepal. It is one of important food and game fish. Body is deep and dorsal side more convex. Body color dark grey with greenish ting along upper half of body. Sides slightly golden colour. Ventral fins reddish orange and dorsal fin slightly dark. Abdomen silvery white with golden. It has the maximum size 30cm and altitudinal range 135-1424m. From the Mahakali river, at least 7kg of Sahar is collected.

Diagnostic character: D12 (3/9); P17; V9; A7(2/5); C19; L₁-25 L.tr8;
TL=30cm

Genus- *Labeo* (Cuvier)

2. *Labeo dero* (Hamilton-Buchanan) Gurdi

A stout, round bodied fish with a broad head. The snout is conical with many horny tubercles. It is dark grey fish with bluish black above, silvery sides and reddish fins. A pair of maxillary barbels are short. Body fully scaled; anal fin with free edge. Altitudinal range for this species is 150-1,000m. It is migratory in habit, spawns in May-June. It is found in Gandaki Bheri, Koshi, Trisuli, Karnali and Mahakali rivers.

Diagnostic character: D12-13(3/9-10); P16-17; V9; A8(3/5); C19; L₁38-43 L.tr8/6-7; TL=30cm

Genus- *Barilius* (Hamilton)

3. *Barilius barna* (Hamilton-Buchanan) Poti

This fish has crossed by fine dark vertical bands. Barbels are absent. Open pores are present on the both jaw and snout in the adults. The body of fish is silvery with 9-11 bluish vertical bands, originating from dorsal sides and crossing the lateral line. This is collected from irrigation canal with measuring 9cm .It also found in major rivers i.e. Koshi, Gandaki, Karnali and Mahakali.

Diagnostic character: D9 (2/7); P15; V9; A13-14(3/10-11);C19; L₁39-42
L.tr8-9/6;TL=9cm

4. *Barilius bendelisis* (Hamilton-Buchanan) Gurdi

It is a medium sized hill-stream fish having fine pores on the snout .The body is crossed with 8-12 lateral bands and dashed with bluish green silvery tinge. The fish has black spots at the base of each scale .The paired fins are whitish, tinge with orange specially fan like. Barbels 2 pairs. Lower jaw covered with spiny tubercle. I collected this fish from irrigation canal where algal bloom is numerous. The fish lives in cohesive school. This fish found on major rivers like Bagmati, Bheri, Koshi, Trisuli, Karnali and Mahakali rivers.

Diagnostic character: D 9(2/7); P15; V9; A 9-10;C18; L₁40-43; L.tr7-8/5,TL=8.5cm

5. *Barilius vagra* (Hamilton-Buchanan) Faketa

It is a slim bodied fish with shallow body and relatively small head and mouth. Short 8-13 vertical bands throughout body not reaching up to lateral line.The lateral side silvery white in colour. The mouth cleft is also extended upon the middle of the eye. Barbels two pairs. It is usually found in clean running water but adapted to slow-flowing low land rivers. It found in Bagmati, Bheri, Koshi, Trisuli, Karnali and Mahakali rivers.

Diagnostic character: D9 (2/7); P16; V9; A13-15; C19; L₁42-44; L.tr7-8/4, TL=10cm

Genus-*Raiamas* (Jordan)

6. *Raiamas bola* (Hamilton-Buchanan) Bhutte, Chala

It is a medium sized snow trout like. The body is silvery with greenish back. It has 15 to 17 greenish blue spots on the sides of the body. Head sharply pointed. Caudal fin deeply forked. Cheek and snout covered with tubercles during breeding season of monsoon. This fish occurs in Bagmati, Bheri, Koshi, Seti, Karnali and Mahakali rivers.

Diagnostic character: D10; P13; V9; A3/10; C19; L₁84-89; L.tr13-814/15, TL =30cm

Genus- *Brachydanio* (Weber de Beaufort)

7. *Brachydanio rerio* (Hamilton-Buchanan) Zebra fish

It is a beautiful ornamental fish with arched silvery body and oblique mouth. Four longitudinal bands of blue color separated by a narrow silvery one on either side of the body run from one end of the operculum to the base of caudal fin. Barbels two pairs. It is a larvivorous fish and can be used for mosquito control. It is collected from canal where algal bloom is more in number.

