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**SYSTEMATICS, DISTRIBUTION AND
ECOLOGY OF THE ICHTHYOSPECIES OF
SIKKIM AND THEIR BEARING ON THE
FISH AND FISHERIES OF THE STATE**

**A THESIS
PRESENTED TO THE GAUHATI UNIVERSITY
IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
(SCIENCE)**



By

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This is to certify that Miss Pushpa Tamang has worked under my supervision and guidance since 1985 for the thesis entitled *Systematics, Distribution and Ecology of the Ichthyospecies of Sikkim and their bearing on the Fish and Fisheries of the state* which she is submitting for the degree of Doctor of Philosophy (Science) in Zoology of Gauhati University. The thesis is based upon original works done by Miss Tamang. No parts of this thesis have been submitted for any other University degree.

Miss Tamang has fulfilled the requirements of the regulations relating to the nature, the period of research and submission of thesis. The assistance and help received during the course of investigation have been fully acknowledged.

Gauhati University
March 23, 1992

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(PUSHPA TAMANG)

CHAPTER ONE

INTRODUCTION

CHAPTER ONE

INTRODUCTION

Sikkim, one of the nature's paradoxes of Eastern Himalayas is wholly a mountainous state dominating both legend and landscape. It derives its name from the Limbu word - *Sukhim* which means the "New House", Lepchas refer to as *Nye-Maeel* - the paradise and for Bhutias, it is the beloved *Bemyul Denzong* - the hidden valley of rice. This small mountainous state became part of India in 1975. The total geographical area of Sikkim is about 7096 square kilometres. The maximum horizontal length from North to South is about 112 km, whereas the maximum width from East to West is 90 km. The Tibetan Plateau (China) on the North, Nathula and other passes on the North - East, Bhutan on the South - East, Darjeeling Gorkha Hill Council of West Bengal on the South and Singalila Range of Nepal on the West form the boundaries of this picturesque Himalayan state. The state predominantly consists of highlands with no plain area. The altitude above mean sea level (msl) varies from 310 m in the south to about 8600 m in the north. The *Kanchanjunga*, the third highest mountain peak in the world at an elevation of 8600 m adorns the state with its beautiful range covered with glittering snow.

The variation in altitude from 310 m to 8000 m in less than 100 km results in abrupt climatic changes of the state. Thus the different range of climatic conditions encountered in Sikkim are : sub - tropical (260 m - 1524 m msl), temperate (1524 m - 2743 m msl), sub - alpine (2748 m - 3962 m msl) and alpine (above 3926 m msl). The flow of South - West monsoon wind from Bay of Bengal, too, has a great impact on the climatic conditions of the state. The distribution of rainfall is largely influenced by its complex topography and the region experiences frequent rainfall of varying intensity and duration. The bulk of the total annual rainfall, however, occurs during monsoon from June to October. The maximum and minimum temperature varies from - 4°C to 34°C. The state is rich in forest resources and inhabits a wide variety of flora and fauna, aquatic as well as terrestrial. The capital city of state is Gangtok.

Sikkim is endowed with plenty of water resource, both lotic as well as lentic. Under the lotic system, the Tista and the Rangit are the two important rivers (Plate I) with innumerable tributaries. The important tributaries of the Tista drainage are Zema chhu (chhu = water / river), Yumthang chhu, Dik chhu, Kanaka chhu, Rani khola (khola = stream) and Rangpo khola. On the other hand, Rimbi khola, Kalej khola, Roathak khola, Rangbhang khola and Little Rangit are the major tributaries of the Rangit drainage. The lentic system comprises of lakes at various gradients

(1550 m to 5300 m msl); the major lakes are Menmoi chho (chho = lake), Kupup, Chhangu, Aritar, Chho Lhamu, Gurudongmar, Gayum Chhona, Green lake, Lam Pokhari (pokhari = lake), Samitik lake and Khechiberi (Plate II). The lentic and lotic water bodies of Sikkim provide good shelter for a variety of aquatic fauna, potamoplankton, aquatic insects and especially the fishes.

Although the drainages of this region do offer lucrative field of ichthyological importance, no serious attempts have so far been made to venture into this field of study. The dearth of authentic and comprehensive data on the fish and fisheries including the fluvial dynamics and ecology of the drainages of Sikkim has since been a serious impediment to undertake any program on the ichthyological development of the region and to put the potentialities into production.

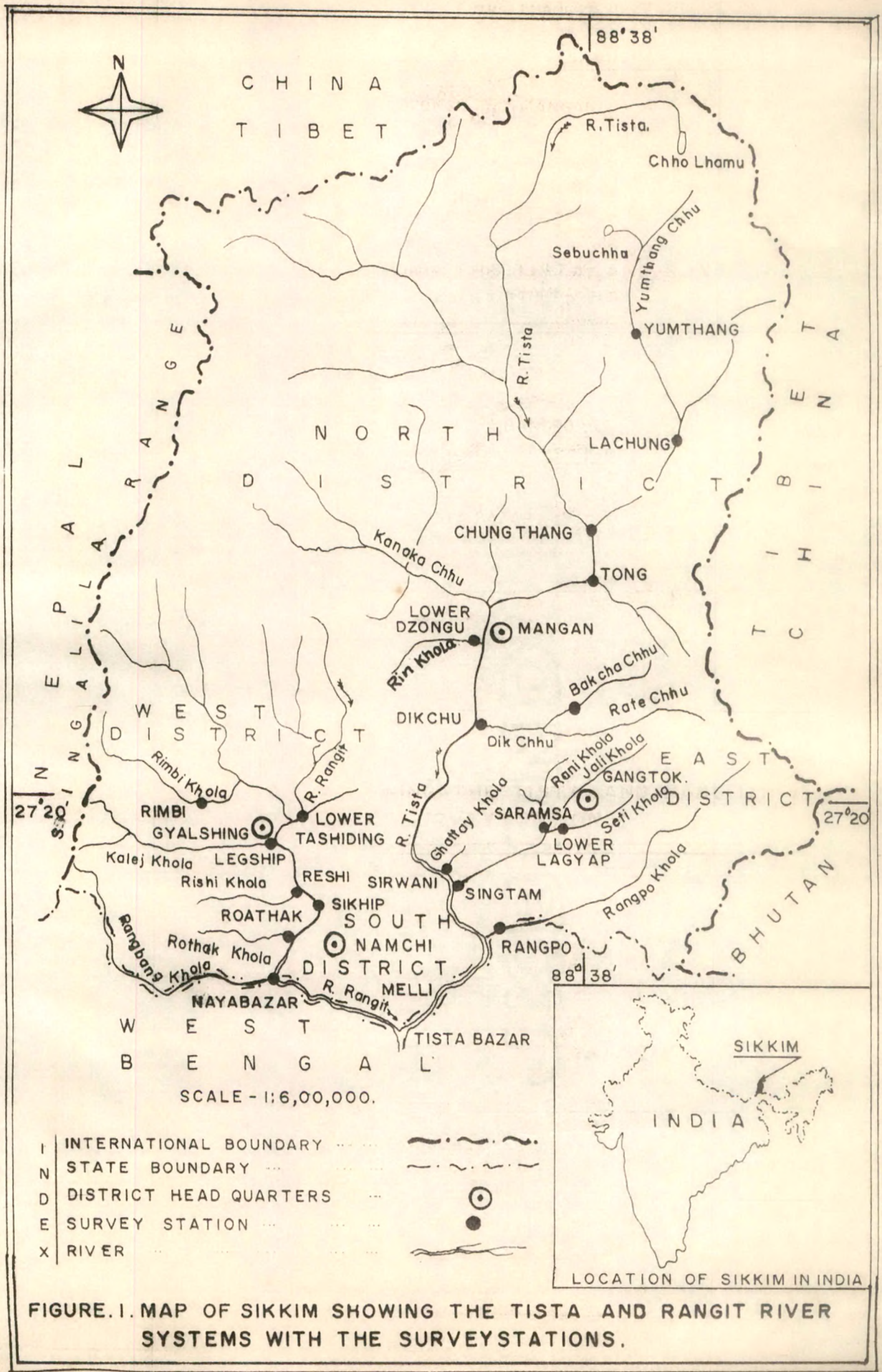
The present study exposes the results of extensive ichthyological survey and also the study of general ecological conditions of Sikkim drainages lying in between $88^{\circ}26'31''$ and $88^{\circ}37'35''$ E and $27^{\circ}15'0''$ and $27^{\circ}19'09''$ N. The Tista (Plate III) originates in the north - east corner of the state at 5300 m (msl) and runs westward for ca 25 km (4480 m), then virtually passes north to south bisecting the state throughout its length while traversing through steep gradients (57 m per km to 50.11 m per km), deep gorges and V - shaped valleys with highly turbulent water up to 650 m (msl). The river basin then gradually widens and passes through broader valleys. The upper catchment of the Tista drainage encloses the state in a gigantic horse-shoe shaped configuration. The river Rangit, on the other hand, traverses towards south for ca 51 km from its origin receiving various tributaries which originate mainly from Singalila range in Indo-Nepal border. The drainage runs eastward demarcating the south district of the state from Darjeeling Gorkha Hill Council of West Bengal and finally confluences with river Tista near Tista bazaar in West Bengal and is known as river Tista. This mighty river then enters Bangladesh at a place 40 km south-east of Jalpaiguri town in West Bengal. After a long meandering course, it discharges its contents into river Brahmaputra (known as river Jamuna as it enters Bangladesh from Assam in India) at a place ($25^{\circ}17'08''$ N and $89^{\circ}29'09''$ E), 20 km south of Chilmari in Bangladesh. Gradient-wise, the riverine elevation ranges from 310 m in the plains to 5300 m in the alpine zone characterizing the sub-basin with steep gradient up to 650 m and huge amount of silt deposits in the lower reaches.

The very topography of these drainages as depicted in Figure 1 clearly indicates twofold pattern of distribution, Tista drainage flowing from north to south draining north east districts while Rangit drainage flowing north to south-east draining south-west districts of the state. Interchange of fish fauna of the Tista drainage with Rangit drainage is quite possible as both confluence with each other at their lower reaches. Besides, in morphological nature as well as in distribution, these riverine fish are of considerable interest for which possibly the fluvial dynamics and the ecology

including the physical and chemical conditions of the respective water system may have some influence.

For the sake of better understanding of the topics, the comprehensive results of the present investigation over 24 months (1987-1988) of empirical studies have been presented through nine elucidated chapters. While an account of the Sikkim drainages has been dealt with in a separate chapter, each fish species has been studied under chapter "Fish Fauna Profile of Sikkim" to throw some new light wherever possible on the variations found in it. Noteworthy, the taxonomic status of the species belonging to the genera *Clupisoma* Swainson, *Laguvia* Hora and *Glyptothorax* Blyth, those occur in the Sikkim drainages and contain new species and sub-species have been analyzed in respect of their meristic, morphometric and other important characters. On the basis of the analyses, a key note to the identification of the species have been given to each genus in the chapter "Discussion".

Besides studying the fish fauna, fluvial dynamics and ecology including the physico - chemical condition and potamoplankton communities of each river system; an attempt is also made to compare the Tista drainages with Rangit drainages to portray the problems of possible faunistic peculiarities with respect to fish of these two different river systems which conjointly form the fish population of Sikkim drainages. Further, an in-depth study has also been made on fisheries of some principal drainages alongwith the fish capturing devices to expose the fish resources as well as their production potentials in the region. *Schizothorax richardsonii* (Gray) forms the most important fisheries of the state, therefore, the biology of the species has been critically studied and presented in the treatise. All the results obtained have been meticulously analyzed and synthesized and purported in the chapter, "Discussion". It is believed that the present comprehensive treatise will help adopt suitable policies and programmes to augment fish production of this Himalayan state of the country.



Explanations of Plate I

Panoramic view of the Tista and the Rangit rivers of Sikkim and their confluence near Tista bazaar in Darjeeling district of West Bengal.

1. River Tista.
2. River Rangit.



Explanations of Plate II

Panoramic views of three high altitude lakes of Sikkim.

1. Menmoi chho (3667 m msl)
2. Kupup lake (3929 m msl)
3. Gayum chhona lake (4850 m msl)

1



2



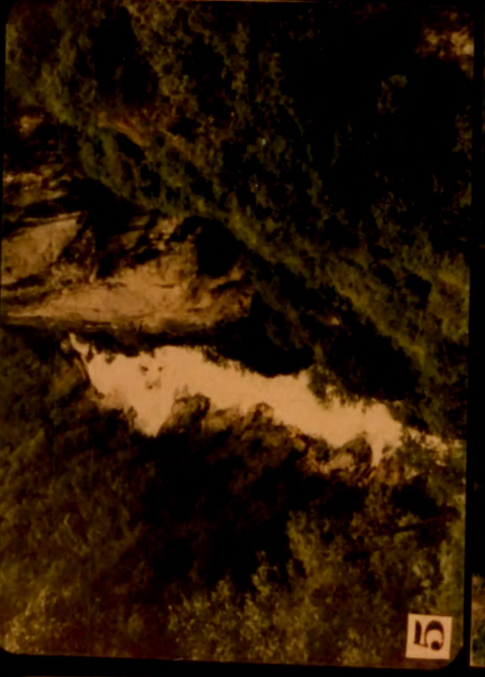
3



Explanations of Plate III

River Tista at different gradients and courses.

1. At an elevation of 4850 m at Oakra
2. At an elevation of 4500 m at Gigaon
3. At an elevation of 4250 m at Gochung
4. At an elevation of 3950 m above Thanggu
5. Tista passing through deep gorge
below Lachen at 2000 m elevation
6. Tista receiving waterfall - Relli chhu
near Singhik at 1500 m elevation
7. At an elevation of 800 m below Mangan
8. At an elevation of 700 m at Sangkalang
9. At an elevation of 260 m at Melli



CHAPTER TWO

REVIEW OF LITERATURE

CHAPTER TWO

REVIEW OF LITERATURE

The study of fish and fishery of India was in existence from time immemorial which revealed from the fish paintings on the earthen vases in the third millennium B.C. (Hora, 1936 a). The systematics on Indian fish had been first studied by Bloch (1785) followed by Lacepede (1798), Schneider (1801) and Russel (1803). Significantly, Hamilton (1822) made a valuable report on 269 fish species from the Ganga river system. Thence Cuvier and Valenciennes (1828), McClelland (1839, 1842), Bleeker (1853), Blyth (1858, 1860) and Gunther (1859 -1870) added important contributions to the field. Indeed, the monumental work of Day (1878, 1889) was considered as epoch making documents on the fishes of India including Burma, Ceylon and Pakistan. In the twentieth century valuable works had been done by De (1910), Hora (1920 -1953), Shaw & Shebbare (1937), Menon (1949 - 1974), Mishra (1953 -1976), Silas (1951 -1960) and Jayaram (1953 -1981). Of late, Menon (1982, 1986) had made important contributions on the classification and taxonomic status of teleostean fish dwelling in Indian waters.

Fish geography of India, especially the freshwater species had been investigated by the workers only lately. Significant contributions were those of Gunther (1880), Day (1885), Hora (1937, 1944, 1951, 1953), Hora & Nair (1941), Hora and Menon (1952, 1953), Silas (1952), Menon (1951, 1955) and Jayaram (1974, 1977). Further, Dey (1976 a) had studied on the probable origin and distribution of the ichthyofauna of the river Brahmaputra while Sen & Dey (1984) elucidated on the fish geography of Meghalaya.

Works on the field of fish and fisheries along with the physico - chemical conditions and plankton communities on Indian rivers had been limited. Indeed, reasonable contributions had been made on the Ganga river system. Notable works were those of Pahwa and Mehrotra (1966), Ray *et al.* (1966) and Ray & David (1966) on the fluvial dynamics, physico -chemical characteristics and potamoplankton population of the river system. Besides, the works of Chakravorty *et al.* (1959), Ray *et al.* (1966) and Jhingran *et al.* (1970) on the hydrobiology of the Yamuna and of David and Jhingran (1964) on the river Gandak were also significant. In the field of fisheries, concerning this river system, valuable investigations had been carried out by Hornell (1924), Jones (1937), Hora (1938), Hora & Nair (1940 a, 1940 b), Jhingran & Chakravarty (1958), David (1959), Motwani & Srivastava (1961), Pillay & Ghosh (1962), David & Ray (1966), Ray & David (1966), Tilak (1967) and Jhingran *et al.* (1970). Recently, Gupta & Jhingran (1982) had reported the Hilsa fishery

in the middle stretch of the Ganges.

Although the Brahmaputra and the Barak river systems form lucrative fields of ichthyological importance in N. E. India, very little works in the field had been attempted and were restricted to the works of Hora (1921, 1935), Menon (1954), Sehgal (1955), Joseph and Narayan (1965), Malhotra and Suri (1969), Yazdani (1972) and Sen (1982).

Fortunately, Dey and his collaborators had made valuable studies in the recent years on the systematics (Dey, 1964, 1965, 1976 b; Dey and Singh, 1967; Dey and Das, 1982; Dey and Nath, 1982), ecomorphology (Dey and Sarma, 1967; Dey, 1975, 1981) and fisheries (Dey, 1973, 1978, 1982, 1984; Dey and Sen, 1982) of the Brahmaputra and the Barak drainages circumventing the States of Meghalaya and Assam.

In sharp contrast to aforesaid investigations, report on the fish and fisheries of Sikkim remained fragmentary. In this context, reference may be made to McClelland (1845) for three species; Day (1878) for 4 species; Hora (1923 - 1935) for 3 species; Hora & Silas (1952) for 4 species and Menon (1954 - 1964) for 3 species. Raj Tilak (1972) however, made a significant contribution and described 26 species which was followed by Jayaram (1981) who mentioned only 2 species. Bhutia & Acharya (1987), however studied the fish fauna as well as certain physico - chemical conditions of Rangit river and listed 25 species of fish from Rangit river. Menon (1987) in his recent publication has included 2 species of *Noemacheilus* from Sikkim drainages. Venu et al. (1990) made some limnological studies of the Tista drainage at eight stations, of Rangit at one station including some lakes and have reported 20 species of phytoplankton from Rangpo khola. Talwar & Jhingran (1991) have however mentioned only 2 species of fish from Sikkim.

CHAPTER THREE

MATERIALS AND METHODS

CHAPTER THREE

MATERIALS AND METHODS

General

Although the present investigations had been carried out in the Sikkim drainages for more than four long years, the results of 24 months of empirical studies from January, 1987 through December, 1988 have been presented in this communication. Only one survey station for each river had been selected on random selection on SF method. But three survey stations had been chosen to cover river Tista, Yumthang chhu and river Rangit to cover the areas especially at their upper and lower reaches. The observations were carried out in the morning hours at each survey station and such data were extrapolated at seasonal level and presented in the relevant chapter(s). Most of the hydro-biological samples were analyzed in the temporary laboratory camped at the respective field station. Besides, assistance for water analysis was also sought from the Soil Testing Laboratory of Agriculture Department, Government of Sikkim.

Climate and fluvial dynamics

The relevant meteorological data were obtained from the Department of Meteorology, Government of India, stationed at Gangtok.

The velocity and discharge rate were recorded after choosing fairly good hydrological control points for measurement of the river near by the survey station (SS) at the time of experiments. The rate of water discharge (W_d) in m^3s^{-1} of each river was determined using the following empirical formula:

$$\begin{aligned} W_d &= \text{Area} \times \text{Velocity} \\ &= (W_m \times 0.6 D_m) \times 0.7 V_s \end{aligned}$$

where, W_m is the average width of the river in metres (m), D_m is the average maximum depth of river in metres (m); and V_s is the average observed surface velocity of water (ms^{-1}) determined using Float Method measurement; 0.70 is the assumed coefficient used to convert surface velocity to actual hydraulic mean velocity to account for the roughness and friction of the typical mountainous river profile, and 0.6 is the multiplying factor used to determine the approximate area of the mountainous river profile as $W_m \times 0.6 D_m$.

Water characteristics

Water samples were collected from the surface by one litre jug and underneath zone by five litre Kemmerer sampler at random covering different spots of river at the respective survey station with least disturbed flow and good control point.

The transparency (cm) of water was estimated by the Sechhi disc on a graduated line and the value was computed in cm.

The water temperature was determined with a mercury in-glass thermometer graduated -10° to 100°C while air temperature with G.H. Zeal (U.K.) max. - min. mercury in-glass thermometer.

Hydrogen ion concentration (pH) was estimated with Hellige Comparator using relevant indicator disc (U .K.) and solution (BDH).

The dissolved oxygen (DO) was estimated by the Alsterberz Azide modification of Winkler's method. The amount of DO was computed in mg^l⁻¹.

The free carbon dioxide (FCO₂) in mg^l⁻¹ was estimated titrometrically with N /44 NaOH after using phenolphthalein solution as indicator.

Total alkalinity (TA) expressed as pH - TH and MO alkalinity was determined as CaCO₃ titrating with 0.02 NH₂SO₄ using the indicator solutions of phenolphthalein and methyl orange and expressed as mg^l⁻¹.

Potamoplankton

Fifty litres of water samples covering maximum surface area in the river were randomly collected using one litre jug. The sample water was filtered through the plankton net made with nylobolt bolting silk of 55 μm mesh size. Utmost care was taken to avoid water disturbances. The density of the concentrated plankton of 50 litres river water was transferred into a 100 ml graduated cylinder and then made to 50 ml with distilled water and preserved in 2 - 4 % (v/v) aqueous formalin solution. For qualitative (up to generic level) and quantitative (ul⁻¹) analyses, one millilitre of well mixed sub-sample was taken with a wide mouthed graduated pipette and poured into a Sedgwick - rafter plankton counter (SRPC) of 1 ml capacity. One thousand cells of SRPC were examined under a CZ - NFPK stereoscopic microscope and recorded the plankton as unit cell per litre and zooplankton as number per litre (ul⁻¹) of the river water as per Welch's (1948) formula,

$$n = \frac{(a \ 1000)c}{l}$$

where n = number of plankton per litre, a = average number of plankton in all counts in a counting cell of 1 ml capacity, c = the volume of original concentrate in ml and l = the volume

of original water filtered.

Various authoritative sources including Indian Works were consulted to identify the potamoplankton notably, Desikachary (1959), Palmer (1969), Saxena (1962), Smith (1950, 1971), Bordoloi (1973), Needham and Needham (1978), Devi (1980) and Fritsch (1959, 1965) for phytoplankton and those of Kudo (1950), Pennak (1953), Edmonson (1959), Brook (1959), Tressler (1959), Wilson and Yeatman (1959), Donner (1966), Michael (1966), Michael *et al.* (1973) and Sharma (1976, 1977, 1978 a - c, 1979 a - c, 1980) for zooplankton.

Fish and Fisheries

A good many samples of fish specimens were collected throughout the years of investigations from different survey stations attached to each river investigated. The fish samples were preserved in 5 to 10 % formalin as warranted. The solution was also suitably injected in big sized fish for proper preservation. The fish samples were identified mostly after Day (1878, 1889), Shaw & Shebbeare (1937), Mishra (1959), Menon (1974, 1987) and Jayaram (1981).

Measurements of various body proportions were taken with utmost care. All are straight point to point measurements with dial reading calipers and with fine pointed dividers and recorded to the nearest tenth of a millimetre. The characters considered important are those shown hereunder and taken in relation to total length.

The total length was taken from the tip of the snout to the end of the longest ray of caudal fin; standard length, from the tip of the snout to the base of the caudal fin; head length, from the tip of the snout to the last margin of operculum; head breadth, the distance across the head in a ventral position; head depth, the perpendicular distance measured from the mid - line at the occiput vertically downwards to the ventral surface of the head; gape of mouth, the greatest transverse distance across the opening of the mouth, without stretching the mouth opening; eye diameter, the distance between the anterior and posterior margins of the orbit; inter orbital distance is the distance between the upper rim of each orbit at the nearest point; post orbital distance is measured from the posterior margin of the orbit to the posterior most extremity of the operculum; inter nasal distance, the distance between the nasal openings at the nearest point; snout length, as the distance from the tip of the snout to the front hard margin of the orbit; body depth, as the highest distance from its back to the ventral surface or profile; body width, the greatest distance across the body at its widest part; dorsal height, is the greatest distance measured along the height of the longest fin ray; anal height, is the maximum distance measured along the height of longest anal fin ray; dorsal base, is the distance along the base of the first to the last dorsal fin ray; anal base, the distance along the

base from the first to the last anal fin ray; pectoral length, is the distance measured between its origin or place of insertion into the body to the extreme tip; pelvic length, is the length of the longest pelvic fin ray; caudal fin length, is distance from the hypural plate to tip of the longest caudal fin ray; length of caudal peduncle, is the distance from the last point of contact of anal fin posteriorly to the end of the vertebral column or the flexure line of the body; highest depth of caudal peduncle, is the distance from the dorsal to ventral profile at the widest part of the caudal peduncle; least depth of caudal peduncle, the distance from the dorsal to the ventral profile at the narrowest part of the caudal peduncle; pre - dorsal distance, is the distance between the tip of the snout to the insertion of the first ray of dorsal fin; pre-pectoral distance, is the distance between the tip of the snout to the insertion of the first ray of pectoral fin; pre - pelvic distance, is the distance from the tip of the snout to the insertion of the first ray of pelvic fin; pre - anal distance is the distance between the tip of the snout to insertion of the first ray of anal fin; distance between the origin of pectoral and pelvic fin is the distance between base of pectoral to base of pelvic fin; distance between the origin of pelvic and anal is the distance between the base of pelvic to base of anal fin; distance between the origin of pelvic and anus is the distance between the base of pelvic and anal opening; distance between the anus and origin of anal fin is the distance from the anal opening to the base of anal fin.

Meristic characters were taken with great care to avoid errors, an error of one or more counts would usually result in a specimen being referred to as the wrong species. The number of unbranched simple rays and branched rays of fins have been shown separately.

Scale counts of lateral line are between upper angle of the operculum and the level of posterior edge of the hypural plate along the normal course of lateral line. The lateral transverse rows of scales are taken from the origin of dorsal fin, vertically downwards to the lateral line. Scales between lateral line and base of pelvic fin are counted from below upwards and forwards from base of pelvic fin to the lateral line. Pre-dorsal scales are counted in the median line from the commencement of the dorsal fin forward as far as they exist. Circumpeduncular scales are counted around the least depth of caudal peduncle. The values shown outside parenthesis are arithmetic ranges, while arithmetic mean are kept inside the brackets.

The ratio index of each morphometric measurements is calculated as a percentage in the total length (TL).

Length-weight relationship of fishes has been developed through the use of general equation $W = cL^n$ (Rounsefell & Everhart, 1953) where W = weight, L = length and c & n are exponents. This equation when expressed in logarithmic form becomes $\log W = \log c + n \log L$. The values

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of c & n can be determined empirically by the following formulae:

$$\log W = \frac{\sum \log W \times \sum (\log L)^2 - \sum \log L \cdot (\sum \log L \cdot \log W)}{N \cdot \sum (\log L)^2 - (\sum \log L)^2}, \text{ and}$$

$$n = \frac{\sum \log W - N \log c}{\sum \log L}$$

All the heterogenous specimens of *Schizothorax richardsonii* (Gray) collected from all the survey stations of the two drainages were recorded to evaluate the L-W relationship. Length was measured through measuring board in millimetre and the weight in gram. Fishes were weighed by spring or pan balance as warranted and they were dried on blotting paper before weighing to get accurate result. The calculated values of weight were rounded at the second decimal place.

The coefficient of correlation (r) between by length and log weight were estimated with SE of r and the significance level has been tested by t -test.

The gonadosomatic index (GDSI) was calculated for individual matured female fish of *Schizothorax richardsonii* (Gray) by employing the formula,

$$\text{GDSI} = \frac{\text{Ovary weight (g)} \times 10^2}{\text{Fish weight (g)}}$$

as followed by Ricker (1975), Marichamy (1971), Wotton (1973) and Banerjee & Prasad (1974).

For fecundity studies, a sub-sample of 10 g was taken from the ovary. Ova were teased out of the follicle and counts were made of all ova comprising the mature group under a Zoom Citoval Dissecting microscope. The fecundity of the fish was thereby calculated by extrapolating the value to the total weight of the ovary (Lagler, 1952). The relationship between fecundity and total body length, total body weight and the total ovary weight had been regressed by least square method taking fecundity as the dependent variable. The coefficient of correlation of each such regression had been estimated and significance tested at variable probability level.

CHAPTER FOUR

**FLUVIAL DYNAMICS, ABIOTIC AND BIOTIC
COMPONENTS OF THE RIVER SYSTEMS**

CHAPTER FOUR

FLUVIAL DYNAMICS, ABIOTIC AND BIOTIC COMPONENTS OF THE RIVER SYSTEMS

The two major river systems Tista and Rangit (Plate I) in Sikkim lie in between $88^{\circ}26'31''$ and $88^{\circ}37'35''$ E and $27^{\circ}15'0''$ and $27^{\circ}19'09''$ N. River Tista is the longest river of Sikkim flowing throughout its length from north to south. Along its course of ca 162 km from its origin down to its confluence with Rangit river near Tista bazaar, it receives eleven major tributaries namely Zema chhu, Yumthang chhu, Kanaka chhu, Rin khola, Dik chhu, Ghattay khola, Rani khola and Rangpo khola. River Rangit on the other hand after originating from Rathong Glacier on the west proximity of the state flows southward up to Nayabazar and then takes south-east course up to Tista bazaar for a total of ca 71 km. Rimbi khola, Kalej khola, Rishi khola, Roathak khola, Rangbhang khola and Little Rangit join main Rangit river at various gradient zones.

Despite the difficult mountainous nature of the state with steep slopes and deep gorges, the two rivers and their tributaries have been studied at nineteen (19) stations. While a single survey station has been selected through random selection for twelve different tributaries, three investigating field stations were fixed to cover Tista, Rangit and Yumthang chhu at different gradients. The geographical positions and courses of different rivers and their tributaries along with their survey stations have been shown in Figure 1.

Three pronounced seasons are discernible in the state namely, Winter (W) extending from November to February, Summer (S) from March to May and Monsoon (M) from June to October in a year.

An account of each river along with its survey station (SS), fluvial dynamics, water characteristics and invertebrate nekton communities recorded during 24 months of empirical studies is given in the following paragraphs.

Water velocity (ms^{-1}) and discharge rate (m^3s^{-1}) are the parameters studied under fluvial dynamics. Six physical and chemical elements of water namely, transparency (cm), temperature ($^{\circ}\text{C}$), hydrogen ion concentration (pH), dissolved oxygen = DO (mg l^{-1}), free carbon dioxide = FCO_2 (mg l^{-1}) and total alkalinity = TA (mg l^{-1}) have been analyzed. While the mean values of fluvial dynamics and water characteristics of the rivers through three seasons are depicted in Figures 2 to 9 respectively; their amplitudinal records are summarized hereunder.

4.1 Tista Drainages

RIVER TISTA

(Plate III & IV)

River Tista is one of the main Himalayan rivers which originates in the north-east corner of the state from Chho Lhamu, located at $88^{\circ}45'35''$ E and $28^{\circ}0'32''$ N at an elevation of over 5300 m from the mean sea level. It is a perennial river fed by Tista Khangse Glacier. It runs westward for a total of ca 25 km through meandering course at gradients of 5150 m to 4480 m up to Dongkong at upper reaches where the river is shallow, feeble with crystal clear water. The river then descends to south through steep gradient of 3757 m to 1660 m and enters Chungthang. Along its course of ca 79 km from its origin to Chungthang, the river receives nine major tributaries - Lungma chhu, Lhasa chhu, Kalep chhu, Gyamthang chhu, Barum chhu, Zema chhu, Gey chhu, Tarum chhu and Rabum chhu and confluences with Yumthang chhu at Chungthang.

The river gradually increases in width and takes a wide loop flowing down to Singhik dropping in elevation from 1550 m to 750 m within a stretch of ca 18 km. At Singhik, Tista receives one of its major tributaries - Kanaka chhu (Talung chhu) on its right which takes its rise from Talung glacier, a part of Kanchanjunga range (C.W.C. report). From Singhik, the river flows south for ca 65 km through its lower reach at elevations from 700 m to 500 m through Dikchu, followed by a big curve down to Singtam at 360 m. Rin khola, Dik chhu and Rani khola join Tista at Lower Dzongu, Dikchu and Singtam respectively. Thereafter, Tista starts widening and flows further for a distance of ca 27 km via Rangpo receiving Rangpo khola and confluences with river Rangit near Tista Bazaar 3.5 km further downstream from Melli in Darjeeling Gorkha Hill Council of West Bengal. River Tista exhibits a total fall of 4900 m within a length of 162 km from its origin to its confluence with river Rangit (Plate III). As a result, the flow of the river is highly turbulent with high velocity and is heavily loaded with silt especially during monsoon. After traversing a distance of ca 40 km from Melli, the river enters into the plain of West Bengal at Sevoke near Silliguri. Throughout its course in Sikkim, the Tista and its tributaries flow through very narrow and deep gorges with densely clad hill slopes; land slips are very common and access to rivers in these reaches is very difficult.

SURVEY STATION

Chungthang ($88^{\circ}39'22''$ E and $27^{\circ}36'40''$ N), Tong ($88^{\circ}39'55''$ E and $27^{\circ}34'09''$ E) and Singtam ($88^{\circ}30'0''$ E and $27^{\circ}14'16''$ N) are the three survey stations selected for the Tista river to cover its different gradients. Chungthang, the main junction towards Lachung and Lachen valleys, is situated at an elevation of 1666 m. Tong lies at an elevation of 1325 m on North Sikkim highway

and is at a road distance of 12 km from Chungthang. Singtam is situated only at a distance of 9 km from Rangpo on National highway in East district of Sikkim and is at an elevation of 360 m.

FLUVIAL DYNAMICS

Chungthang: Water velocity 0.93 (W) - 1.60 (S), \bar{X} 1.32, \underline{A} 0.67; discharge rate 15.30 (W) - 80.32 (M), \bar{X} 47.04, \underline{A} 65.02.

Tong: Water velocity 1.37 (W) - 1.89 (M), \bar{X} 1.70, \underline{A} 0.52; discharge rate 23.40 (W) - 119.34 (M), \bar{X} 70.77, \underline{A} 95.94

Singtam: Water velocity 0.75 (W) - 1.71 (M), \bar{X} 1.18, \underline{A} 0.96; discharge rate 67.44 (W) - 404.64 (M), \bar{X} 202.38, \underline{A} 337.20

WATER CHARACTERISTICS

Chungthang: Transparency 24.00 (M) - 42.20 (W), \bar{X} 32.40, \underline{A} 18.20; temperature 9.50 (W) - 13.00 (S), \bar{X} 11.58, \underline{A} 3.50; hydrogen ion concentration 6.80 (W) - 7.20 (S,M), \bar{X} 7.06, \underline{A} 0.40; DO 8.82 (M) - 13.16 (W), \bar{X} 10.71, \underline{A} 4.34; FCO₂ 1.25 (M) - 2.30 (W), \bar{X} 1.68, \underline{A} 1.05; TA 25.50 (M) - 100.00 (W), \bar{X} 61.83, \underline{A} 74.50.

Tong: Transparency 22.00 (S) - 39.29 (W), \bar{X} 30.18, \underline{A} 17.29; temperature 9.25 (W) - 15.00 (M), \bar{X} 12.08, \underline{A} 5.75; hydrogen ion concentration 6.20 (S) - 7.20 (W), \bar{X} 6.73, \underline{A} 1.00; DO 8.07 (M) - 13.02 (W), \bar{X} 10.93, \underline{A} 4.95; FCO₂ 1.35 (W) - 3.60 (M), \bar{X} 2.15, \underline{A} 2.10; TA 14.00 (M) - 83.5 (W), \bar{X} 49.16, \underline{A} 69.50.

Singtam: Transparency 20 (M) - 90.00 (S), \bar{X} 45.00, \underline{A} 70.00; temperature 15.50 (W) - 25.00 (M), \bar{X} 19.16, \underline{A} 9.50; hydrogen ion concentration 6.20 (S) - 6.80 (W), \bar{X} 6.53, \underline{A} 0.60; DO 4.14 (M) - 14.88 (W), \bar{X} 9.28, \underline{A} 10.74; FCO₂ 1.50 (S) - 7.00 (M), \bar{X} 3.68, \underline{A} 5.50; TA 17.00 (W) - 52.00 (S), \bar{X} 29.66, \underline{A} 35.00.

INVERTEBRATE NEKTON

Chungthang: SUMMER *Rhithrogena* sp. > *Isonychia* sp.

MONSOON *Rhithrogena* sp. > *Isonychia* sp. > *Baetis* sp., Ephemeroid nymph > Caddis larva > *Iron* sp.

WINTER Ephemeroid nymph > *Isonychia* sp. > *Baetis* sp. > Caddis larva > *Iron* sp. & *Rhithrogena* sp.

Tong: SUMMER Ephemeroid nymph > *Iron* sp. > Caddis larva.

MONSOON *Baetis* sp. > Ephemeroid nymph > Caddis larva > *Isonychia* sp. > *Neoperla* sp. > *Iron* sp.

WINTER Ephemeroid nymph > Caddis larva > *Iron* sp.

Singtam: SUMMER Ephemeroid nymph > Frog tadpole

MONSOON Ephemerid nymph > *Macrobrachium* sp.

WINTER *Iron* sp. > Ephemerid nymph > *Baetis* sp. > Caddis larva.

YUMTHANG CHHU

(Plate V)

It takes its rise on the North - East corner at Sebo chho below Donky la ($88^{\circ}46'47''$ E and $27^{\circ}59'30''$ N) at an elevation of 4850 m in North Sikkim. Along its course of ca 29 km from Yumthang to its confluence with Tista at Chungthang, it traverses ca 8 km at its upper elevation (gradient altitude 3600 to 3300 m) through Phuni followed by ca 3 km from Phuni (3300 m) to Yakchey (2800 m) forming its mid zone and finally through ca 18 km down to Chungthang through Lachung (2600 m to 1666 m). Yumthang chhu receives one of its principal tributaries - Sebo chhu at Yakchey ($88^{\circ}45'0''$ E and $27^{\circ}44'04''$ N) and runs South to Chungthang as Lachung chhu.

SURVEY STATION

Yumthang ($88^{\circ}42'49''$ E and $27^{\circ}49'49''$ N), Lachung ($88^{\circ}45'0''$ E and $27^{\circ}41'58''$ N) and Chungthang are the three survey stations selected for the proper Yumthang chhu to cover its upper, middle and lower gradients respectively. Yumthang (locally *hyium* = snow, *thang* = plain/meadow) is a picturesque valley of Rhododendron, Primula and other alpine vegetation. It lies at 3600 m and is 24 km from Lachung, connected by a paved road. Lachung (2600 m. msl) is connected to Chungthang at 22 km. It is situated right at the base of very steep rocky mountain. Chungthang is 28 km from Mangan - the district headquarter of North Sikkim. It lies at an elevation of 1666 m.

FLUVIAL DYNAMICS

Yumthang: Water velocity 0.96 (M) - 1.25 (S), \bar{X} 1.09, A 0.29; discharge rate 2.20 (W) - 11.22 (S), \bar{X} 8.01, A 9.02

Lachung: Water velocity 0.96 (W) - 1.39 (S), \bar{X} 1.16, A 0.43; discharge rate 6.75 (W) - 32.50 (M), \bar{X} 19.44, A 25.75.

Chungthang: Water velocity 1.02 (M) - 1.49 (S), \bar{X} 1.26, A 0.48; discharge rate 8.10 (W) - 39.02 (M), \bar{X} 23.73, A 30.92.

WATER CHARACTERISTICS

Yumthang: Transparency 20.00 (W) - 35.00 (M), \bar{X} 29.33, A 15.00; temperature - 2.00 (W) - 9.00 (S), \bar{X} 5.16, A 11.00; hydrogen ion concentration 6.50 (M) - 6.80 (S), \bar{X} 6.63, A 0.30; DO 7.35 (M) - 11.83 (W), \bar{X} 9.36, A 4.48; FCO₂ 1.15 (M) - 2.40 (W), \bar{X} 1.78, A 1.25; TA 15.00 (M) - 28.00 (S), \bar{X} 19.71, A 13.00.

Lachung: Transparency 31.50 (M) - 53.00 (S), \bar{X} 39.83, A 21.50; temperature 6.0 (W) - 10.00 (S), \bar{X} 8.25, A 4.00; hydrogen ion concentration 6.70 (W) - 6.80 (S), \bar{X} 6.73, A 0.10; DO 8.10 (M) - 12.78 (W), \bar{X} 10.44, A 4.68; FCO₂ 1.20 (M) - 2.40 (W), \bar{X} 1.70, A 1.20; TA 16.00 (M) - 25.00 (S), \bar{X} 19.8, A 9.00.

Chungthang: Transparency 32.66 (M) - 70.00 (S), \bar{X} 54.22, A 37.34; temperature 8.50 (S) - 13.50 (M), \bar{X} 10.58, A 5.00; hydrogen ion concentration 6.0 (S) - 6.6 (M), \bar{X} 6.28, A 0.60; DO 6.83 (M) - 13.50 (W), \bar{X} 9.92, A 6.67; FCO₂, 1.90 (S) - 3.05 (M), \bar{X} 2.50, A 1.15; TA 23.00 (M) - 27.00 (S), \bar{X} 25.16, A 4.00.

INVERTEBRATE NEKTON

Yumthang: SUMMER *Iron* sp. > Ephemeroptera nymph > *Isonychia* sp.
 MONSOON Ephemeroptera nymph > *Baetis* sp. > Caddis larva > *Neoperla* sp. & *Rhithrogena* sp. > *Hydrophilus* sp.
 WINTER *Baetis* sp. > Ephemeroptera nymph > *Rhithrogena* sp.

Lachung: SUMMER *Rhithrogena* sp. and Caddis larva
 MONSOON *Rhithrogena* sp.
 WINTER Ephemeroptera nymph > *Neoperla* sp. and Caddis larva.

Chungthang: SUMMER Ephemerid nymph & *Rhithrogena* sp. > Caddis larva
 MONSOON *Baetis* sp., *Rhithrogena* sp. > Ephemerid nymph and *Iron* sp.
 WINTER Caddis larva > Ephemerid nymph > *Neoperla* sp.