Diagnostic character: D 9(2/7); P13; V8; A15-16; C19; L₁27-30; L.tr8; TL=12.5cm

Genus-*Esomus* (Swainson)

8. *Esomus denricus* (Hamilton-Buchanan) Dedhawa

It is small fish with bright pearly iridescences. The dorsal part is large. A dark band from behind the eye to the base of caudal fin. Lips thin, lower jaw quite prominent. Pelvic fin raddish, other fins brownish

orange. Barbels two pairs. They live and breed in shallow water streams, ponds and paddy fields. This fish is common in the Terai and the hills in altitudinal range 80-1,400m. This fish breeds in shallow water stream during May and June. Found in Bagmati, Bheri, Koshi, Seti, Karnali and Mahakali rivers.

Diagnostic character: D8-9(2/6-7); P11-12; V8; A9(3/6); L₁10-114; L.tr20/1/30; TL=25cm

Genus- *Schizothoraichthys* (Misra)

9. *Schizothoraichthys progastus* (McClelland) Chuchhe Asla

It has silvery body with pointed snout. Colouration, usually silvery brown above, the sides and belly creamy. The dorsal, and caudal fins are spotted black; opercle golden yellow. Mouth large subterminal with two pairs of barbels.

It is found middle reaches, clear, rapidly flowing streams. It feeds on insect's larvae and molluscs. It migrate upper reaches to spawn and migrates lower reaches. It is found in Sun Koshi, Chamelia, Bheri, Rapti Narayani, Karnali, and Mahakali rivers.

Diagnostic character: D11-13(3/8-9); P19; V11; A7 (2/5); C19; L₁10-114; L.tr20/1/30; TL=25cm

Genus- *Schizothorx* (Heckel)

10. *Schizothorx plagiostomus* (Heckel) Buche Asla

It is a heavy spotted golden snow trout with blunt snout. Body is more cylindrical. Mouth is inferior with a suctional disc in chin formed by edge of lower lips. Barbels 2 pairs. Snout is covered by horny tubercles. Paired fins tinged with red. It occurs in all snow fed feeder stream and river 600 to 2,000m. This fish spawns in springs and creeks as well as

gravel beds of river. I have collected this fish from Mahakali river and also from irrigation canal. It seems to be well adopted in the low land coarses. It feeds on algal blooms, small insects etc. It is a tasty fish and fishing in a large scale in major rivers of Nepal.

Diagnostic character: D10 (3/7); P16-17; V10; A7 (2/5); C19-20; L₁105; L.tr23/23; TL=32cm

Genus- *Crossocheilus* (Kul et.al van Hesselt)

11. *Crossocheilus latius* (Hamilton-Buchanan) Buduna

It is an elongate hill-stream fish having general body colour greyish above, silvery below. Ventral profile horizontal or slightly curved. Mouth inferior with upper lip indented. Eyes large lower lip simple without any modification. A pair of rostral barbels present. It is collected from Mahakali river and also found on major rivers of Nepal.

Diagnostic character: D11 (3/8); P15; V9; A7 (2/5); C19; L₁39; L.tr6/6; TL=20cm

Genus- *Garra* (Hamilton)

12. *Garra annandalei* (Hora) Buduna

It is a dark grey hill-stream fish with blackish brown dorsum and pale belly. This fish has slender body with a smooth, pointed snout having the groove and tubercles. Barbels two pairs. The ventral adhesive disc is much reduced, small and oval. It occurs in high mountain streams lakes of rivers above 200 to 1,000m. These fishes are in numerous number collected from the Sarada barrage of Mahakali rivers.