BAKCHA CHHU

(Plate VI)

Bakcha chhu takes its rise at an elevation of 5245 m on Sikkim (India) and Tibet (China) border within 88°46'02" E and 27°28'35" N. It traverses for ca 15 km towards west along its upper reaches at gradient of 5000 m to 1360 m at Bakcha bridge point, receiving several small streams.

SURVEY STATION

Bakcha (88°37'01" E and 27°25'35" N), the bridge point is situated at a distance of 22 km from Gangtok on North - Sikkim Highway. It lies at an elevation of 1360 m.

FLUVIAL DYNAMICS

Water Velocity 0.95 (W) - 1.81 (S), \bar{X} 1.24, A 0.87; discharge rate 9.00 (W) - 44.90 (M), \bar{X} 24.24, A 35.90

WATER CHARACTERISTICS

Transparency 30.0 (W) - 60.32 (M), \bar{X} 47.60, \underline{A} 30.32; temperature 11.0 (W) - 16.7 (M), \bar{X} 14.46, \underline{A} 5.70; hydrogen ion concentration 6.6 (S) - 7.1 (W), \bar{X} 6.85, \underline{A} 0.5; DO 7.52 (M) - 11.47 (W), \bar{X} 9.69, \underline{A} 3.95; FCO₂ 1.2 (M) - 1.4 (W), \bar{X} 1.3, \underline{A} 0.2; TA 14.5 (M) - 82.6 (W), \bar{X} 41.3, \underline{A} 68.10.

INVERTEBRATE NEKTON

SUMMER *Rhithrogena* sp.

MONSOON Ephemeroid nymph > *Iron* sp. > Caddis larva

WINTER Ephemeroid nymph > *Neoperla* sp.

SETI KHOLA

(Plate VI)

It takes its rise as Takchom chhu from Bhusuk reserve forests (88°42'20" E & 27°19'09" N) at an elevation of 3200 m. It flows south through gradient of 3000 m to 900 m (msl) for ca 13 km and enters Lower Lagyap (760 m msl) and finally to Saramsa to confluence with Rani khola as Seti khola at 88°35'58" E and 27°17'01" N.

SURVEY STATION

Lower Lagyap (88°35'36" E & 27°17'19" N) is at a distance of only 3 km from Ranipool and lies at an elevation of 760 m. The hydroelectric power house, situated at Lower Lagyap, generates electricity mainly to supply power to its adjoining towns and villages including Gangtok.

FLUVIAL DYNAMICS

Water velocity 0.60 (S) - 0.97 (M), \bar{X} 0.74, \underline{A} 0.37; discharge rate 3.54 (S) - 37.33 (M), \bar{X} 14.86, \underline{A} 33.79 .

WATER CHARACTERISTICS

Transparency 21.0 (M) - 40.1 (S), \bar{X} 33.7, \underline{A} 19.1; temperature 17.0 (W) - 25.0 (M), \bar{X} 21.6, \underline{A} 8.0; hydrogen ion concentration 6.7 (M) - 7.4 (W), \bar{X} 7.0, \underline{A} 0.7; DO 6.41 (M) - 9.28 (S), \bar{X} 8.03, \underline{A} 3.02; FCO₂ 2.1 (S) - 10.6 (M), \bar{X} 5.06, \underline{A} 8.5; TA 4.5 (W) - 62.5 (S), \bar{X} 28.33, \underline{A} 58.00.

INVERTEBRATE NEKTON

SUMMER Ephemeroid nymph

MONSOON Ephemeroid nymph > Caddis larva

WINTER Ephemeroid nymph > Caddis larva > *Isonychia* sp.

JALI KHOLA

(Plate VII)

Two small streams originating from Kyangnosla (88°43'18"E) and Eli forests (27°15'04"N) unite together at ca 4000 m (msl) to form Rora chhu. It runs south for a distance of ca 18 km and enters Saramsa where it is commonly known as Jali khola.

SURVEY STATION

Saramsa lies at an elevation of 745 m and is only 2 km from Ranipool on a paved road. The huge amount of boulders, gravel and sand carried by Jali khola during monsoon season get deposited along its banks at Saramsa.

FLUVIAL DYNAMICS

Water velocity 0.88 (W) - 1.19 (M), \bar{X} 0.99, \underline{A} 0.31; discharge rate 6.01 (S) - 68.12 (M), \bar{X} 26.98, \underline{A} 62.11

WATER CHARACTERISTICS

Transparency 30.43 (M) - 35.0 (S), \bar{X} 32.47, \underline{A} 4.57; temperature 17.75 (W) - 26.0 (M), \bar{X} 21.75, \underline{A} 8.25; hydrogen ion concentration 6.7 (M) - 6.9 (W), \bar{X} 6.8, \underline{A} 0.2; DO 6.01 (M) - 8.64 (W), \bar{X} 7.53, \underline{A} 2.63; FCO₂ 2.10 (S) - 9.60 (M), \bar{X} 4.73, \underline{A} 7.50; TA 16.7 (W) - 88.5 (S), \bar{X} 41.4, \underline{A} 71.8.

INVERTEBRATE NEKTON

SUMMER *Iron* sp. > *Baetis* sp. > *Isonychia* sp. > Frog tadpole and Caddis larva

MONSOON *Baetis* sp. > Ephemerid nymph

WINTER *Baetis* sp. > *Isonychia* sp. > Ephemerid nymph > Caddis larva.

RANI KHOLA

(Plate VII)

Three small streams namely Maney Jhora, Seti Jhora and Bakthang Jhora originating from the Gangtok reserve Forest at an elevation of 2621 m, run for 4 km through 1800 m gradient and unite together at a place called Singting (88°34'07" E & 27°19'49" N) to form Rani khola. It further traverses ca 10 km through Ranipool and enters Saramsa.

SURVEY STATION

Saramsa (88°35'43" E & 27°17'17" N) lies at an elevation of 745 m. It is 2 km away from Ranipool on a paved road. The river basin at the confluence of Jali khola and Rani khola is used as a crematorium ground.

FLUVIAL DYNAMICS

Water velocity 0.57 (S) - 0.90 (M), \bar{X} 0.74, \underline{A} 0.33; discharge rate 2.97 (W) - 39.68 (M), \bar{X} 15.49,

A 36.71.

WATER CHARACTERISTICS

Transparency 30.0 (W) - 34.67 (M), \bar{X} 31.89, A 4.67; temperature 18.5 (W) - 27.0 (M), \bar{X} 21.83, A 8.50; hydrogen ion concentration 6.8 (M) - 7.2 (S), \bar{X} 7.03, A 0.4; DO 5.97 (M) - 8.47 (S), \bar{X} 7.54, A 2.50; FCO₂ 2.6 (S) - 10.5 (M), \bar{X} 5.31, A 7.9; TA 1.9 (M) - 102.5 (S), \bar{X} 39.69, A 100.60.

INVERTEBRATE NEKTON

SUMMER *Rhithrogena* sp. > Caddis larva > *Isonychia* sp. > *Baetis* sp. & Ephemeroid nymph

MONSOON Dragonfly nymph, *Neoperla* sp. and Caddis larva

WINTER Ephemeroid nymph > *Isonychia* sp. and *Iron* sp.

RIN KHOLA

(Plate VIII)

It takes its rise from a mountain peak - Lingi Lhu (88°30'39" E & 27°30'39" N) at an elevation of 2725 m. It traverses for ca 8 km towards the east from upper reaches of dense Hi reserve forests to Lower Dzongu at 775 m elevation and finally confluences with river Tista at a further distance of 1.15 km.

SURVEY STATION

Lower Dzongu, the survey station (88°31'32" E & 27°29'31" N) is 3 km away from Hee - Gyathang and 6 km from Sangkalang on a narrow unpaved road. It lies at an elevation of 775 m.

FLUVIAL DYNAMICS

Water velocity 0.74 (W) - 1.22 (M), \bar{X} 1.05, A 0.48; discharge rate 2.10 (W) - 34.56 (M), \bar{X} 13.24, A 32.46.

WATER CHARACTERISTICS

Transparency 25.00 (W) - 42.00 (M), \bar{X} 35.66, A 17.00; temperature 15.0 (W) - 21.0 (S), \bar{X} 18.66, A 6.0; hydrogen ion concentration 6.5 (W) - 6.8 (S.M), \bar{X} 6.7, A 0.3; DO 7.29 (M) - 13.05 (W), \bar{X} 10.08, A 5.76; FCO₂ 2.0 (S) - 4.4 (M), \bar{X} 3.03, A 2.4; TA 9.0 (M) - 76 (W), \bar{X} 40.0, A 67.

INVERTEBRATE NEKTON

SUMMER Ephemeroid nymph

MONSOON Ephemeroid nymph

WINTER Ephemeroid nymph > Frog tadpole > Caddis larva, *Neoperla* sp.

DIK CHHU

(Plate VIII)

It originates at Tamje reserve forests (4400 m) near Cho La (88°48'23" E & 27°25'23" N) on Indo (Sikkim) - China (Tibet) border. It runs for a total distance of ca 24 km through dense mixed jungle of Shotak reserve forests (3000 m) at upper reaches via Tingda up to its confluence with Bakcha chhu (920 m, msl) at 88°35'14" E and 27°24'12" N. It then finally enters Dikchu bazaar after flowing ca 11 km to join Tista river at 88°31'17" E and 27°23'45" N.

SURVEY STATION

Dikchu (88°31'17" E & 27°23'45" N), the survey station lies at an elevation of 500 m where Dik chhu confluences with river Tista. It is connected to Singtam by a broad pitched road of distance 30 km.

FLUVIAL DYNAMICS

Water velocity 0.76 (W) - 1.60 (M), \bar{X} 1.20, \underline{A} 0.84; discharge rate 13.50 (W) - 70.87 (M), \bar{X} 37.47, \underline{A} 57.37.

WATER CHARACTERISTICS

Transparency 19.0 (W) - 25.0 (M), \bar{X} 22.0, \underline{A} 6.0; temperature 19.0 (W) - 25.0 (M), \bar{X} 22.0, \underline{A} 6.0; hydrogen ion concentration 6.7 (M) - 7.0 (W), \bar{X} 6.83, \underline{A} 0.3; DO 6.43 (M) - 14.98 (W), \bar{X} 10.43, \underline{A} 8.55; FCO₂ 2.0 (W) - 3.3 (M), \bar{X} 2.53, \underline{A} 1.3; TA 12.0 (M) - 34.0 (S), \bar{X} 19.56, \underline{A} 22.0.

INVERTEBRATE NEKTON

SUMMER Ephemeroid nymph

MONSOON Ephemeroid nymph > *Macrobrachium* sp.

WINTER Ephemeroid nymph > Caddis larva > *Iron* sp. > Dragonfly nymph.

GHATTAY KHOLA

(Plate IX)

It takes its rise below Sang (88°28'47" E and 27°15'33" N) at an altitude of ca 1100 m. It flows south to ca 8 km collecting waters from smaller streams and finally discharges its contents to river Tista at Sirwani.

SURVEY STATION

Sirwani (88°28'47"E & 27°14'27"N) is situated at a distance of 2 km on a broad paved road from Singtam and lies at an elevation of 365 m.

FLUVIAL DYNAMICS

Water Velocity 0.20 (S) - 0.95 (M), \bar{X} 0.54, \underline{A} 0.76; discharge rate 0.08 (W) - 2.01 (M), \bar{X} 0.83,

A 1.93.

WATER CHARACTERISTICS

Transparency 10 (W) - 35 (S), \bar{X} 20, A 25; temperature 18.0 (W) - 22.5 (S), \bar{X} 19.8, A 4.5; hydrogen ion concentration 6.8 (M) - 7.0 (W, S), \bar{X} 6.9, A 0.2; DO 7.74 (M) - 13.4 (W), \bar{X} 9.83, A 5.66; FCO₂ 0.5 (M) - 2.5 (S), \bar{X} 1.78, A 2.0; TA 11.0 (M) - 128.0 (S), \bar{X} 53.0, A 117.0.

INVERTEBRATE NEKTON

SUMMER *Rhithrogena* sp. > *Isonychia* sp. > Caddis larva > Ephemeropterid nymph

MONSOON *Isonychia* sp., *Baetis* sp. > Ephemeropterid nymph > Caddis larva

WINTER *Isonychia* sp. > Caddis larva.

RANGPO KHOLA

(Plate IX)

Rangpo khola takes its rise from Menmoi chho at 88°49'20" E and 27°20'43" N at an elevation of 3667 m. It runs for a distance of ca 14 km through gradient of 3600 m to 1524 m and receives Lunzey chhu from Chhanggu lake (3720 m) at 88°43'08" E & 27°17'59" N. The river further traverses ca 26.5 km receiving Rongli khola, Rishi khola and Dikling khola till it joins river Tista at Rangpo (88°31'47" E & 27°10'49" N) where it is widened with 0.2 m deep banks, and forms one of the principal tributaries of river Tista.

SURVEY STATION

Rangpo (88°31'47" E & 27°10'49" N) lies at an elevation of 310 m. It acts as the boundary town between East Sikkim and Gorkha Hill Council of West Bengal. It is 7 km from Singtam and 19 km from Melli on National Highway.

FLUVIAL DYNAMICS

Water velocity 0.67 (S) - 1.46 (M), \bar{X} 1.16, A 0.78; discharge rate 15.24 (S) - 106.68 (M), \bar{X} 55.55, A 91.44.

WATER CHARACTERISTICS

Transparency 55 (W) - 95 (M), \bar{X} 70.33, A 40; temperature 15.0 (W) - 21.0 (S,M), \bar{X} 19.0, A 6.0; hydrogen ion concentration 7.0 (W) - 7.2 (S, M), \bar{X} 7.13, A 0.2; DO 8.1 (S) - 9.45 (W), \bar{X} 9.0, A 1.35; FCO₂ 1.0 (S) - 2.2 (W), \bar{X} 1.63, A 1.2; TA 25.0 (M) - 50.0 (S), \bar{X} 35.0, A 25.0.

INVERTEBRATE NEKTON

SUMMER Ephemeropterid nymph

MONSOON Ephemeropterid nymph

WINTER *Isonychia* sp. > Ephemeropterid nymph > Caddis larva & *Iron* sp.

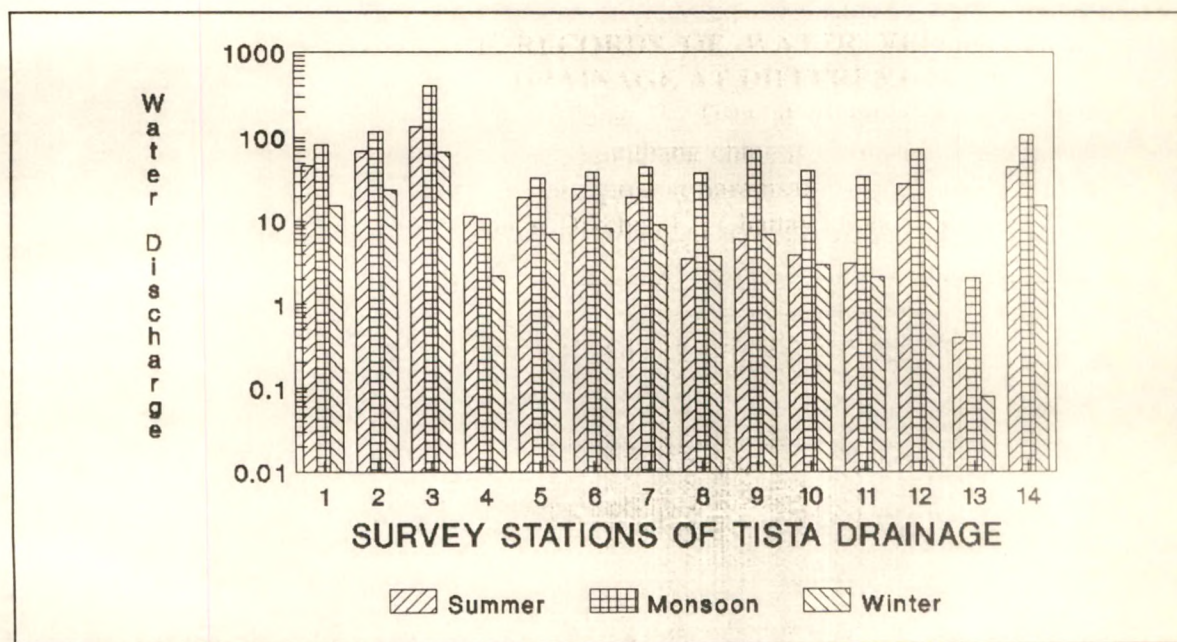
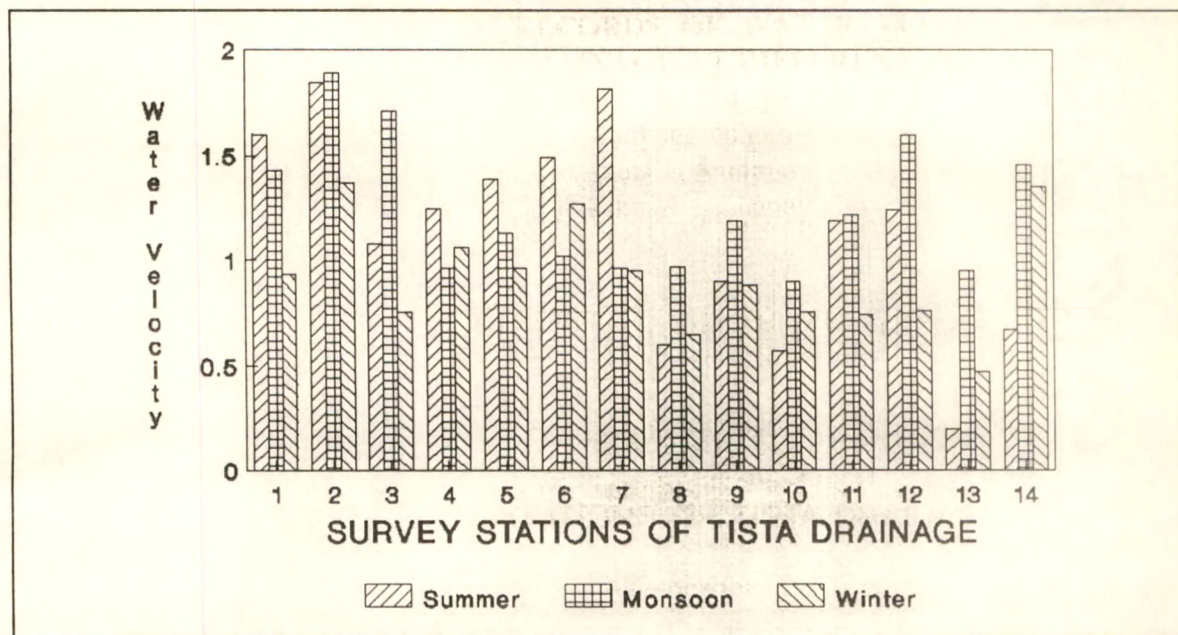


Figure 2. AVERAGE SEASONAL RECORDS OF WATER VELOCITY (ms^{-1}) AND DISCHARGE RATE (m^3s^{-1}) OF TISTA DRAINAGE AT DIFFERENT SURVEY STATIONS (Abbr. 1, Tista at Chungthang; 2, Tista at Tong; 3, Tista at Singtam; 4, Yumthang chhu at Yumthang; 5, Yumthang chhu at Lachung; 6, Yumthang chhu at Chungthang; 7, Bakcha chhu at Bakcha; 8, Seti khola at Lower Lagyap; 9, Jali khola at Saramsa; 10, Rani khola at Saramsa; 11, Rin khola at Lower Dzongu; 12, Dik chhu at Dikchu; 13, Ghattay khola at Sirwani & 14, Rangpo khola at Rangpo)

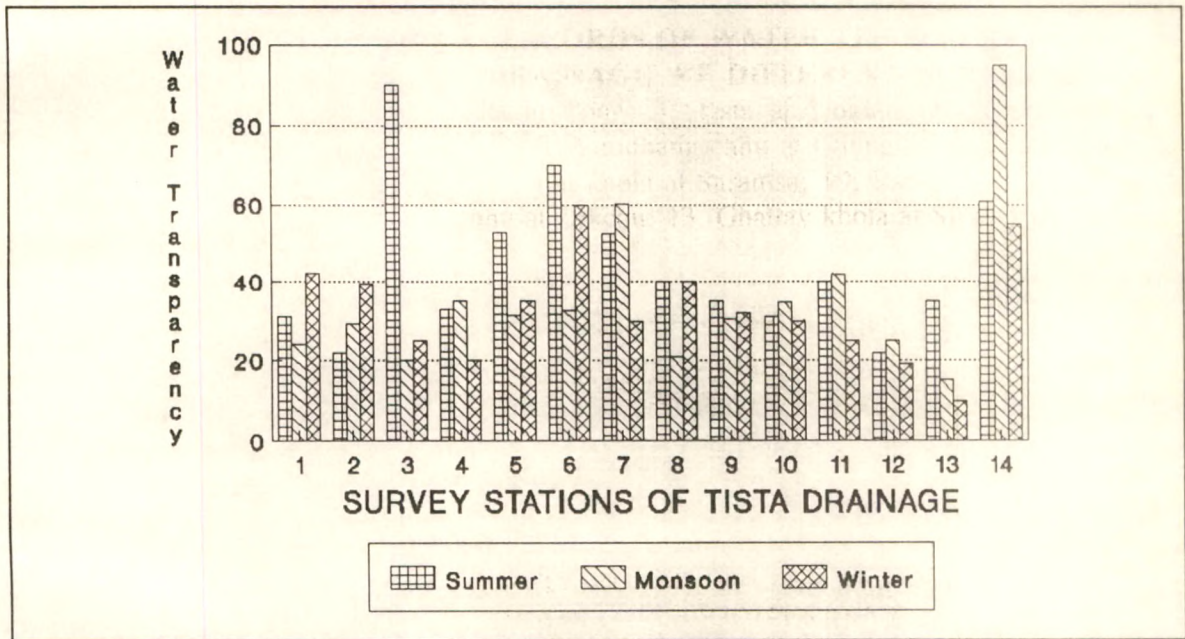
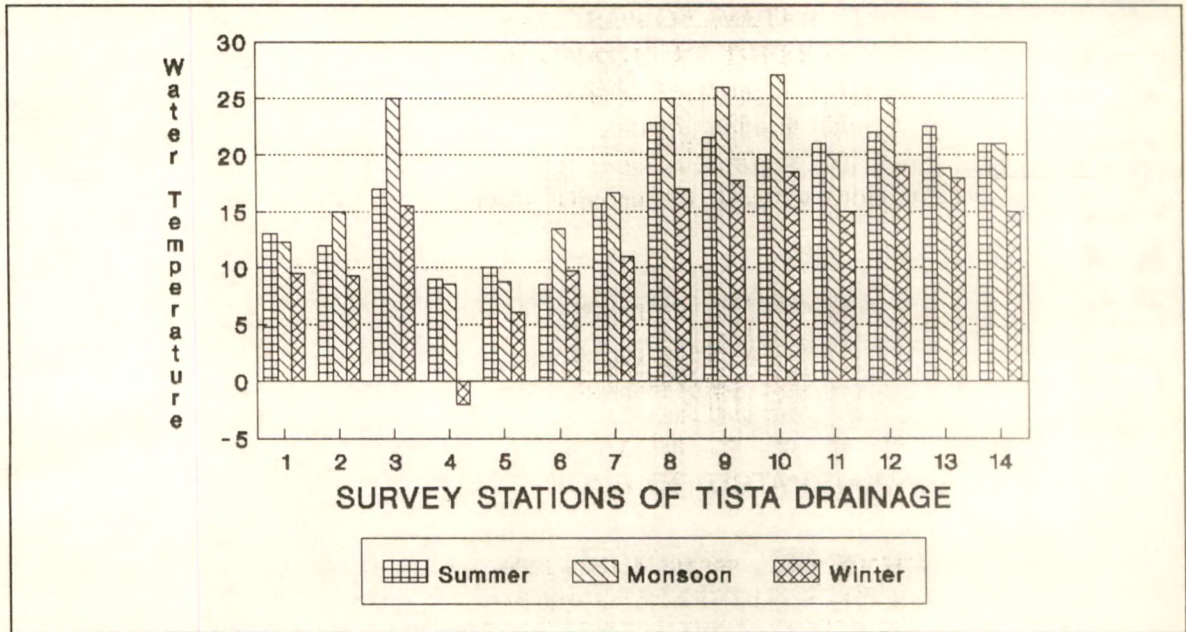


Figure 3. AVERAGE SEASONAL RECORDS OF WATER TEMPERATURE (°C) AND TRANSPARENCY (cm) OF TISTA DRAINAGE AT DIFFERENT SURVEY STATIONS (Abbr. 1, Tista at Chungthang; 2, Tista at Tong; 3, Tista at Singtam; 4, Yumthang chhu at Yumthang; 5, Yumthang chhu at Lachung; 6, Yumthang chhu at Chungthang; 7, Bakcha chhu at Bakcha; 8, Seti khola at Lower Lagyap; 9, Jali khola at Saramsa; 10, Rani khola at Saramsa; 11, Rin khola at Lower Dzongu; 12, Dik chhu at Dikchu; 13, Ghattay khola at Sirwani & 14, Rangpo khola at Rangpo)

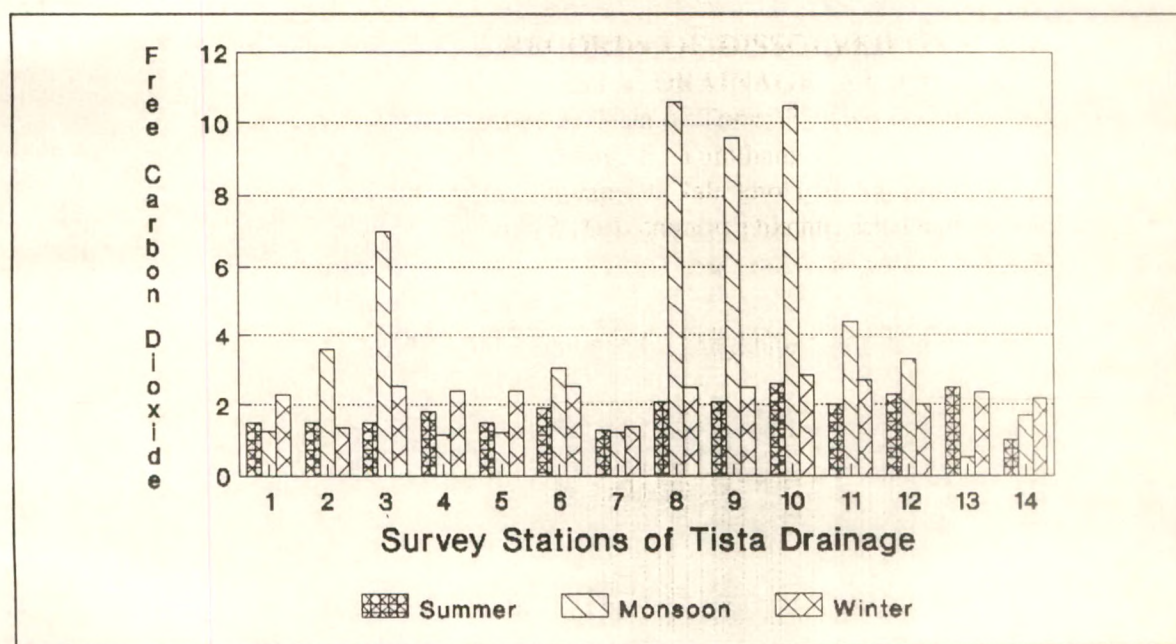
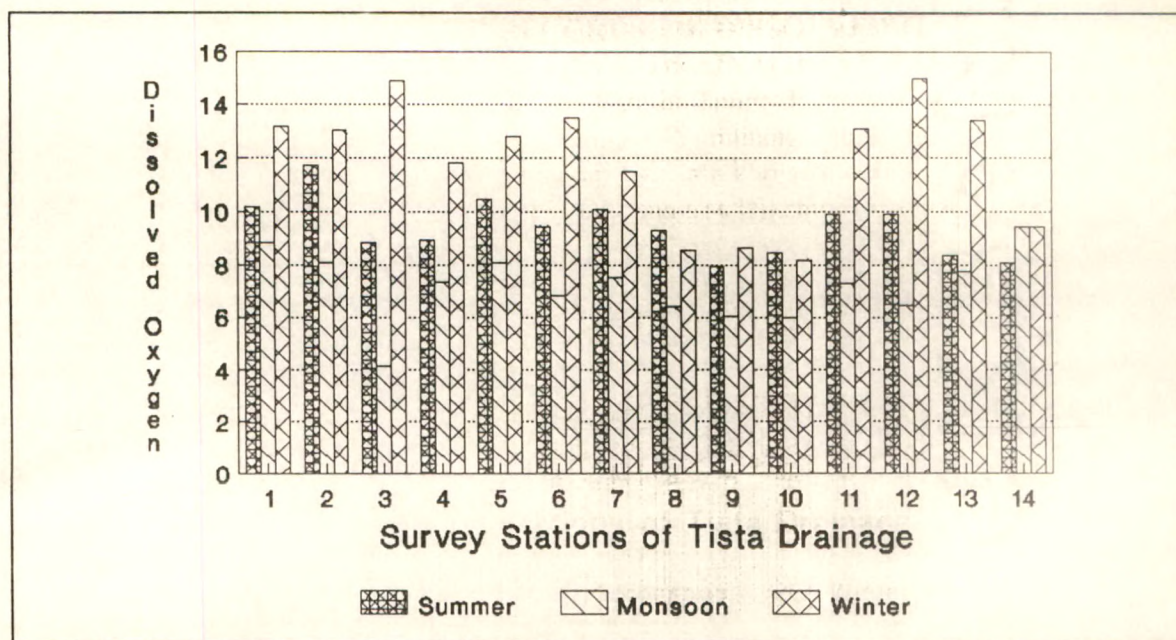


Figure 4. AVERAGE SEASONAL RECORDS OF DISSOLVED OXYGEN (mg l⁻¹) AND FREE CARBON DIOXIDE (mg l⁻¹) OF TISTA DRAINAGE AT DIFFERENT SURVEY STATIONS (Abbr. 1, Tista at Chungthang; 2, Tista at Tong; 3, Tista at Singtam; 4, Yumthang chhu at Yumthang; 5, Yumthang chhu at Lachung; 6, Yumthang chhu at Chungthang; 7, Bakcha chhu at Bakcha; 8, Seti khola at Lower Lagyap; 9, Jali khola at Saramsa; 10, Rani khola at Saramsa; 11, Rin khola at Lower Dzongu; 12, Dik chhu at Dikchu; 13, Ghattay khola at Sirwani & 14, Rangpo khola at Rangpo)

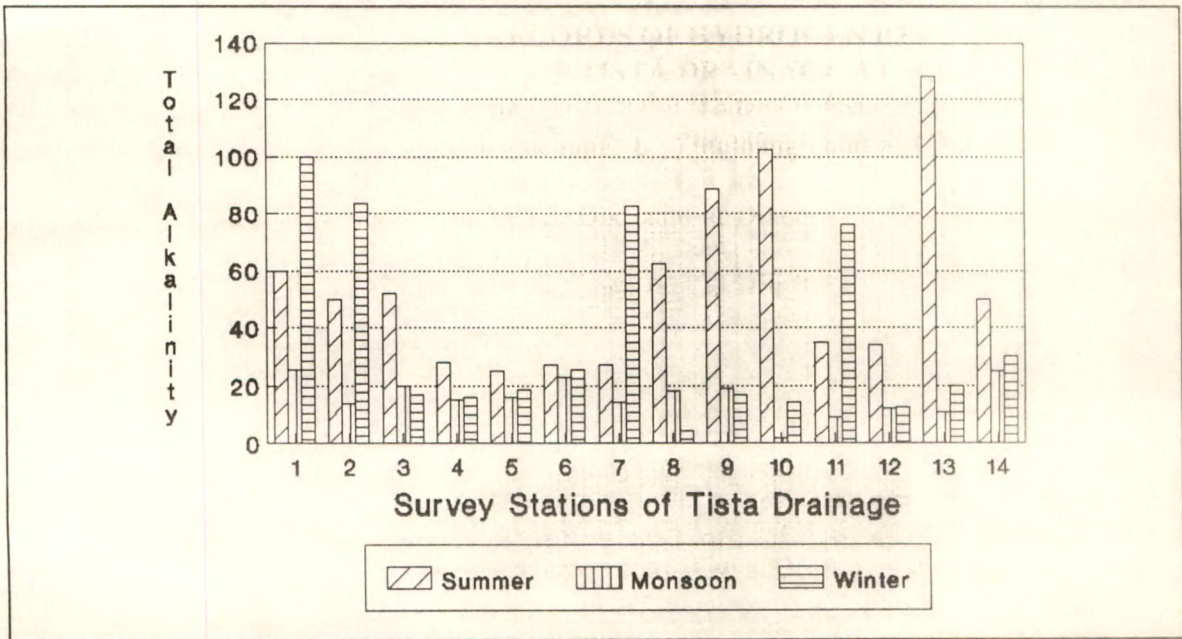
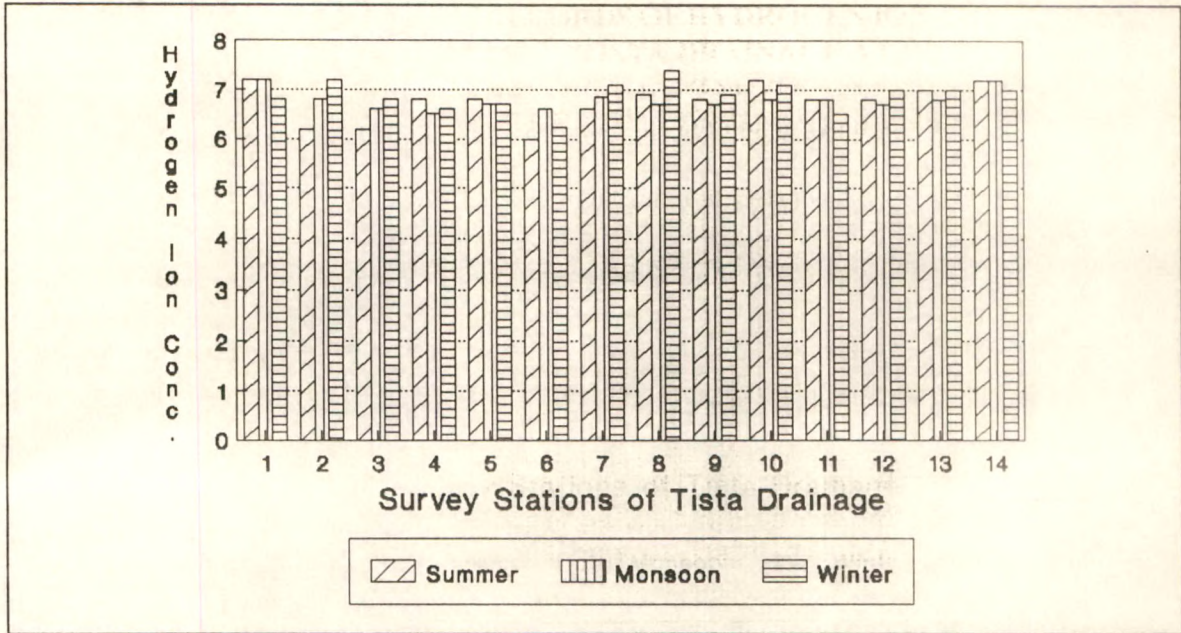
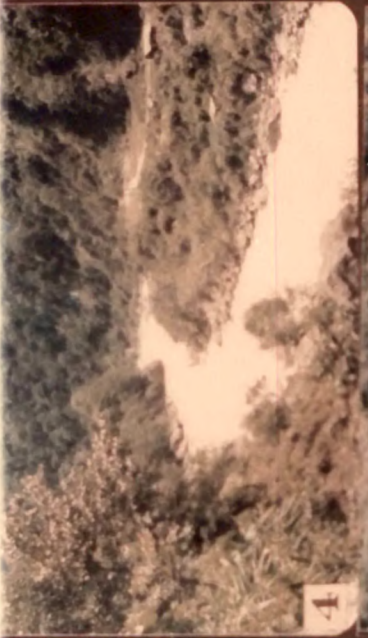


Figure 5. AVERAGE SEASONAL RECORDS OF HYDROGEN ION CONCENTRATION (pH) AND TOTAL ALKALINITY (mg^l⁻¹) OF TISTA DRAINAGE AT DIFFERENT SURVEY STATIONS (Abbr. 1, Tista at Chungthang; 2, Tista at Tong; 3, Tista at Singtam; 4, Yumthang chhu at Yumthang; 5, Yumthang chhu at Lachung; 6, Yumthang chhu at Chungthang; 7, Bakcha chhu at Bakcha; 8, Seti khola at Lower Lagyap; 9, Jali khola at Saramsa; 10, Rani khola at Saramsa; 11, Rin khola at Lower Dzongu; 12, Dik chhu at Dikchu; 13, Ghattay khola at Sirwani & 14, Rangpo khola at Rangpo)

Explanations of Plate IV

Panoramic views of river Tista at three survey stations (SS) during different seasons.

- 1 - 3. **At Chungthang (SS) in Summer (1),
Monsoon (2) and Winter (3)**
- 4 - 6. **At Tong (SS) in Summer (4),
Monsoon (5) and Winter (6)**
- 7 - 9. **At Singtam (SS) in Summer (7),
Monsoon (8) and Winter (9)**



Explanations of Plate V

**Panoramic views of Yumthang chhu at three survey stations (SS)
during different seasons.**

- | | |
|-----------|--|
| 1 - 3. | At Yumthang (SS) in Summer (1),
Monsoon (2) and Winter (3) |
| 4, 5 & 7. | At Lachung (SS) in Summer (4),
Monsoon (5) and Winter (7) |
| 6, 8 & 9. | At Chungthang (SS) in Summer (6),
Monsoon (8) and Winter (9) |



Explanations of Plate VI

Panoramic views of Bakcha chhu & Seti khola at respective survey stations (SS) during three seasons.

- 1 - 3. **At Bakcha (SS) in Summer (1),
 Monsoon (2) and Winter (3)**
- 4 - 6. **At Lower Lagyap (SS) in Summer (4),
 Monsoon (5) and Winter (6)**



Explanations of Plate VII

Panoramic views of Jali khola and Rani khola at Saramsa (SS)
during three seasons.

- 1 - 3. Jali khola in Summer (1),
 Monsoon (2) and Winter (3)
- 4 - 6. Rani khola in Summer (4),
 Monsoon (5) and Winter (6)



Explanations of Plate VIII

Panoramic views of Rin khola & Dik chhu at respective survey stations (SS) during three seasons.

- 1 - 3. Rin khola at Lower Dzongu (SS) in Summer (1), Monsoon (2) and Winter (3)
- 4 - 6. Dik chhu at Dikchu (SS) in Summer (4), Monsoon (5) and Winter (6)



Explanations of Plate IX

Panoramic views of Ghattay khola & Rangpo khola at respective survey stations during three seasons.

- 1 - 2. Ghattay khola at Sirwani (SS) in
Summer (1) and Monsoon (2)
- 3. Confluence of Rangpo khola &
river Tista at Rangpo
- 4 - 6. Rangpo khola at Rangpo (SS) in
Summer (4), Monsoon (5) and
Winter (6)



4.2 Rangit Drainages

RIVER RANGIT

(Plate X)

River Rangit takes its rise from Rathong Glacier ($88^{\circ}7'57''$ E & $27^{\circ}32'44''$ N) at an elevation of 4401 m in West Sikkim. It traverses for ca 30 km south along its upper reach through very high valleys and steep slopes at gradient zones of 4000 m to 645 m and 600 m where it receives Lodung khola and Kalej khola at Lower Tashiding and Legship respectively. The river then acts as south-west boundary for ca 21 km along its gradient up to Nayabazar receiving Rishi khola, Roathak khola, Rangbhang khola, Little Rangit and several small streams. It then widens to 24 m (mean value) and runs towards east for ca 20 km demarcating the South district of the state from Darjeeling Gorkha Hill Council of West Bengal until it joins the Tista near Tista bazaar (240 m msl) in West Bengal.

SURVEY STATION

Lower Tashiding ($88^{\circ}18'23''$ E & $27^{\circ}17'31''$ N), Sikhip ($88^{\circ}19'20''$ E & $27^{\circ}12'13''$ N) and Nayabazar ($88^{\circ}17'16''$ E and $27^{\circ}8'30''$ N) are the three Field Stations selected for the Rangit to cover its upper, middle and lower reaches at different gradients. Lower Tashiding lies at the base of Tashiding where Annual Fair is held in February and people gather from far and wide especially to receive holy water from the monks of Tashiding Gompa (Buddhist temple). The survey station is situated at an elevation of 645 m with high valleys and densely clad forests on its both sides, and is 4 km away from Legship on a narrow, unpaved jeepable road. Sikhip is only 4 km from Rishi bazaar and 14 km from Nayabazar on a broad paved road and is 455 m above mean sea level. Nayabazar lies at an elevation of only 340 m. It is just ca 5 km away from Singla bazaar in west Bengal and 1 km from Jorethang (South Sikkim) on a broad paved road.

FLUVIAL DYNAMICS

Lower Tashiding: Water velocity 0.91 (W) - 1.41 (M), \bar{X} 1.13, \underline{A} 0.50; discharge rate 13.74 (W) - 104.39 (M), \bar{X} 52.29, \underline{A} 90.65.

Sikhip: Water velocity 0.45 (W) - 1.17 (S), \bar{X} 0.89, \underline{A} 0.72; discharge rate 30.80 (W) - 145.51 (M), \bar{X} 81.88, \underline{A} 114.71.

Nayabazar: Water velocity 0.53 (W) - 1.17 (M), \bar{X} 0.95, \underline{A} 0.64; discharge rate 34.43 (W) - 180.72 (M), \bar{X} 101.19, \underline{A} 146.29.

WATER CHARACTERISTICS

Lower Tashiding: Transparency 62 (W) - 92 (M), \bar{X} 73, \underline{A} 30; temperature 13.0 (W) - 19.0 (M), \bar{X} 16.41, \underline{A} 6.0; hydrogen ion concentration 6.95 (S) - 7.4 (M), \bar{X} 7.11, \underline{A} 0.45; DO 8.93 (W) - 10.16 (S), \bar{X} 9.48, \underline{A} 1.23; FCO₂ 1.9 (M) - 60.6 (S), \bar{X} 22.48, \underline{A} 58.7; TA 18.0 (M) - 64.5 (S),

\bar{X} 47.33, \underline{A} 46.5.

Sikhip: Transparency 62 (W) - 85.17 (M), \bar{X} 70.05, \underline{A} 23.17; temperature 14.0 (W) - 21.5 (M), \bar{X} 18.16, \underline{A} 7.5; hydrogen ion concentration 6.6 (W) - 7.3 (S), \bar{X} 7.03, \underline{A} 0.7; DO 8.77 (W) - 9.90 (S), \bar{X} 9.38, \underline{A} 1.13; FCO₂ 1.5 (S) - 3.6 (M), \bar{X} 2.36, \underline{A} 2.1; TA 25.0 (M) - 98.0 (W), \bar{X} 57.66, \underline{A} 73.0.

Nayabazar: Transparency 39 (M) - 89.28 (S), \bar{X} 71.59, \underline{A} 50.28; temperature 14.7 (W) - 21.5 (M), \bar{X} 19.06, \underline{A} 6.8; hydrogen ion concentration 6.7 (M) - 7.3 (S), \bar{X} 7.06, \underline{A} 0.6; DO 8.45 (M) - 9.47 (S), \bar{X} 9.06, \underline{A} 1.02; FCO₂ 1.5 (S) - 15.9 (M), \bar{X} 6.36, \underline{A} 14.4; TA 25.0 (M) - 81.0 (S), \bar{X} 62.0, \underline{A} 56.0.

INVERTEBRATE NEKTON

Lower Tashiding:	SUMMER	Ephemeropterid nymph > <i>Iron</i> sp.
	MONSOON	Ephemeropterid nymph > <i>Neoperla</i> sp.
	WINTER	Ephemeropterid nymph > Frog tadpole.
Sikhip:	SUMMER	Ephemeropterid nymph > Caddis larva > <i>Baetis</i> sp. > <i>Isonychia</i> sp.
	MONSOON	Ephemeropterid nymph > Frog tadpole
	WINTER	Ephemeropterid nymph > <i>Isonychia</i> sp. > Caddis larva.
Nayabazar:	SUMMER	Ephemeropterid nymph
	MONSOON	Ephemeropterid nymph
	WINTER	Ephemeropterid nymph .

RIMBI KHOLA

(Plate XI)

Rimbi khola takes its rise from Lachhmi Pokhari (Koktang Lake) at Daju La khang (ridge) at 4616 m (88°4'26" E & 27°26'13" N), near Indo- Nepal border in West Sikkim. It runs to the south for ca 14 km along gradients of 3000 m to 1245 m at its upper reaches to enter Rimbi. It further traverses a distance of ca 11 km up to its confluence with Rathong chhu to form Lodung khola which in its turn, runs ca 10 km and finally pours its contents to Rangit river 0.5 km below Lower Tashiding bridge point.

SURVEY STATION

Rimbi (88°8'08" E & 27°21'12" N) is 26 km away from Gyalshing - the district head quarter of West Sikkim by unpaved road and its elevation is 1065 m. The state has already established a hydroelectric power house at Rimbi and about 50 % of the river discharge is diverted

for hydropower generation.

FLUVIAL DYNAMICS

Water velocity 0.53 (S) - 0.70 (W), \bar{X} 0.61, Δ 0.17; Water discharge 6.29 (W) - 47.19 (M), \bar{X} 21.67, Δ 40.90

WATER CHARACTERISTICS

Transparency 51 (W) - 82 (M), \bar{X} 64.66, Δ 31; temperature 12 (W) - 15.75 (S), \bar{X} 14.25, Δ 3.75; hydrogen ion concentration 7.0 (S, W) - 7.4 (M), \bar{X} 7.13, Δ 0.4; DO 8.46 (S) - 9.45 (M), \bar{X} 8.85, Δ 0.99; FCO₂ 1.7 (M) - 30.2 (S), \bar{X} 11.16, Δ 28.5; TA 7.5 (M) - 60.0 (S), \bar{X} 30.5, Δ 52.5.

INVERTEBRATE NEKTON

SUMMER Ephemeroid nymph > *Isonychia* sp.

MONSOON Ephemeroid nymph

WINTER Caddis larva > Ephemeroid nymph & *Isonychia* sp. > *Iron* sp. & *Baetis* sp.

KALEJ KHOLA

(Plate XI)

Kalej khola originates at Lampheram (88°4'26" E & 27°20'17" N), west of Uttare in Singalila range along Indo-Nepal border in West Sikkim at an elevation of 3879 m. It flows for a total distance of ca 25 km through gradients of 1440 m at Dentam to 600 m at its confluence with river Rangit near Legship. As a result of the huge landslide caused by Kalej khola at Sunguray near Uttare, large amount of boulders and mud have been deposited along the river bed, which turns Kalej khola highly turbid especially during the monsoon. A number of small streams namely Kachhu khola, Rangsang khola, Toyang khola, Hee khola and Reshi khola join Kalej khola along its course.

SURVEY STATION

Legship (88°18'23" E & 27°17'04" N), the survey station is 17 km from Gyalshing on a paved road. It lies at an elevation of 600 m above the mean sea level.

FLUVIAL DYNAMICS

Water velocity 0.71 (W) - 1.13 (S), \bar{X} 0.93, Δ 0.42; discharge rate 8.00 (W) - 58.97 (M), \bar{X} 26.51, Δ 50.97

WATER CHARACTERISTICS

Transparency 41.0 (M) - 82.55 (S), \bar{X} 66.18, Δ 41.55; temperature 15.0 (W) - 21.5 (S,M), \bar{X} 19.33, Δ 6.5; hydrogen ion concentration 6.8 (M) - 7.3 (S), \bar{X} 7.1, Δ 0.5; DO 8.85 (S, M) - 9.18 (W), \bar{X} 8.96, Δ 0.33; FCO₂ 1.5 (W) - 33.5 (S), \bar{X} 13.68, Δ 32.0; TA 20.0 (M) - 69.5 (S), \bar{X}

38.16, Δ 49.5.

INVERTEBRATE NEKTON

SUMMER Ephemerid nymph > Caddis larva

MONSOON Ephemerid nymph > *Neoperla* sp., Frog tadpole

WINTER Ephemerid nymph > *Isonychia* sp. and Caddis larva.

RISHI KHOLA

(Plate XII)

Rishi khola originates ($88^{\circ}11'02''$ E & $27^{\circ}12'54''$ N) from Siribadam reserve forests at an elevation of over 2000 m. It flows south for ca 14 km through different gradients till it confluences with river Rangit at Rishi bazaar. It is narrow and feeble with 0.26 m deep banks from the river bed. It exposes only 13 cm of water during winter.

SURVEY STATION

Rishi bazaar ($88^{\circ}19'22''$ E & $27^{\circ}13'36''$ N) lies at the bank of river Rangit at an elevation of 490 m. It is connected to Legship by a paved road of distance of 12 km.

FLUVIAL DYNAMICS

Water velocity 0.63 (W) - 1.20 (M), \bar{X} 0.90, Δ 0.57; discharge rate 3.41 (W) - 27.09 (M), \bar{X} 12.37, Δ 23.68

WATER CHARACTERISTICS

Transparency 35 (W) - 52.48 (M), \bar{X} 42.82, Δ 17.48; temperature 15.5 (W) - 24.0 (M), \bar{X} 20.66, Δ 8.5; hydrogen ion concentration 7.0 (M, W) - 7.45 (S), \bar{X} 7.15, Δ 0.45; DO 8.5 (M) - 9.1 (W), \bar{X} 8.73, Δ 0.6; FCO₂ 2.3 (W) - 5.25 (S), \bar{X} 3.73, Δ 2.95; TA 25.0 (M) - 90.0 (S), \bar{X} 57.55, Δ 65.0.

INVERTEBRATE NEKTON

SUMMER Ephemerid nymph > *Iron* sp. > *Neoperla* sp.

MONSOON Ephemerid nymph

WINTER *Iron* sp.

ROATHAK KHOLA

(Plate XII)

Roathak khola originates at Simdhap (1700 m msl) near Gompadanra about 2 km above Singling, Soreng ($88^{\circ}12'30''$ E & $27^{\circ}10'22''$ N). It runs for a total of ca 13 km and passes by Rothak (380 m, msl) till it confluences with river Rangit. It is narrow in its upper reaches and

gradually widens to 6.84 m at Rothak during monsoon.

SURVEY STATION

Rothak (88°18'38" E & 27°10'25" N), the survey station is just 5.5 km from Nayabazar by a paved road and lies at an elevation of 380 m in West Sikkim.

FLUVIAL DYNAMICS

Water velocity 0.57 (W) - 0.85 (M), \bar{X} 0.72, \underline{A} 0.28; discharge rate 3.16 (W) - 28.44 (M), \bar{X} 12.58, \underline{A} 25.28.

WATER CHARACTERISTICS

Transparency 28 (W) - 34.5 (M), \bar{X} 31.16, \underline{A} 6.5; temperature 15.0 (W) - 24.0 (M), \bar{X} 20.83, \underline{A} 9.0; hydrogen ion concentration 7.2 (M) - 7.4 (S), \bar{X} 7.3, \underline{A} 0.2; DO 8.82 (W) - 9.02 (S), \bar{X} 8.91, \underline{A} 0.2; FCO₂ 3.25 (M) - 20.7 (W), \bar{X} 9.85, \underline{A} 17.45; TA 40.0 (M) - 225 (S), \bar{X} 117.5, \underline{A} 185.0.

INVERTEBRATE NEKTON

SUMMER Ephemeropterid nymph > Caddis larva > Dragonfly nymph > *Hydrophilus* sp.

MONSOON Ephemeropterid nymph

WINTER Caddis larva > Ephemeropterid nymph > *Baetis* sp. > Dragonfly nymph & *Hydrophilus* sp.

RANGBHANG KHOLA

(Plate XIII)

Rangbhang khola originates in Phalut peak at Singalila range (3650 m, msl) in Indo - Nepal border within 88°2'31" E and 27°14'45" N. It runs to the south-east for ca 20 km along gradient zones of 3350 m to 1067 m at upper reaches through Sombare followed by 17.81 km and confluences with river Rangit at 88°17'16" E & 27°14'45" N at an elevation of 340 m. Its upper reach acts as the boundary of Nepal with West district of Sikkim and the lower reach between Darjeeling (West Bengal) and West district of Sikkim.

SURVEY STATION

Nayabazar, the survey station where Rangbhang khola confluences with river Rangit lies at an elevation of 340 m and is situated at a distance of only 1 km from Jorethang (South Sikkim) on a broad paved road.

FLUVIAL DYNAMICS

Water velocity 0.61 (W) - 1.27 (M), \bar{X} 0.95, \underline{A} 0.66; discharge rate 9.92 (W) - 97.65 (M), \bar{X} 48.21, \underline{A} 87.73.

WATER CHARACTERISTICS

Transparency 38.0 (M) - 79.03 (S), \bar{X} 63.74, A 41.03; temperature 15.0 (W) - 23.0 (M), \bar{X} 20.0, A 8.0; hydrogen ion concentration 6.4 (M) - 7.2 (S), \bar{X} 6.9, A 0.8; DO 8.06 (S) - 9.23 (W), \bar{X} 8.61, A 1.17; FCO₂ 1.55 (S) - 11.25 (M), \bar{X} 4.81, A 9.7; TA 17.0 (M) - 75.0 (W), \bar{X} 51.66, A 58.0.

INVERTEBRATE NEKTON

SUMMER Ephemeropterid nymph > Caddis larva > *Neoperla* sp.

MONSOON Ephemeropterid nymph > Caddis larva

WINTER Ephemeropterid nymph > *Isonychia* sp. > *Iron* sp. > *Hirudinaria* sp. > Caddis larva.

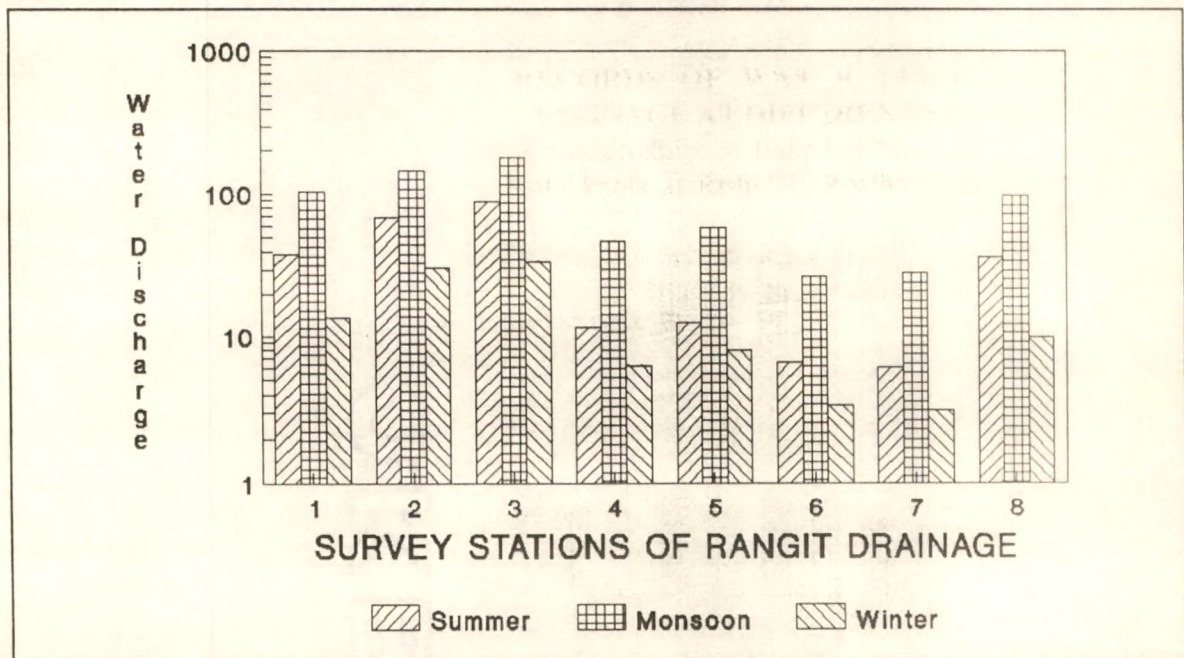
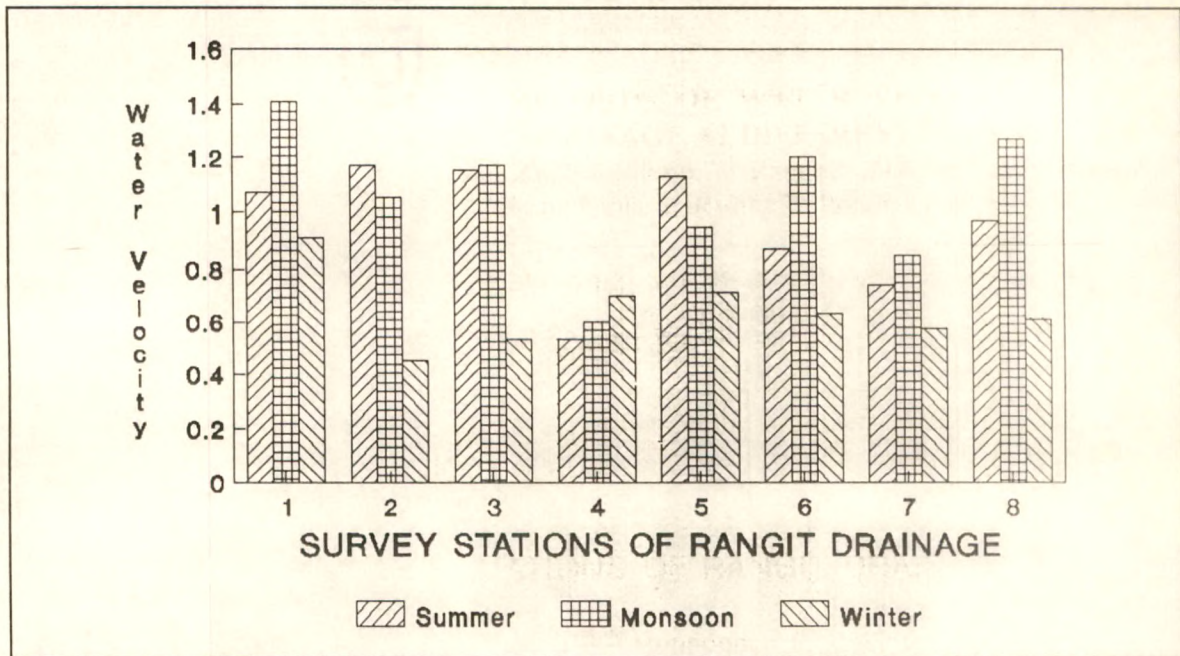


Figure 6. AVERAGE SEASONAL RECORDS OF WATER VELOCITY (ms^{-1}) AND DISCHARGE RATE (m^3s^{-1}) OF RANGIT DRAINAGE AT DIFFERENT SURVEY STATIONS (Abbr. 1, Rangit at Lower Tashiding; 2, Rangit at Sikhrip; 3, Rangit at Nayabazar; 4, Rimbi khola at Rimbi; 5, Kalej khola at Legship; 6, Rishi khola at Rishi; 7, Roathak khola at Rothak & 8, Rangbhang khola at Nayabazar)

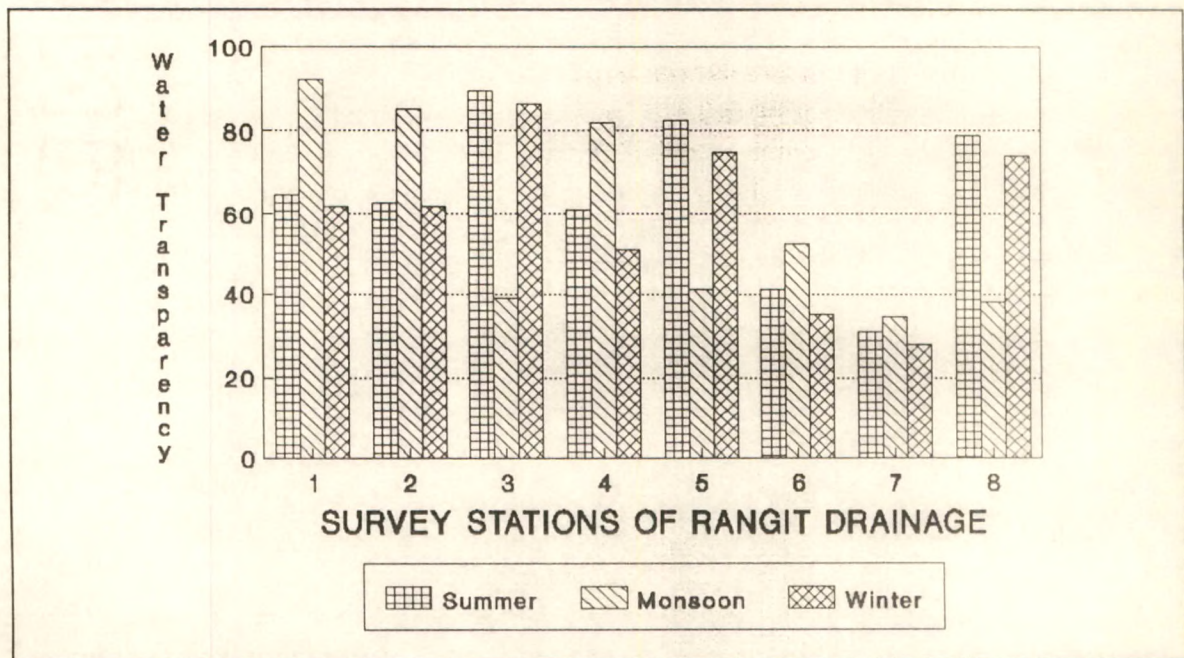
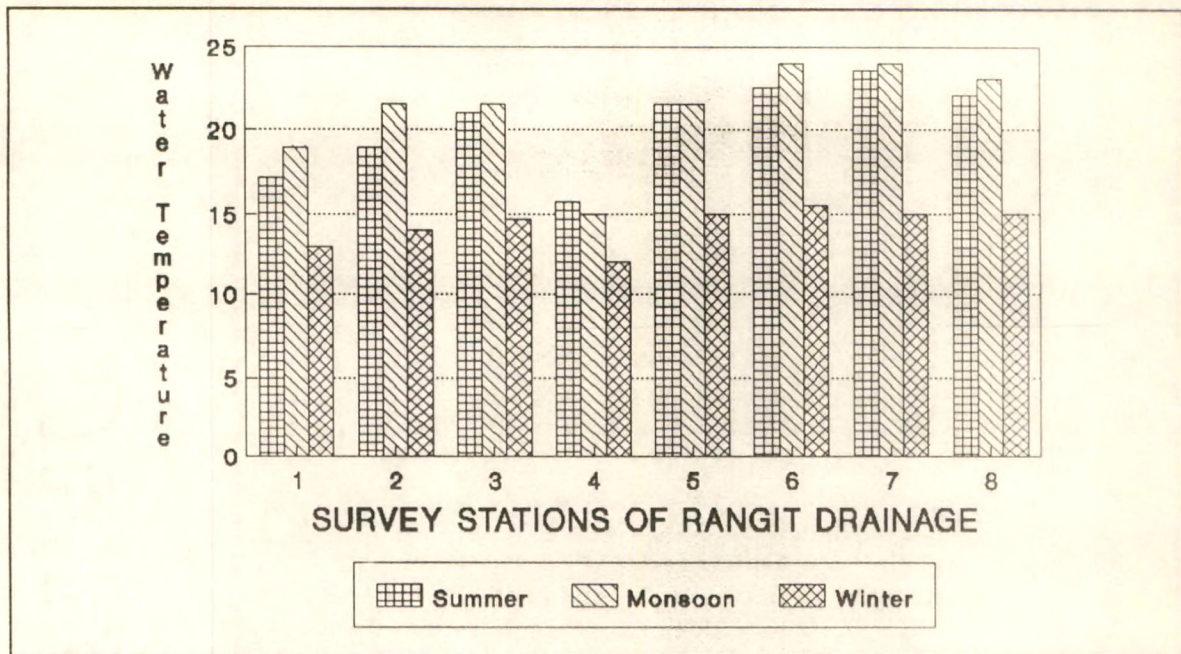


Figure 7. AVERAGE SEASONAL RECORDS OF WATER TEMPERATURE (°C) AND TRANSPARENCY (cm) OF RANGIT DRAINAGE AT DIFFERENT SURVEY STATIONS (Abbr. 1, Rangit at Lower Tashiding; 2, Rangit at Sikhip; 3, Rangit at Nayabazar; 4, Rimbi khola at Rimbi; 5, Kalej khola at Legship; 6, Rishi khola at Rishi; 7, Roathak khola at Rothak & 8, Rangbhang khola at Nayabazar)

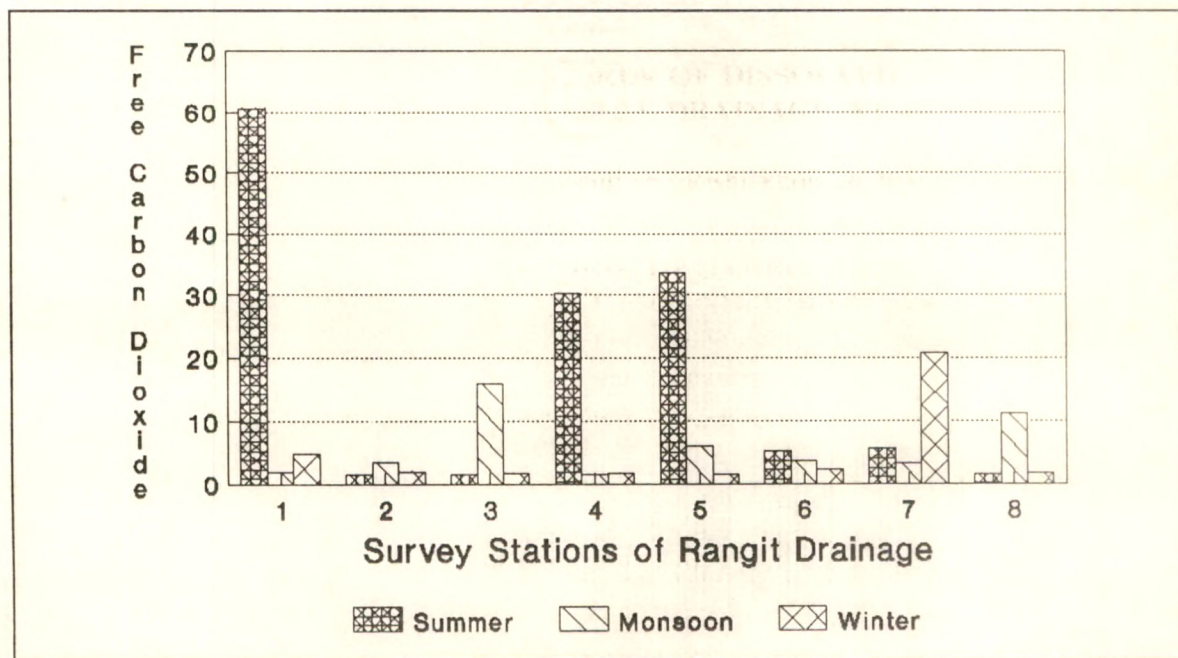
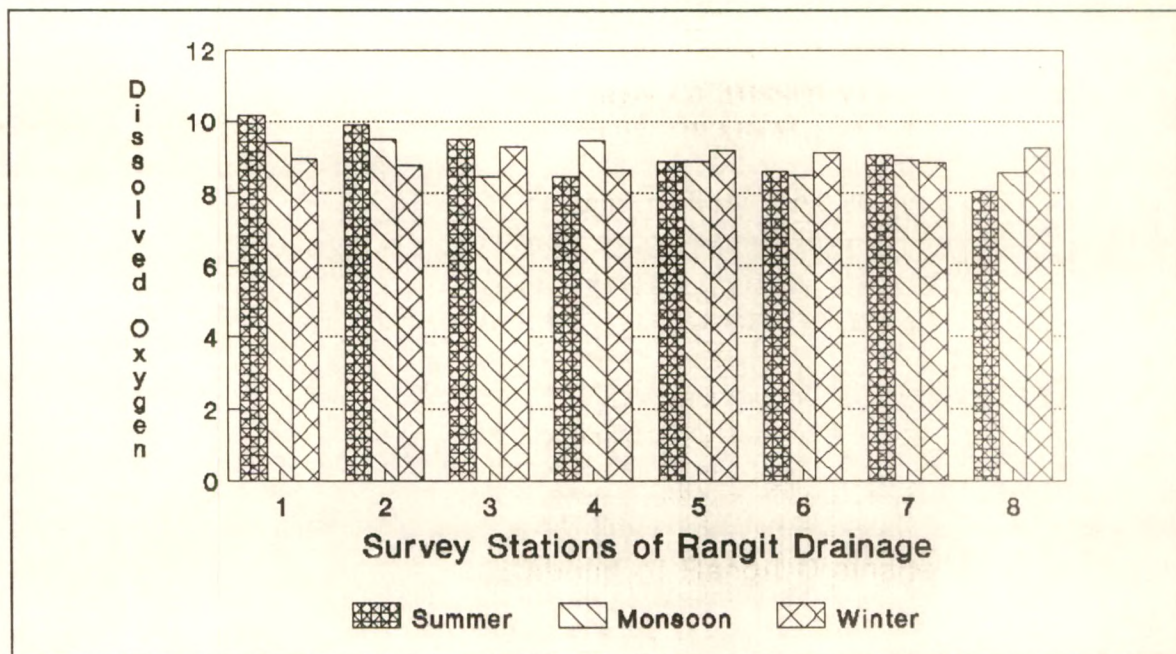


Figure 8. AVERAGE SEASONAL RECORDS OF DISSOLVED OXYGEN (mg l^{-1}) AND FREE CARBON DIOXIDE (mg l^{-1}) OF RANGIT DRAINAGE AT DIFFERENT SURVEY STATIONS (Abbr. 1, Rangit at Lower Tashiding; 2, Rangit at Sikhrip; 3, Rangit at Nayabazar; 4, Rimbi khola at Rimbi; 5, Kalej khola at Legship; 6, Rishi khola at Rishi; 7, Roathak khola at Rothak & 8, Ranghbang khola at Nayabazar)

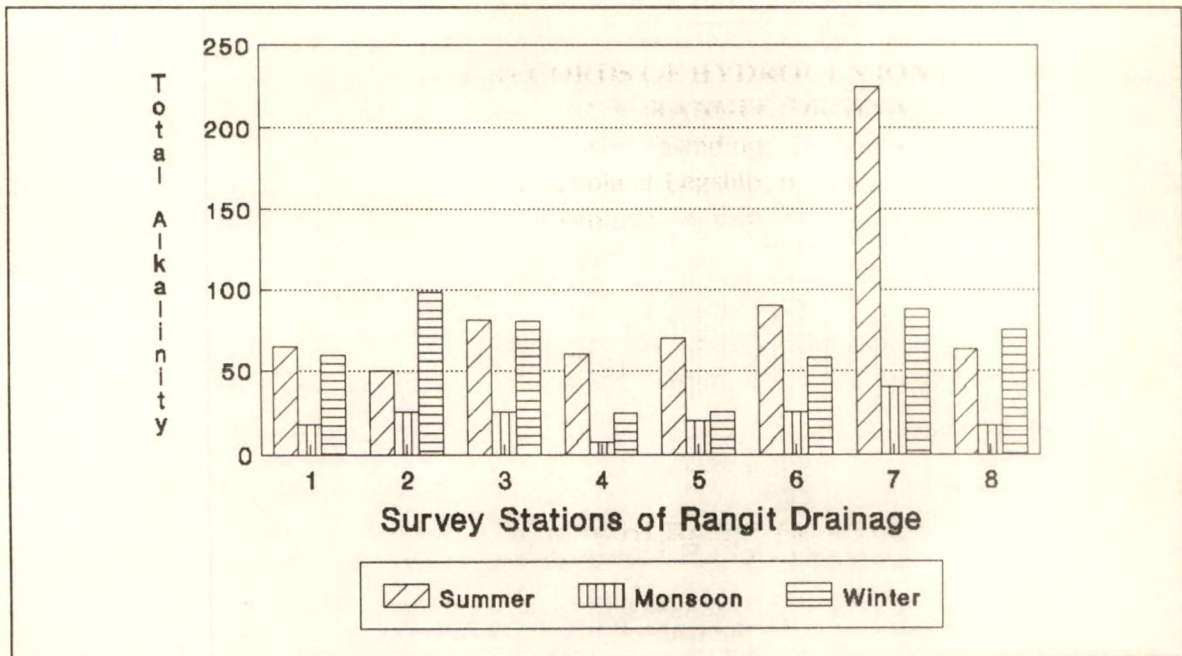
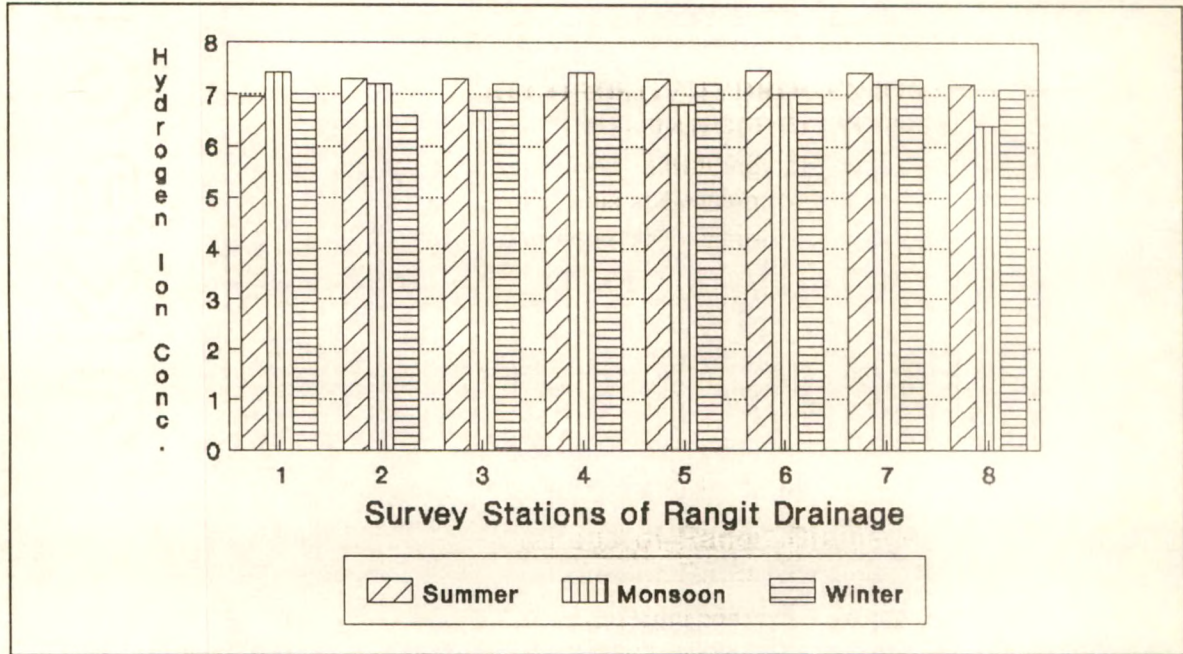


Figure 9. AVERAGE SEASONAL RECORDS OF HYDROGEN ION CONCENTRATION (pH) AND TOTAL ALKALINITY (mg l^{-1}) OF RANGIT DRAINAGE AT DIFFERENT SURVEY STATIONS (Abbr. 1, Rangit at Lower Tashiding; 2, Rangit at Sikhrip; 3, Rangit at Nayabazar; 4, Rimbi khola at Rimbi; 5, Kalej khola at Legship; 6, Rishi khola at Rishi; 7, Roathak khola at Rothak & 8, Rangbhang khola at Nayabazar).

Explanations of Plate X

Panoramic views of river Rangit at three survey stations (SS) during different seasons.

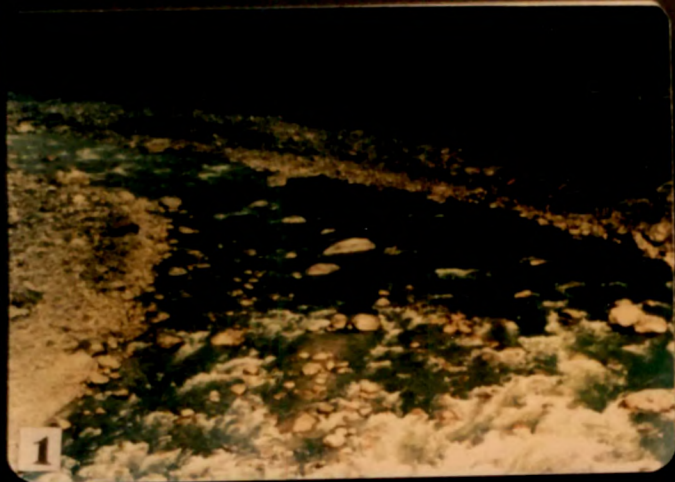
- 1 - 3. At Lower Tashiding (SS) in Summer (1),
 Monsoon (2) and Winter (3)
- 4 - 6. At Sikhip (SS) in Summer (4), Monsoon (5)
 and Winter (6)
- 7 - 9. At Nayabazar (SS) in Summer (7),
 Monsoon (8) and Winter (9)



Explanations of Plate XI

Panoramic views of Rimbi khola & Kalej khola at respective survey stations (SS) during three seasons.

- 1 - 3. Rimbi khola at Rimbi (SS) in
 Summer (1), Monsoon (2) and
 Winter (3)
- 4 - 6. Kalej khola at Legship (SS) in
 Summer (4), Monsoon (5) and
 Winter (6)



Explanations of Plate XII

Panoramic views of Rishi khola & Roathak khola at respective survey stations (SS) during three seasons.

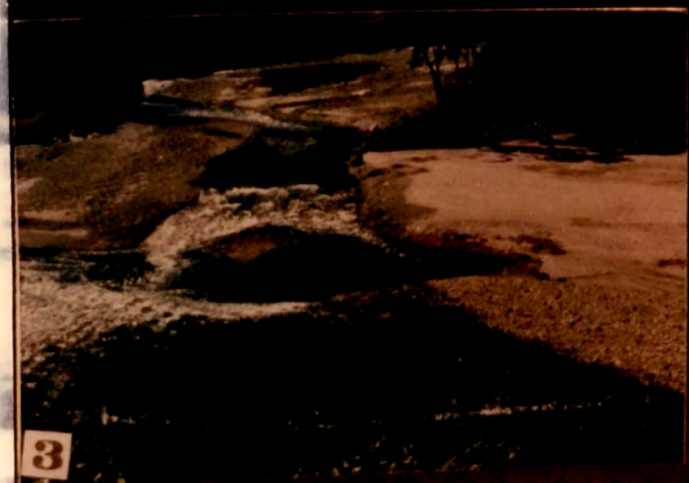
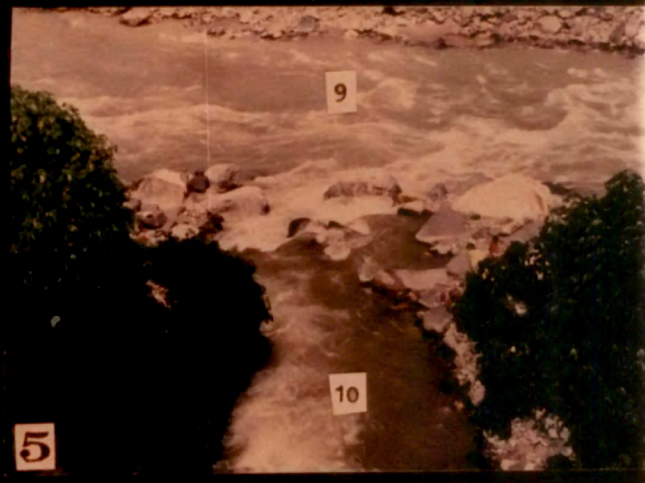
- 1 - 3. Rishi khola at Rishi (SS) in
Summer (1), Monsoon (2) and
Winter (3)
- 4 - 6. Roathak khola at Rothak (SS) in
Summer (4), Monsoon (5) and
Winter (6)



Explanations of Plate XIII

Panoramic views of confluence of river Rangit with some of its tributaries in different seasons.

- 1 - 3. Confluence of river Rangit & Rangbhang khola at Nayabazar (SS) in Summer (1), Monsoon (2) and Winter (3)
4. Confluence of Kalej khola (11) & river Rangit (12) at Legship in Monsoon
5. Confluence of river Rangit (9) & Rishi khola (10) at Rishi in Monsoon
6. Physical analysis is in progress at Rani khola



CHAPTER FIVE

**POTAMOPLANKTON COMMUNITIES
OF THE DRAINAGES**

CHAPTER FIVE

POTAMOPLANKTON COMMUNITIES OF THE DRAINAGES

Potamoplankton communities

A total of 80 potamoplankton genera were recorded from the Sikkim drainages during the present investigation period. The average density of potamoplankton during 1987 and 1988 have been recorded as 35357 ul^{-1} . Season-wise distribution of total plankton showed maximum density during winter (13262 ul^{-1}) followed by Monsoon (13260 ul^{-1}) and summer (8835 ul^{-1}).

5.1 Phytoplankton

Altogether six classes of algae have been encountered in the Tista and the Rangit river systems during 1987 & 1988 which are arranged in order of their dominance as Chlorophyceae > Bacillariophyceae > Myxophyceae > Chrysophyceae > Xanthophyceae > Rhodophyceae. Phytoplankton (96.58 % and 95.90 %) dominance has been observed in both the Tista and the Rangit drainages respectively. The total phytoplankton density of the two river systems recorded during 1987 & 1988 is 34053 ul^{-1} . The details of structure of phytoplankton communities in the river systems of Sikkim is shown in Table 1.

5.1.1 Systematic list

The phytoplankton community of Sikkim drainages comprises of 63 genera under 30 families. Of these, 59 genera belonging to 6 classes have been observed in the Tista drainage while Rangit drainage have been recorded with only 36 genera under 4 classes. The combined systematic list is purported hereunder :

Class:	CHLOROPHYCEAE
Order:	TETRASPORALES
FAMILY:	Palmellaceae
	1. <i>Palmodictyon</i> sp.
FAMILY:	Tetrasporaceae
	2. <i>Tetraspora</i> spp.
Order:	CHLOROCOCCOLALES
FAMILY:	Hydrodictyaceae
	3. <i>Hydrodictyon</i> sp.