Diagnostic character: D11 (3/8); P15; V8; A7(2/5); C17; 3 L₁3-34; TL=20cm

13. *Garra gotyla gotyla* (Gray) Buduna

It is a dark brown fish with greenish golden tinge and pale belly. The head is small, eyes large, snout obtuse with median proboscis leset with coarse tubercles. Barbels two pairs. An adhesive apparatus in the ventral cavity. This fish is collected from irrigation canal and Mahakali river. The fish has reddish tinge on nose like aperture formed in snout. There is slightly difference between the species found on Mahakali River and canal. The riverine species is less blackish than which found in irrigation canal.

Diagnostic character: D11 (3/8); P15; V9; A7(2/5); C17; L₁39
L.tr;TL=8cm

Genus - *Schistura* (McClelland)

14. *Schistura corica* (Hamilton Buchanan) Stone loach

It is a small fish with 13 to14 broad and slightly curved vertical bands along the back. Small rounded patches alternate with elongated and slightly curved blotches. Barbels 3 pairs. It is found 100 to1, 500m in altitude. This fish is collected from canal where algal bloom is more numerous.

Diagnostic character: D10 (2/8); P13; V8; A7(2/5); C17; TL=5.5cm

15. *Schistura rupecola* (McClelland) Bhotte gadelo

It is collected from irrigation canal. Ventrally this fish has elongated and cylindrical bodies. Small body with minute scales set in skin. This fish is yellow-brown in color with darker 14 to 16 bands. A distinct black spot on second ray of dorsal fin.3 pairs of barbels and broad snout. Mouth with fleshy lips. It feeds on small larvae and is itself prey of predatory fishes. It is also found in major rivers of Nepal.

Diagnostic character: D9-11(2-3/7-8); P10; V8; A7(2/5); C18; L₁39; TL=8cm

Genus- *Acanthocobatis* (Peters)

16. *Acanthocobatis botia* (Hamilton-Buchanan) Baghe

It is hill-stream fish having 10 mottled bands. Many small oval patches are distributed along lateral line. Barbels 3 pairs. A distinct black ocellus present at caudal peduncle above lateral line. It hunts small aquatic insects and earthworms. It is collected from irrigation canal and also found on major rivers of Nepal.

Genus – *Lepidocephalus* (Bleeker)

17. *Lepidocephalus guntea* (Hamilton -Buchanan) Guntea

This is small cylindrical fish with caudal peduncle elongated. General body colour is black patterns and a bright dark band. Body colour variable ground colour. Dorsal, pectoral and caudal fins have black dots and are crossed with stripes. A black ocellus on caudal fin base. Barbels 4 pairs. It is common in low land waters. The altitudinal range is 80-1400m.

Diagnostic character: D 8(2/6); P8; V7; A7(2/5); C16; L₁15; TL=8cm

Genus-*Botia* (Gray)

18. *Botia lohachata* (Chaudhuri) Baghi

This fish enormously found on Mahakali river and collected in large number by fisherman. The fish is yellowish brown popularly known as Y-loach. Two distinct spots occurs posterior to eye. Body has Y-shaped yellow band. Barbels 4 pairs. At caudal peduncle dark bands

presents. It has a mouse like head and contains spines on head. Altitudinal range is 180 to 500m.

Diagnostic character: D11 (2/9); P13-15; V8; A7(2/5); C19; TL=8cm

II. Order-Perciformes

Sub order-Gobiodei

Family -Gobiidae

Subfamily - Gobiinae

Genus-*Glossogobius* (Gill)

19. *Glossogobius giuris* (Hamilton-Buchanan) Bulla

It is a common gobiid fish found in rivers and lakes where bottom is stony. Its pectoral fin has broad base and ventral fin are united forming a cup like structure which acts as a sucking disc. The anal fin is pointed posteriorly caudal oblong. The eyes are situated on head region. Its dorsal fin is single rayed. It is bottom dweller and feeds on wide variety of benthic organism. It is found in lowland stretches of altitudinal range is 80 to 200m of Gandaki, Koshi, Karnali, Bheri and Mahakali River.