4. *Pediastrum* spp.
 FAMILY: Oocystaceae
 5. *Chlorella* sp.
 Order: ULOTRICHALES
 FAMILY: Ulotricaceae
 6. *Binuclearia* sp.
 7. *Geminella* spp.
 8. *Hormidium* sp.
 9. *Pearsoniella* sp.
 10. *Ulothrix* spp.
 11. *Uronema* sp.
 FAMILY: Sphaeropleaceae
 12. *Sphaeroplea* spp.
 Order: CLADOPHORALES
 FAMILY: Cladophoraceae
 13. *Chaetomorpha* sp.
 14. *Cladophora* spp.
 15. *Pithophora* spp.
 16. *Rhizoclonium* sp.
 Order: Chaetophorales
 FAMILY: Chaetophoraceae
 17. *Dermatophyton* sp.
 18. *Protoderma* sp.
 19. *Stigeoclonium* sp.
 FAMILY: Trentepohliaceae
 20. *Gongrosira* sp.
 21. *Ctenocladus* sp.
 FAMILY: Coleochataceae
 22. *Coleochaete* sp.
 FAMILY: Chaetosphaeridiaceae
 23. *Chaetosphaeridium* sp.
 Order: OEDOGONIALES
 FAMILY: Oedogoniaceae

24. *Bulbochaete* sp.
 25. *Oedogonium* spp.
- Order: ZYGNEMATALES
- FAMILY: Mesotaeniaceae
 26. *Netrium* sp.
- FAMILY: Desmidiaceae
 27. *Closterium* spp.
 28. *Cosmarium* sp.
 29. *Docidium* sp.
 30. *Oocardium* sp.
 31. *Pleurotaenium* sp.
- FAMILY: Zygnemataaceae
 32. *Spirogyra* sp.
 33. *Zygnema* spp.
- Order: CHARALES
 34. *Chara* spp.
- Class: XANTHOPHYCEAE
- Order: HETEROTRICHALES
- FAMILY: Monociliaceae
 35. *Monocilia* sp.
- Class: CHRYSOPHYCEAE
- Order: CHRYSOMONADALES
- FAMILY: Synuraceae
 36. *Synura* spp.
- FAMILY: Chrysocapsineae
 37. *Celloniella* sp.
 38. *Hydrurus* sp.
- Order: CHRYSOTRICHALES
- FAMILY: Thallochrysidaceae
 39. *Phaeoplaca* sp.
- Class: BACILLARIOPHYCEAE
- Order: BACILLARIALES
- FAMILY: Coscinodiscaceae

40. *Melosira* sp.
41. *Stephanodiscus* sp.
- FAMILY: Biddulphiaceae
42. *Terpsinoe* sp.
- FAMILY: Fragilariaceae
43. *Diatoma* sp.
44. *Fragilaria* sp.
45. *Rhabdonema* sp.
46. *Synedra* sp.
47. *Tabellaria* spp.
- FAMILY: Achnanthaceae
48. *Achnanthes* sp.
- FAMILY: Naviculaceae
49. *Frustulia* sp.
50. *Navicula* sp.
51. *Pinnularia* sp.
52. *Pleurosigma* sp.
53. *Stauroneis* sp.
- FAMILY: Gomphonemaceae
54. *Gomphonema* spp.
- FAMILY: Cymbellaceae
55. *Amphora* sp.
56. *Cymbella* sp.
- FAMILY: Nitzschiaceae
57. *Nitzschia* sp.
- FAMILY: Surirellaceae
58. *Surirella* spp.
- Class: RHODOPHYCEAE
- Order: NEMALIONALES
59. *Batrachospermum* sp.
- Class: MYXOPHYCEAE
- Order: NOSTOCALES
- FAMILY: Nostocaceae

60. *Anabaena* sp.
 61. *Nostoc* sp.
 FAMILY: Oscillatoriaceae
 62. *Oscillatoria* sp.
 63. *Spirulina* sp.

Table 1. THE STRUCTURE OF PHYTOPLANKTON COMMUNITIES IN THE RIVER SYSTEM OF SIKKIM (the taxa ranked by numbers)

Sl. No.	PHYTOPLANKTON	TISTA Drainage	RANGIT Drainage	TOTAL Number	% BY Number	CUMULATIVE %
CHLOROPHYCEAE						
1	Binuclearia	799	408	1207	3.544	3.544
2	Bulbochaete	200	0	200	0.587	4.132
3	Chaetomorpha	114	248	362	1.063	5.195
4	Chaetosphaeridium	181	79	260	0.764	5.958
5	Chara	236	471	707	2.076	8.035
6	Chlorella	708	355	1063	3.122	11.156
7	Cladophora	2003	241	2244	6.590	17.746
8	Closterium	22	0	22	0.065	17.810
9	Coleochaete	4	0	4	0.012	17.822
10	Cosmarium	4	0	4	0.012	17.834
11	Ctenocladus	9	0	9	0.026	17.860
12	Dermatophyton	673	553	1226	3.600	21.461
13	Docidium	29	6	35	0.103	21.563
14	Geminella	1311	241	1552	4.558	26.121
15	Gongrosira	9	0	9	0.026	26.147
16	Hormidium	43	37	80	0.235	26.382
17	Hydrodictyon	5	0	5	0.015	26.397
18	Netrium	14	0	14	0.041	26.438
19	Oocardium	61	0	61	0.179	26.617
20	Oedogonium	484	435	919	2.699	29.316
21	Palmodictyon	78	0	78	0.229	29.545
22	Pearsoniella	1134	0	1134	3.330	32.875
23	Pediastrum	71	0	71	0.208	33.084

24	Pithophora	4	0	4	0.012	33.095
25	Pleurotaenium	143	28	171	0.502	33.598
26	Protoderma	7	0	7	0.021	33.618
27	Rhizoclonium	5	0	5	0.015	33.633
28	Sphaeroplea	764	452	1216	3.571	37.204
29	Spirogyra	1465	360	1825	5.359	42.563
30	Stigeoclonium	64	333	397	1.166	43.729
31	Tetraspora	9	0	9	0.026	43.755
32	Ulothrix	1369	667	2036	5.979	49.734
33	Uronema	16	7	23	0.068	49.802
34	Zygnema	108	71	179	0.526	50.327
XANTHOPHYCEAE						
35	Monocilia	79	0	79	0.232	50.559
CHRYSOPHYCEAE						
36	Celloniella	63	0	63	0.185	50.744
37	Hydrurus	0	12	12	0.035	50.780
38	Phaeoplaca	19	0	19	0.056	50.835
39	Synura	5	0	5	0.015	50.850
BACILLARIOPHYCEAE						
40	Achnanthes	57	41	98	0.288	51.138
41	Amphora	0	34	34	0.100	51.238
42	Cymbella	88	336	424	1.245	52.483
43	Diatoma	146	73	219	0.643	53.126
44	Fragilaria	155	0	155	0.455	53.581
45	Frustulia	335	116	451	1.324	54.906
46	Gomphonema	257	0	257	0.755	55.660
47	Melosira	1088	72	1160	3.406	59.067
48	Navicula	366	947	1313	3.856	62.923
49	Nitzschia	177	14	191	0.561	63.483
50	Pinnularia	842	456	1298	3.812	67.295
51	Pleurosigma	0	16	16	0.047	67.342
52	Rhabdonema	371	0	371	1.089	68.432
53	Stauroneis	56	185	241	0.708	69.139
54	Stephanodiscus	672	258	930	2.731	71.870

55	Surirella	0	658	658	1.932	73.803
56	Synedra	5	0	5	0.015	73.817
57	Tabellaria	1263	1473	2736	8.035	81.852
58	Terpsinoe	34	0	34	0.100	81.952
RHODOPHYCEAE						
59	Batrachospermum	44	0	44	0.129	82.081
MYXOPHYCEAE						
60	Anabaena	685	1589	2274	6.678	88.759
61	Nostoc	954	2044	2998	8.804	97.563
62	Oscillatoria	383	0	383	1.125	98.687
63	Spirulina	431	16	447	1.313	100.000
	Total	20721	13332	34053	100.000	

5.1.2 An account of the phytoplankton

Six classes of phytoplankton with the corresponding number of genera recorded in the two river systems during 1987 & 1988 are as follows: Chlorophyceae, 34 ; Xanthophyceae, 1; Chrysophyceae, 4; Bacillariophyceae, 19; Rhodophyceae, 1 and Myxophyceae, 4 (Table 1).

The phytoplankton density (ul^{-1}) of different classes alongwith the seasonal incidence of the two river systems recorded during 1987 & 1988 have been presented in Table 2 and Table 3 while the relative composition of phytoplankton groups are depicted in Figure 10 and Figure 12. A summary on their respective values are given below:

TISTA DRAINAGES

Altogether 59 genera under 6 classes have been observed in the Tista drainage during 1987 & 1988. Ten different rivers under Tista drainage in order of their phytoplankton density rank as follows: Ghattay khola > Bakcha chhu > Dik chhu > Jali khola > river Tista > Rin khola > Seti khola > Rani khola > Yumthang chhu > Rangpo khola. The river-wise results are purported hereunder.

River Tista

Chlorophyceae : 114 (S) - 532 (M); \bar{X} 292.33; A 418.

Chrysophyceae : 9 (S) - 15 (W); \bar{X} 12.83; A 6.

Bacillariophyceae: 58.5 (S) - 183.0 (W); \bar{X} 131.38 ; A 124.5 .

Myxophyceae : 25.0 (S) - 320.0 (M); \bar{X} 217.00 ; A 295 .

Yumthang chhu

- Chlorophyceae : 84 (S) - 448.0 (W); \bar{X} 248.88; A 364.
Chrysophyceae : 5.0 (W) - 19.0 (M); \bar{X} 12.0; A 14 .
Bacillariophyceae : 31.5 (S) - 111.0 (W); \bar{X} 75.72; A 79.5 .
Rhodophyceae : 44.0 (W).

Bakcha chhu

- Chlorophyceae : 215.0 (S) - 889.0 (W); \bar{X} 544.66; A 674 .
Xanthophyceae : 79.0 (S)
Bacillariophyceae : 9.0 (S) - 364.0 (M); \bar{X} 145.33; A 355 .
Myxophyceae : 76.0 (W) - 159.0 (S); \bar{X} 117.5; A 83 .

Seti khola

- Chlorophyceae : 87.0(S) - 345.0 (W); \bar{X} 209.33; A 258 .
Bacillariophyceae : 17.0 (M) - 353.0 (W); \bar{X} 134.00; A 336 .

Jali khola

- Chlorophyceae : 85.0 (W) - 671.0 (M) ; \bar{X} 375.66; A 586 .
Bacillariophyceae : 48.0 (S) - 267.0 (W) ; \bar{X} 141.66; A 219 .

Rani khola

- Chlorophyceae : 6.0 (S) - 449.0 (W); \bar{X} 236.66; A 443 .
Chrysophyceae : 5.0 (W)
Bacillariophyceae : 25.0 (M) - 117 (W); \bar{X} 71.0; A 92 .
Myxophyceae : 136.0 (W)

Rin khola

- Chlorophyceae : 392.0 (W) - 396.0 (M); \bar{X} 394.0; A 4 .
Bacillariophyceae : 18.0 (M) - 144.0 (W); \bar{X} 81.0; A 126 .
Myxophyceae : 121.0 (M) - 261.0 (W); \bar{X} 191.0; A 140 .

Dik chhu

- Chlorophyceae : 92.0 (S) - 670.0 (W); \bar{X} 410.33; A 578 .
Bacillariophyceae : 207.0 (W) - 251.0 (S); \bar{X} 224.66; A 44 .
Myxophyceae : 79.0 (W) - 284.0 (M); \bar{X} 181.5; A 205 .

Ghattay khola

- Chlorophyceae : 208.0 (S) - 359.0 (W); \bar{X} 305.66; A 151 .
Bacillariophyceae : 275.0 (W) - 842.0 (M); \bar{X} 511.66; A 567 .
Myxophyceae : 156.0 (M) - 352.0 (S); \bar{X} 228.66; A 196 .

Rangpo khola

Chlorophyceae : 55.0 (W) - 116.0 (M); \bar{X} 79.0; A 61 .

Bacillariophyceae : 17.0 (M) - 181.0 (S); \bar{X} 120.66; A 164 .

RANGIT DRAINAGES

The Rangit drainages in respect of their phytoplankton density (μl^{-1}) recorded during 1987 & 1988 have been found in the order of Kalej khola > Rangbhang khola > Rimbi khola > river Rangit > Roathak khola > Rishi khola. Phytoplankton composition and diversity in each river are recorded as follows:

River Rangit

Chlorophyceae : 90.0 (W) - 246.0 (S); \bar{X} 187.05; A 156 .

Chrysophyceae : 6.0 (S)

Bacillariophyceae : 77.5 (M) - 375.0 (S); \bar{X} 239.83; A 297.5 .

Myxophyceae : 171.5 (S) - 361.0 (M); \bar{X} 239.66; A 189.5 .

Rimbi khola

Chlorophyceae : 306.0 (S) - 539.0 (M); \bar{X} 454.66; A 233 .

Bacillariophyceae : 41.0 (S) - 224.0 (W); \bar{X} 124.0; A 183 .

Kalej khola

Chlorophyceae : 100.0 (W) - 480.0 (S); \bar{X} 331.66; A 380 .

Bacillariophyceae : 156.0 (W) - 267.0 (S); \bar{X} 216.66; A 111 .

Myxophyceae : 107.0 (W) - 127.0 (M); \bar{X} 117.0; A 20 .

Rishi khola

Chlorophyceae : 50.0 (W) - 237.0 (S); \bar{X} 116.66; A 187 .

Bacillariophyceae : 163.0 (S) - 215.0 (W); \bar{X} 188.0; A 52 .

Myxophyceae : 127.0 (W) - 155.0 (S); \bar{X} 141.0; A 28 .

Roathak khola

Chlorophyceae : 156.0 (S) - 322.0 (M); \bar{X} 239.0; A 166 .

Bacillariophyceae : 50.0 (W) - 134.0 (M); \bar{X} 88.33; A 84 .

Myxophyceae : 218.0 (W) - 386.0 (M); \bar{X} 305.66; A 168 .

Rangbhang khola

Chlorophyceae : 41.0 (M) - 182.0 (S); \bar{X} 115.66; A 141 .

Bacillariophyceae : 154.0 (W) - 308.0 (M); \bar{X} 249.0; A 154 .

Myxophyceae : 92.0 (M) - 551.0 (W); \bar{X} 259.33; A 459 .

Synura	Summer																						
	Monsoon																						
	Winter					5																	
BACILLARIOPHYCEAE																							
Achnanthes	Summer																						
	Monsoon							5														7	
	Winter						17	11												5			12
Cymbella	Summer																						
	Monsoon																					5	
	Winter																						12
Diatoma	Summer																						
	Monsoon																					6	
	Winter																					23	6
Fragilaria	Summer																						
	Monsoon																						
	Winter																					24	8
Frustulia	Summer																						
	Monsoon																						
	Winter																						
Gomphonema	Summer																						
	Monsoon																						
	Winter																						
Total																							
212																							
12																							

Melosira						4												320	
Summer																			
Monsoon								38		198							92	259	
Winter	12	89						69										7	
Navicula																			
Summer												7		13			31	18	18
Monsoon		5	21						7	13						9	8	7	0
Winter		19	54									17	30			41	7	17	17
Nitzschia																		35	
Summer																			
Monsoon		22						14									8	17	
Winter		7																74	
Pinnularia																			
Summer	12	15								9	19	7					6	4	12
Monsoon	25	220				15	61		9	9		5	16	10		22	75		
Winter	44	11	15		19	19			11	27	64				7	19	49	6	
Rhabdonema																			
Summer																			
Monsoon																		371	
Winter																			
Stauroneis																			
Summer																		17	
Monsoon		17							5	6									
Winter																			
Stephanodiscus																			
Summer	24																	19	
Monsoon	77								14	135		105					51		
Winter	42	17						39			25	63					47		

Geminella	Summer							
	Monsoon							
	Winter	12	0		205			
Hormidium	Summer							37
	Monsoon							
	Winter							
Oedogonium	Summer							145
	Monsoon		126			39	84	41
	Winter							
Pleurotaenium	Summer						7	
	Monsoon							
	Winter			21				
Sphaeroplea	Summer		55			27		
	Monsoon				215	51	104	
	Winter							
Spirogyra	Summer		49		175			95
	Monsoon							
	Winter				41			
Stigeoclonium	Summer		134			116		
	Monsoon							
	Winter						9	74
Ulothrix	Summer		149			104		
	Monsoon	121				209		
	Winter				84			
Uronema	Summer							
	Monsoon							
	Winter							7
Zygnema	Summer				71			
	Monsoon							
	Winter							
Germinating stage of Unicellular algae	Summer					14		14
	Monsoon		15					
	Winter					21		

Unidentified algae	Summer			14					
	Monsoon							14	
	Winter								
Unidentified palmelloid	Summer								17
	Monsoon								
	Winter								
Algal lumps in reproductive stage	Summer								
	Monsoon								
	Winter	*			*				
Systemic parts	Summer								
	Monsoon		*						
	Winter								
CHRYSOPHYCEAE									
Hydrurus	Summer			6					6
	Monsoon								
	Winter								
BACILLARIOPHYCEAE									
Achnanthes	Summer		5						
	Monsoon	14						4	7
	Winter			11					
Amphora	Summer								
	Monsoon								
	Winter	27			7				
Cymbella	Summer		24	9		39	15	9	8
	Monsoon	18				19		51	6
	Winter	10		74	10	11	6		27
Diatoma	Summer		7			14			
	Monsoon								17
	Winter		4			17	7	7	
Frustulia	Summer		14			12	12	12	7
	Monsoon				11	14	5		
	Winter		6		7		16		

Melosira	Summer								
	Monsoon								
	Winter			72					
Navicula	Summer	18	97	210		31	8	4	61
	Monsoon	11	16		7	44	17	27	46
	Winter		116	95	10	19	76	34	
Nitzschia	Summer								
	Monsoon								
	Winter					14			
Pinnularia	Summer	36	36	15		11	65		
	Monsoon						17	25	94
	Winter		7	42	64	24	6		14
Pleurosigma	Summer		11					5	
	Monsoon								
	Winter								
Stauroneis	Summer		7	65		21	7		7
	Monsoon							14	21
	Winter				6	21		9	7
Stephanodiscus	Summer	42		49		46			
	Monsoon					14			
	Winter	41			21		45		
Suriella	Summer	31	14	136		26	56	5	155
	Monsoon				8	14		13	45
	Winter			91	4	11	7		42
Tabellaria	Summer	227	23	49	41	67		46	47
	Monsoon	49	47		81	122	147		72
	Winter		205		95	39	52		64

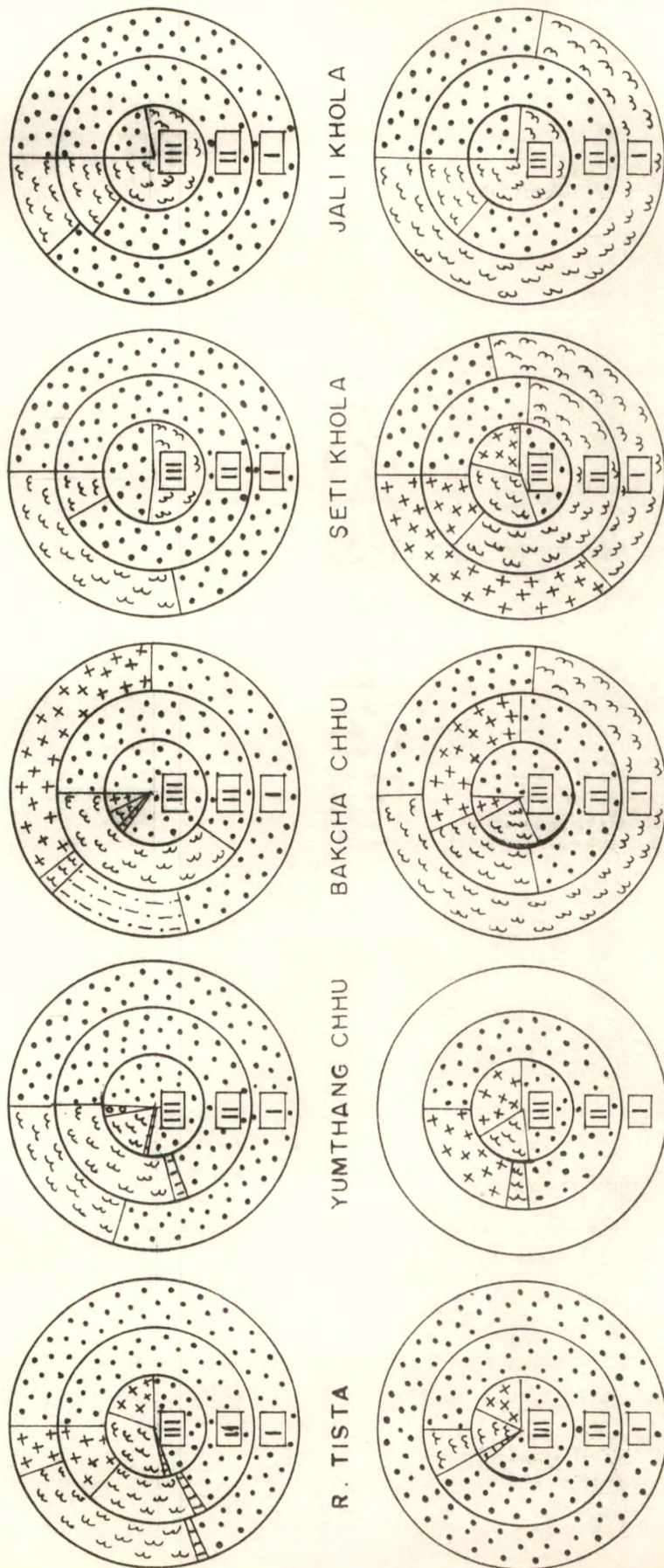
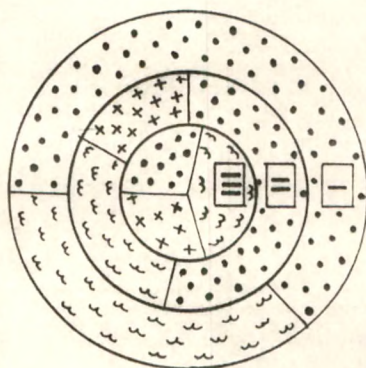


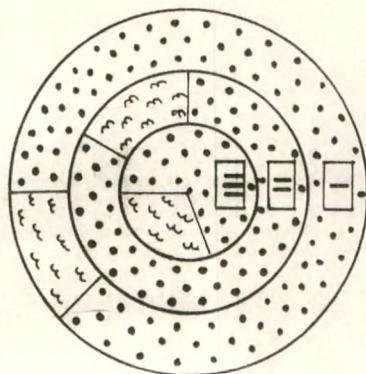
FIGURE. 10. SEASONAL SUCCESSION OF THE PHYTOPLANKTON GROUPS (EXPRESSED IN RELATIVE COMPOSITION) RECORDED IN TISTA DRAINAGES DURING 1987 AND 1988.

INDEX:- [●●●] CHLOROPHYCEAE; [---] XANTHOPHYCEAE; [---] CHRYSOPHYCEAE; [°°°] RHODOPHYCEAE; [wavy] BACILLARIOPHYCEAE; [+ +] MYXOPHYCEAE; [] NOT RECORDED.

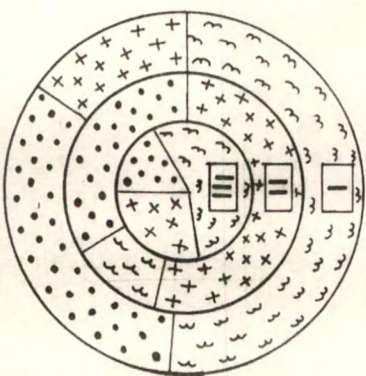
I, SUMMER; II, MONSOON; III, WINTER.



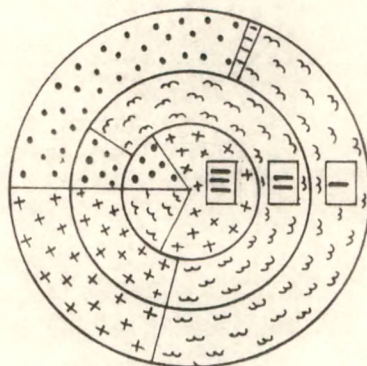
KALEJ KHOLA



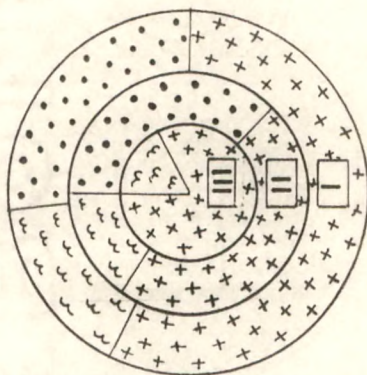
RIMBI KHOLA



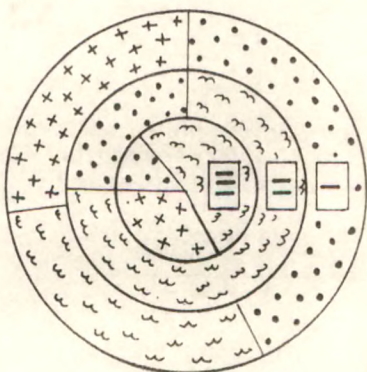
R. RANGIT.



RANGBANG KHOLA.



ROTHAK KHOLA



RISHI KHOLA

FIGURE.12. SEASONAL SUCCESSION OF THE PHYTOPLANKTON GROUPS (EXPRESSED IN RELATIVE COMPOSITION) RECORDED IN RANGIT DRAINAGES DURING 1987 AND 1988.

INDEX:- SAME AS FIGURE 10.

5.2 Zooplankton

Five classes of zooplankton encountered in the Tista and the Rangit river systems during 1987 & 1988 may be arranged in order of their dominance as Rotifer > Protozoa > Copepoda > Cladocera > Ostracoda. The total zooplankton density extrapolated from the two drainages during 1987 & 1988 is 1304 ul⁻¹. This accounts to only 3.42 % and 4.10 % of the total plankton density in the Tista and the Rangit drainages respectively.

5.2.1 Systematic list

Altogether 17 genera have been observed in the two drainages. Of these, Tista drainages have been recorded with 16 genera under 5 classes while Rangit with only 10 genera belonging to 4 classes (Table 4). The systematic list of the zooplankton covering both the drainages of Sikkim is presented below.

Indeed, a good many protozoa which appeared only in cystic form could not be identified even up to genera and are excluded from the present account.

Phylum:	PROTOZOA
Class:	LOBOSA
Order:	TESTACEALOBOSA
FAMILY:	Arcellidae
	1. <i>Arcella sp.</i>
FAMILY:	Diffugiidae
	2. <i>Diffugia spp.</i>
FAMILY:	Centropyxidae
	3. <i>Centropyxis sp.</i>
FAMILY:	Mayorellidae
	4. <i>Astramoeba sp.</i>
Phylum:	ROTIFERA
Class:	MONOGONONTA
Order:	PLOIMA
FAMILY:	Brachionidae
	5. <i>Brachionus spp.</i>
	6. <i>Keratella spp.</i>
	7. <i>Notholca spp.</i>
FAMILY:	Lecanidae

	8. <i>Lecane sp.</i>
	9. <i>Monostyla sp.</i>
FAMILY:	Trichocercidae
	10. <i>Trichocerca spp.</i>
FAMILY:	Asplanchnidae
	11. <i>Asplanchna spp.</i>
Phylum:	ARTHROPODA
Class:	CRUSTACEA
Order:	CLADOCERA
FAMILY:	Sididae
	12. <i>Diaphanosoma sp.</i>
FAMILY:	Chydoridae
	13. <i>Alona sp.</i>
Order:	OSTRACODA
FAMILY:	Cypridae
	14. <i>Stenocypris sp.</i>
Order:	COPEPODA
FAMILY:	Diaptomidae
	15. <i>Diaptomus sp.</i>
FAMILY:	Cyclopidae
	16. <i>Cyclop sp.</i>
	17. <i>Macrocylop sp.</i>

5.2.2 An account of the zooplankton

Five different classes of zooplankton represented by the corresponding number of genera observed in twin drainages of Sikkim during 1987 & 1988 are as follows: Protozoa, 4; Rotifera, 7; Copepoda, 3; Cladocera, 2; and Ostracoda, 1.

The zooplankton density (ul^{-1}) of different classes of the Tista and the Rangit river systems recorded at three seasons during 1987 & 1988 have been depicted in Table 5 and Table 6. The relative composition of different zooplankton groups are depicted in Figures 11 and 13.

TISTA DRAINAGE

Ten rivers under Tista drainages have been found in order of their zooplankton density (ul^{-1}) rank as Ghattay khola > Bakcha chhu > river Tista > Seti khola > Rin khola > Yumthang

chhu > Dik chhu > Jali khola & Rani khola > Rangpo khola.

Qualitative and quantitative compositions of the zooplankton groups recorded in the different rivers under Tista drainage are presented hereunder.

River Tista

Protozoa : 4.5 (S) - 12.0 (W); \bar{X} 8.66; A 7.5 .

Rotifera : 5.5 (W) - 13.5 (M); \bar{X} 9.77; A 8 .

Copepoda : 5.0 (W)

Cladocera : 7.0 (M)

Ostracoda : 45.0 (M)

Yumthang chhu

Protozoa : 11.5 (W)

Rotifera : 7.0 (S) - 11.0 (W); \bar{X} 9.0; A 4 .

Ostracoda : 12.0 (W) - 45.0 (M); \bar{X} 28.5; A 33 .

Bakcha chhu

Protozoa : 5.0 (W) - 59.0 (M); \bar{X} 32.0; A 54 .

Rotifera : 5.0 (M) - 22.0 (W); \bar{X} 13.5; A 17 .

Ostracoda : 5.0 (S & W) - 11.0 (M); \bar{X} 7.0; A 6 .

Seti khola

Protozoa : 5.0 (W) - 12.0 (S); \bar{X} 9.0; A 7 .

Rotifera : 5.0 (W) - 7.0 (M); \bar{X} 6.0; A 2 .

Copepoda : 5.0 (M)

Ostracoda : 6.0 (M)

Jali khola

Ostracoda : 24.0 (S)

Rani khola

Protozoa : 5.0 (W, M); \bar{X} 5.0;

Rotifera : 5.0 (W);

Copepoda : 4.0 (W);

Ostracoda : 5.0 (S).

Rin khola

Protozoa : 7.0 (W) - 8 (M); \bar{X} 7.5; A 1 .

Rotifera : 21.0 (W)

Copepoda : 5.0 (W)

Dik chhu

<u>Protozoa</u> :	5.0 (S)
<u>Rotifera</u> :	14.0 (W)
<u>Copepoda</u> :	5.0 (M)
<u>Cladocera</u> :	7.0 (M)
<u>Ostracoda</u> :	7.0 (S)

Ghattay khola

<u>Protozoa</u> :	30.0 (S) - 38.0 (M); \bar{X} 34.0; Δ 8.0
<u>Rotifera</u> :	35.0 (W)
<u>Cladocera</u> :	5.0 (W)
<u>Ostracoda</u> :	15.0 (S).

Rangpo khola

<u>Rotifera</u> :	6.0 (S)
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RANGIT DRAINAGES

Six rivers studied under Rangit drainages during present investigation have been arranged in order of their zooplankton density (ul^{-1}) as Rimbi khola > river Rangit > Rangbhang khola > Rishi khola > Kalej khola > Roathak khola. Zooplankton composition of these rivers are recorded as follows:

River Rangit

<u>Protozoa</u> :	17.5 (M) - 22.0 (S); \bar{X} 19.75; Δ 4.5 .
<u>Rotifera</u> :	48.0 (S)
<u>Ostracoda</u> :	8.0 (S)

Rimbi khola

<u>Protozoa</u> :	33.0 (W) - 150 (M); \bar{X} 91.5; Δ 117.0
<u>Rotifera</u> :	8.0 (W)

Kalej khola

<u>Protozoa</u> :	16.0 (S)
<u>Rotifera</u> :	8.0 (W)
<u>Ostracoda</u> :	14.0 (S)

Rishi khola

Protozoa : 5.0 (S)

Rotifera : 8.0 (M) - 12.0 (W); \bar{X} 10.0; \underline{A} 4.0

Cladocera : 7.0 (S).

Roathak khola

Protozoa : 6.0 (S)

Rotifera : 5.0 (S) - 11.0 (M); \bar{X} 8.0; \underline{A} 6.0

Ostracoda : 12.0 (S).

Rangbhang khola

Protozoa : 5.0 (W)

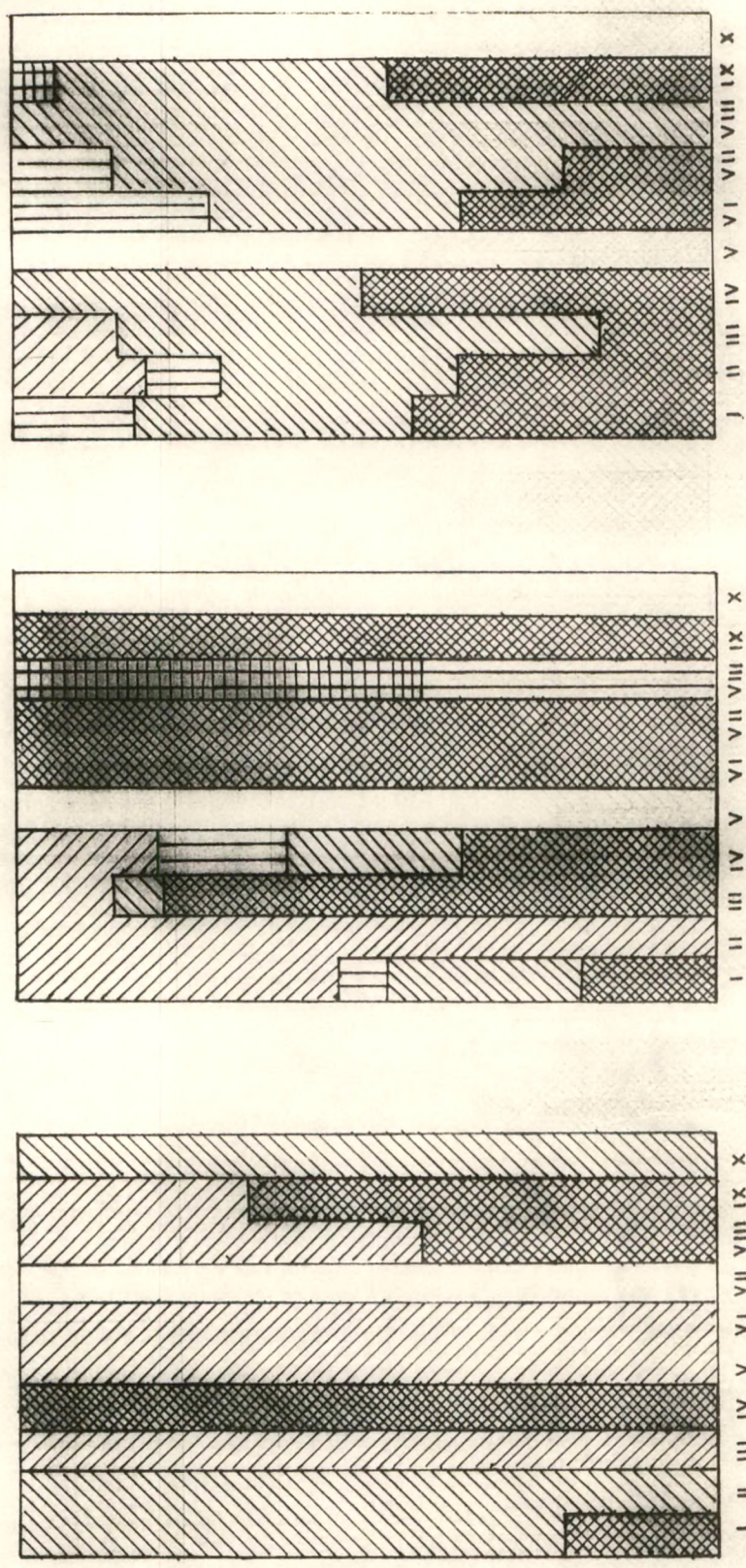
Rotifera : 21.0 (W) - 31.0 (S); \bar{X} 26.0; \underline{A} 10.

Table 4. THE STRUCTURE OF ZOOPLANKTON COMMUNITIES IN THE RIVER SYSTEM OF SIKKIM (the taxa are ranked by numbers).

Sl. No.	ZOOPLANKTON	TISTA Drainage	RANGIT Drainage	TOTAL Number	% BY Number	CUMULATIVE %
PROTOZOA						
1	Arcella	63	32	95	7.285	7.285
2	Astramoeba	101	46	147	11.273	18.558
3	Centropyxis	109	189	298	22.853	41.411
4	Diffugia	13	5	18	1.380	42.791
ROTIFERA						
5	Asplanchna	70	158	228	17.485	60.276
6	Brachionus	53	62	115	8.819	69.095
7	Keratella	9	0	9	0.690	69.785
8	Lecane	8	0	8	0.613	70.399
9	Monostyla	6	19	25	1.917	72.316
10	Notholca	72	0	72	5.521	77.837
11	Trichocerca	0	10	10	0.767	78.604
COPEPODA						
12	Cyclop	5	0	5	0.383	78.988
13	Diaptomus	5	0	5	0.383	79.371
14	Macrocylop	21	0	21	1.610	80.982
CLADOCERA						
15	Alona	12	7	19	1.457	82.439
16	Diaphanosoma	7	0	7	0.537	82.975
OSTRACODA						
17	Stenocypris	180	42	222	17.025	100.000
	Total	734	570	1304	100.000	

Table 6. SEASONAL INCIDENCE OF THE ZOOPLANKTON DENSITY (μl^{-1}) AND GENERIC COMPOSITION RECORDED AT DIFFERENT SURVEY STATIONS OF THE RANGIT DRAINAGE DURING 1987 AND 1988 (Abbr. I, Rangit at Lower Tashiding; II, Rangit at Sikhip; III, Rangit at Nayabazar; IV, Rimbi khola at Rimbi; V, Kalej khola at Legship; VI, Rishi khola at Rishi; VII, Roathak khola at Rothak & VIII, Rangbhang khola at Nayabazar).

ZOOPLANKTON	SEASON	DIFFERENT RIVERS AT VARIOUS SURVEY STATIONS OF THE RANGIT DRAINAGE							
		I	II	III	IV	V	VI	VII	VIII
PROTOZOA									
Arcella	Summer	14					5		
	Monsoon				13				
	Winter								
Astramoeba	Summer								
	Monsoon	14	21						
	Winter				11				
Centropyxis	Summer	8				16		6	
	Monsoon				137				
	Winter				22				
Diffugia	Summer								
	Monsoon								
	Winter								5
Protozoan cyst	Summer	29				34			
	Monsoon				12				
	Winter	129			56				
ROTIFER									
Asplanchna	Summer			99					31
	Monsoon								
	Winter						7		21
Brachionus	Summer	29	17						
	Monsoon						8		
	Winter				8				
Monostyla	Summer								
	Monsoon							11	
	Winter					8			

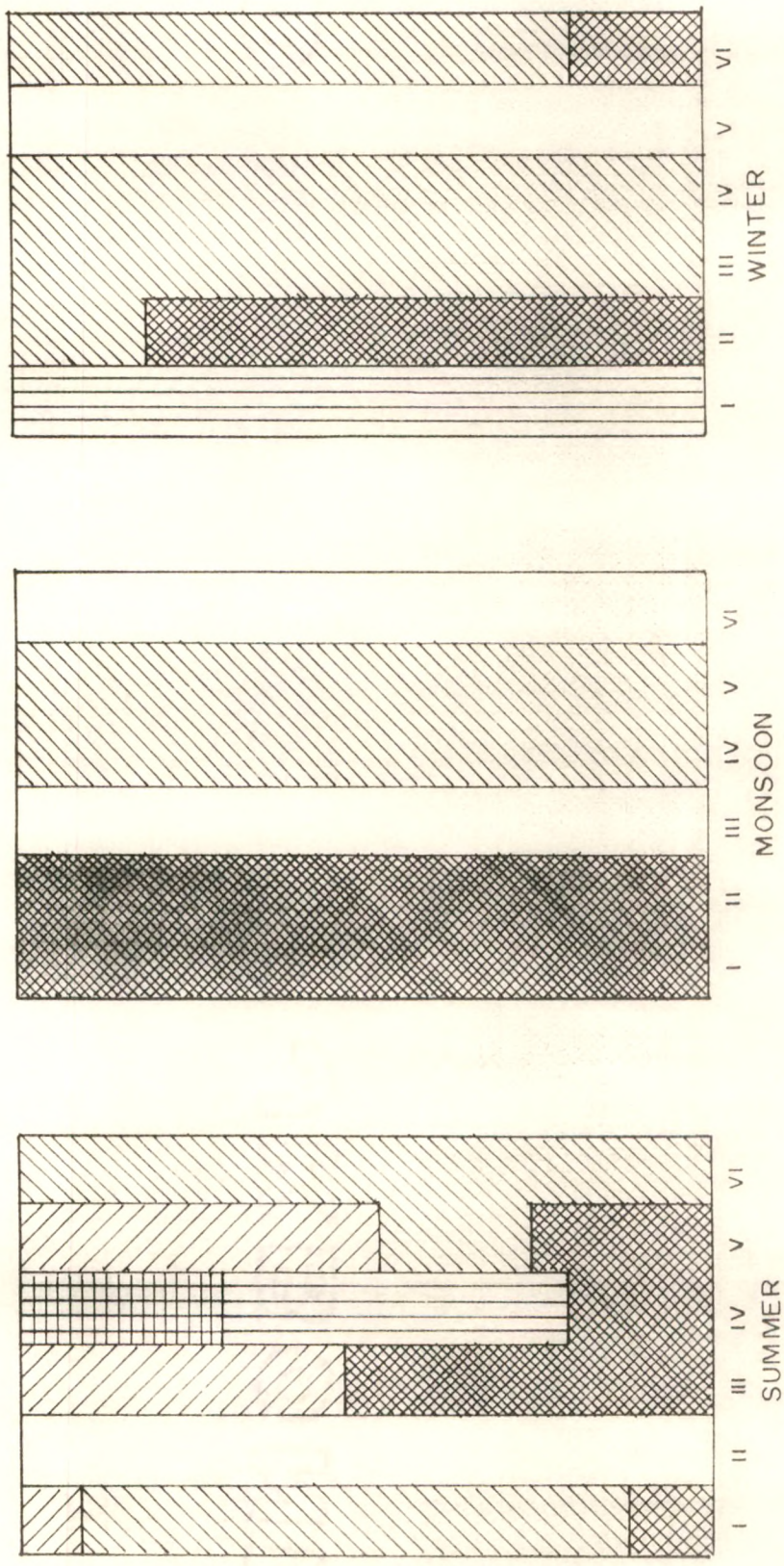


SCALE :- 20%

FIGURE. II. SEASONAL SUCCESSION OF THE ZOOPLANKTON GROUPS (EXPRESSED IN RELATIVE COMPOSITION) RECORDED IN TISTA DRAINAGES DURING 1987 AND 1988.

INDEX :- [diagonal lines], PROTOZOA; [grid pattern], CLADOCERA; [vertical lines], COPEPODA; [cross-hatch], ROTIFERA; [horizontal lines], OSTRACODA; [white box], NOT RECORDED.

I, R. TISTA; II, YUMTHANG CHHU; III, BAKCHA CHHU; IV, SETI KHOLA; V, JALI KHOLA; VI, RANI KHOLA; VII, RIN KHOLA; VIII, DIK CHHU; IX, GHATTAY KHOLA; X, RANGPO KHOLA.



SCALE :- 20%

FIGURE.13. SEASONAL SUCCESSION OF THE ZOOPLANKTON GROUPS (EXPRESSED IN RELATIVE COMPOSITION) RECORDED IN RANGIT DRAINAGES DURING 1987 AND 1988.

INDEX :- SAME AS FIGURE II.
 I, R. RANGIT; II, RIMBI KHOLA; III, KALEJ KHOLA; IV, RISHI KHOLA; V, ROTHAK KHOLA; VI, RANGBANG KHOLA.

CHAPTER SIX

FISH FAUNA PROFILE OF SIKKIM



CHAPTER SIX

FISH FAUNA PROFILE OF SIKKIM

6.1 Systematic List

In the present investigation forty-eight (48) species belonging to 9 families under 23 genera have been reported. The collection comprises of four new species and two new sub-species. The classification is mostly followed after Greenwood *et al* (1966) and Rosen and Patterson (1969). The genera under each family have been arranged in accordance to their phylogenetic and/or intergeneric affinities while the species under a genus have been presented in alphabetic sequences.

- Class: PISCES
- Subclass: TELEOSTOMI
- Super-order: ELOMORPHA
- Order: ANGUILLIFORMES
- FAMILY: Anguillidae
- Genus: *Anguilla* Shaw, 1803
1. *A. bengalensis* (Gray), 1831
- Super-order: PROCANTHOPTERYGII
- Order: SALMONIFORMES
- FAMILY: Salmonidae
- Genus: *Salmo* Linnaeus, 1758
2. *S. trutta fario* Linnaeus, 1758
- Super-order: OSTARIOPHYSI
- Order: CYPRINIFORMES
- FAMILY: Cyprinidae
- SUB-FAMILY: Schizothoracinae
- Genus: *Schizopyge* Heckel, 1843
3. *S. progastus* (McClelland), 1839
- Genus: *Schizothorax* Heckel, 1838
4. *S. richardsonii* (Gray), 1831
- SUB-FAMILY: Rasborineae
- Genus: *Danio* Hamilton, 1822
5. *D. aequipinnatus* (McClelland), 1839

6. *D. naganensis* Chaudhuri, 1913

Genus: *Barilius* Hamilton, 1822

7. *B. bendelisis bendelisis* (Hamilton), 1807

8. *B. bendelisis chedra* (Hamilton), 1822

9. *B. vagra* (Hamilton), 1822

Genus: *Semiplotus* Bleeker, 1869

10. *S. semiplotus* (McClelland), 1839

Genus: *Labeo* Cuvier, 1817

11. *L. dero* (Hamilton), 1822

12. *L. pangusia* (Hamilton), 1822

Genus: *Acrossocheilus* Oshima, 1919

13. *A. hexagonolepis* (McClelland), 1839

Genus: *Tor* Gray, 1833

14. *T. putitora* (Hamilton), 1822

SUB-FAMILY: Garrinae

Genus: *Crossocheilus* Van Hasselt, 1823

15. *C. latius latius* (Hamilton), 1822

Genus: *Garra* Hamilton, 1822

16. *G. annandalei* Hora, 1921

17. *G. goryla goryla* (Gray), 1832

18. *G. goryla stenorhynchus* (Jerdon), 1849

19. *G. lamta* (Hamilton), 1822

20. *G. mcClellandi* (Jerdon), 1849

21. *G. mullya* (Sykes), 1841

FAMILY: Homalopteridae

Genus: *Balitora* Gray, 1833

22. *B. brucei* Gray, 1832

FAMILY: Cobitidae

SUB-FAMILY: Noemacheilinae

Genus: *Noemacheilus* Van Hasselt, 1823

23. *N. beavani* Gunther, 1869

24. *N. carletoni* Fowler, 1924

25. *N. corica* (Hamilton), 1822

26. *N. devdevi* Hora, 1935
 27. *N. kangjupkhulensis* Hora, 1921
 28. *N. multifasciatus* Day, 1878
 29. *N. scaturigina* (McClelland), 1839
 30. *N. sikmaiensis* Hora, 1921
 31. *N. spilopterus* (Cuvier & Valenciennes), 1828

SUB-FAMILY: Cobitinae

Genus: *Acanthophthalmus* Van Hasselt, 1823

32. *A. pangia* (Hamilton), 1822

Order: SILURIFORMES

FAMILY: Schilbeidae

SUB-FAMILY: Schilbeinae

Genus: *Clupisoma* Swainson, 1839

33. *C. bhandarii* sp. nov.

FAMILY: Pangasiidae

Genus: *Pangasius* Valenciennes, 1840

34. *P. pangasius* (Hamilton), 1822

FAMILY: Sisoridae

Genus: *Bagarius* Bleeker, 1853

35. *B. bagarius* (Hamilton), 1822

Genus: *Laguvia* Hora, 1921

36. *L. ribeiroi ribeiroi* Hora, 1921
 37. *L. ribeiroi jorethangensis* sub. sp. nov.

Genus: *Glyptothorax* Blyth, 1860

38. *G. basnetti* sp. nov.
 39. *G. bhutiai* sp. nov.
 40. *G. conirostrae* (Steindachner), 1867
 41. *G. deyi* sp. nov.
 42. *G. gracilis* (Gunther), 1861
 43. *G. sinense manipurensis* Menon, 1954
 44. *G. sinense sikkimensis* sub. sp. nov.
 45. *G. trilineatus* Blyth, 1860

Genus: *Euchiloglanis* Regan, 1907

46. *E. hodgarti* (Hora), 1923
 Genus: *Pseudecheneis* Blyth, 1860
 47. *P. sulcatus* (McClelland), 1842
 Super-order: ACANTHOPTERYGII
 Order: CHANNIFORMES
 FAMILY: Channidae
 Genus: *Channa* Scopoli, 1777
 48. *C. orientalis* Schneider, 1801

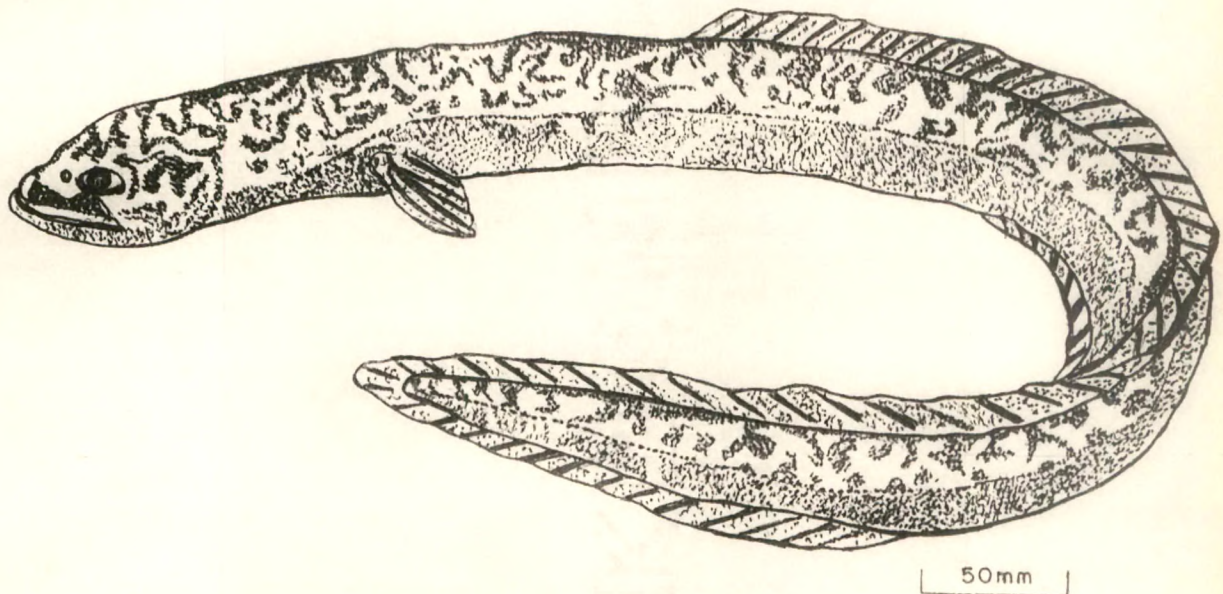
6.2 Taxonomic Account

Forty-eight (48) good species of fish recorded in the Tista and the Rangit river systems of Sikkim have been described hereunder supported with text figures and actual photographs. For the purpose of removing complexity usually encountered in a systematic study characters in the form of relative morphometrics notably, standard length, head length, head breadth, head depth, gape of mouth, eye diameter, inter orbital distance, post orbital distance, inter nasal distance, snout length, maxillary barbel length, outer mandibular barbel length, inner mandibular barbel length, nasal barbel length, rostral barbel length, body depth, body width, length of the sucker, breadth of sucker, dorsal height, dorsal base, anal height, anal base, pectoral length, pelvic length, length of caudal fin, length of upper caudal lobe, length of lower caudal lobe, length of caudal peduncle, highest depth of caudal peduncle, least depth of caudal peduncle, pre-dorsal distance, pre-pectoral distance, pre-pelvic distance, preanal distance, distance between origin of pectoral and origin of pelvic, distance between origin of pelvic and origin of anal, distance between origin of pelvic and anus, and distance between anus and origin of anal fin, important body characters and colouration are incorporated in the present communication. All measurements given in ranges with mean in parenthesis under the morphometric characters are expressed in relation to total length and in table, measurements of only five specimens from the population have been presented wherever applicable.

Synonyms of the fish are well known and therefore, have been excluded from the present account. However, the original reference with the type locality are cited in each species. While local name of each species is given wherever available, identifying characters from allied species along with occurrence trend and character differences from previous descriptions, if any, have been cited in the column Remarks. Previous record, wherever omitted from the individual account denotes that the species forms a new record from Sikkim. The river followed by the survey station (SS) and/or fish capturing centre (FCC) in both Rangit and Tista drainages as applicable where a species was collected has been purported under Present Record.

1. *Anguilla bengalensis* (Gray), 1831

(Plate XVIII-1)

Text Figure 1. *Anguilla bengalensis* (Gray)

1831. *Muraena bengalensis* Gray, Illust. Indian Zool: pl. 95, fig. 5

(Type locality, the Ganges).

Previous records from Sikkim: R. Rangit (Bhutia & Acharya, 1987).

Present records: RANGIT DRAINAGE: R. Rangit, FCC Tatopani 760 - 980 mm (2 exs.); SS Sikihip 410 mm (1 ex.); SS Nayabazar 521 mm (1 ex.); local name: *Balm*.

Meristic Counts: D. 250 - 305; P. 18; A. 220 - 250; C. 10 -12.

Morphometric Characters:

Standard length 1.01 - 1.02 (1.019), head length 9.86 - 10.53 (10.19), head breadth 15.07 - 15.83 (15.45), head depth 17.27 - 18.14 (17.70), gape of mouth 17.81 - 19.48 (18.61), eye diameter 75.98 - 98.04 (85.61), inter orbital distance 33.79 - 36.19 (34.95), post orbital distance 22.79 - 23.03 (22.91), inter nasal distance 54.28 - 54.43 (54.37), snout length 28.82 - 29.23 (29.02), body depth 13.61 -15.83 (14.63), body width 15.55 - 17.27 (16.37), dorsal height 58.44 - 75.60 (65.83), pectoral length 21.30 - 23.74 (22.46), pre-dorsal distance 3.30 - 3.37 (3.34), pre-pectoral distance 7.23 - 7.71 (7.47), pre-pelvic distance 2.30 - 2.41 (2.35), distance between anus and origin of anal fin 65.31 - 108.57 (81.56).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of

morphometric characters of the species is purported in the following table.

Table 7. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *A. bengalensis* (Gray); 1834.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	98.095	98.026	98.163	0.068
Head length	9.811	9.490	10.132	0.321
Head breadth	6.474	6.316	6.633	0.158
Head depth	5.650	5.510	5.789	0.140
Gape of mouth	5.372	5.132	5.612	0.240
Eye diameter	1.168	1.020	1.316	0.148
Inter orbital distance	2.861	2.763	2.959	0.098
Post orbital distance	4.365	4.342	4.388	0.023
Inter nasal distance	1.839	1.837	1.842	0.003
Snout length	3.445	3.421	3.469	0.024
Body depth	6.831	6.316	7.347	0.516
Body width	6.109	5.789	6.429	0.320
Dorsal height	1.519	1.327	1.711	0.192
Pectoral length	4.452	4.211	4.694	0.242
Pre dorsal distance	29.927	29.592	30.263	0.336
Pre pectoral distance	13.387	12.959	13.816	0.428
Pre anal distance	42.476	41.531	43.421	0.945
Distance between anus and origin of anal fin	1.226	0.921	1.531	0.305

Other Characteristics:

Body: Elongated, cylindrical with rounded abdominal edge.

Head: Long, compressed, snout pointed.

Eyes: Moderate, eye diameter 7.7 to 9.3 in head length, superior, located in the anterior half of head, not visible from below ventral surface.

Mouth: Terminal, cleft of mouth 1.81 - 1.85 in length of head. Lips are thick and well developed with equal jaws.

Teeth: Villiform teeth on jaws and palate.

Fins: Dorsal fin long, without spine, inserted nearer tip of snout than caudal base. Pectoral fin 2.16 - 2.25 in length of head. Anal fin equally long as dorsal, continuous with the caudal. Caudal fin continued round the end of tail.

Scales: Rudimentary, imbedded in the skin.

Lateral Line: Not very distinct, complete.

Colour: Brownish superiorly, becoming yellowish on the sides and beneath; the upper surface of the body covered with black spots and blotches. Anal fin with a dark marginal band and a light outer edging.

Distribution: India: Throughout India. Elsewhere: Pakistan, Bangladesh, Sri Lanka, Burma, Malaya Archipelago, Formosa and Pacific.

Remarks: This rare catadromous species is confined to lower elevations (up to 500 msl) of river Rangit. It becomes available mostly during monsoon and post monsoon seasons. The fish is of commercial importance and is considered to have special nutritional value.

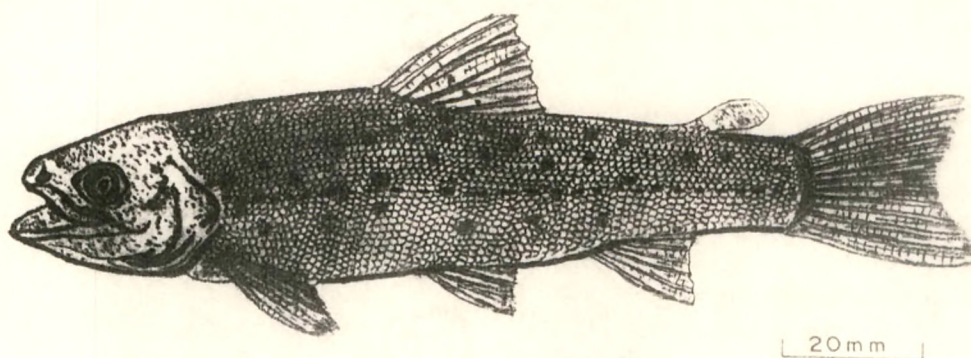
Table 8. Measurements (in mm) of *Anguilla bengalensis* (Gray), 1831.

CHARACTERS	NUMBER OF SPECIMENS		RANGE		MEAN
	I	II	Min.	Max.	
Total length	980.0	760.0	760.0	980.0	870.000
Standard length	962.0	745.0	745.0	962.0	853.500
Head length	93.0	77.0	77.0	93.0	85.000
Head breadth	65.0	48.0	48.0	65.0	56.500
Head depth	54.0	44.0	44.0	54.0	49.000
Gape of mouth	55.0	39.0	39.0	55.0	47.000
Eye diameter	10.0	10.0	10.0	10.0	10.000
Inter orbital distance	29.0	21.0	21.0	29.0	25.000
Post orbital distance	43.0	33.0	33.0	43.0	38.000
Inter nasal distance	18.0	14.0	14.0	18.0	16.000
Snout length	34.0	26.0	26.0	34.0	30.000
Body depth	72.0	48.0	48.0	72.0	60.000
Body width	63.0	44.0	44.0	63.0	53.500
Dorsal height	13.0	13.0	13.0	13.0	13.000
Pectoral length	46.0	32.0	32.0	46.0	39.000

Pre dorsal distance	290.0	230.0	230.0	290.0	260.000
Pre pectoral distance	127.0	105.0	105.0	127.0	116.000
Pre anal distance	407.0	330.0	330.0	407.0	368.500
Distance between anus and origin of anal fin	15.0	7.0	7.0	15.0	11.000

2. *Salmo trutta fario* Linnaeus, 1758

(Plate No XIV - 2)



Text Figure 2. *Salmo trutta fario* Linnaeus

1758. *Salmo trutta fario* Linnaeus, Systema, Naturae, 10 ed.

(Type locality: Europe).

Present records: TISTA DRAINAGE: Yumthang chhu, SS Yumthang 193 mm (1 ex.); FCC Phuni 130 - 311 mm (13 exs.); SS Chungthang 125 - 470 mm (6 exs.).

Meristic Counts: D. i 10 -11; P. ii 10 - 12; V. i. 8; A. ii. 8; C. 19.

Lateral line scales 115, scales from lateral line to base of dorsal 22, scales from lateral line to base of pelvic 26, pre dorsal scales 51, circumpeduncular scales 48.

Morphometric Characters:

Standard length 1.08 - 1.11 (1.096), head length 4.21 - 5.09 (4.686), head breadth 7.29 - 8.03 (7.744), head depth 6.27 - 7.50 (6.892), gape of mouth 9.31 - 12.61 (10.607), eye diameter 22.5 - 28.92 (24.838), inter orbital distance 12.85 -14.06 (13.388), post orbital distance 7.61 - 8.70 (8.311), inter nasal distance 20.00 - 23.04 (21.177), snout length 13.33 - 16.19 (14.988), body depth 4.21 - 4.90 (4.453), body width 6.0 - 6.97 (6.546), dorsal height 6.4 - 7.36 (6.881), dorsal base 6.95 - 7.78 (7.371), anal height 6.4 - 7.79 (7.349), anal base 8.88 -10.12 (9.549), pectoral

length 6.15 - 7.94 (7.276), pelvic length 7.44 - 10.38 (9.010), length of caudal fin 8.0 - 9.41 (8.433), length of caudal peduncle 6.30 - 6.61 (6.456), highest depth of caudal peduncle 7.61 - 8.61 (8.135), least depth of caudal peduncle 8.88 - 10.65 (9.713), pre-dorsal distance 2.22 - 2.85 (2.446), pre pectoral distance 4.32 - 5.06 (4.822), pre-pelvic distance 1.95 - 2.16 (2.061), preanal distance 1.44 - 1.49 (1.464), distance between origin of pectoral and origin of pelvic 3.29 - 3.6 (3.425), distance between origin of pelvic and origin of anal 4.5 - 5.33 (4.898), distance between origin of pelvic and anus 5.0 - 5.71 (5.395).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 9. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *S. trutta fario* Linnaeus, 1758.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	91.170	90.000	92.444	0.835
Head length	21.336	19.623	23.750	1.351
Head breadth	12.913	12.444	13.704	0.471
Head depth	14.509	13.333	15.926	1.066
Gape of mouth	9.427	7.925	10.741	0.939
Eye diameter	4.026	3.457	4.444	0.385
Inter orbital distance	7.469	7.111	7.778	0.216
Post orbital distance	12.031	11.481	13.125	0.573
Inter nasal distance	4.722	4.340	5.000	0.274
Snout length	6.672	6.173	7.500	0.552
Body depth	22.455	20.377	23.750	1.238
Body width	15.275	14.340	16.667	0.797
Dorsal height	14.531	13.580	15.625	0.658
Dorsal base	13.566	12.840	14.375	0.570
Anal height	13.607	12.830	15.625	1.069
Anal base	10.472	9.877	11.250	0.496
Pectoral length	13.743	12.593	16.250	1.283
Pelvic length	11.098	9.630	13.438	1.279
Length of caudal fin	11.858	10.617	13.208	0.931

Length of caudal peduncle	15.490	15.111	15.849	0.256
Highest depth of caudal peduncle	12.293	11.605	13.125	0.571
Least depth of caudal peduncle	10.295	9.383	11.250	0.751
Pre dorsal distance	40.878	35.000	44.938	3.288
Pre pectoral distance	20.739	19.753	23.125	1.219
Pre pelvic distance	48.526	46.296	51.250	1.926
Pre anal distance	68.295	66.792	69.375	0.892
Distance between origin of pectoral & origin of pelvic	29.196	27.778	30.370	0.898
Distance between origin of pelvic & origin of anal	20.418	18.750	22.222	1.124
Distance between origin of pelvic & anus	18.534	17.500	20.000	0.886

Other Characteristics:

Body: Moderately elongated, dorsal profile slightly more convex than ventral, abdominal edge rounded.

Head: Moderate in size, snout obtusely pointed.

Eyes: Large, diameter 5.3 - 5.6 in length of head; located in the anterior half of head, not visible from below ventral surface.

Mouth: Terminal, moderate, width of gape of mouth 2.2 - 2.4 in length of head. Upper jaw overhanging the mouth at the angle. Lips thin and upper lip continuous with the lower.

Teeth: Conical teeth present on jaws, palate and tongue.

Barbel: Absent

Scales: Minute, cycloid uniform scales present on the body.

Lateral Line: Present, straight & complete.

Fins: Dorsal inserted nearer snout than base of caudal. Adipose dorsal small, fleshy smooth and posteriorly free inserted above mid anal. Pectoral does not reach pelvic. Pelvic with scaly appendage at its axil far from reaching anal base. Anal almost as high as rayed dorsal base. Caudal fin forked.

Colour: Body brownish. Numerous many-coloured spots on the body above & below lateral line.

Distribution: Introduced into India, Pakistan, Bangladesh. Also in South Africa, Australia, North America. Naturally found in Eurasia.

Remarks: This is an exotic cold water fish introduced into Sikkim by Chhogyal, ex-monarch of Sikkim during early 1950. At present, the State Fisheries has a well established hatchery unit at

Menmoi chho producing about 200,000 seeds a year.

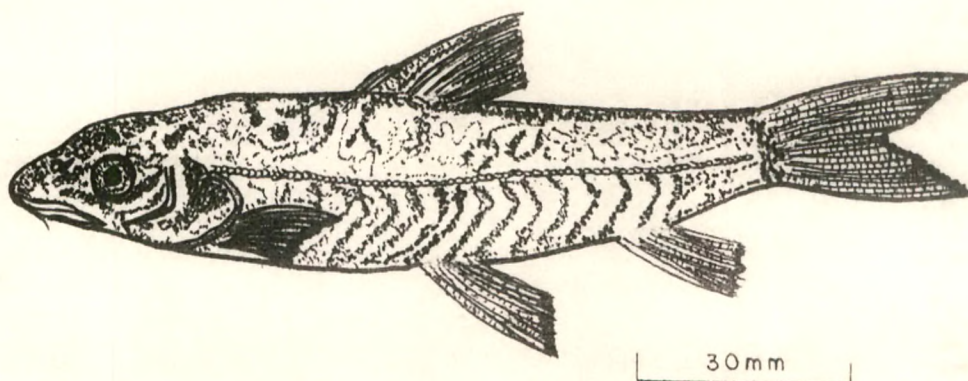
Table 10. Measurements (in mm) of *Salmo trutta fario* Linnaeus, 1758.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	405.0	270.0	265.0	225.0	160.0	160.0	405.0	265.00
Standard length	370.0	247.0	240.0	208.0	144.0	144.0	370.0	241.80
Head length	86.0	56.0	52.0	48.0	38.0	38.0	86.0	56.00
Head breadth	52.0	37.0	33.0	28.0	21.0	21.0	52.0	34.20
Head depth	57.0	43.0	36.0	30.0	25.0	25.0	57.0	38.20
Gape of mouth	37.0	29.0	21.0	21.0	16.0	16.0	37.0	24.80
Eye diameter	14.0	10.0	11.0	10.0	7.0	7.0	14.0	10.40
Inter orbital distance	30.0	21.0	20.0	16.0	12.0	12.0	30.0	19.80
Post orbital distance	48.0	31.0	31.0	27.0	21.0	21.0	48.0	31.60
Inter nasal distance	20.0	12.0	11.5	11.0	8.0	8.0	20.0	12.50
Snout length	25.0	17.0	19.0	14.0	12.0	12.0	25.0	17.40
Body depth	96.0	60.0	54.0	50.0	38.0	38.0	96.0	59.60
Body width	60.0	45.0	38.0	35.0	24.0	24.0	60.0	40.40
Dorsal height	55.0	39.0	38.0	33.0	25.0	25.0	55.0	38.00
Dorsal base	52.0	38.0	35.0	30.0	23.0	23.0	52.0	35.60
Anal height	52.0	35.0	34.0	31.0	25.0	25.0	52.0	35.40
Anal base	40.0	27.0	28.0	24.0	18.0	18.0	40.0	27.40
Pectoral length	54.0	34.0	35.0	30.0	26.0	26.0	54.0	35.80
Pelvic length	42.0	26.0	29.0	25.0	21.5	21.5	42.0	28.70
Length of caudal fin	43.0	32.0	35.0	25.0	20.0	20.0	43.0	31.00
Length of caudal peduncle	62.0	42.0	42.0	34.0	25.0	25.0	62.0	41.00
Highest depth of caudal peduncle	47.0	34.0	31.0	28.0	21.0	21.0	47.0	32.20
Least depth of caudal peduncle	38.0	29.0	25.0	24.0	18.0	18.0	38.0	26.80
Pre dorsal distance	182.0	113.0	107.0	95.0	56.0	56.0	182.0	110.60
Pre pectoral distance	80.0	55.0	53.0	46.0	37.0	37.0	80.0	54.20
Pre pelvic distance	198.0	125.0	123.0	112.0	82.0	82.0	198.0	128.00
Pre anal distance	275.0	185.0	177.0	155.0	111.0	111.0	275.0	180.60
Distance between origin of pectoral & origin of pelvic	123.0	75.0	76.0	67.0	47.0	47.0	123.0	77.60

Distance between origin of pelvic & origin of anal	84.0	60.0	54.0	45.0	30.0	30.0	84.0	54.60
Distance between origin of pelvic & anus	76.0	54.0	47.0	42.0	28.0	28.0	76.0	49.40

3. *Schizopyge progastus* (McClelland), 1839

(Plate XIV-1)



Text Figure 3. *Schizopyge progastus* (McClelland)

1839. *Orienus progastus* McClelland, *Asiat. Res.*, 19: 274, 343, pl. 40, fig. 4

(Type locality, Upper Assam).

Previous records from Sikkim: Rongni chu, Tardhong, Coll. unknown (Tilak, 1972); R. Rangit (Bhutia & Acharya, 1987).

Present Records: TISTA DRAINAGE: Jali khola, SS Saramsa 135 mm (1 ex.); Rani khola, FCC 32 No. 115 - 129 mm (2 exs.); Kanaka chhu, FCC Passingdong 226 - 350 mm (4 exs.); Dik chhu, SS Dikchu 130 - 190 mm (6 exs.); Ghattay khola, SS Sirwani 110 - 165 mm (7 exs.); Confluence of Tista & Rani khola, SS Singtam 53 - 230 mm (14 exs.); Rangpo khola, FCC Rorethang 122 - 200 mm (14 exs.); SS Rangpo 85 - 217 mm (2 exs.); RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 90 - 155 mm (7 exs.); FCC Tatopani 130 - 370 mm (10 exs.); SS Sikip 89 - 174 mm (20 exs.); SS Nayabazar 42 - 240 mm (54 exs.); Kalej khola, SS Legship 70 - 229 mm (16 exs.); Rishi khola, SS Rishi 80 - 146 mm (9 exs.); Roathak khola, SS Roathak 66 - 155 mm (3 exs.); Rangbhang khola, SS Nayabazar 95 - 126 (5 exs.); Confluence of Tista and Rangit, FCC Tista 115 - 170 mm (4 exs.); local name: *Chuchay Asala*.

Meristic Counts: D. iii.8; P. i.18; V. i.10; A. ii.5; C. 19.

Lateral line 108; scales from dorsal base to lateral line 28; scales from lateral line to base of pelvic 23.

Morphometric Characters:

Standard length 1.17 - 1.24 (1.214), head length 5.04 - 5.40 (5.168), head breadth 8.50 - 10.46 (9.312), head depth 7.16 - 8.10 (7.632), gape of mouth 15.11 - 20.25 (18.130), eye diameter 20.67 - 35.0 (24.886), inter orbital distance 13.60 - 16.20 (14.798), post orbital distance 10.78 - 12.46 (11.558), inter nasal distance 18.14 - 20.1 (19.268), snout length 10.61 - 13.50 (12.118), maxillary barbel length 18.14 - 31.0 (23.016), rostral barbel length 21.17 - 35.43 (27.156), body depth 4.88 - 6.48 (5.652), body width 8.00 - 8.53 (8.186), dorsal height 5.04 - 7.00 (5.576), dorsal base 7.75 - 9.0 (8.494), anal height 5.93 - 7.36 (6.732), anal base 11.27 - 16.20 (13.734), pectoral length 6.48 - 7.36 (6.904), pelvic length 7.16 - 8.00 (7.512), length of caudal fin 4.96 - 6.14 (5.484), length of caudal peduncle 6.18 - 6.89 (6.518), highest depth of caudal peduncle 8.86 - 9.58 (9.148), least depth of caudal peduncle 10.33 - 11.57 (10.710), pre-dorsal distance 2.38 - 2.43 (2.402), pre-pectoral distance 4.53 - 5.06 (4.820), pre-pelvic distance 2.19 - 2.31 (2.256), preanal distance 1.56 - 1.59 (1.574), distance between origin of pectoral and origin of pelvic 3.85 - 4.15 (3.994), distance between origin of pelvic and origin of anal 4.79 - 5.17 (4.958), distance between origin of pelvic and anus 5.22 - 5.67 (5.456).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 11. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *S. progastus* (McClelland), 1839.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.268	80.645	85.143	1.568
Head length	19.368	18.519	19.853	0.461
Head breadth	10.928	10.236	11.765	0.548
Head depth	13.311	12.346	13.971	0.559
Gape of mouth	5.571	4.938	6.618	0.581
Eye diameter	4.169	2.857	4.839	0.716
Inter orbital distance	6.784	6.173	7.353	0.425
Post orbital distance	8.671	8.025	9.274	0.404
Inter nasal distance	5.196	4.938	5.512	0.186

Snout length	8.318	7.407	9.429	0.742
Maxillary barbel length	4.482	3.226	5.512	0.743
Rostral barbel length	3.797	2.823	4.724	0.644
Body depth	17.845	15.441	20.472	1.625
Body width	12.399	11.728	13.386	0.555
Dorsal height	18.216	14.286	19.853	2.082
Dorsal base	11.804	11.111	12.903	0.605
Anal height	14.924	13.580	16.857	1.073
Anal base	7.429	6.173	8.871	1.044
Pectoral length	14.514	13.580	15.441	0.627
Pelvic length	13.511	12.903	13.971	0.358
Length of caudal fin	18.326	16.286	20.161	1.268
Length of caudal peduncle	15.360	14.516	16.176	0.578
Highest depth of caudal peduncle	10.939	10.494	11.290	0.262
Least depth of caudal peduncle	9.351	8.642	9.677	0.366
Pre dorsal distance	41.640	41.176	42.000	0.322
Pre pectoral distance	20.775	19.753	22.059	0.847
Pre pelvic distance	44.321	43.210	45.588	0.953
Pre anal distance	63.584	62.963	64.286	0.528
Distance between origin of pectoral & origin of pelvic	25.068	24.074	26.000	0.783
Distance between origin of pelvic & origin of anal	20.182	19.355	20.857	0.523
Distance between origin of pelvic & anus	18.356	17.647	19.143	0.658
Distance between anus and anal fin	0.152	0.000	0.394	0.187

Other Characteristics:

Body: Elongate, sub-cylindrical. Both the profiles are arched, abdomen rounded.

Head: Large, pointed anteriorly. Snout smooth, obtuse.

Eyes: Large, diameter 4.0 - 6.8 in length of head with circular pupil, placed in the middle of the head, not visible from below ventral surface; inter orbital space convex.

Mouth: Inferior, small, width of gape of mouth 3.0 - 3.7 in length of head. Lips thick, fleshy & continuous at angles of mouth. Upper jaw projecting. Lower lip without suctorial dose, with a central lobe and a lateral one on either side.

Barbels: Two pairs, a pair each of maxillary & rostral.

Teeth: Pharyngeal, crooked, pointed, 5, 3, 2/2, 3,5.

Fins: Dorsal fin inserted slightly in advance of the ventrals & almost midway between the end of snout and root of the caudal fin; dorsal spine strong, coarsely serrated. Pectoral does not reach the ventral, nor the latter reaches the anal. Anal fin far from reaching the caudal base. Caudal fin deeply forked with equal lobes.

Scales: Minute in tiled row.

Skin: Smooth.

Colour: Uniformly silvery, often with few fine spots in living specimens. Head dark; a golden streak surrounds iris. A yellow green longitudinal band runs along the lateral line. Fins: Dorsal & caudal dark with blood red outer margins. Pectoral dark, ventral & anal pale pink.

Distribution: India Jammu & Kashmir valley, Ganges river in Uttar Pradesh, Brahmaputra in Assam, Arunachal Pradesh. Elsewhere: Nepal.

Remarks: This species known as snow trout is commonly available throughout the year in both drainages within 240 m to 745 m elevation. It is a cold water species attaining a length of ca 600 mm (Talwar & Jhingran, 1991).

The species resembles *Schizothorax richardsonii* but differs from it in the absence of a suction disc in the lower lip.

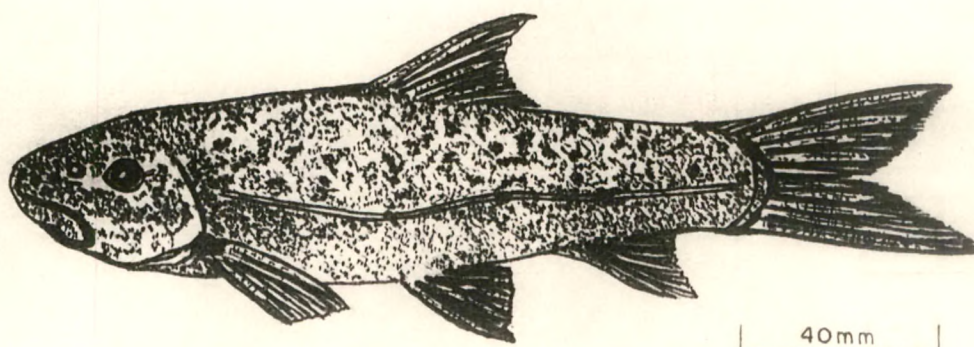
Table 12. Measurements (in mm) of *Schizopyge progastus* (McClelland), 1839.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	124.0	136.0	127.0	162.0	350.0	124.0	350.0	179.800
Standard length	100.0	112.0	103.0	133.0	298.0	100.0	298.0	149.200
Head length	24.0	27.0	25.0	30.0	68.0	24.0	68.0	34.800
Head breadth	14.0	16.0	13.0	17.0	38.0	13.0	38.0	19.600
Head depth	17.0	19.0	17.0	20.0	46.0	17.0	46.0	23.800
Gape of mouth	7.0	9.0	7.0	8.0	18.0	7.0	18.0	9.800
Eye diameter	6.0	6.0	6.0	6.5	10.0	6.0	10.0	6.900
Inter orbital distance	8.0	10.0	9.0	10.0	24.0	8.0	24.0	12.200
Post orbital distance	11.5	12.0	11.0	13.0	30.0	11.0	30.0	15.500
Inter nasal distance	6.5	7.0	7.0	8.0	18.0	6.5	18.0	9.300
Snout length	9.5	12.0	10.5	12.0	33.0	9.5	33.0	15.400
Maxillary barbel length	4.0	6.5	7.0	7.0	16.0	4.0	16.0	8.100

Rostral barbel length	3.5	5.5	6.0	5.5	14.0	3.5	14.0	6.900
Body depth	22.0	21.0	26.0	28.0	64.0	21.0	64.0	32.200
Body width	15.0	17.0	17.0	19.0	43.0	15.0	43.0	22.200
Dorsal height	24.0	27.0	25.0	29.0	50.0	24.0	50.0	31.000
Dorsal base	16.0	16.0	15.0	18.0	40.0	15.0	40.0	21.000
Anal height	18.0	20.0	19.0	22.0	59.0	18.0	59.0	27.600
Anal base	11.0	11.0	8.0	10.0	27.0	8.0	27.0	13.400
Pectoral length	18.0	21.0	18.0	22.0	52.0	18.0	52.0	26.200
Pelvic length	16.0	19.0	17.0	22.0	48.0	16.0	48.0	24.400
Length of caudal fin	25.0	25.0	24.0	29.0	57.0	24.0	57.0	32.000
Length of caudal peduncle	18.0	22.0	19.0	25.0	55.0	18.0	55.0	27.800
Highest depth of caudal peduncle	14.0	15.0	14.0	17.0	38.0	14.0	38.0	19.600
Least depth of caudal peduncle	12.0	13.0	12.0	14.0	33.0	12.0	33.0	16.800
Pre dorsal distance	52.0	56.0	53.0	67.0	147.0	52.0	147.0	75.000
Pre pectoral distance	25.0	30.0	26.0	32.0	75.0	25.0	75.0	37.600
Pre pelvic distance	55.0	62.0	55.0	70.0	158.0	55.0	158.0	80.000
Pre anal distance	79.0	87.0	80.0	102.0	225.0	79.0	225.0	114.600
Distance between origin of pectoral & origin of pelvic	32.0	33.0	32.0	39.0	91.0	32.0	91.0	45.400
Distance between origin of pelvic & origin of anal	24.0	27.0	26.0	33.0	73.0	24.0	73.0	36.600
Distance between origin of pelvic & anus	22.0	24.0	23.0	31.0	67.0	22.0	67.0	33.400
Distance between anus and anal fin		0.5	0.5			0.0	0.5	0.500

4. *Schizothorax richardsonii* (Gray), 1831

(Plate XIV-4)

Text Figure 4. *Schizothorax richardsonii* (Gray)

1831. *Cyprinus richardsonii* Gray, Ill. Indian, Zool., 1, pl. 94, fig. 2

(Type locality, not given).

Previous records from Sikkim: Rangit river, Manjhitar, Coll. B.L. Chaudhuri (Tilak, 1972); R. Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: R. Tista, SS Tong 135 - 165 mm (3 exs.); Bakcha chhu, SS Bakcha 90 - 320 mm (187 exs.); Rani khola, SS Saramsa 14 - 170 mm (146 exs.); FCC 32 No. 80 - 245 mm (114 exs.); Jali khola, SS Saramsa 80 - 290 mm (52 exs.); Seti khola, SS Lower Lagyap 60 - 236 mm (68 exs.); Rin khola, SS Lower Dzongu 55 - 272 mm (95 exs.); Kanaka chhu, FCC Passingdong 90 - 390 mm (133 exs.); Dik chhu, SS Dikchu 75 - 400 mm (150 exs.); Ghattay khola, SS Sirwani 92 - 342 mm (19 exs.); Confluence of Tista and Rani khola, SS Singtam 50 - 257 mm (79 exs.); Rangpo khola, FCC Rorethang 42 - 282 mm (114 exs.); SS Rangpo 49 - 200 mm (61 exs.). RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 330 - 293 mm (102 exs.); FCC Tatopani 50 - 290 mm (20 exs.); SS Sikhip 45 - 261 mm (57 exs.); SS Nayabazar 47 - 283 mm (70 exs.); Rimbi khola, SS Rimbi 50 - 269 (378 exs.); Kalej khola, SS Legship 112 - 410 mm (102 exs.); Rishi khola, SS Rishi 50 - 245 mm (66 exs.); Roathak khola, SS Rothak 70 - 206 mm (37 exs.); Rangbhang khola, SS Nayabazar 108 - 235 mm (23 exs.); local name: *Dothay Asala*.

Meristic Counts: D. ii.8; P.i.16; V.i.8; A.ii.5; C.19.

Morphometric Characters:

Standard length 1.20 - 1.24 (1.222), head length 5.36 - 5.68 (5.484), head breadth 7.68 - 8.73 (8.269), head depth 7.30 - 8.11 (7.608), gape of mouth 11.24 - 12.79 (12.265), eye diameter 23.60 - 32.57 (28.106), inter orbital distance 12.70 - 14.25 (13.414), post orbital distance 11.19 -

12.67 (11.939), inter nasal distance 16.27 - 20.73 (17.851), snout length 11.80 - 12.61 (12.096), maxillary barbel length 47.19 - 59.67 (52.165), rostral barbel length 47.19 - 59.67 (52.165), body depth 4.92 - 5.82 (5.468), body width 7.38 - 8.14 (7.838), length of sucker 19.89 - 23.60 (21.673), breadth of sucker 9.68 - 10.73 (10.058), dorsal height 5.62 - 6.39 (6.050), dorsal base 8.11 - 9.46 (8.782), anal height 5.97 - 6.95 (6.450), anal base 12.42 - 14.60 (13.637), pectoral length 6.35 - 6.71 (6.495), pelvic length 7.09 - 7.61 (7.408), length of caudal fin 4.87 - 5.43 (5.089), length of caudal peduncle 6.64 - 7.35 (6.943), highest depth of caudal peduncle 8.95 - 9.46 (9.143), least depth of caudal peduncle 10.32 - 10.86 (10.568), pre-dorsal distance 2.31 - 2.58 (2.466), pre-pectoral distance 4.72 - 5.28 (4.974), pre-pelvic distance 2.21 - 2.32 (2.263), preanal distance 1.54 - 1.66 (1.609), distance between origin of pectoral and origin of pelvic 3.80 - 4.37 (4.025), distance between origin of pelvic and origin of anal 4.85 - 5.62 (5.187), distance between origin of pelvic and anus 5.30 - 6.94 (5.838).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 13. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *S. richardsonii* (Gray), 1831.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	81.835	80.508	83.333	1.074
Head length	18.235	17.621	18.644	0.378
Head breadth	12.093	11.454	13.014	0.531
Head depth	13.144	12.335	13.699	0.526
Gape of mouth	8.153	7.821	8.898	0.397
Eye diameter	3.558	3.070	4.237	0.441
Inter orbital distance	7.455	7.018	7.877	0.296
Post orbital distance	8.376	7.895	8.939	0.457
Inter nasal distance	5.602	4.825	6.145	0.481
Snout length	8.267	7.930	8.475	0.188
Maxillary barbel length	1.917	1.676	2.119	0.172
Rostral barbel length	1.917	1.676	2.119	0.172
Body depth	18.287	17.181	20.339	1.113
Body width	12.759	12.281	13.559	0.461

Length of sucker	4.614	4.237	5.028	0.282
Breadth of sucker	9.942	9.322	10.335	0.383
Dorsal height	16.530	15.642	17.797	0.818
Dorsal base	11.387	10.573	12.329	0.623
Anal height	15.505	14.407	16.740	0.851
Anal base	7.333	6.849	8.051	0.412
Pectoral length	15.396	14.912	15.753	0.298
Pelvic length	13.499	13.136	14.097	0.362
Length of caudal fin	19.649	18.421	20.548	0.758
Length of caudal peduncle	14.403	13.596	15.068	0.568
Highest depth of caudal peduncle	10.937	10.573	11.173	0.198
Least depth of caudal peduncle	9.462	9.211	9.692	0.175
Pre dorsal distance	40.547	39.106	43.220	1.420
Pre pectoral distance	20.105	18.943	21.186	0.755
Pre pelvic distance	44.180	43.172	45.251	0.838
Pre anal distance	62.153	60.169	64.804	1.595
Distance between origin of pectoral & origin of pelvic	24.845	22.881	26.316	1.167
Distance between origin of pelvic & origin of anal	19.280	17.797	20.614	1.030
Distance between origin of pelvic & anus	17.129	14.407	18.860	1.569

Other Characteristics:

Body: Elongated, sub-cylindrical, dorsal profile slightly more convex than the ventral. Abdomen rounded.