Diagnostic character: D6/1/8-9; P20; V1/5; A1/8-9(2/5); C17;L₁30-34
TL=8cm

CHAPTER –V

Result

The family Cyprinidae dominates with 21 species, followed by family, Balitoridae with 5 species, Bagridae represented by 2 species, Claridae with 2 species, Channidae with 2 species, Mastacembelidae 2 species, Siluridae 1 species, Chandidae 1 species, Nandidae 1 species, Gobiidae 1 species and finally Anguillidae represent 1 species.

I have collected 554 number of fish from first station and 238 from the second station including different species. *Botia lohachata* has the higher percentage in number about 14.44 percent where as *Raiamas bola bola* has found in least percent about 0.18 in first station. The higher percentage number of species in second station is *Garra gotyla* about 14.70 percent where as least percentage number is 0.42 percent of *Glossogobius giuris*.

The physico-chemical parameter of Mahakali river is found suitable for riverine fisheries. The the higher temperture is found to be 21°C in the month of June where as minimum temperature is found to be 12 °c in February. The water becomes hazy in October in rainy season and the oxygen content measured to be 8.3 as high quantity. The CO₂ level is maximum as 5 in February. Total hardness is found to be high in October as 5. Besides these the P^H quantity is found to be higher in 7.6 in June.

In the cold waters of the Mahakali river *Labeo dero* and *Tor tor* are the dominant fish followed by *Schizothorax plagiostomus* and *Schizothoraichthys progastus* and the small loaches of Balitoridae group. In the cold waters of high hills the above mentioned fish species are accompanied by the cyprinids *Tor tor*, *Crossocheilus latius* and *Barilius bendelisis* followed by *Botia lohachata*. A large number of

Schizothoracinae migrates from the mountain region to the hill and low hill region during winter to avoid low temperatures in higher streams and fish of lower streams migrate upstream during summer to spawn.

Amongst the recorded fish, one species varies from other in shape, size and weight. Some of the fish are small and may weigh a few grams, e.g. *Brachydanio rerio*, *Acanthocobatis botia*, *Schistura rupecola*, *Schistura corica*, *Botia lohachata*, *Lepidocephalus guntia*, *Garra gotyla* and *Garra anandalei* while the biggest fish range to over one metre, e.g. *Tor tor* weigh over 20 kg. Most of the indigenous fish have not yet been domesticated for aquaculture.

The fish also show diversity on the basis of their feeding habits, ranging from herbivorous to larvivorous and from insectivorous to omnivorous. Under aquaculture conditions the herbivorous and omnivorous fish can be produced more economically as food fish than the carnivorous fish. In cold waters there are less predatory fish and predation on other fish is considerably lower than in warm waters. Some indigenous cold water fish species have special adaptations for the fast water current. *Schizothorax plagiostomus*, *Schizothoraichthys progastus* and *Tor tor* have developed conical or pointed head with slender and strong tail. *Raiamas bola* have a laterally compressed body to resist the water current, *Garra gotyla* and some others have an adhesive organ on the ventral side of the flattened head to get attached to a rock.

The head and the body of a number of hill-stream fishes are greatly flattened and highly specialized. The ventral profile is straight and horizontal in most of hill-stream fishes while the dorsal profile is slightly arched. Those fishes living in slow river are cylindrical body as *Crossocheilus latius*, while those inhabiting rapid stream has flattened body. The scales of cyprinid fishes living in the hill streams undergo

reduction. They are small in size and partly or completely embedded in the skin. Scales are very minute and embedded in the skin in *Schizothorax plagiostomus*, *Schizothoraichthys progastus* and *Acanthocobatis botia*. Paired fins especially pectorals, are modified in the hill stream fishes. The outer rays of the paired fins are modified for adhesion. The girdles are also modified in some species of hill-stream fishes, especially in those species in which fins are used as organ for adhesion. The mouth instead of being a transverse cleft at the anterior end of the snout is shifted towards the rostral side, behind. In *Acanthocobatis botia* the lips modified so as to form a sucker with help of mouth. The lips are divided in the middle and are swollen, so that to form a ring like sucker. In some species of *Garra gotyla*, the gill opening are a little wider, but still separated from each other by a considerable distance. The muscle of mouth is also develops into adhesive organ. A simple condition is seen in *Acanthocobatis botia*, *Schistura rupecola* and *Schistura corica* in which mouth aperture is surrounded by thick horny lips which functions as a suckers. The base of the pectoral fins is thickened and cushionlike. In *Schizothorax plagiostomus* and *Crossocheilus latius* the jaws are covered by a hard callous plate for scraping the food. Posterior to this callous plate, the skin thickened and tuberculated. The anterior labial fold may also be fringed. In *Garra gotyla*, the adhesive organ looks like a disk on the postero-ventral side of mouth openings. They consist of a central callous part and free tuberculated lateral and posterior borders. The anterior labial fold of the fish is fringed and tuberculated. The whole structure helps the fish in adhesion to rocks and stones.

Internally they have many changes in their body organs. For example the primary gill lamellae undergo division to give rise to

additional lamellae in several hill-stream fishes. The lamellae may bifurcate in the middle or at the base to produce two branches. Sometimes three or four branches are formed or several branches of the filaments are believed to increase the gill surface area, as an adaptation to life in hill-stream and have been observed in *Garra gotyla*, *Botia lohachata*, *Acanthobatis botia* and *Lepidocephalus guntia*. In some tropical fresh water fishes, special structures called the accessory air breathing organs are present in addition to gills. Such structures are generally developed in response to the exceptional environmental condition which include life in foul water or life out of water for short period. The air breathing hill-stream fishes are *Lepidocephalus guntea*, *Macrogathus pancalus* and *Macrogathus aculeata*. In genus *Macrogathus*, the modified gills secrete a large amount of mucus to keep them moist and facilitate gas diffusion for sometime when the fish is out of water.

CHAPTER-VI

Economic importance

Fish as food

Culturally, fish is considered as an auspicious item in Nepal. Thus fish is used in all social and religious ceremonies. A fish dish is always considered a delicacy and valued food in the Nepalese society. *Tor tor*, *Crossocheilus latius*, *Labeo dero*, *Barilius barila*, *Barilius barna*, *Barilius bola*, *Barilius bendelisis*, *Schizothorax plagiostomus*, and *Schizothoraichthys progastus* have a good economic value:

These economically important fish are famous for their value as food, sport/recreational fishery, decorative/aquarium value, and academic value. Fish of food and sport value are usually larger while the fish of decorative and academic value are small. But, there is no bar on the species and its size for its consumption. Cold water fish are considered tastier than other fish, and are therefore preferred to warm water fish and in high demand. Because of this, cold water fish always fetch a good market price in rural as well as urban markets. *Schizothorax plagiostomus*, *Schizothoraichthys progastus*, *Barilius barila*, *Tor tor* are considered of exceptionally good quality food. Asla(*Schizothorax plagiostomus* and *Schizothoraichthys progastus*) have a long tradition of being a delicacy.

Fish are mostly consumed fresh but in case of surplus catches they are sun dried and smoked. The sun dried and smoked fish are also considered a delicacy and are in high demand. They fetch very good price in the markets.

The capture fishery for cold water fish is at subsistence level, not well organised, and widely scattered throughout the country and is not

well organized. No reliable catch statistics are available, but effort is being made to establish a database, which would include information on fish catch, fish species composition, number of fishermen and families involved in cold water capture fisheries.

More information is also needed on the biology, behavior, reproduction, domestication and culture of cold water fish. Studies on the aquaculture potential of *Tor tor*, *Schizothorax plagiostomus*, *Schizothoraichthys progastus* and *Barilius barila* are in progress.