Head: Large. Snout tuberculated in males.

Eyes: Large, diameter 4.4 - 5.8 in length of head; placed in the middle of the head, not visible from below ventral surface.

Mouth: Inferior, transverse, width of gape of mouth 2.09 - 2.3 in length of head. Lips thick, fleshy. Lower lip with a free posterior edge forming a sucker. Lower jaw with a hard, horny covering inside.

Barbels: Two pairs, a pair each of maxillary & rostral. Both the pairs short.

Teeth: Pharyngeal, 4, 4, 2/2, 4, 4.

Fins: Dorsal fin inserted slightly ahead of pelvic, almost midway between the tip of snout and

caudal base; its spine moderately strong & serrated. Pectoral does not reach ventral, nor the latter reaches the anal. Anal fin reaches the origin of the caudal fin which is forked with two equal lobes.

Lateral line: Simple, complete.

Scales: Minute .

Skin: Smooth.

Colour: Dorsal yellowish grey and silvery on the sides and beneath, with innumerable black spots which are diffused in some specimens. Head dark, operculum glassed with yellowish green. A broad bright yellowish band present above lateral line. Iris surrounded by yellow streak. Fins: Dorsal dark with reddish outer fin rays. Pectoral, ventral and anal pale pinkish with reddish edges. Caudal greyish with dark fin rays.

Distribution: India: Kashmir, Eastern Himalayas - Assam, Arunachal Pradesh. Elsewhere: Bhutan, Nepal, Pakistan, Afghanistan.

Remarks: This snow trout is by far, the most dominant species widely distributed in all the rivers of Sikkim within 240 m to 1340 m elevation. Its flesh is highly relished and contributes as the most important commercial fishery of the state. This species* is a valuable game fish and attains a maximum size of 600 mm (Talwar & Jhingran, 1991).

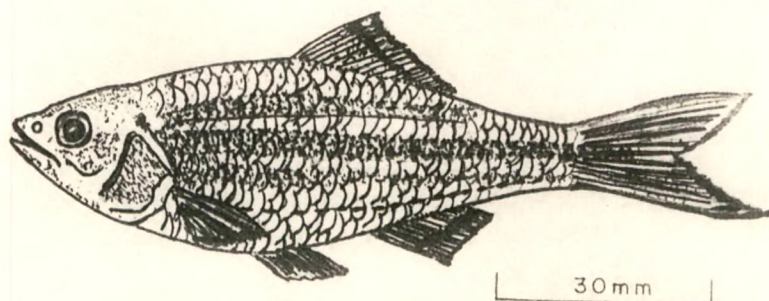
Table 14. Measurements (in mm) of *Schizothorax richardsonii* (Gray), 1831.

CHARACTER	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	118.0	146.0	179.0	227.0	228.0	118.0	228.0	179.000
Standard length	95.0	119.0	145.0	188.0	190.0	95.0	190.0	147.400
Head length	22.0	27.0	33.0	40.0	41.0	22.0	41.0	32.600
Head breadth	14.0	19.0	22.0	26.0	27.0	14.0	27.0	21.600
Head depth	16.0	20.0	24.0	28.0	29.0	16.0	29.0	23.400
Gape of mouth	10.5	12.0	14.0	18.0	18.0	10.5	18.0	14.500
Eye diameter	5.0	5.5	6.5	7.0	7.0	5.0	7.0	6.200
Inter orbital distance	9.0	11.5	13.0	17.0	16.0	9.0	17.0	13.300
Post orbital distance	10.5	12.0	16.0	18.0	18.0	10.5	18.0	14.900
Inter nasal distance	7.0	8.5	11.0	12.0	11.0	7.0	12.0	9.900
Snout length	10.0	12.0	15.0	18.0	19.0	10.0	19.0	14.800
Maxillary barbel length	2.5	3.0	3.0	4.5	4.0	2.5	4.5	3.400
Rostral barbel length	2.5	3.0	3.0	4.5	4.0	2.5	4.5	3.400

Body depth	24.0	27.0	32.0	39.0	40.0	24.0	40.0	32.400
Body width	16.0	18.0	23.0	29.0	28.0	16.0	29.0	22.800
Length of sucker	5.0	7.0	9.0	10.5	10.0	5.0	10.5	8.300
Breadth of sucker	11.0	15.0	18.5	22.0	23.0	11.0	23.0	17.900
Dorsal height	21.0	25.0	28.0	37.0	36.0	21.0	37.0	29.400
Dorsal base	13.0	18.0	20.0	24.0	27.0	13.0	27.0	20.400
Anal height	17.0	22.0	27.0	38.0	37.0	17.0	38.0	28.200
Anal base	9.5	10.0	13.0	16.0	17.0	9.5	17.0	13.100
Pectoral length	18.0	23.0	28.0	35.0	34.0	18.0	35.0	27.600
Pelvic length	15.5	20.0	24.0	32.0	30.0	15.5	32.0	24.300
Length of caudal fin	24.0	30.0	35.0	44.0	42.0	24.0	44.0	35.000
Length of caudal peduncle	17.0	22.0	25.0	34.0	31.0	17.0	34.0	25.800
Highest depth of caudal peduncle	13.0	16.0	20.0	24.0	25.0	13.0	25.0	19.600
Least depth of caudal peduncle	11.0	14.0	17.0	22.0	21.0	11.0	22.0	17.000
Pre dorsal distance	51.0	59.0	70.0	90.0	92.0	51.0	92.0	72.400
Pre pectoral distance	25.0	30.0	36.0	43.0	45.0	25.0	45.0	35.800
Pre pelvic distance	51.0	65.0	81.0	98.0	102.0	51.0	102.0	79.400
Pre anal distance	71.0	89.0	116.0	141.0	143.0	71.0	143.0	112.000
Distance between origin of pectoral & origin of pelvic	27.0	36.0	46.0	56.0	60.0	27.0	60.0	45.000
Distance between origin of pelvic & origin of anal	21.0	27.0	36.0	44.0	47.0	21.0	47.0	35.000
Distance between origin of pelvic & anus	17.0	24.0	32.0	41.0	43.0	17.0	43.0	31.400

5. *Danio aequipinnatus* McClelland, 1839

(Plate XVI-10)



Text Figure 5. *Danio aequipinnatus* McClelland

1839. *Perilampus aequipinnatus* McClelland, *Asiat. Res.*, 19 (2), p. 393; pl. 60; fig. 1
(Type locality, Assam).

Previous records from Sikkim: Rangit River, Manjhitar, Coll. B.L. Chaudhuri (Tilak, 1972);
River Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Rin khola, SS Lower Dzongu 65 - 90 mm (7 exs.); Rangpo khola, FCC Rorethang 63 - 81 (15 exs.); SS Rangpo 63 - 70 mm (2 exs.); RANGIT DRAINAGE: R. Rangit, SS Nayabazar 68 - 95 mm (25 exs.); Roathak khola, Rothak 59 - 116 mm (10 exs.); Rangbhang khola, SS Nayabazar 65 - 97 mm (4 exs.); Confluence of Tista & Rangit, FCC Tista 55 - 79 mm (3 exs.); local name: *Bhitti*.

Meristic Counts: D. ii. 10; P.i.16; V.i.7; A.ii.12; C.19.

Lateral line scales 34; scales from dorsal base to lateral line 6½; Scales from lateral line to base of pelvic 4.

Morphometric Characters:

Standard length 1.23 - 1.28 (1.254), head length 5.12 - 5.35 (5.276), head breadth 8.70 - 9.41 (9.142), head depth 6.00 - 6.73 (6.276), gape of mouth 13.00 - 16.00 (14.396), eye diameter 16.44 - 18.20 (17.252), inter orbital distance 10.57 - 11.43 (11.128), post orbital distance 10.57 - 11.43 (11.128), inter nasal distance 14.55 - 16.44 (15.356), snout length 12.43 - 14.80 (13.046), body depth 4.35 - 4.93 (4.672), body width 8.70 - 10.57 (9.788), dorsal height 5.69 - 6.21 (5.982), dorsal base 5.29 - 7.00 (6.076), anal height 6.43 - 7.91 (6.968), anal base 6.07 - 6.69 (6.154), pectoral length 6.17 - 6.67 (6.344), pelvic length 8.27 - 9.67 (8.850), length of caudal fin 4.79 - 5.33 (5.092), length of caudal peduncle 6.67 - 7.58 (7.260), highest depth of caudal peduncle 8.71 - 9.67 (9.016), least depth of caudal peduncle 9.25 - 10.71 (9.896), pre-dorsal distance 2.16 - 2.24

(2.208), pre-pectoral distance 4.93 - 5.29 (5.080), pre-pelvic distance 2.60 - 2.85 (2.738), pre-anal distance 1.81 - 2.00 (1.924), distance between origin of pectoral and origin of pelvic 4.79 - 5.29 (5.072), distance between origin of pelvic and origin of anal 5.12 - 7.40 (6.158), distance between origin of pelvic and anus 5.27 - 7.79 (6.340), distance between anus and origin of anal fin 67.27 - 182.00 (146.254).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in table below.

Table 15. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *D. aequipinnatus* McClelland, 1839.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	79.778	78.378	81.250	0.953
Head length	18.962	18.681	19.540	0.304
Head breadth	10.946	10.625	11.494	0.297
Head depth	15.961	14.865	16.667	0.668
Gape of mouth	6.985	6.250	7.692	0.526
Eye diameter	5.806	5.495	6.081	0.239
Inter orbital distance	8.996	8.750	9.459	0.284
Post orbital distance	8.996	8.750	9.459	0.284
Inter nasal distance	6.526	6.081	6.875	0.290
Snout length	7.360	6.757	8.046	0.487
Body depth	21.567	20.270	22.973	0.927
Body width	10.280	9.459	11.494	0.825
Dorsal height	16.742	16.092	17.582	0.682
Dorsal base	16.643	14.286	18.919	1.745
Anal height	14.437	12.644	15.541	1.094
Anal base	16.292	14.943	17.568	0.836
Pectoral length	15.782	15.000	16.216	0.499
Pelvic length	11.331	10.345	12.088	0.566
Length of caudal fin	19.672	18.750	20.879	0.806
Length of caudal peduncle	13.801	13.187	15.000	0.629
Highest depth of caudal peduncle	11.111	10.345	11.486	0.425

Least depth of caudal peduncle	10.136	9.341	10.811	0.541
Pre dorsal distance	45.294	44.595	46.250	0.695
Pre pectoral distance	19.702	18.919	20.270	0.460
Pre pelvic distance	36.603	35.000	38.462	1.411
Pre anal distance	52.074	50.000	55.172	2.091
Distance between origin of pectoral & origin of pelvic	19.756	18.919	20.879	0.858
Distance between origin of pelvic & origin of anal	16.485	13.514	19.540	2.016
Distance between origin of pelvic & anus	16.026	12.838	18.966	1.960
Distance between anus & origin of anal fin	0.890	0.549	2.027	0.570

Other Characteristics:

Body: Compressed, sub-cylindrical; Ventral surface more curved than dorsal. Abdomen rounded.

Head: Small, compressed, snout obtuse.

Eyes: Large, diameter 3.1 - 3.4 in length of head, placed in the posterior half of head, not visible from below ventral surface.

Mouth: Anterior, cleft of mouth shallow, not protractile directed obliquely upwards. The lower jaw being slightly longer than upper jaw. Cleft of mouth 13.0 - 14.8 in length of head, and extending to almost under the anterior margin of the orbit, a blunt knob at the symphysis.

Barbels: Rostral half as long as the orbit, the maxillary ones minute.

Teeth: Pharyngeal teeth hooked.

Fins: Dorsal fin inserted more towards caudal base than tip of snout. Pectoral as long as head without snout, does not reach pelvic which is shorter than pectorals. Anal fin long. Caudal fin forked but not deeply so.

Lateral Line: Simple & complete

Scales: Moderate

Colour: Body silvery with three bluish band extending along the body from the eye to the centre of the base of the caudal fin, interspaced between these are two orange coloured bands. All fins reddish in colour. There is a dark mark behind the gill opening.

Distribution: India: Eastern Himalayas, Meghalaya, Khasi Hills, Garo Hills, Assam, Darjeeling, West Bengal, Manipur, Arunachal Pradesh, Andhra Pradesh, Cochin, Karnataka, Nagpur, Poona, Rajasthan, Tamil Nadu, Travencore, Western Ghats. Elsewhere: Bangladesh, Pakistan, Burma, Sri Lanka, Thailand and Nepal.

Remarks: It is not a common species and is recorded from Rin khola, Rangpo khola, Rangit river, Rangbhag khola and Roathak khola. The fish has brilliant colour bands along its body and therefore is an excellent ornamental fish.

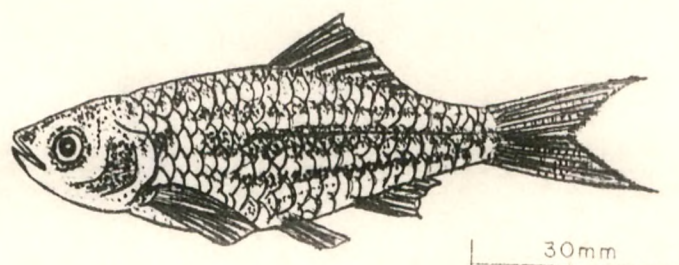
Table 16. Measurements (in mm) of *Danio aequipinnatus* McClelland, 1839.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	91.0	87.0	80.0	74.0	74.0	74.0	91.0	81.200
Standard length	73.0	69.0	65.0	59.0	58.0	58.0	73.0	64.800
Head length	17.0	17.0	15.0	14.0	14.0	14.0	17.0	15.400
Head breadth	10.0	10.0	8.5	8.0	8.0	8.0	10.0	8.900
Head depth	15.0	14.5	13.0	11.5	11.0	11.0	15.0	13.000
Gape of mouth	7.0	6.5	5.0	5.0	5.0	5.0	7.0	5.700
Eye diameter	5.0	5.0	4.5	4.5	4.5	4.5	5.0	4.700
Inter orbital distance	8.0	8.0	7.0	7.0	6.5	6.5	8.0	7.300
Post orbital distance	8.0	8.0	7.0	7.0	6.5	6.5	8.0	7.300
Inter nasal distance	6.0	5.5	5.5	4.5	5.0	4.5	6.0	5.300
Snout length	7.0	7.0	5.5	5.5	5.0	5.0	7.0	6.000
Body depth	19.0	19.0	17.5	17.0	15.0	15.0	19.0	17.500
Body width	10.0	10.0	8.0	7.0	7.0	7.0	10.0	8.400
Dorsal height	16.0	14.0	13.0	12.0	13.0	12.0	16.0	13.600
Dorsal base	13.0	13.0	14.0	13.0	14.0	13.0	14.0	13.400
Anal height	14.0	11.0	11.0	11.0	11.5	11.0	14.0	11.700
Anal base	15.0	13.0	13.0	12.0	13.0	12.0	15.0	13.200
Pectoral length	14.0	14.0	12.0	12.0	12.0	12.0	14.0	12.800
Pelvic length	11.0	9.0	9.0	8.5	8.5	8.5	11.0	9.200
Length of caudal fin	19.0	17.0	15.0	15.0	14.0	14.0	19.0	16.000
Length of caudal peduncle	12.0	12.0	12.0	10.0	10.0	10.0	12.0	11.200
Highest depth of caudal peduncle	10.0	9.0	9.0	8.5	8.5	8.5	10.0	9.000
Least depth of caudal peduncle	8.5	8.5	8.5	7.5	8.0	7.5	8.5	8.200
Pre dorsal distance	41.0	40.0	37.0	33.0	33.0	33.0	41.0	36.800
Pre pectoral distance	18.0	17.0	16.0	14.0	15.0	14.0	18.0	16.000
Pre pelvic distance	35.0	33.0	28.0	26.0	27.0	26.0	35.0	29.800

Pre anal distance	49.0	48.0	40.0	38.0	37.0	37.0	49.0	42.400
Distance between origin of pectoral & origin of pelvic	19.0	18.0	15.5	14.0	14.0	14.0	19.0	16.100
Distance between origin of pelvic & origin of anal	16.0	17.0	13.0	11.5	10.0	10.0	17.0	13.500
Distance between origin of pelvic & anus	15.0	16.5	12.5	12.0	9.5	9.5	16.5	13.100
Distance between anus and anal fin	0.5	0.5	0.5	1.5	0.5	0.5	1.5	0.700

6. *Danio naganensis* Chaudhuri, 1913

(Plate XVI-11)



Text Figure 6. *Danio naganensis* Chaudhuri

1913. *Danio naganensis* Chaudhuri, Rec. Indian Mus., 8;

(Type locality, Naga Hills) .

Present records: TISTA DRAINAGE : Rin khola, SS Lower Dzongu 72 - 74 mm (4 exs.); Dik chhu, SS Dikchu 24 mm (1 ex.); Roathak khola, SS Rothak 74 - 81 mm (7 exs.); local name: **Bhitti**.

Meristic Counts: D.ii.10; P.i.16; V.i.7; A.ii.12; C.19 .

Morphometric Characters:

Standard length 1.21 - 1.26 (1.238), Head length 4.80 - 5.29 (4.998), Head breadth 10.13 - 10.57 (10.422), Head depth 6.17 - 6.73 (6.359), Gape of mouth 14.40 - 16.20 (14.976), Eye diameter 16.44 - 20.25 (18.258), Inter orbital distance 12.00 - 13.50 (12.480), Post orbital distance 9.87 - 10.80 (10.409), Inter nasal distance 14.40 - 20.25 (16.597), Snout length 14.40 - 18.50 (15.607), Body depth 4.24 - 4.63 (4.409), Body width 9.00 - 12.33 (10.388), Dorsal height 5.69 - 6.73 (6.045), Dorsal base 5.29 - 6.17 (5.689), Anal height 6.55 - 7.40 (6.818), Anal base 5.54 - 6.23 (5.945), Pectoral length 5.79 - 6.73 (6.154), Pelvic length 8.22 - 10.57 (9.148), Length of caudal fin 4.63 - 5.79 (4.986), Length of caudal peduncle 6.17 - 7.40 (6.586), Highest depth of

caudal peduncle 8.22 - 9.25 (8.928), Least depth of caudal peduncle 9.25 - 12.00 (10.430), Pre dorsal distance 2.18 - 2.25 (2.218), Pre pectoral distance 4.80 - 5.40 (5.130), Pre pelvic distance 2.64 - 2.74 (2.698), Pre anal distance 1.85 - 2.00 (1.904), Distance between origin of pectoral & origin of pelvic 4.93 - 5.29 (5.068), Distance between origin of pelvic & origin of anal 5.79 - 7.40 (6.477), Distance between origin of pelvic & anus 6.75 - 8.22 (7.5141).

The Mean \pm Standard deviations (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Tables 17. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *D. naganensis* Chaudhuri, 1913.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	80.802	79.167	82.432	1.077
Head length	20.009	18.919	20.833	0.643
Head breadth	9.595	9.459	9.877	0.174
Head depth	15.725	14.865	16.216	0.553
Gape of mouth	6.678	6.173	6.944	0.263
Eye diameter	5.477	4.938	6.081	0.366
Inter orbital distance	8.013	7.407	8.333	0.315
Post orbital distance	9.607	9.259	10.135	0.302
Inter nasal distance	6.025	4.938	6.944	0.768
Snout length	6.407	5.405	6.944	0.564
Body depth	22.680	21.622	23.611	0.688
Body width	9.626	8.108	11.111	1.176
Dorsal height	16.543	14.865	17.568	1.017
Dorsal base	17.578	16.216	18.919	1.036
Anal height	14.667	13.514	15.278	0.601
Anal base	16.821	16.049	18.056	0.826
Pectoral length	16.250	14.865	17.284	0.795
Pelvic length	10.931	9.459	12.162	0.867
Length of caudal fin	20.056	17.284	21.622	1.472
Length of caudal peduncle	15.184	13.514	16.216	0.971
Highest depth of caudal peduncle	11.201	10.811	12.162	0.499

Least depth of caudal peduncle	9.588	8.333	10.811	0.798
Pre dorsal distance	45.083	44.444	45.946	0.662
Pre pectoral distance	19.492	18.519	20.833	0.895
Pre pelvic distance	37.070	36.486	37.838	0.540
Pre anal distance	52.524	50.000	54.054	1.351
Distance between origin of pectoral & origin of pelvic	19.731	18.919	20.270	0.515
Distance between origin of pelvic & origin of anal	15.439	13.514	17.284	1.608
Distance between origin of pelvic & anus	13.308	12.162	14.815	1.027

Other Characteristics:

Body: Elongate, compressed, sub-cylindrical. Dorsal & ventral profiles abruptly narrowed after dorsal and anal base. Abdomen rounded.

Head: Moderate, snout obtuse.

Eyes: Large, diameter 3.3 - 4.0 in length of head, centrally placed, not visible from below ventral surface.

Mouth: Terminal, directed upwards, width of gape of mouth 2.8 - 3.2 in length of head. Lips thin and simple. Lower jaw prominent, with a knob at the symphysis.

Barbels: Two pairs of rudimentary barbels.

Teeth: Pharyngeal teeth hooked.

Fins: Dorsal fin inserted interspace between anal and pelvic fins, near to caudal base than to tip of snout. Pectoral shorter than head length and pelvic almost half the length of pectoral. Anal fin base long. Caudal fin deeply forked with equal lobes.

Lateral Line: Concave, complete

Scales: Moderate

Colour: Body silvery with a single lateral band well marked posteriorly.

Distribution: India: Naga hills, Manipur.

Remarks: The species is reported for the first time from Sikkim drainages. It is a rare species found in Dik chhu, Rin khola and Roathak khola during the present investigation. The species apparently resembles *D. aequipinnatus* but distinctly differs from the latter in the presence of a single lateral band well marked posteriorly. It is an important ornamental fish.

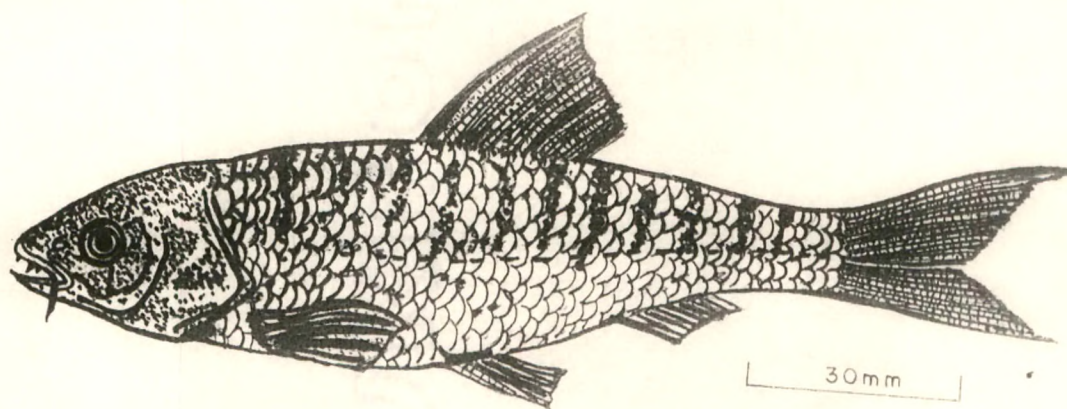
Table 18. Measurements (in mm) of *D. naganensis* Chaudhuri, 1913.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	81	74	72	74	74	72	81	75.00
Standard length	65	61	57	60	60	57	65	60.60
Head length	16	15	15	15	14	14	16	15.00
Head breadth	8	7	7	7	7	7	8	7.20
Head depth	13	12	11	12	11	11	13	11.80
Gape of mouth	5	5	5	5	5	5	5	5.00
Eye diameter	4	4	4	4.5	4	4	4.5	4.10
Inter orbital distance	6	6	6	6	6	6	6	6.00
Post orbital distance	7.5	7.5	7	7	7	7	7.5	7.20
Inter nasal distance	4	4	5	4.5	5	4	5	4.50
Snout length	5	5	5	5	4	4	5	4.80
Body depth	18	17	17	16	17	16	18	17.00
Body width	7	8	8	7	6	6	8	7.20
Dorsal height	13	11	12	13	13	11	13	12.40
Dorsal base	15	12	12	13	14	12	15	13.20
Anal height	12	11	11	11	10	10	12	11.00
Anal base	13	12	13	12	13	12	13	12.60
Pectoral length	14	12	12	11	12	11	14	12.20
Pelvic length	9	9	8	8	7	7	9	8.20
Length of caudal fin	14	15	15	15	16	14	16	15.00
Length of caudal peduncle	13	11	11	12	10	10	13	11.40
Highest depth of caudal peduncle	9	9	8	8	8	8	9	8.40
Least depth of caudal peduncle	8	8	6	7	7	6	8	7.20
Pre dorsal distance	36	33	33	34	33	33	36	33.80
Pre pectoral distance	15	14	15	15	14	14	15	14.60
Pre pelvic distance	30	28	27	27	27	27	30	27.80
Pre anal distance	43	40	38	37	39	37	43	39.40

Distance between origin of pectoral & origin of pelvic	16	15	14	14	15	14	16	14.80
Distance between origin of pelvic & origin of anal	14	12	12	10	10	10	14	11.60
Distance between origin of pelvic & anus	12	10	10	9	9	9	12	10.00

7. *Barilius bendelisis bendelisis* (Hamilton), 1807

(Plate XIV-10)



Text Figure 7. *Barilius bendelisis bendelisis* (Hamilton)

1807. *Cyprinus bendelisis* Hamilton, Journey in Mysore, 3, p. 345;

(Type locality, Vedawati stream, head waters of the Kista near Heriuru, Mysore).

Previous records from Sikkim: Martin river, Coll. unknown (Tilak, 1972); River Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Confluence of Tista & Rani khola, SS Singtam 113 mm (2 exs.); Rani khola, FCC 32 No. 90 - 150 mm (6 exs.); Rangpo Chhu, FCC Rorethang 40 - 150 mm (49 exs.); SS Rangpo 42 - 145 mm (23 exs.); RANGIT DRAINAGE: R. Rangit, FCC Tatopani 95 - 137 mm (2 exs.); SS Sikip 80 - 120 mm (6 exs.); SS Nayabazar 46 - 137 mm (70 exs.); Kalej khola, SS Legship 79 mm (1 ex.); Roathak khola, SS Rothak 75 - 131 mm (4 exs.); Rangbhang khola, SS Nayabazar 45 - 142 mm (17 exs.); local name: *Challay/Khasray*.

Meristic Counts: D. i. 7; P.i.11-13; V.i.8; A.ii.7; C.19.

Lateral line scales 41 - 44; scales from dorsal base to lateral line 7.5 - 8.5; Scales from lateral line to base of pelvic 3.0 - 3.5; Pre-dorsal scales 19 - 21.

Morphometric Characters:

Standard length 1.18 - 1.23 (1.20), head length 5.12 - 5.72 (5.466), head breadth 9.14 - 10.94 (9.844), head depth 6.63 - 7.42 (6.934), gape of mouth 14.22 - 18.90 (16.038), eye diameter 20.80 - 26.90 (23.966), inter orbital distance 12.60 - 13.86 (13.166), post orbital distance 9.84 - 10.57 (10.198), inter nasal distance 19.73 - 21.33 (20.510), snout length 12.80 - 14.82 (14.044), body depth 4.22 - 4.92 (4.51), body width 7.00 - 12.00 (8.312), dorsal height 5.88 - 7.00 (6.526), dorsal base 8.34 - 9.69 (9.016), anal height 8.66 - 9.69 (9.150), anal base 8.96 - 9.69 (9.368), pectoral length 6.09 - 6.63 (6.410), pelvic length 7.41 - 9.60 (9.028), length of caudal fin 4.95 - 6.30 (5.566), length of caudal peduncle 6.63 - 7.11 (6.912), highest depth of caudal peduncle 8.70 - 9.84 (9.142), least depth of caudal peduncle 11.13 - 11.55 (11.360), pre-dorsal distance 1.97 - 2.08 (2.028), pre-pectoral distance 4.26 - 4.80 (4.502), pre-pelvic distance 2.20 - 2.40 (2.266), preanal distance 1.55 - 1.71 (1.610), distance between origin of pectoral and origin of pelvic 4.00 - 4.57 (4.302), distance between origin of pelvic and origin of anal 4.95 - 5.74 (5.350), distance between origin of pelvic and anus 5.47 - 6.40 (5.920), distance between anus and origin of anal fin 42.0 - 96.0 (65.60).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in table below.

Table 19. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *Barilius bendelisis* (Hamilton), 1807.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.053	81.250	84.375	1.299
Head length	18.316	17.460	19.531	0.769
Head breadth	10.188	9.135	10.938	0.590
Head depth	14.431	13.462	15.079	0.568
Gape of mouth	6.310	5.288	7.031	0.677
Eye diameter	4.217	3.716	4.808	0.443
Inter orbital distance	7.604	7.212	7.937	0.294
Post orbital distance	9.810	9.459	10.156	0.245
Inter nasal distance	4.881	4.688	5.078	0.162
Snout length	7.135	6.731	7.813	0.400
Body depth	22.193	20.313	23.649	1.135

Body width	12.518	8.333	14.286	2.191
Dorsal height	14.881	14.286	15.625	0.524
Dorsal base	11.117	10.317	11.979	0.581
Anal height	10.945	10.317	11.538	0.496
Anal base	10.679	10.317	11.149	0.315
Pectoral length	15.607	15.079	16.406	0.441
Pelvic length	11.179	10.417	13.492	1.171
Length of caudal fin	18.070	15.873	20.192	1.418
Length of caudal peduncle	14.467	14.063	15.079	0.355
Highest depth of caudal peduncle	10.958	10.156	11.486	0.518
Least depth of caudal peduncle	8.801	8.654	8.984	0.113
Pre dorsal distance	49.214	47.917	50.676	1.007
Pre pectoral distance	22.238	20.833	23.438	0.948
Pre pelvic distance	44.107	41.667	45.313	1.322
Pre anal distance	62.068	58.333	64.423	2.217
Distance between origin of pectoral & origin of pelvic	23.284	21.875	25.000	1.114
Distance between origin of pelvic & origin of anal	18.788	17.708	20.192	0.837
Distance between origin of pelvic & anus	16.658	15.541	18.269	1.019
Distance between anus and anal fin	1.652	1.042	2.381	0.464

Other Characteristics:

Body: Elongate, compressed, dorsal & ventral profiles equally arched gradually tapering towards caudal base, abdomen round.

Head: Moderate, sharply pointed & compressed. Snout pointed.

Eyes: Large, diameter 3.8 - 5.0 in length of head; placed slightly upwards & outward on the anterior half of head, partially visible from below ventral surface.

Mouth: Anterior, obliquely directed upwards, not protractile. Width of gape of mouth 2.5 - 3.4 in length of head, extends up to below anterior border of eye. Lips thin and simple, jaws equal.

Barbels: Two pairs, a pair each of maxillary & rostral. Both pairs short.

Teeth: Pharyngeal 5, 4, 2/2, 4, 5.

Fins: Dorsal higher than long, inserted nearer base of caudal than tip of snout. Pectoral slightly longer than dorsal. Ventral short, and does not reach caudal which is forked with equal upper & lower lobes.

Lateral Line: Simple, curved downwards from behind the operculum to caudal base.

Colour: Dull yellowish above, silvery below. 13 - 17 dark vertical bars descending from back to the lateral line. Each scale with a black spot at its base. Fins: Dorsal dark; pectoral, ventral and anal pinkish pale, caudal yellowish with dark fin rays.

Distribution: India: Throughout India except Kerala. Elsewhere: Bangladesh, Burma, Nepal, Pakistan, Sri Lanka.

Remarks: It is a hill stream dweller abundantly distributed in both the river systems of Sikkim at low elevations up to 700 m. The species closely resembles *B. bendelisis chedra* but differs from the latter in small size of the fins, snout and body scales without tuberculations. The species shows marked differences from *B. bendelisis chedra* in some morphometric characters in relation to total length as height of dorsal fin 6.5 - 7.4 (vs. 4.8 - 5.5 in *chedra*), breadth of dorsal fin 6.3 - 8.1 (vs. 4.3 - 4.5), length of pectoral fin 6.1 - 7.0 (vs. 4.6 - 6.0), length of the ventral fin 8.3 - 9.8 (6.7 - 7.3). A distinct black spot is present at the base of each scale.

This attains a length of 15.5 cm (Talwar & Jhingran, 1991) and forms an important fisheries of the state.

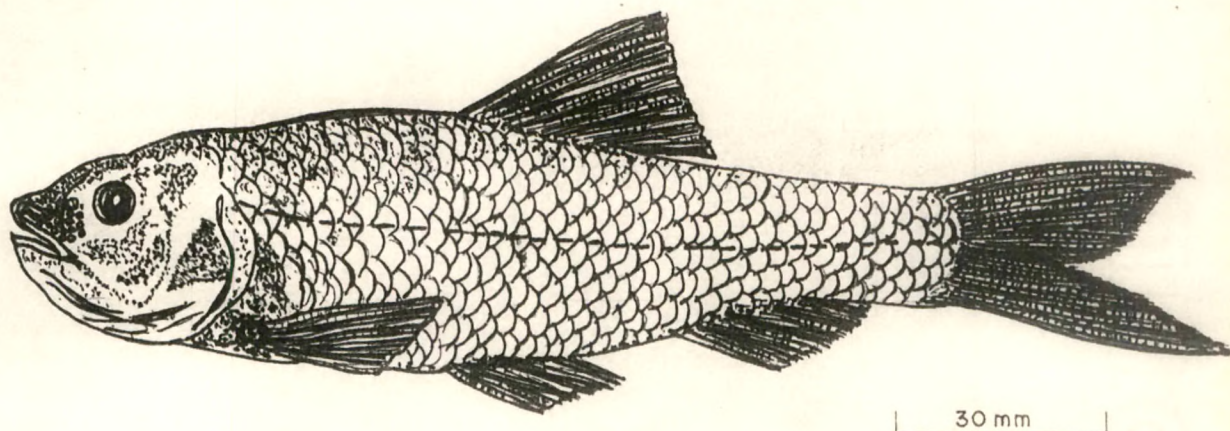
Table 20. Measurements (in mm) of *Barilius bendelisis* (Hamilton), 1807.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	148.0	126.0	128.0	104.0	96.0	96.0	148.0	120.400
Standard length	124.0	106.0	108.0	85.0	78.0	78.0	124.0	100.200
Head length	26.0	22.0	25.0	19.0	18.0	18.0	26.0	22.000
Head breadth	15.0	13.0	14.0	9.5	10.0	9.5	15.0	12.300
Head depth	21.0	19.0	19.0	14.0	14.0	14.0	21.0	17.400
Gape of mouth	10.0	8.5	9.0	5.5	5.5	5.5	10.0	7.700
Eye diameter	5.5	5.0	5.0	5.0	4.5	4.5	5.5	5.000
Inter orbital distance	11.5	10.0	10.0	7.5	7.0	7.0	11.5	9.200
Post orbital distance	14.0	12.5	13.0	10.0	9.5	9.5	14.0	11.800
Inter nasal distance	7.5	6.0	6.5	5.0	4.5	4.5	7.5	5.900
Snout length	10.5	8.5	10.0	7.0	7.0	7.0	10.5	8.600
Body depth	35.0	29.0	26.0	23.0	21.0	21.0	35.0	26.800
Body width	21.0	18.0	17.0	13.0	8.0	8.0	21.0	15.400
Dorsal height	21.5	18.0	20.0	16.0	14.0	14.0	21.5	17.900

Dorsal base	16.0	13.0	14.0	12.0	11.5	11.5	16.0	13.300
Anal height	15.5	13.0	14.0	12.0	11.0	11.0	15.5	13.100
Anal base	16.5	13.0	14.0	11.0	10.0	10.0	16.5	12.900
Pectoral length	23.0	19.0	21.0	16.0	15.0	15.0	23.0	18.800
Pelvic length	15.5	17.0	14.0	11.0	10.0	10.0	17.0	13.500
Length of caudal fin	26.0	20.0	23.0	21.0	18.0	18.0	26.0	21.600
Length of caudal peduncle	21.0	19.0	18.0	15.0	14.0	14.0	21.0	17.400
Highest depth of caudal peduncle	17.0	14.0	13.0	11.0	11.0	11.0	17.0	13.200
Least depth of caudal peduncle	13.0	11.0	11.5	9.0	8.5	8.5	13.0	10.600
Pre dorsal distance	75.0	63.0	62.0	51.0	46.0	46.0	75.0	59.400
Pre pectoral distance	32.0	28.0	30.0	24.0	20.0	20.0	32.0	26.800
Pre pelvic distance	65.0	56.0	58.0	47.0	40.0	40.0	65.0	53.200
Pre anal distance	90.0	80.0	81.0	67.0	56.0	56.0	90.0	74.800
Distance between origin of pectoral & origin of pelvic	33.0	30.0	30.0	26.0	21.0	21.0	33.0	28.000
Distance between origin of pelvic & origin of anal	27.0	24.0	24.0	21.0	17.0	17.0	27.0	22.600
Distance between origin of pelvic & anus	23.0	21.0	22.0	19.0	15.0	15.0	23.0	20.000
Distance between anus and anal fin	2.0	3.0	2.0	2.0	1.0	1.0	3.0	2.000

8. *Barilius bendelisis chedra* (Hamilton), 1822

(Plate XIV-9)

Text Figure 8. *Barilius bendelisis chedra* (Hamilton)

1822. *Cyprinus chedrio* Hamilton, Fish, Ganges, p. 268;

(Type locality, Rivers of Northern Bengal).

Present records: TISTA DRAINAGE: Confluence of Tista & Rani khola, SS Singtam 137 mm (1 ex.); Rani khola, FCC 32 No. 147 mm (1 ex.). RANGIT DRAINAGE: R. Rangit, SS Nayabazar 160 mm (2 ex.); local name: *Challay/Khasray*.

Meristic Counts: D. ii. 6; P.i.12 - 13; V.i. 7 - 8; A.ii.7; C. 18 - 19.

Lateral line scales 41 - 43; scales from dorsal base to lateral line 8; Scales from lateral line to base of pelvic 3.5; Pre-dorsal scales 19 - 20.

Morphometric Characters:

Standard length 1.19 - 1.24 (1.210), head length 4.89 - 5.16 (5.006), head breadth 6.125 - 11.42 (8.811), head depth 5.33 - 6.39 (5.941), gape of mouth 13.36 - 16.00 (14.661), eye diameter 22.61 - 32.00 (26.759), inter orbital distance 12.25 - 13.91 (13.266), post orbital distance 8.4 - 9.41 (9.069), inter nasal distance 17.12 - 22.85 (19.689), snout length 12.25 - 14.54 (13.407), body depth 4.21 - 4.74 (4.514), body width 8.90 - 11.42 (9.952), dorsal height 4.59 - 5.70 (5.126), dorsal base 7.61 - 8.56 (8.073), anal height 8.00 - 11.30 (8.888), anal base 6.66 - 8.16 (7.670), pectoral length 5.25 - 5.92 (5.589), pelvic length 6.52 - 7.35 (6.860), length of caudal fin 5.07 - 5.44 (5.293), length of caudal peduncle 5.95 - 6.66 (6.343), highest depth of caudal peduncle 7.61 - 9.8 (8.908), least depth of caudal peduncle 9.78 - 12.25 (10.864), pre-dorsal distance 2.0 - 2.10 (2.040), pre-pectoral distance 3.42 - 3.80 (3.567), pre-pelvic distance 2.25 - 2.33 (2.306), pre-anal

distance 1.63 - 1.72 (1.673), distance between origin of pectoral and origin of pelvic 5.71 - 6.22 (6.085), distance between origin of pelvic and origin of anal 4.95 - 5.74 (5.350), distance between origin of pelvic and anus 5.47 - 6.40 (5.920), distance between anus and origin of anal fin 42.0 - 96.0 (65.60).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in table below.