Sport and recreational fishery

The cold water fish *Tor tor*, *Neolissocheilus hexagonolepis*, *Schizothorax plagiostomus*, *Schizothoraichthys progastus* and *Barilius barila* are well known by anglers. These fish migrate downstream in winter and upstream in summer seeking rapid current. They are very strong and grow to big size. *Schizothorax*, *Schizothoraichthys* and *Barilius* are active and called "snow trout". For catching the snow trout the local people have invented a simple loop made of monofilament thread. The fishing method is called "looping of Asla" and while simple it is an effective method of fishing in hill streams. It is in wide use by the locals fishing the hill streams of Central Nepal (Rajbanshi, 1976).

Sport and recreational fishery can be further developed with the involvement of the local population which would benefit from job opportunities and income.

Fish of decorative and academic values

The fish of hill region such as *Acanthocobatis botia* and *Botia lohachata* are not multicolored as some fish of the warm tropical waters but their peculiar morphology and coloration are of interest to aquarists.

Morphological structure, especially adaptations to fast current as seen in a number of species, are of academic interest.

Future opportunities for indigenous fish

Effort should focus on the development of aquaculture technologies to provide stocking material for enhancing fish stocks in rivers, streams and lakes as well as to initiate their culture. Good stocks of cold water fish in rivers would support the development of sport and recreational fisheries and this would assist with the development of ecotourism in remote areas. Aquaculture of cold water fish species and production of aquarium fish would lead to employment opportunities and to raising living standard through marketing the produce. This would help in slowing down the outward migration of the hill people seeking employment outside the region.

CHAPTER – SEVEN

Conservation and management

Fish fauna of Mahakali river is diverse. Its water bodies rivers, ponds, contains, large number of rare fish species. It supports 44 diverse fish species with predominance of cyprinids. Among 44 species, I have collected 19 hill-stream fishes from Mahakali river. The diversity of hill-stream fishes in the Mahakali river seems to be very wide and due to many illegal and harmful fishing activities, some species are going to be indanger condition. So there is necessary to protect these species from harmful fishing activities. The following are some points which may resist the declining population of hill-stream fishes in Mahakali river.

1. The population of rare fish species such as *Tor tor* (Mahseer) declining faster in Mahakali river. The main cause of their depletion are the habitat changes due to unsuitable environment and migratory in nature. It is therefore necessary to maintain population of these fishes by artificial breeding program.
2. Due the formation of hydropower project in Mahakali river, the mechanical tress would occur in the fish species. Mechanical stress cause mortality during embryonic development in *Tor tor* and hatching success is retarded (Sharma, 1996). So, during formation of such project, the conservation measures are must be noticed.
3. Small mesh size fishing used in the Mahakali river which cause the destruction of large number of small sized fishes so it should be checked.
4. Fish ladder and other bypass facilities should be developed to facilitate upriver and down rive migration of rare fishes.

5. In various section of Mahakali river fish screens, fish weirs and fine meshed cloth are used. These devices are very destructive measures for rare species are caught by these implements so they should be immediately banned.
6. Fish poisoning devices are widely used in the Mahakali River. This poisoning cause many side effects on fishes, fish becomes semi blind and rest less, finally paralyzed. So it should be banned in the Mahakali river.
7. Rare fishes breed in different seasons. So spawning ground particularly rare fish such as *Tor tor*, *Schizothorax plagiostomus*, *Schizothoraichthys progastus* should be protected during breeding season of June to September. During these month both males and females are caught in high number. So, such practices should be stopped by low of conservation of rare fishes.
8. Many hydropower projects are regulating in the Mahakali river from the community as well as from government. For eg., Chamelia hydroelectric project. These engineering works have been responsible for immediate elimination of various species in fresh waters.

7.2 Recommendation

For the further investigation of the fishes of Mahakali river following recommendation are proposed:

1. To carry out long term investigation of fishes of Mahakali river especially on hill-stream fishes.
2. To study the ecology of hill-stream fish species occurring in the Mahakali river and its swamplands.

3. To study the impact of harmful fishing activities on water ecology and their side effect in human being.
4. To study breeding periodicity and reproductive success of hill-stream fishes as well as rare and migratory fishes.
5. To study the different adaptive features of hill-stream fishes.