Table 21. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *B. bendelisis chedra* (Hamilton), 1822.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.659	80.625	83.673	1.193
Head length	19.977	19.375	20.438	0.460
Head breadth	11.350	8.750	16.327	2.983
Head depth	16.832	15.646	18.750	1.192
Gape of mouth	6.821	6.250	7.483	0.574
Eye diameter	3.737	3.125	4.422	0.461
Inter orbital distance	7.538	7.188	8.163	0.378
Post orbital distance	11.026	10.625	11.905	0.524
Inter nasal distance	5.079	4.375	5.839	0.520
Snout length	7.459	6.875	8.163	0.465
Body depth	22.153	21.088	23.750	0.978
Body width	10.048	8.750	11.224	0.880
Dorsal height	19.509	17.518	21.769	1.572
Dorsal base	12.387	11.679	13.125	0.519
Anal height	11.251	8.844	12.500	1.474
Anal base	13.038	12.245	15.000	1.136
Pectoral length	17.891	16.875	19.048	0.801
Pelvic length	14.577	13.605	15.328	0.657
Length of caudal fin	18.894	18.367	19.708	0.495
Length of caudal peduncle	15.765	15.000	16.788	0.645
Highest depth of caudal peduncle	11.226	10.204	13.125	1.128
Least depth of caudal peduncle	9.205	8.163	10.219	0.735

Pre dorsal distance	49.029	47.500	50.000	0.955
Pre pectoral distance	28.036	26.250	29.197	1.099
Pre pelvic distance	43.356	42.857	44.375	0.597
Pre anal distance	59.786	58.125	61.250	1.215
Distance between origin of pectoral & origin of pelvic	16.690	16.058	17.500	0.553
Distance between origin of pelvic & origin of anal	16.769	15.000	18.248	1.230
Distance between origin of pelvic & anus	15.171	14.375	16.058	0.694
Distance between anus and origin of anal fin	1.643	1.361	1.875	0.235

Other Characteristics:

Body: Elongate, compressed, both the profiles equally arched.

Head: Large. Snout sharply pointed hard; rough prominent tuberculations.

Eyes: Large, diameter 4.6 - 6.2 in length of head; placed upwards & outward on the anterior half of head, not visible from below ventral surface.

Mouth: Anterior, obliquely directed upwards, width of gape of mouth 2.7 - 3.1 in length of head.

Lips thin with equal upper & lower jaw.

Barbels: Two pairs, a pair each of maxillary & rostral. Both short.

Fins: Dorsal 1.5 - 1.7 as high as long, inserted behind pelvic, distinctly nearer caudal base than tip of snout. Pectoral slightly shorter than head length reaches up to the origin of pelvic. Anal base longer than the base of dorsal, does not reach caudal. Caudal is deeply forked with equal lobes.

Lateral Line: Simple, complete.

Colour: Grayish above, silvery beneath. Vertical bars not visible. Each scale tuberculated & with a dark spot at its base. Fins: Dorsal and caudal pale with dark free margins. Pectoral, ventral and anal pinkish pale.

Distribution: India: Himalayas, Assam, Nagaland, Western Ghats. Elsewhere: Sri Lanka, Bangladesh.

Remarks: The species is reported for the first time from Sikkim drainages in the present communication. It has somewhat restricted distribution in a few rivers namely Tista, Rani khola and Rangit up to 700 m elevation. The species are much larger and stoutly built than *B. bendelisis bendelisis*. The paired fins, dorsal and anal are enlarged and fan like, especially the pectorals with outer three rays thickened. The top of the snout and its sides, and also lower jaw with a thick layer of spiny tubercles. The body is rough due to the presence of fine tubercles on the scales. The vertical colour bands almost disappear and the ventral fin is dark edged.

The maximum growth of the species is reported to be 155 mm (Talwar & Jhingran, 1991) which has been extended to 160 mm in the present investigation.

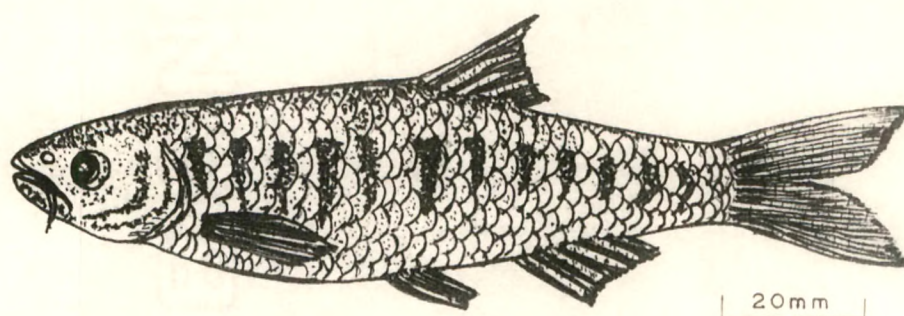
Table 22. Measurements (in mm) of *Barilius bendelisis chedra* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS				RANGE		MEAN
	I	II	III	IV	Min.	Max.	
Total length	160.0	160.0	147.0	137.0	137.0	160.0	151.000
Standard length	129.0	133.0	123.0	114.0	114.0	133.0	124.750
Head length	31.0	31.5	30.0	28.0	28.0	31.5	30.125
Head breadth	14.0	15.0	24.0	15.0	14.0	24.0	17.000
Head depth	30.0	27.0	23.0	22.0	22.0	30.0	25.500
Gape of mouth	10.0	10.0	11.0	10.0	10.0	11.0	10.250
Eye diameter	6.0	5.0	6.5	5.0	5.0	6.5	5.625
Inter orbital distance	12.0	11.5	12.0	10.0	10.0	12.0	11.375
Post orbital distance	17.0	17.0	17.5	15.0	15.0	17.5	16.625
Inter nasal distance	7.0	8.0	7.5	8.0	7.0	8.0	7.625
Snout length	11.0	12.0	12.0	10.0	10.0	12.0	11.250
Body depth	38.0	35.0	31.0	30.0	30.0	38.0	33.500
Body width	14.0	16.0	16.5	14.0	14.0	16.5	15.125
Dorsal height	30.0	32.0	32.0	24.0	24.0	32.0	29.500
Dorsal base	20.0	21.0	18.0	16.0	16.0	21.0	18.750
Anal height	20.0	18.0	13.0	17.0	13.0	20.0	17.000
Anal base	24.0	20.0	18.0	17.0	17.0	24.0	19.750
Pectoral length	29.0	27.0	28.0	24.0	24.0	29.0	27.000
Pelvic length	23.0	24.0	20.0	21.0	20.0	24.0	22.000
Length of caudal fin	30.0	30.0	27.0	27.0	27.0	30.0	28.500
Length of caudal peduncle	25.0	24.0	23.0	23.0	23.0	25.0	23.750
Highest depth of caudal peduncle	21.0	17.0	15.0	15.0	15.0	21.0	17.000
Least depth of caudal peduncle	15.0	14.5	12.0	14.0	12.0	15.0	13.875
Pre dorsal distance	80.0	76.0	72.0	68.0	68.0	80.0	74.000
Pre pectoral distance	45.0	42.0	42.0	40.0	40.0	45.0	42.250
Pre pelvic distance	71.0	69.0	63.0	59.0	59.0	71.0	65.500
Pre anal distance	98.0	93.0	87.0	83.0	83.0	98.0	90.250

Distance between origin of pectoral & origin of pelvic	28.0	27.0	24.0	22.0	22.0	28.0	25.250
Distance between origin of pelvic & origin of anal	28.0	24.0	24.0	25.0	24.0	28.0	25.250
Distance between origin of pelvic & anus	25.0	23.0	21.5	22.0	21.5	25.0	22.875
Distance between anus and anal fin	3.0	3.0	2.0	2.0	2.0	3.0	2.500

9. *Barilius vagra* (Hamilton), 1822

(Plate XIV-11)



Text Figure 9. *Barilius vagra* (Hamilton)

1822. *Cyprinus vagra* Hamilton, Fish, Ganges, pp. 269; 385

(Type locality, Ganges at Patna).

Previous records from Sikkim: R. Rangit, Manjhitar, Coll. B.L. Chaudhuri (Tilak, 1972); R. Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Confluence of Tista & Rani khola, SS Singtam 83 - 125 mm (11 exs.); Rani khola, FCC 32 No. 119 - 131 mm (2 exs.); Dik chhu, SS Dikchu 118 - 120 mm (2 exs.); Rangpo khola, FCC Rorethang 40 - 152 mm (47 exs.); SS Rangpo 30 - 120 mm (75 exs.). RANGIT DRAINAGE: R. Rangit, FCC Tatopani 95 - 112 mm (2 exs.), SS Sikhip 13 - 89 mm (6 exs.); SS Nayabazar 90 - 142 mm (12 exs.); Rishi khola, SS Rishi 35 - 71 mm (3 exs.); Rangbhang khola, SS Nayabazar 124 mm (1 ex.); Confluence of Tista and Rangit, FCC Tista 39 - 64 mm (3 exs.); local name: *Chirkay*.

Meristic Counts: D. 7 - 8; P. 11 - 14; C. 19.

Lateral line scales 40 - 44; scales from dorsal base to lateral line 7.5; Scales from lateral line to base of pelvic 2.5; Pre-dorsal scales 18 - 22.

Morphometric Characters:

Standard length 1.18 - 1.23 (1.209), head length 5.75 - 5.88 (5.824), head breadth 11.11 - 12.13 (11.587), head depth 7.41 - 9.10 (7.952), gape of mouth 16.40 - 18.20 (17.510), eye diameter 18.20 - 24.40 (21.322), inter orbital distance 14.28 - 15.25 (14.674), post orbital distance 11.09 - 12.50 (11.710), inter nasal distance 22.18 - 25.00 (23.416), snout length 16.54 - 17.69 (17.141), rostral barbel length 14.28 - 18.76 (16.559), body depth 5.12 - 6.06 (5.363), body width 8.71 - 13.00 (10.292), dorsal height 7.66 - 8.13 (7.752), dorsal base 11.09 - 11.61 (11.335), anal height 8.71 - 10.16 (9.157), anal base 6.06 - 6.97 (6.493), pectoral length 5.80 - 7.18 (6.325), pelvic length 8.71 - 10.16 (9.230), length of caudal fin 4.69 - 5.75 (5.352), length of caudal peduncle 5.67 - 6.50 (6.232), highest depth of caudal peduncle 8.84 - 11.37 (9.884), least depth of caudal peduncle 11.50 - 13.00 (12.112), pre-dorsal distance 2.01 - 2.08 (2.047), pre-pectoral distance 5.08 - 5.55 (5.255), pre-pelvic distance 2.34 - 2.67 (2.532), preanal distance 1.69 - 1.89 (1.799), distance between origin of pectoral and origin of pelvic 4.10 - 5.05 (4.676), distance between origin of pelvic and origin of anal 5.80 - 6.50 (6.200), distance between origin of pelvic and anus 6.42 - 7.58 (7.031), distance between anus and origin of anal fin 61.01 - 100 (79.45).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in table below.

Table 23. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *B. vagra* (Hamilton), 1822.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.704	81.148	84.348	1.142
Head length	17.170	17.000	17.391	0.142
Head breadth	8.630	8.242	9.000	0.242
Head depth	12.575	10.989	13.478	0.881
Gape of mouth	5.711	5.495	6.087	0.216
Eye diameter	4.690	4.098	5.495	0.499
Inter orbital distance	6.815	6.557	7.000	0.196
Post orbital distance	8.540	8.000	9.016	0.380
Inter nasal distance	4.270	4.000	4.508	0.190
Snout length	5.834	5.652	6.044	0.157
Rostral barbel length	6.039	5.328	7.000	0.552

Body depth	18.646	16.484	19.500	1.101
Body width	9.716	7.692	11.475	1.483
Dorsal height	12.900	12.295	13.525	0.414
Dorsal base	8.822	8.607	9.016	0.163
Anal height	10.921	9.836	11.475	0.573
Anal base	15.401	14.344	16.484	0.874
Pectoral length	15.811	13.934	17.213	1.114
Pelvic length	10.834	9.836	11.475	0.540
Length of caudal fin	18.683	17.391	21.311	1.376
Length of caudal peduncle	16.047	15.385	17.623	0.813
Highest depth of caudal peduncle	10.117	8.791	11.304	0.843
Least depth of caudal peduncle	8.256	7.692	8.696	0.340
Pre dorsal distance	48.856	48.000	49.565	0.583
Pre pectoral distance	19.031	18.000	19.672	0.635
Pre pelvic distance	39.496	37.363	42.609	1.841
Pre anal distance	55.589	52.747	59.016	2.612
Distance between origin of pectoral & origin of pelvic	21.386	19.780	24.348	1.569
Distance between origin of pelvic & origin of anal	16.129	15.385	17.213	0.639
Distance between origin of pelvic & anus	14.222	13.187	15.574	0.794
Distance between anus and origin of anal fin	1.254	1.000	1.639	0.219

Other Characteristics:

Body: Elongated, compressed, dorsal almost straight, ventral profile more convex with round abdominal edge.

Head: Moderate, sharply pointed, snout compressed, pointed.

Eyes: Large, diameter 3.4 - 4.2 in length of head; placed slightly upwards & outward on the anterior half of head; partially visible from below ventral surface.

Mouth: Anterior, obliquely directed upwards, not protractile. The posterior extremity of the maxilla extends to beneath the middle of the orbit. Lips thin and simple; jaws equal.

Barbels: Two pairs, a pair each of maxillary & rostral. Maxillary minute, rostral 2.4 - 3.2 in length of head.

Teeth: Pharyngeal, crooked, 5, 3, 2/2, 3, 5.

Fins: Dorsal higher than long, inserted opposite interspace between pelvic and anal fin, more

towards caudal base than top of snout. Pectoral not quite so long as the head. Pelvic short. Anal fin base longer and lower than dorsal. Caudal fin forked.

Lateral Line: Simple, curved downwards to pectoral, pelvic & anal, complete.

Colour: Body yellowish dorsally with 8 - 12 dark vertical bars descending from the back to the lateral line. Dorsal & caudal dark with yellow tinge; pectoral, ventral and anal pinkish yellow.

Distribution: India: Indus, Yamuna, Ganga, Brahmaputra river systems, Arunachal Pradesh.

Elsewhere: Nepal, Bangladesh, Sri Lanka, Pakistan.

Remarks: Two different populations of the species have been recorded in the present study, one with narrow body where body depth is 4.9 - 6.0 in total length and the other with body depth 5.9 - 6.6 in total length. Both the populations with 8 - 11 vertical bars, anterior bars almost reaching lateral line. However, in young specimens, the body depth is 5.8 - 6.9 with 10 - 11 vertical bars extending from dorsal to ventral side which may be absent in some specimens.

The species is widely distributed in both the drainages at low elevations ranging from 240 to 700 m (msl).

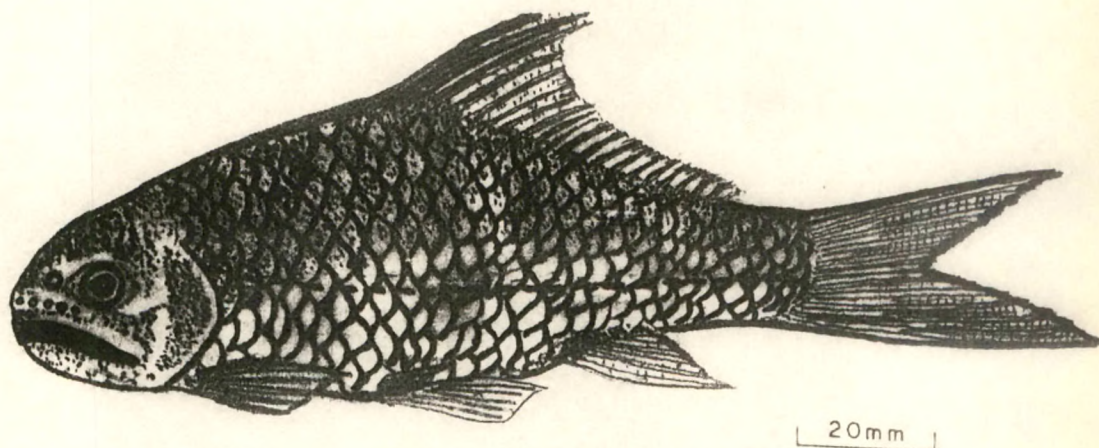
Table 24. Measurements (in mm) of *Barilius vagra* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	122.0	122.0	115.0	100.0	91.0	91.0	122.0	110.000
Standard length	102.0	99.0	97.0	82.0	75.0	75.0	102.0	91.000
Head length	21.0	21.0	20.0	17.0	15.5	15.5	21.0	18.900
Head breadth	10.5	10.5	10.0	9.0	7.5	7.5	10.5	9.500
Head depth	16.0	15.0	15.5	13.0	10.0	10.0	16.0	13.900
Gape of mouth	7.0	7.0	7.0	5.5	5.0	5.0	7.0	6.300
Eye diameter	5.5	5.0	5.0	5.0	5.0	5.0	5.5	5.100
Inter orbital distance	8.0	8.5	8.0	7.0	6.0	6.0	8.5	7.500
Post orbital distance	11.0	10.0	10.0	8.0	8.0	8.0	11.0	9.400
Inter nasal distance	5.0	5.5	5.0	4.0	4.0	4.0	5.5	4.700
Snout length	7.0	7.0	6.5	6.0	5.5	5.5	7.0	6.400
Rostral barbel length	6.5	7.0	7.0	7.0	5.5	5.5	7.0	6.600
Body depth	23.0	23.5	22.0	19.5	15.0	15.0	23.5	20.600
Body width	14.0	10.5	13.0	9.5	7.0	7.0	14.0	10.800
Dorsal height	15.0	16.5	15.0	13.0	11.5	11.5	16.5	14.200

Dorsal base	11.0	10.5	10.0	9.0	8.0	8.0	11.0	9.700
Anal height	12.0	14.0	13.0	11.0	10.0	10.0	14.0	12.000
Anal base	20.0	17.5	17.0	15.0	15.0	15.0	20.0	16.900
Pectoral length	17.0	21.0	19.0	16.0	14.0	14.0	21.0	17.400
Pelvic length	12.0	14.0	12.5	11.0	10.0	10.0	14.0	11.900
Length of caudal fin	22.0	26.0	20.0	18.0	17.0	17.0	26.0	20.600
Length of caudal peduncle	19.0	21.5	18.0	16.0	14.0	14.0	21.5	17.700
Highest depth of caudal peduncle	12.0	13.0	13.0	10.0	8.0	8.0	13.0	11.200
Least depth of caudal peduncle	10.0	10.0	10.0	8.5	7.0	7.0	10.0	9.100
Pre dorsal distance	60.0	60.0	57.0	48.0	44.0	44.0	60.0	53.800
Pre pectoral distance	24.0	24.0	22.0	18.0	17.0	17.0	24.0	21.000
Pre pelvic distance	49.0	48.0	49.0	38.0	34.0	34.0	49.0	43.600
Pre anal distance	72.0	67.0	67.0	53.0	48.0	48.0	72.0	61.400
Distance between origin of pectoral & origin of pelvic	26.0	25.0	28.0	21.0	18.0	18.0	28.0	23.600
Distance between origin of pelvic & origin of anal	21.0	20.0	18.0	16.0	14.0	14.0	21.0	17.800
Distance between origin of pelvic & anus	19.0	17.0	16.0	14.5	12.0	12.0	19.0	15.700
Distance between anus and anal fin	1.5	2.0	1.5	1.0	1.0	1.0	2.0	1.400

10. *Semiplotus semiplotus* (McClelland), 1839

(Plate XIV-8)

Text Figure 10. *Semiplotus semiplotus* (McClelland)

1839. *Cyprinus semiplotus* McClelland, *Asiat. Res.*, 19 (2): 274- 346, pl.37. fig. 2

(Type locality, R. Brahmaputra, Upper Assam).

Previous records from Sikkim: R. Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Rangpo khola, FCC Rorethang 110 -193 mm (6 exs.).

RANGIT DRAINAGE: R. Rangit, SS Nayabazar 115 - 145 mm (2 exs.); Rangbhang khola, SS Nayabazar 65 - 117 mm (2 exs.); Roathak khola, SS Rothak 45 - 131 mm (3 exs.); local name:

Chepti.

Meristic Counts: D.i.24; P.15; V.10; A.10; C. 19.

Lateral line scales 33; scales between dorsal base and lateral line 5.5 - 6.0; Scales from lateral line to base of pelvic 3.5; Pre-dorsal scales 12.

Morphometric Characters:

Standard length 1.18 - 1.32 (1.284), head length 5.67 - 5.94 (5.755), head breadth 5.67 - 8.73 (7.575), head depth 5.67 - 6.04 (5.907), gape of mouth 8.77 - 10.27 (9.659), eye diameter 21.16 - 27.57 (23.403), inter orbital distance 10.57 - 12.47 (11.943), post orbital distance 11.30 - 13.36 (12.185), inter nasal distance 14.8 - 16.93 (16.234), snout length 12.08 - 14.12 (13.129), body depth 3.32 - 3.89 (3.575), body width 6.23 - 7.14 (6.548), dorsal height 5.28 - 5.77 (5.556), dorsal base 2.92 - 3.27 (3.083), anal height 5.69 - 6.64 (6.174), anal base 9.82 - 10.91 (10.511), pectoral length 5.95 - 6.43 (6.232), pelvic length 6.16 - 6.89 (6.448), length of caudal fin 3.79 - 4.38 (3.994), length of upper caudal lobe 3.79 - 4.38 (3.994), length of lower caudal lobe 4.11 - 4.70 (4.408), length of caudal peduncle 6.90 - 8.07 (7.383), highest depth of caudal peduncle 9.35 -

9.86 (9.608), least depth of caudal peduncle 10.04 - 11.38 (11.068), pre-dorsal distance 2.70 - 2.89 (2.846), pre-pectoral distance 4.91 - 5.77 (5.295), pre-pelvic distance 2.45 - 2.64 (2.535), preanal distance 1.62 - 1.81 (1.729), distance between origin of pectoral and origin of pelvic 4.22 - 5.10 (4.542), distance between origin of pelvic and origin of anal 4.10 - 5.48 (4.852), distance between origin of pelvic and anus 4.38 - 5.94 (5.290), distance between anus and origin of anal fin 65.5 - 148 (107.527).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in table below.

Table 25. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *S. Semiplotus* (McClelland), 1839.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	77.879	75.591	84.071	3.189
Head length	17.376	16.814	17.617	0.299
Head breadth	13.202	11.450	17.617	2.278
Head depth	16.930	16.535	17.617	0.363
Gape of mouth	10.353	9.735	11.399	0.581
Eye diameter	4.273	3.627	4.724	0.364
Inter orbital distance	8.373	7.874	9.459	0.592
Post orbital distance	8.207	7.480	8.850	0.567
Inter nasal distance	6.160	5.725	6.757	0.351
Snout length	7.617	7.080	8.108	0.388
Body depth	27.970	25.676	30.052	1.412
Body width	15.271	13.990	16.031	0.717
Dorsal height	18.000	17.323	18.919	0.630
Dorsal base	32.441	30.534	34.197	1.381
Anal height	16.197	15.044	17.568	1.060
Anal base	9.514	9.160	10.177	0.348
Pectoral length	16.046	15.544	16.794	0.434
Pelvic length	15.509	14.508	16.216	0.640
Length of caudal fin	25.040	22.798	26.351	1.199
Length of upper caudal lobe	25.040	22.798	26.351	1.199

Length of lower caudal lobe	22.685	21.244	24.324	1.015
Length of caudal peduncle	13.544	12.389	14.189	0.730
Highest depth of caudal peduncle	10.408	10.135	10.687	0.214
Least depth of caudal peduncle	9.035	8.784	9.326	0.199
Pre dorsal distance	35.135	34.513	35.878	0.491
Pre pectoral distance	18.884	17.323	20.354	1.095
Pre pelvic distance	39.447	37.838	40.708	1.054
Pre anal distance	57.833	54.962	61.658	2.205
Distance between origin of pectoral & origin of pelvic	22.015	19.595	23.664	1.388
Distance between origin of pelvic & origin of anal	20.610	18.243	24.352	2.197
Distance between origin of pelvic & anus	18.902	16.814	22.798	2.215
Distance between anus and anal fin	0.930	0.676	1.527	0.305

Other Characteristics:

Body: Short, deep & compressed. Dorsal profile more convex than ventral and abruptly tapering towards caudal. Abdominal edge rounded.

Head: Moderate. Snout thick, prominent broad, obtuse and overhanging the mouth. The height of the head equals its length. A row of ten open pores passing across snout towards orbit present.

Eyes: Large, diameter 3.7 - 4.6 in length of head; placed towards upwards in the middle of the head; not visible from below ventral surface.

Mouth: Wide with gape 1.5 - 1.7 in length of head; transverse and inferior. Lips thick, covering the jaws; a horny covering to lower jaw.

Barbels: A pair of minute maxillary.

Teeth: Pharyngeal, plough - shaped, 4, 3, 2/2, 3, 4.

Fins: Dorsal with a strong spine inserted nearer tip of snout than caudal base, almost as high as head length. Dorsal fin long but far from reaching caudal. Pectoral almost as long as pelvic. A scaly appendage present at the base of pelvic. Caudal fin deeply forked with longer upper lobe.

Lateral Line: Nearly straight, simple & complete.

Colour: Light grayish above, sides and ventral surface silvery. Fins: Dorsal & caudal pale with dark fin rays. Pectoral, ventral and anal pinkish.

Distribution: India: Assam, Meghalaya, Arunachal Pradesh, North Bengal. Elsewhere: Nepal, Burma.

Remarks: It is one of the commercially important fish available in Rangpo khola, river Rangit,

Rangbhang khola and Roathak khola. Day (1878) and Jayaram (1981) have mentioned that barbels absent but a pair of minute maxillary barbels have been observed in all the present specimens collected. This grows to a size of 600 mm (Talwar & Jhingran, 1991).

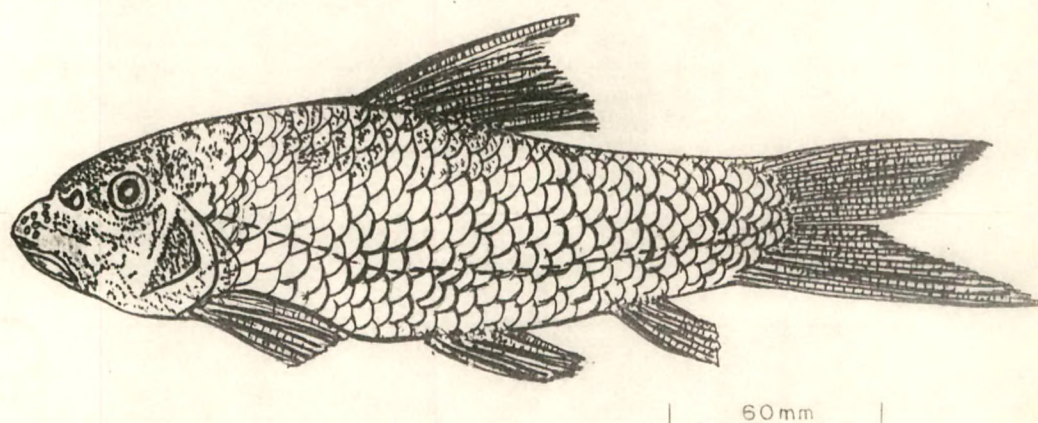
Table 26. Measurements (in mm) of *Semiplotus semiplotus* (McClelland), 1839.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Max.	Max.	
Total length	193.0	148.0	127.0	131.0	113.0	113.0	193.0	142.400
Standard length	150.0	112.0	96.0	100.0	95.0	95.0	150.0	110.600
Head length	34.0	26.0	22.0	23.0	19.0	19.0	34.0	24.800
Head breadth	34.0	19.0	16.0	15.0	13.0	13.0	34.0	19.400
Head depth	34.0	25.0	21.0	22.0	19.0	19.0	34.0	24.200
Gape of mouth	22.0	15.5	13.0	13.0	11.0	11.0	22.0	14.900
Eye diameter	7.0	6.5	6.0	5.5	5.0	5.0	7.0	6.000
Inter orbital distance	16.5	14.0	10.0	10.5	9.0	9.0	16.5	12.000
Post orbital distance	16.0	13.0	9.5	10.0	10.0	9.5	16.0	11.700
Inter nasal distance	12.0	10.0	7.5	7.5	7.0	7.0	12.0	8.800
Snout length	15.0	12.0	10.0	9.5	8.0	8.0	15.0	10.900
Body depth	58.0	38.0	35.0	37.0	32.0	32.0	58.0	40.000
Body width	27.0	23.0	20.0	21.0	17.0	17.0	27.0	21.600
Dorsal height	34.0	28.0	22.0	23.0	21.0	21.0	34.0	25.600
Dorsal base	66.0	47.0	43.0	40.0	36.0	36.0	66.0	46.400
Anal height	33.5	26.0	20.0	20.0	17.0	17.0	33.5	23.300
Anal base	18.0	14.0	12.0	12.0	11.5	11.5	18.0	13.500
Pectoral length	30.0	24.0	20.0	22.0	18.0	18.0	30.0	22.800
Pelvic length	28.0	24.0	20.0	21.0	17.0	17.0	28.0	22.000
Length of caudal fin	41.0	39.0	32.0	33.0	29.0	29.0	41.0	35.400
Length of upper caudal lobe	44.0	39.0	32.0	33.0	29.0	29.0	44.0	35.400
Length of lower caudal lobe	41.0	36.0	29.0	30.0	25.0	25.0	41.0	32.200
Length of caudal peduncle	27.0	21.0	18.0	17.0	14.0	14.0	27.0	19.400
Highest depth of caudal peduncle	20.0	15.0	13.0	14.0	12.0	12.0	20.0	14.800
Least depth of caudal peduncle	18.0	13.0	11.5	12.0	10.0	10.0	18.0	12.900
Pre dorsal distance	67.0	52.0	45.0	47.0	39.0	39.0	67.0	50.000

Pre pectoral distance	36.0	27.0	22.0	26.0	23.0	22.0	36.0	26.800
Pre pelvic distance	75.0	56.0	50.0	53.0	46.0	46.0	75.0	56.000
Pre anal distance	119.0	84.0	74.0	72.0	65.0	65.0	119.0	82.800
Distance between origin of pectoral & origin of pelvic	42.0	29.0	28.0	31.0	26.0	26.0	42.0	31.200
Distance between origin of pelvic & origin of anal	47.0	27.0	27.0	27.0	21.0	21.0	47.0	29.800
Distance between origin of pelvic & anus	44.0	25.0	25.0	24.0	19.0	19.0	44.0	27.400
Distance between anus and anal fin	1.5	1.0	1.0	2.0	1.0	1.0	2.0	1.300

11. *Labeo dero* (Hamilton), 1822

(Plate XVIII-4)



Text Figure 11. *Labeo dero* (Hamilton)

1822. *Cyprinus dero* Hamilton, Fish. Ganges, pp. 277, 331, 385

(Type locality, R. Brahmaputra).

Previous records from Sikkim: R. Rangit (Bhutia & Acharya, 1987)

Present records: TISTA DRAINAGE: Confluence of Tista & Rani khola, SS Singtam 293 - 335 mm (2 exs.); Rangpo khola, FCC Rorethang 159 - 315 mm (2 exs.). RANGIT DRAINAGE: R. Rangit, SS Nayabazar 250 - 293 mm (2 exs.); Rangbhang khola, SS Nayabazar 293 mm (1 ex.); local name: **Gardi**.

Meristic Counts: D. ii - iii. 9; P.i. 15 - 16; V.i.8; A.ii.5; C.19.

Lateral line scales 43 - 45, scales from dorsal base to lateral line 11, scales from lateral line to

pelvic base 14, pre-dorsal scales 9 - 10, scales around caudal peduncle 12.

Morphometric Characters:

Standard length 1.19 - 1.23 (1.215), head length 5.5 - 5.83 (5.697), head breadth 7.7 - 9.08 (8.416), head depth 7.0 - 7.6 (7.331), gape of mouth 13.5 - 15.57 (14.505), eye diameter 31.11 - 38.47 (35.026), inter orbital distance 12.72 - 13.5 (13.151), post orbital distance 11.66 - 11.77 (11.715), inter nasal distance 19.87 - 21.8 (20.969), snout length 11.66 - 12.27 (11.898), body depth 4.24 - 5.10 (4.790), body width 7.06 - 8.38 (7.546), dorsal height 4.08 - 4.82 (4.561), dorsal base 5.8 - 6.54 (6.242), anal height 5.94 - 7.0 (6.380), anal base 12.17 - 13.08 (12.574), pectoral length 5.94 - 6.36 (6.164), pelvic length 6.54 - 7.0 (6.760), length of caudal fin 4.59 - 4.9 (4.745), length of upper caudal lobe 4.59 - 4.90 (4.745), length of lower caudal lobe 4.95 - 5.40 (5.181), length of caudal peduncle 6.36 - 6.91 (6.595), highest depth of caudal peduncle 7.39 - 8.43 (8.041), least depth of caudal peduncle 9.08 - 9.33 (9.201), pre-dorsal distance 2.65 - 3.01 (2.850), pre-pectoral distance 4.81 - 5.28 (5.110), pre-pelvic distance 2.27 - 2.5 (2.385), preanal distance 1.56 - 1.71 (1.626), distance between origin of pectoral and origin of pelvic 3.97 - 4.36 (4.128), distance between origin of pelvic and origin of anal 4.28 - 5.0 (4.612), distance between origin of pelvic and anus 5.45 - 5.71 (5.562), distance between anus and origin of anal fin 31.79 - 46.66 (37.397).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 27. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *L. dero* (Hamilton), 1822.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.271	81.071	83.962	1.119
Head length	17.553	17.143	17.925	0.301
Head breadth	11.882	11.009	12.893	0.709
Head depth	13.641	13.150	14.151	0.412
Gape of mouth	6.894	6.422	7.407	0.398
Eye diameter	2.855	2.599	3.214	0.224
Inter orbital distance	7.604	7.407	7.862	0.171
Post orbital distance	8.536	8.491	8.571	0.033
Inter nasal distance	4.769	4.587	5.031	0.173
Snout length	8.405	8.148	8.571	0.159

Body depth	20.875	19.572	23.585	1.629
Body width	13.252	11.927	14.151	0.921
Dorsal height	21.926	20.741	24.465	1.486
Dorsal base	16.021	15.291	17.143	0.687
Anal height	15.675	14.286	16.820	0.920
Anal base	7.953	7.645	8.214	0.247
Pectoral length	16.224	15.723	16.820	0.429
Pelvic length	14.793	14.286	15.291	0.355
Length of caudal fin	21.077	20.370	21.786	0.673
Length of upper caudal lobe	21.077	20.370	21.786	0.673
Length of lower caudal lobe	19.303	18.519	20.183	0.651
Length of caudal peduncle	15.164	14.465	15.714	0.449
Highest depth of caudal peduncle	12.437	11.852	13.522	0.642
Least depth of caudal peduncle	10.868	10.714	11.009	0.140
Pre dorsal distance	35.092	33.214	37.736	1.910
Pre pectoral distance	19.568	18.929	20.755	0.740
Pre pelvic distance	41.931	40.000	44.025	1.770
Pre anal distance	61.493	58.214	63.704	2.104
Distance between origin of pectoral & origin of pelvic	24.223	22.936	25.185	0.874
Distance between origin of pelvic & origin of anal	21.684	20.000	23.333	1.200
Distance between origin of pelvic & anus	17.980	17.500	18.349	0.315
Distance between anus and origin of anal fin	2.674	2.143	3.145	0.400

Other Characteristics:

Body: Moderately elongated, abdomen rounded, dorsal profile more convex than vertical profile.

Head: Moderately large. Snout over hanging the jaws with a groove across it and covered with pores, but no lateral lobes.

Eyes: Large, diameter 5.3 - 6.8 in length of head, located upwards not visible from below ventral surface.

Mouth: Moderate, inferior, width of gape of mouth 2.3 - 2.7 in length of head. Both the lips are continuous at the angles.

Barbels: One pair of short maxillary barbels.

Teeth: Pharyngeal, plough shaped, 5, 4, 2/2, 4, 5.

Fins: Dorsal fin commences nearer the snout than the base of caudal fin and is higher than the length of the head. Pectoral does not extend to the ventral, nor the ventral reaches up to anal opening. Caudal fin deeply forked with upper lobe longer than the lower.

Lateral Line: Present, complete

Scales: Large

Colour: Dorsal brownish and silvery along the sides and belly.

Distribution: India: All along the Himalayas - Meghalaya, Assam, Darjeeling, Punjab, Uttar Pradesh, Kashmir. Elsewhere: Bangladesh, Burma, China, Nepal, Pakistan and Sri Lanka.

Remarks: The species is available in the lower stretches of both Tista and Rangit drainages from March till October and is an excellent food fish. Datta Munshi & Srivastava (1988) made a remark that eyes are located in the anterior half of head but in the present specimens, eyes are located in the middle of head. The species is characterized by moderately obtuse snout with a groove across it; lower jaws interrupted; lips thick and not fringed.

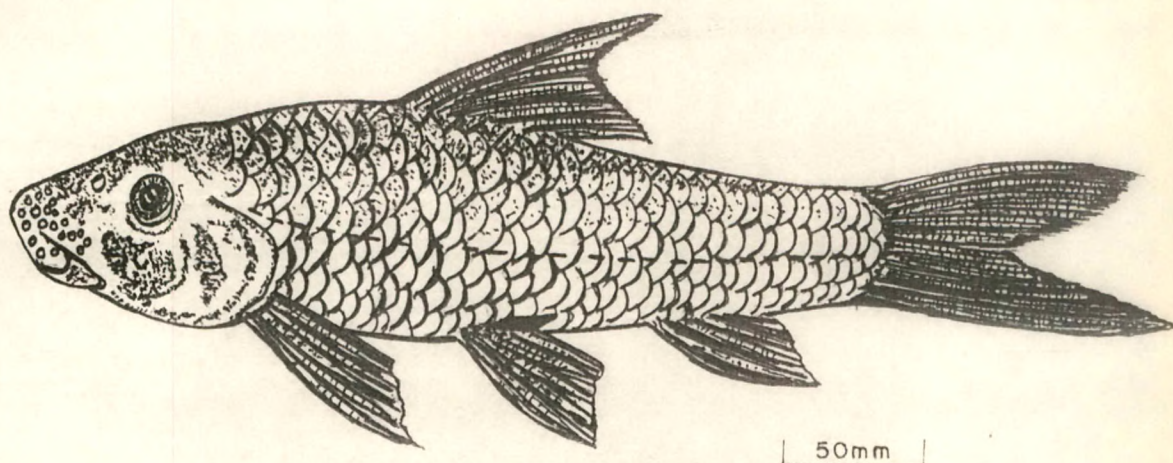
Table 28. Measurements (in mm) of *Labeo dero* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS				RANGE		MEAN
	I	II	III	IV	Min.	Max.	
Total length	318.0	327.0	270.0	280.0	270.0	327.0	298.750
Standard length	267.0	270.0	220.0	227.0	220.0	270.0	246.000
Head length	57.0	58.0	47.0	48.0	47.0	58.0	52.500
Head breadth	41.0	36.0	31.0	34.0	31.0	41.0	35.500
Head depth	45.0	43.0	36.0	39.0	36.0	45.0	40.750
Gape of mouth	21.0	21.0	20.0	20.0	20.0	21.0	20.500
Eye diameter	9.0	8.5	7.5	9.0	7.5	9.0	8.500
Inter orbital distance	25.0	25.0	20.0	21.0	20.0	25.0	22.750
Post orbital distance	27.0	28.0	23.0	24.0	23.0	28.0	25.500
Inter nasal distance	16.0	15.0	13.0	13.0	13.0	16.0	14.250
Snout length	27.0	27.5	22.0	24.0	22.0	27.5	25.125
Body depth	75.0	64.0	53.0	58.0	53.0	75.0	62.500
Body width	45.0	39.0	38.0	36.0	36.0	45.0	39.500
Dorsal height	67.0	80.0	56.0	60.0	56.0	80.0	65.750
Dorsal base	50.0	50.0	43.0	48.0	43.0	50.0	47.750
Anal height	51.0	55.0	42.0	40.0	40.0	55.0	47.000

Anal base	26.0	25.0	21.0	23.0	21.0	26.0	23.750
Pectoral length	50.0	55.0	43.0	46.0	43.0	55.0	48.500
Pelvic length	47.0	50.0	40.0	40.0	40.0	50.0	44.250
Length of caudal fin	65.0	71.0	55.0	61.0	55.0	71.0	63.000
Length of upper caudal lobe	65.0	71.0	55.0	61.0	55.0	71.0	63.000
Length of lower caudal lobe	60.0	66.0	50.0	55.0	50.0	66.0	57.750
Length of caudal peduncle	46.0	50.0	41.0	44.0	41.0	50.0	45.250
Highest depth of caudal peduncle	43.0	40.0	32.0	34.0	32.0	43.0	37.250
Least depth of caudal peduncle	35.0	36.0	29.0	30.0	29.0	36.0	32.500
Pre dorsal distance	120.0	118.0	90.0	93.0	90.0	120.0	105.250
Pre pectoral distance	66.0	62.0	53.0	53.0	53.0	66.0	58.500
Pre pelvic distance	140.0	132.0	117.0	112.0	112.0	140.0	125.250
Pre anal distance	200.0	200.0	172.0	163.0	163.0	200.0	183.750
Distance between origin of pectoral & origin of pelvic	79.0	75.0	68.0	67.0	67.0	79.0	72.250
Distance between origin of pelvic & origin of anal	68.0	72.0	63.0	56.0	56.0	72.0	64.750
Distance between origin of pelvic & anus	57.0	60.0	49.0	49.0	49.0	60.0	53.750
Distance between anus and anal fin	10.0	8.0	8.0	6.0	6.0	10.0	8.000

12. *Labeo pangusia* (Hamilton), 1822

(Plate XVIII-3)



Text Figure 12. *Labeo pangusia* (Hamilton)

1822. *Cyprinus pangusia* Hamilton, Fish. Ganges, pp. 285, 386;

(Type locality, River Kosi).

Previous records from Sikkim: R. Rangit (Bhutia & Acharya, 1987).

Present records: RANGIT DRAINAGE: R. Rangit, SS Nayabazar/Jorethang 390 mm (1 ex.);

local name: *Theyr*.

Meristic Counts: D. ii. 11; P.i. 14; V.i.8; A.ii.5; C.19.

Lateral line scales 44, scales from dorsal base to lateral line 8, scales from lateral line to pelvic base 7.5, pre-dorsal scales 15, scales around caudal peduncle 20.

Morphometric Characters:

Standard length 1.23, head length 5.82, head breadth 8.29, head depth 8.12, gape of mouth 14.44, eye diameter 39.0, inter orbital distance 10.26, post orbital distance 14.44, inter nasal distance 13.93, snout length 10.26, body depth 5.20, body width 7.09, dorsal height 5.65, dorsal base 7.35, anal height 6.34, anal base 17.72, pectoral length 6.0, pelvic length 6.61, length of caudal fin 4.58, length of upper caudal lobe 4.58, length of lower caudal lobe 5.0, length of caudal peduncle 6.84, highest depth of caudal peduncle 8.66, least depth of caudal peduncle 9.28, pre-dorsal distance 2.95, pre-pectoral distance 5.65, pre-pelvic distance 2.65, preanal distance 1.67, distance between origin of pectoral and origin of pelvic 4.64, distance between origin of pelvic and origin of anal 4.43, distance between origin of pelvic and anus 5.2, distance between anus and origin of anal fin 30.