CHAPTER-EIGHT

Discussion

Mahakali river flows between India- Nepal boarder. It has diverse form and support a diverse fish fauna. I have collected 44 species of fish from different area of Kanchanpur District including Mahakali river. This includes 5 order, 12 family, 29 genus. Among them, 5 species are exotic and 39 are indigenous species which are collected from Mahakali river and it's irrigation canal. The family Cyprinidae dominates with 21 species, followed by family Balitoridae with 5 species, Bagridae represented by 2 species, Claridae with 2 species, Channidae with 2 species, Mastacembelidae 2 species, Siluridae 1 species, Chandidae 1 species, Nandidae 1 species, Gobiidae 1 species and finally Anguillidae represent 1 species. Among them, 19 species are hill-stream fishes.

The present list of hill-stream fishes of Mahakali river has been made on the basis of collection at field study. But for more detail information this will require a systematic survey of water bodies of Mahakali river. This study was oriented on the two section of Mahakali river, mainly upper Sarada barrage and Suspension bridge of Dodhara Chadani. Sarada barrage is 6km far from Mahendranagar. It is atleast 1km long bridge. A large number of fishing activities is happened by fisherman. Different types of fish gear is used to catch the fishes such as cast net (Maha Jaal), drift net, hook and line fishing, poisoning etc. Large scale of fishes are collected from this station by using cast net.

The *Schizothorax Plagiostomus*, *Schizothoraichthys progastus*, *Acanthocobatis botia*, *Botia lohachata*, *Garra gotyla* and *Garra annandalei* are always dominant in the first station(Sarada barrage).There is high volume of water, stagnant as well as fast flowing water. Due to this, a large number of fish species are found at this station. In the present study atleast 19 hill-stream fishes are collected. Among them the *Tor tor*, *Schizothorax Plagiostomus*, *Schizothoraichthys progastus*, *Acanthocobatis botia*, *Botia lohachata*, *Garra gotyla* and *Garra annandalei* are found in large number where as *Raiamas bola*, *Crossocheilus latius*, *Barilius barila* are found in least number.

The second station lies 10km far from the first station. There is plane area and the river flows in a continuous way. The water level increases in the rainy season and creates floods in neighbouring village i.e. Dodhara chadani and Piparia village. The water level is very low in summer season. The fishing activity takes place in a large scale in this station. Generally drag net, cast net, hook and line fishing is very common to this station. Sometimes poisoning is seen in summer season and they collect fish in a large scale.

Bhatt, D.D. and Shrestha (1973) explained the 27 species fish from the Ranital of Suklaphanta wildlife reserve. Besides, Shrestha (1990) has recorded 69 fish species from Mahakali river. Shrestha (1990) explained 43 species of hill-stream fishes in his book entitled "Fishes, fishing and catching methods". Again, Shrestha (2008) described and reported 232 rare and ornamental fishes. In the present study 44 species are reported. Among 44 indiginous fish species which are collected from the Mahakali river during my research, I have seen small sized and large sized fish. The small sized fish is found *Brachydanio rerio* masuring about 3.6cm in length. There are other small sized fishes which average size less than

10cm are *Garra annandalei*, *Garra gotyla gotyla*, *Schistura corica*, *Acanthocobatis botia*, *Schistura rupecola*, *Lepidocephalus guntea*, *Botia lohachata*, *Glossogobius giuris*, *Esomus denricus*, *Puntius chola*, *Puntius sarana*, *Puntius sophore*, *Rasbora deniconius*, *Oxygaster bacaila*. The large sized fish is found about 103.7 cm as *Anguilla bengalensis* collected from dam of Sarada barrage. Among hill-stream fishes the *Tor tor*, *Labeo dero*, *Barilius vagra*, *Barilius barna*, *Barilius bendelisis*, *Brachydanio rerio*, *Raiamas bola*, *Schizothoraichthys progastus*, *Schizothorx plagiostomus*, *Crossocheilus latius* are average sized fishes.

The study paper may to assist for the development of cold water fisheries of Mahakali river in future and help in economic growth of the nation.

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