The Ratio index and the Measurements of morphometric characters of the species is purported in the following combined table.

Tables 29 & 30. Ratio Index and Measurements (in mm) of morphometric characters of *Labeo pangusia* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS	RATIO INDEX
	I	
Total length	390.0	100.000
Standard length	315.0	80.769
Head length	67.0	17.179
Head breadth	47.0	12.051
Head depth	48.0	12.308
Gape of mouth	27.0	6.923
Eye diameter	10.0	2.564
Inter orbital distance	38.0	9.744
Post orbital distance	27.0	6.923
Inter nasal distance	28.0	7.179
Snout length	38.0	9.744
Body depth	75.0	19.231
Body width	55.0	14.103
Dorsal height	69.0	17.692
Dorsal base	53.0	13.590
Anal height	61.0	15.641
Anal base	22.0	5.641
Pectoral length	65.0	16.667
Pelvic length	59.0	15.128
Length of caudal fin	85.0	21.795
Length of upper caudal lobe	85.0	21.795
Length of lower caudal lobe	78.0	20.000
Length of caudal peduncle	57.0	14.615
Highest depth of caudal peduncle	45.0	11.538
Least depth of caudal peduncle	42.0	10.769
Pre dorsal distance	132.0	33.846

Pre pectoral distance	69.0	17.692
Pre pelvic distance	147.0	37.692
Pre anal distance	233.0	59.744
Distance between origin of pectoral & origin of pelvic	84.0	21.538
Distance between origin of pelvic & origin of anal	88.0	22.564
Distance between origin of pelvic & anus	75.0	19.231
Distance between anus and anal fin	13.0	3.333

Other Characteristics:

Body: Elongated with a rounded abdomen. Dorsal profile more convex than ventral.

Head: Large, granulated, blunt. Snout more or less prominent with tubercles, bluntly pointed, fringed, projects beyond the mouth with a lateral prolongation.

Eyes: Large, eye diameter 6.7 in length of head, situated behind the middle of head not visible from below ventral surface.

Mouth: Inferior with a thin fold of lips, which are continuous in both the jaws forming a horse shoe shaped labial fold.

Barbels: Two pairs, one pair each of maxillary and mandibular. Both the pairs are minute and concealed with the folds of upper and lower lip.

Teeth: Pharyngeal teeth hooked, in three rows, generally 5, 4, 2/2, 4, 5.

Fins: Rayed dorsal fin originates a little anterior to the ventral fin and is nearer the snout than to the base of caudal fin. Height of the dorsal fin is 1.1 in the height of body. Neither the pectoral reaches the ventral nor the ventral does the anal fin. Caudal deeply forked.

Lateral Line: Simple & complete.

Scales: Moderate size wedge shaped thin.

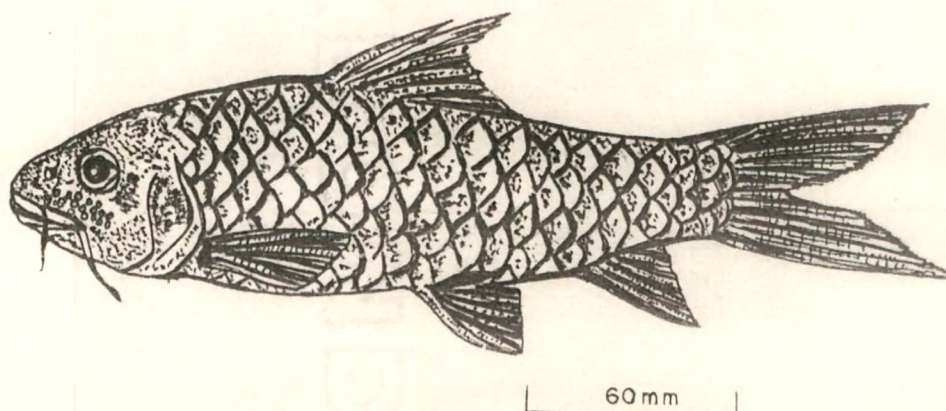
Colour: Dark grey dorsally, about one fourth of the body from ventral side silvery. Dorsal and caudal fins grey; ventral and anal are pale white.

Distribution: India: Deccan, West Bengal, Assam, Arunachal Pradesh, Meghalaya. Elsewhere: Pakistan, Bangladesh.

Remarks: It is a rare species found only in the lower gradients of river Rangit (340 m msl) from March to October. It apparently resembles *L. dero* but differs from it in much over-hung snout covered with tubercular base pores; lips thick, folded and highly fringed.

13. *Acrossocheilus hexagonolepis* (McClelland), 1839

(Plate XIV-7)

Text Figure 13. *Acrossocheilus hexagonolepis* (McClelland)

1839. *Barbus hexagonolepis* McClelland, *Asiat. Res.* 19, pp. 270, 271, 236,
(Type locality, Upper Assam).

Previous records from Sikkim: Rongni chhu, Tardong, North Martin, Coll. Unknown;
Martin River, Martin, Coll. Unknown; Rani khola, Ranipool, Coll. Menon; Rishi khola, Rishi,
Coll. Menon (Tilak, 1972) ; Rangit river (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Rani khola, SS Saramsa 73 - 170 mm (3 exs.); FCC 32
No. 75 - 215 mm (29 exs.); Kanaka chhu, FCC Passingdong 71 - 205 mm (7 exs.); Dik chhu, SS
Dikchu 139 - 257 mm (3 exs.); Ghattay khola, SS Sirwani 74 - 290 mm (19 exs.); Confluence of
Tista & Rani khola, SS Singtam 71 - 240 mm (23 exs.); Rangpo khola, FCC Rorethang 37 - 160
mm (32 exs.); SS Rangpo 42 - 190 mm (18 exs.). RANGIT DRAINAGE: R. Rangit, FCC
Tatopani/Phurcha chhu 125 - 280 mm (8 exs.); SS Sikip 120 - 171 mm (5 exs.); SS Nayabazar
40 - 290 mm (8 exs.); Kalej khola, SS Legship 93 - 300 mm (13 exs.); Rishi khola, SS Rishi 124 -
157 mm (6 exs.); Roathak khola, SS Rothak 32 - 130 mm (39 exs.); Rangbhang khola, SS
Nayabazar/Jorethang, 84 - 146 mm (7 exs.); Confluence of Tista & Rangit, FCC Tista, 75 - 210
(3 exs.); local name: *Katlay*.

Meristic Counts: D. i. 9; P.i.15; V.i.8; A.ii.5; C. 19.

Lateral line scales 25 - 27, 3.5 - 4 rows of scales between lateral line and base of dorsal fin, 2.5
rows of scales between lateral line and base of pelvic fin, pre-dorsal scales 9 and circumpeduncular
scales 10 - 11.

Morphometric Characters:

Standard length 1.2 - 1.28 (1.241), head length 4.5 - 5.32 (5.019), head breadth 7.2 - 8.44 (7.791), head depth 6.0 - 7.0 (6.517), gape of mouth 12.35 - 14.41 (13.071), eye diameter 17.99 - 27.22 (21.561), inter orbital distance 11.24 - 13.30 (12.457), post orbital distance 9.92 - 11.66 (10.631), inter nasal distance 17.37 - 19.22 (18.385), snout length 12.35 - 14.30 (13.116), maxillary barbel length 10.0 - 17.50 (13.299), Rostral barbel length 12.85 - 20.41 (16.210), body depth 4.22 - 4.73 (4.564), body width 6.20 - 7.50 (6.924), dorsal height 4.73 - 6.62 (5.656), dorsal base 6.92 - 8.23 (7.783), anal height 6.92 - 7.52 (7.144), anal base 12.85 - 14.41 (13.952), pectoral length 5.62 - 6.95 (6.264), pelvic length 6.80 - 7.43 (7.130), length of caudal fin 3.97 - 4.62 (4.216), length of caudal peduncle 5.02 - 6.42 (5.871), highest depth of caudal peduncle 8.08 - 9.0 (8.504), least depth of caudal peduncle 9.78 - 10.69 (10.080), pre-dorsal distance 2.45 - 2.57 (2.503), pre-pectoral distance 4.50 - 5.10 (4.898), pre-pelvic distance 2.36 - 2.48 (2.422), preanal distance 1.61 - 1.71 (1.659), distance between origin of pectoral and origin of pelvic 4.37 - 4.73 (4.539), distance between origin of pelvic and origin of anal 4.65 - 5.62 (5.099), distance between origin of pelvic and anus 4.67 - 5.62 (5.179), distance between anus and origin of anal fin 81.69 - 139.00 (107.225).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 31. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *A. hexagonolepis* (McClelland), 1839.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	80.550	77.778	83.265	1.802
Head length	19.922	18.776	22.222	1.261
Head breadth	12.835	11.837	13.873	0.734
Head depth	15.344	14.286	16.667	0.785
Gape of mouth	7.650	6.939	8.092	0.401
Eye diameter	4.638	3.673	5.556	0.639
Inter orbital distance	8.027	7.514	8.889	0.468
Post orbital distance	9.406	8.571	10.072	0.564
Inter nasal distance	5.439	5.202	5.755	0.196
Snout length	7.624	6.989	8.092	0.402

Maxillary barbel length	7.519	5.714	10.000	1.463
Rostral barbel length	6.169	4.898	7.778	0.950
Body depth	21.908	21.111	23.656	0.924
Body width	14.442	13.333	16.129	1.181
Dorsal height	17.678	15.102	21.111	2.097
Dorsal base	12.848	12.139	14.444	0.862
Anal height	13.997	13.295	14.444	0.415
Anal base	7.167	6.936	7.778	0.320
Pectoral length	15.964	14.388	17.778	1.089
Pelvic length	14.024	13.441	14.694	0.472
Length of caudal fin	23.714	21.633	25.180	1.233
Length of caudal peduncle	17.031	15.556	19.892	1.606
Highest depth of caudal peduncle	11.759	11.111	12.366	0.474
Least depth of caudal peduncle	9.920	9.353	10.215	0.318
Pre dorsal distance	39.941	38.889	40.816	0.741
Pre pectoral distance	20.416	19.592	22.222	0.930
Pre pelvic distance	41.277	40.288	42.222	0.788
Pre anal distance	60.241	58.273	61.828	1.156
Distance between origin of pectoral & origin of pelvic	22.027	21.111	22.857	0.631
Distance between origin of pelvic & origin of anal	19.610	17.778	21.505	1.297
Distance between origin of pelvic & anus	19.308	17.778	21.387	1.237
Distance between anus and origin of anal fin	0.777	0.000	1.224	0.425

Other Characteristics:

Body: Elongated, both the profiles gently arched.

Head: Short, broad with several rows of horny tubercles on the sides extending up to below the eyes. Head length always less than body depth.

Eyes: Large, not visible from below ventral surface.

Mouth: Moderate, upper lip separated from the snout by a groove, lower labial fold interrupted, lips fleshy.

Barbels: Four a pair of each rostral and maxillary. Maxillary pairs slightly longer and fleshy.

Fins: Dorsal opposite to or slightly ahead of pelvics, last spine strong and smooth; pelvic almost midway between tip of snout and base of caudal fin. A scaly appendage present before each pelvic

fin. Anal does not extend up to the base of the caudal fin; caudal fin deeply forked with two equal lobes.

Lateral Line: Complete, curved anteriorly extending from behind the opercula to base of caudal fin.

Colour: Dorsal grayish blue and silvery below with a band of copper coloured/ golden yellow above lateral line. Fins: dorsal and caudal dark; pectoral, ventral and anal whitish. operculum - golden yellow. A streak of golden colour surrounds the black iris.

Distribution: India: North India, Eastern Himalayas- Darjeeling, Meghalaya, Arunachal Pradesh, Assam. Elsewhere: Bangladesh, Burma, Nepal, Sumatra, Malaysia. Thailand, Pakistan, Sri Lanka.

Remarks: Jayaram (1981) writes D.iv.9 but only D.i.9 is found in the present sample. It is very common in both the Tista and Rangit drainages occurring up to 850 m msl. The species is an esteemed game fish as well as food fish in Sikkim.

The spelling of genus has been presented wrongly by Jayaram (1981) as *Accrossocheilus* which should be *Acrossocheilus* as per D.S. Jordan 1967, page 570.

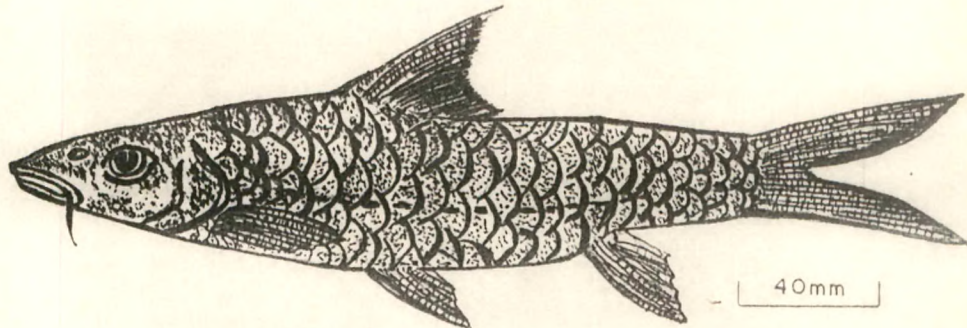
Table 32. Measurements (in mm) of *Acrossocheilus hexagonolepis* (McClelland), 1839.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	245.0	186.0	173.0	139.0	90.0	90.0	245.0	166.600
Standard length	204.0	150.0	138.0	113.0	70.0	70.0	204.0	135.000
Head length	46.0	35.0	34.0	28.0	20.0	20.0	46.0	32.600
Head breadth	29.0	24.0	24.0	17.0	12.0	12.0	29.0	21.200
Head depth	35.0	28.0	27.0	21.0	15.0	15.0	35.0	25.200
Gape of mouth	17.0	14.0	14.0	11.0	7.0	7.0	17.0	12.600
Eye diameter	9.0	8.0	8.0	7.0	5.0	5.0	9.0	7.400
Inter orbital distance	19.0	15.0	13.0	11.0	8.0	8.0	19.0	13.200
Post orbital distance	21.0	17.0	16.0	14.0	9.0	9.0	21.0	15.400
Inter nasal distance	13.0	10.0	9.0	8.0	5.0	5.0	13.0	9.000
Snout length	18.0	13.0	14.0	11.0	7.0	7.0	18.0	12.600
Maxillary barbel length	14.0	12.0	13.0	11.0	9.0	9.0	14.0	11.800
Rostral barbel length	12.0	11.0	10.0	9.0	7.0	7.0	12.0	9.800
Body depth	52.0	44.0	38.0	30.0	19.0	19.0	52.0	36.600
Body width	33.0	30.0	27.0	19.0	12.0	12.0	33.0	24.200

Dorsal height	37.0	30.0	30.0	26.0	19.0	19.0	37.0	28.400
Dorsal base	32.0	23.0	21.0	17.0	13.0	13.0	32.0	21.200
Anal height	34.0	26.0	23.0	20.0	13.0	13.0	34.0	23.200
Anal base	17.0	13.0	12.0	10.0	7.0	7.0	17.0	11.800
Pectoral length	39.0	30.0	27.0	20.0	16.0	16.0	39.0	26.400
Pelvic length	36.0	25.0	24.0	19.0	13.0	13.0	36.0	23.400
Length of caudal fin	53.0	45.0	40.0	35.0	22.0	22.0	53.0	39.000
Length of caudal peduncle	43.0	37.0	27.0	23.0	14.0	14.0	43.0	28.800
Highest depth of caudal peduncle	30.0	23.0	20.0	16.0	10.0	10.0	30.0	19.800
Least depth of caudal peduncle	25.0	19.0	17.0	13.0	9.0	9.0	25.0	16.600
Pre dorsal distance	100.0	73.0	70.0	56.0	35.0	35.0	100.0	66.800
Pre pectoral distance	48.0	37.0	35.0	28.0	20.0	20.0	48.0	33.600
Pre pelvic distance	100.0	76.0	73.0	56.0	38.0	38.0	100.0	68.600
Pre anal distance	148.0	115.0	105.0	81.0	54.0	54.0	148.0	100.600
Distance between origin of pectoral & origin of pelvic	56.0	41.0	39.0	30.0	19.0	19.0	56.0	37.000
Distance between origin of pelvic & origin of anal	50.0	40.0	34.0	26.0	16.0	16.0	50.0	33.200
Distance between origin of pelvic & anus	46.0	37.0	37.0	26.0	16.0	16.0	46.0	32.400
Distance between anus and anal fin	3.0	2.0	1.5	1.0		0	3.0	1.500

14. *Tor putitora* (Hamilton), 1822

(Plate XIV-5)

Text Figure 14. *Tor putitora* (Hamilton)

1822. *Cyprinus putitora* Hamilton, Fish. Ganges, pp. 303, 388

(Type locality, Eastern parts of Bengal).

Previous records from Sikkim: R. Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Confluence of Tista & Rani khola, SS Singtam 99 - 102 mm (3 exs.); Rangpo khola, FCC Rorethang 46 - 530 mm (11 exs.). RANGIT DRAINAGE: R. Rangit, FCC Tatopani 45 - 120 mm (2 exs.); SS Sikip 85 - 140 mm (2 exs.); SS Nayabazar 57 - 83 mm (12 exs.); Kalej khola, SS Legship 51 - 79 (2 exs.); Rishi khola, SS Rishi 71 mm (1 ex.); Rothak khola, SS Rothak 71 - 94 mm (2 exs.); Rangbhang khola, SS Nayabazar 99 - 249 mm (2 exs.); local name: *Sahar*.

Meristic Counts: D. iii - iv. 8 - 9; P.i. 16 - 17; V.i. 8 - 9; A.ii.5 - 6; C.19.

Lateral line scales 25 - 27, 4.5 rows of scales between lateral line and base of dorsal fin, 2.5 rows of scales between lateral line and base of pelvic fin, pre-dorsal scales 10 - 13 and circumpeduncular scales 12 - 14.

Morphometric Characters:

Standard length 1.19 - 1.28 (1.236), Head length 4.08 - 4.82 (4.404), Head breadth 8.25 - 10.38 (9.213), Head depth 6.60 - 8.41 (7.425), Gape of mouth 15.23 - 20.75 (17.401), Eye diameter 18.00 - 44.17 (23.445), Inter orbital distance 12.38 - 17.00 (14.935), Post orbital distance 8.28 - 10.20 (8.865), Inter nasal distance 15.69 - 25.24 (19.752), Snout length 11.33 - 13.95 (12.360), Maxillary barbel length 14.57 - 19.63 (17.231), Rostral barbel length 19.15 - 24.09 (20.639), Body depth 4.50 - 5.41 (5.061), Body width 4.27 - 10.20 (7.341), Dorsal height 4.71 - 6.79 (5.263), Dorsal base 7.85 - 9.81 (8.821), Anal height 6.38 - 7.79 (6.818), Anal base 12.38 -

17.10 (14.547), Pectoral length 6.73 - 7.07 (6.891), Pelvic length 7.11 - 8.55 (7.767), Length of caudal fin 4.50 - 5.52 (4.981), Length of caudal peduncle 5.58 - 8.50 (6.999), Highest depth of caudal peduncle 9.00 - 10.20 (9.448), Least depth of caudal peduncle 9.90 - 11.33 (10.865), Pre dorsal distance 2.20 - 2.48 (2.355), Pre pectoral distance 4.08 - 4.95 (4.443), Pre pelvic distance 2.27 - 2.48 (2.345), Pre anal distance 1.59 - 1.71 (1.625), Distance between origin of pectoral & origin of pelvic 4.42 - 5.21 (4.723), Distance between origin of pelvic & origin of anal 4.42 - 5.50 (4.896), Distance between origin of pelvic & anus 4.61 - 6.19 (5.502),

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 33. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *T. putitora* (Hamilton), 1822.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	80.903	78.431	84.340	2.027
Head length	22.707	20.755	24.510	1.217
Head breadth	10.854	9.639	12.121	1.002
Head depth	13.468	11.887	15.152	1.081
Gape of mouth	5.747	4.819	6.566	0.688
Eye diameter	4.265	2.264	5.556	1.300
Inter orbital distance	6.696	5.882	8.081	0.762
Post orbital distance	11.280	9.804	12.075	0.801
Inter nasal distance	5.063	3.962	6.373	1.004
Snout length	8.091	7.170	8.824	0.582
Maxillary barbel length	5.803	5.094	6.863	0.587
Rostral barbel length	4.845	4.151	5.221	0.367
Body depth	19.761	18.491	22.222	1.444
Body width	13.621	9.804	23.396	5.019
Dorsal height	19.000	14.717	21.212	2.287
Dorsal base	11.337	10.189	12.745	0.945
Anal height	14.667	12.830	15.686	1.043
Anal base	6.874	5.849	8.081	0.795
Pectoral length	14.513	14.141	14.859	0.304

Pelvic length	12.875	11.698	14.056	0.759
Length of caudal fin	20.077	18.113	22.222	1.444
Length of caudal peduncle	14.287	11.765	17.925	2.113
Highest depth of caudal peduncle	10.584	9.804	11.111	0.455
Least depth of caudal peduncle	9.203	8.824	10.101	0.507
Pre dorsal distance	42.463	40.377	45.455	1.648
Pre pectoral distance	22.508	20.189	24.510	1.462
Pre pelvic distance	42.641	40.377	44.118	1.397
Pre anal distance	61.557	58.586	62.745	1.560
Distance between origin of pectoral & origin of pelvic	21.171	19.192	22.642	1.138
Distance between origin of pelvic & origin of anal	20.425	18.182	22.642	1.676
Distance between origin of pelvic & anus	18.174	16.162	21.698	2.158
Distance between anus and anal fin	0.276	0.000	0.980	0.385

Other Characteristics:

Body: Elongate, moderately compressed. Both the dorsal and ventral profiles gently and gracefully arched.

Head: Broadly pointed, always greater than depth of body; 4.3 - 4.8 in total length.

Eyes: Large. Eyes are far forward with circular pupils.

Mouth: Small, width of gape of mouth 3.5 - 4.6 in length of head. Mouth obliquely directed upwards, almost reaching below anterior border of eyes. Lips are fleshy and continuous at angles of mouth, while posterior lip is produced into a median lobe.

Teeth: Pharyngeal teeth 5, 3, 2/2, 3, 5.

Barbels: Two pairs, a pair of maxillary and rostral. Maxillary as long as the width of gape of mouth.

Fins: Dorsal fin inserted opposite to that of origin of pelvic and is almost midway between the tip of snout and base of caudal. Dorsal spine is bony and strong, and its length is shorter than depth of body. Pectoral fins are low and considerably shorter than the head length. The pelvic does not reach the anal opening. The anal fin does not reach up to the caudal. The caudal fin is sharply divided with lower lobe somewhat more pointed.

Lateral Line: complete

Colour: Body greenish above, light pink at sides with silvery band and white abdomen. a broad light greyish blue lateral band. Fins are without spots and mostly yellow shot with large tinge red

at juvenile stage while yellowish green at adult stage. Pectoral, pelvic and caudal are often shot with pink.

Distribution: India: All along the Himalayas particularly fresh waters of Punjab, Uttar Pradesh, Bihar, Darjeeling district of West Bengal, Madhya Pradesh. Elsewhere: Nepal, Bangladesh, China and Pakistan.

Remarks: It was earlier reported only from Rangit drainage (Bhutia & Acharya, 1987). Its occurrence has been extended to Tista drainage in the present study. It is the most common mahseer of the Himalayas also known as the golden, yellow - finned or thick-lipped mahseer.

The species ascends fresh water streams for breeding and are available in the lower stretches of both the Tista and Rangit up to 525 m elevation from March till October. This most attractive and popular game fish with excellent food value is fast approaching extinction. The species can readily be distinguished from its distinctly longer head length than body depth and almost equally arched dorsal and ventral profiles.

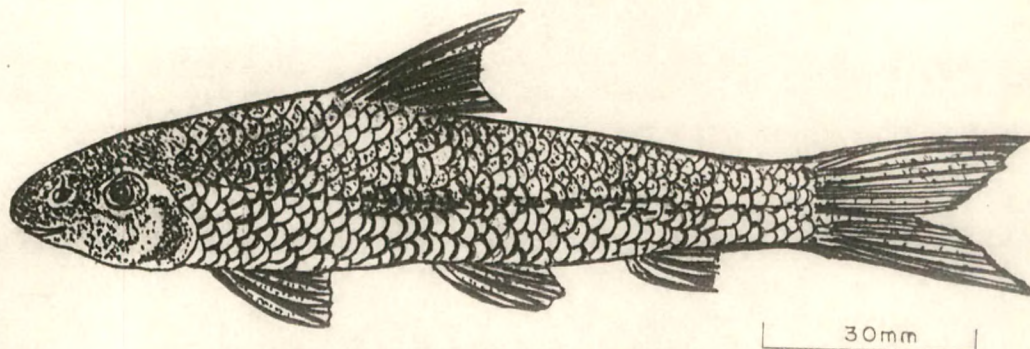
Table 34. Measurements (in mm) of *Tor putitora* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	530.0	249.0	102.0	99.0	102.0	99.0	530.0	216.400
Standard length	447.0	203.0	81.0	80.0	80.0	80.0	447.0	178.200
Head length	110.0	56.0	25.0	23.0	23.0	23.0	110.0	47.400
Head breadth	58.0	24.0	12.0	12.0	10.0	10.0	58.0	23.200
Head depth	63.0	32.0	14.0	15.0	14.0	14.0	63.0	27.600
Gape of mouth	27.0	12.0	6.5	6.5	6.0	6.0	27.0	11.600
Eye diameter	12.0	8.0	5.0	5.5	5.5	5.0	12.0	7.200
Inter orbital distance	33.0	16.0	7.0	8.0	6.0	6.0	33.0	14.000
Post orbital distance	64.0	29.0	12.0	11.0	10.0	10.0	64.0	25.200
Inter nasal distance	21.0	10.0	6.5	6.0	5.0	5.0	21.0	9.700
Snout length	38.0	20.0	9.0	8.5	8.0	8.0	38.0	16.700
Maxillary barbel length	27.0	14.0	7.0	5.5	6.0	5.5	27.0	11.900
Rostral barbel length	22.0	13.0	5.0	5.0	5.0	5.0	22.0	10.000
Body depth	98.0	47.0	21.0	22.0	19.0	19.0	98.0	41.400
Body width	124.0	25.0	13.0	12.0	10.0	10.0	124.0	36.800
Dorsal height	78.0	47.0	21.0	21.0	20.0	20.0	78.0	37.400

Dorsal base	54.0	27.0	13.0	12.0	11.0	11.0	54.0	23.400
Anal height	68.0	36.0	16.0	15.5	15.0	15.0	68.0	30.100
Anal base	31.0	15.5	7.5	8.0	7.0	7.0	31.0	13.800
Pectoral length	75.0	37.0	15.0	14.0	15.0	14.0	75.0	31.200
Pelvic length	62.0	35.0	13.0	13.0	13.0	13.0	62.0	27.200
Length of caudal fin	96.0	47.0	21.0	22.0	21.0	21.0	96.0	41.400
Length of caudal peduncle	95.0	37.0	13.0	14.0	12.0	12.0	95.0	34.200
Highest depth of caudal peduncle	55.0	27.0	11.0	11.0	10.0	10.0	55.0	22.800
Least depth of caudal peduncle	50.0	22.0	9.0	10.0	9.0	9.0	50.0	20.000
Pre dorsal distance	214.0	105.0	43.0	45.0	43.0	43.0	214.0	90.000
Pre pectoral distance	107.0	55.0	25.0	22.0	24.0	22.0	107.0	46.600
Pre pelvic distance	214.0	105.0	45.0	42.0	45.0	42.0	214.0	90.200
Pre anal distance	330.0	153.0	64.0	58.0	64.0	58.0	330.0	133.800
Distance between origin of pectoral & origin of pelvic	120.0	52.0	22.0	19.0	22.0	19.0	120.0	47.000
Distance between origin of pelvic & origin of anal	120.0	55.0	20.0	18.0	20.0	18.0	120.0	46.600
Distance between origin of pelvic & anus	115.0	49.0	17.0	16.0	17.0	16.0	115.0	42.800
Distance between anus and anal fin		1.0	1.0			0.0	1.0	0.400

15. *Crossocheilus latius latius* (Hamilton), 1822

(Plate XIV-3)

Text Figure 15. *Crossocheilus latius latius* (Hamilton)

1822. *Cyprinus latius* Hamilton, Fish. Ganges, pp.345, 395

(Type locality, R. Tista).

Previous records from Sikkim: River Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Rani khola, FCC 32 No. 97 - 151 mm (14 exs.); Dik chhu, SS Dikchu 120 - 130 mm (3 exs.); Ghattay khola, SS Sirwani 110 - 135 mm (4 exs.); Confluence of Tista & Rani khola, SS Singtam 100 - 196 mm (6 exs.); Rangpo khola, FCC Rorethang 118 - 210 mm (29 exs.); Rangpo khola, SS Rangpo 100 - 170 mm (10 exs.). RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 105 - 155 mm (2 exs.); Rangit, FCC Tatopani 111 - 167 mm (6 exs.); SS Sikip 79 - 170 mm (10 exs.); SS Nayabazar 100 - 191 mm (34 exs.); Kalej khola, SS Legship 140 - 160 (8 exs.); Rishi khola, SS Rishi 170 - 189 mm (7 exs.); Roathak khola, SS Rothak 100 - 180 mm (8 exs.); Rangbhang khola, SS Nayabazar 142 - 180 mm (13 exs.); Confluence of Tista and Rangit, FCC Tista 75 - 210 mm (8 exs.); local name: *Lohori Buduna*.

Meristic Counts: D.i.9; P.i.14; V.i.8; A.6; C.19.

Lateral line scales 39 - 40, 5½ rows of scales between lateral line and base of dorsal fin, 3.5 - 4 rows of scales between lateral line and base of pelvic fin, pre-dorsal scales 9 and circumpeduncular scales 18 - 19.

Morphometric Characters:

Standard length 1.21 - 1.26 (1.240), Head length 6.04 - 6.65 (6.366), Head breadth 8.06 - 9.50 (8.659), Head depth 7.61 - 9.32 (8.245), Gape of mouth 12.06 - 14.78 (13.513), Eye diameter 20.46 - 25.63 (22.926), Inter orbital distance 11.42 - 14.29 (12.862), Post orbital distance 16.67 - 20.50 (18.530), Inter nasal distance 15.22 - 16.67 (15.977), Snout length 11.21 - 12.09 (11.699),

Body depth 4.89 - 7.07 (6.266), Body width 5.96 - 9.09 (7.363), Dorsal height 5.06 - 5.96 (5.286), Dorsal base 7.14 - 8.31 (7.737), Anal height 6.83 - 7.85 (7.542), Anal base 13.33 - 17.08 (14.524), Pectoral length 6.41 - 7.00 (6.744), Pelvic length 6.83 - 7.61 (7.280), Length of caudal fin 4.18 - 5.27 (4.659), Length of upper caudal lobe 4.27 - 4.89 (4.502), Length of lower caudal lobe 4.35 - 5.06 (4.601), Length of caudal peduncle 6.65 - 7.59 (7.199), Highest depth of caudal peduncle 9.79 - 11.39 (10.346), Least depth of caudal peduncle 11.11 - 13.67 (12.226), Pre dorsal distance 2.71 - 2.91 (2.807), Pre pectoral distance 5.61 - 7.14 (6.115), Pre pelvic distance 2.32 - 2.51 (2.443), Pre anal distance 1.56 - 1.67 (1.623), Distance between origin of pectoral & origin of pelvic 3.61 - 4.35 (4.048), Distance between origin of pelvic & origin of anal 4.46 - 4.76 (4.596), Distance between origin of pelvic & anus 7.00 - 9.32 (7.7370), Distance between anus and anal fin 9.32 - 12.45 (11.284).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 35. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *C. latius latius* (Hamilton), 1822.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	80.661	79.618	82.482	1.056
Head length	15.707	15.038	16.561	0.532
Head breadth	11.549	10.526	12.409	0.695
Head depth	12.128	10.732	13.139	0.821
Gape of mouth	7.400	6.767	8.293	0.534
Eye diameter	4.362	3.902	4.887	0.333
Inter orbital distance	7.775	7.000	8.759	0.648
Post orbital distance	5.397	4.878	6.000	0.411
Inter nasal distance	6.259	6.000	6.569	0.220
Snout length	8.548	8.271	8.917	0.255
Body depth	15.959	14.146	20.438	2.327
Body width	13.581	11.000	16.788	1.977
Dorsal height	18.919	16.788	19.745	1.093
Dorsal base	12.924	12.030	14.013	0.681
Anal height	13.259	12.739	14.634	0.703

Anal base	6.885	5.854	7.500	0.573
Pectoral length	14.829	14.286	15.610	0.451
Pelvic length	13.736	13.139	14.634	0.530
Length of caudal fin	21.463	18.978	23.902	1.779
Length of upper caudal lobe	22.213	20.438	23.415	1.062
Length of lower caudal lobe	21.733	19.745	23.000	1.367
Length of caudal peduncle	13.891	13.171	15.038	0.650
Highest depth of caudal peduncle	9.666	8.780	10.219	0.495
Least depth of caudal peduncle	8.179	7.317	9.000	0.540
Pre dorsal distance	35.625	34.395	36.842	0.826
Pre pectoral distance	16.354	14.000	17.834	1.323
Pre pelvic distance	40.936	39.850	43.066	1.151
Pre anal distance	61.602	60.000	64.234	1.421
Distance between origin of pectoral & origin of pelvic	24.701	23.000	27.737	1.644
Distance between origin of pelvic & origin of anal	21.759	21.000	22.439	0.463
Distance between origin of pelvic & anus	12.925	10.732	14.286	1.232
Distance between anus and anal fin	8.862	8.029	10.732	0.990

Other Characteristics:

Body: Elongated, cylindrical. Dorsal profile slightly convex than ventral; ventral horizontal up to abdomen.

Head: Moderate in size, snout prominent obtusely pointed overhanging the mouth with a small lateral pendulous lobe.

Eyes: Large, more towards posterior half of head, not visible from below the ventral surface.

Mouth: Inferior, upper lip and lower lip not continuous, upper lip deeply indented on its edge. Lower lip with a strong cushion like horny pad.

Barbels: Short rostral barbels, maxillary wherever present are found rudimentary.

Fins: Dorsal commences nearer tip of snout than base of caudal. Pectoral not plaited, horizontal, outer 4-5 rays are thickened. Ventral extends up to anal opening. Anal does not extend up to caudal. Caudal fin deeply forked, upper lobe slightly longer in larger specimens.

Lateral Line: Simple & complete.

Colour: Dark grayish above and silvery beneath. Dorsal and caudal fins whitish with dark fin rays. Pectoral, ventral and anal pinkish yellow.

Distribution: India: Freshwater rivers (mostly originating from the Himalayas) like river Kosi and its tributaries of this area. Gangetic watershed of the Himalaya (Punjab, Northern Uttar Pradesh, Bihar, West Bengal, Assam); Maharastra, Peninsular India. Elsewhere: Nepal, Burma, Thailand, Malaysia, Indonesia, Bangladesh, Pakistan.

Remarks: It is found in plenty in this region in both the drainages up to 850 m msl and forms an important fishery of the state. Maxillary barbels short but distinct in smaller specimens; absent in larger specimens. Day (1978) says that Dorsal fin inserted midway between tip of snout and base of caudal and Datta Munshi and Srivastava (1987) write that Dorsal fin inserted midway between tip of snout and base of caudal in young specimens but rather nearer snout in the adult. But in the present specimens, dorsal fin is found to be inserted nearer tip of snout than base of caudal both in young and adult. Further Dutta, Munshi & Srivastava (1987) write that dorsal inserted between pectoral and pelvic. But it is situated nearer pelvic than pectorals in the present specimens.

Maximum length observed in present investigations is 210 mm but Datta Munshi and Srivastava (1987) write longest growth up to 6 inches and Talwar & Jhingran (1991) up to 124 mm.

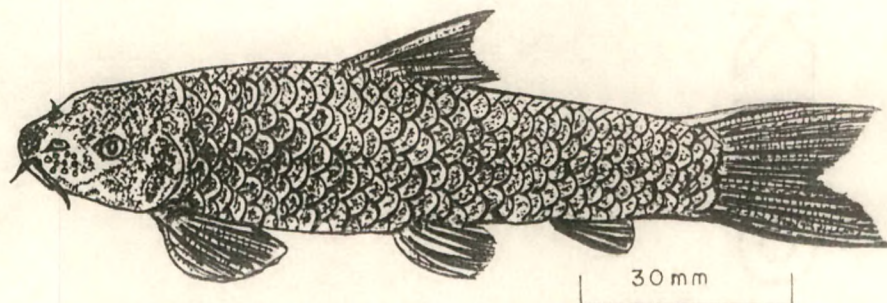
Table 36. Measurements (in mm) of *Crossocheilus latius latius* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	205.0	157.0	137.0	133.0	100.0	100.0	205.0	146.400
Standard length	164.0	125.0	113.0	108.0	80.0	80.0	164.0	118.000
Head length	32.0	26.0	21.0	20.0	16.0	16.0	32.0	23.000
Head breadth	24.0	19.0	17.0	14.0	11.0	11.0	24.0	17.000
Head depth	22.0	20.0	18.0	16.0	12.0	12.0	22.0	17.600
Gape of mouth	17.0	12.0	10.0	9.0	7.0	7.0	17.0	11.000
Eye diameter	8.0	6.5	6.0	6.5	4.5	4.5	8.0	6.300
Inter orbital distance	15.0	13.0	12.0	10.0	7.0	7.0	15.0	11.400
Post orbital distance	10.0	9.0	7.0	7.0	6.0	6.0	10.0	7.800
Inter nasal distance	13.0	10.0	9.0	8.0	6.0	6.0	13.0	9.200
Snout length	17.0	14.0	12.0	11.0	8.5	8.5	17.0	12.500
Body depth	29.0	25.0	28.0	19.0	15.0	15.0	29.0	23.200
Body width	26.0	23.0	23.0	17.0	11.0	11.0	26.0	20.000
Dorsal height	40.0	31.0	23.0	26.0	19.0	19.0	40.0	27.800
Dorsal base	27.0	22.0	17.0	16.0	13.0	13.0	27.0	19.000

Anal height	30.0	20.0	18.0	17.0	13.0	13.0	30.0	19.600
Anal base	12.0	11.0	10.0	9.0	7.5	7.5	12.0	9.900
Pectoral length	32.0	23.0	20.0	19.0	15.0	15.0	32.0	21.800
Pelvic length	30.0	21.0	18.0	18.0	14.0	14.0	30.0	20.200
Length of caudal fin	49.0	32.0	26.0	28.0	23.0	23.0	49.0	31.600
Length of upper caudal lobe	48.0	34.0	28.0	30.0	23.0	23.0	48.0	32.600
Length of lower caudal lobe	47.0	31.0	28.0	30.0	23.0	23.0	47.0	31.800
Length of caudal peduncle	27.0	21.0	19.0	20.0	14.0	14.0	27.0	20.200
Highest depth of caudal peduncle	18.0	15.0	14.0	13.0	10.0	10.0	18.0	14.000
Least depth of caudal peduncle	15.0	13.0	11.0	11.0	9.0	9.0	15.0	11.800
Pre dorsal distance	72.0	54.0	49.0	49.0	36.0	36.0	72.0	52.000
Pre pectoral distance	34.0	28.0	22.0	23.0	14.0	14.0	34.0	24.200
Pre pelvic distance	82.0	64.0	59.0	53.0	41.0	41.0	82.0	59.800
Pre anal distance	125.0	96.0	88.0	82.0	60.0	60.0	125.0	90.200
Distance between origin of pectoral & origin of pelvic	50.0	37.0	38.0	33.0	23.0	23.0	50.0	36.200
Distance between origin of pelvic & origin of anal	46.0	34.0	30.0	29.0	21.0	21.0	46.0	32.000
Distance between origin of pelvic & anus	22.0	20.0	19.0	19.0	13.0	13.0	22.0	18.600
Distance between anus and anal fin	22.0	13.0	11.0	11.0	9.0	9.0	22.0	13.200

16. *Garra annandalei* Hora, 1921

(Plate XV-2 & XX-2)

Text Figure 16. *Garra annandalei* Hora1921. *Garra annandalei* Hora, Rec. Indian Mus., 22 : 657

(Type locality, Mahanadi river, below Darjeeling).

Previous records from Sikkim: Hi, West of Pachrek (1 ex.), Coll. Menon (Tilak, 1972); Rishi khola, Rishi Coll. Menon (Tilak, 1972).

Present records: TISTA DRAINAGE: Confluence of Tista & Rani khola, SS Singtam 49 - 162 mm (37 exs.); Jali khola, SS Saramsa 105 - 110 mm (2 exs.); Rani khola, FCC 32 No. 55 - 121 mm (65 exs.); Dik chhu, SS Dikchu 105 - 122 (3 exs.); Ghattay khola, SS Sirwani 88 - 120 mm (13 exs.); Rangpo khola, FCC Rorethang 56 - 136 mm (56 exs.); SS Rangpo 50 - 153 mm (31 exs.) + fry 34 mm; RANGIT DRAINAGE: R. Rangit, FCC Tatopani 90 - 127 mm (3 exs.); SS Sikip 80 - 140 mm (8 exs.); SS Nayabazar 38 - 157 mm (28 exs.); Kalej khola, SS Legship 90 - 123 mm (8 exs.); Rishi khola, SS Rishi 100 - 106 mm (10 exs.); Roathak khola, SS Rothak 60 - 155 mm (13 exs.) + 2 fry; Rangbhang khola, SS Nayabazar 93 - 155 mm (38 exs.); Confluence of Tista and Rangit, FCC Tista (W.B.) 45 - 145 mm (6 exs.); local name: *Buduna* .

Meristic Counts: D.iii.8; P.ii.13; V.i.8; A.ii.5; C.19.

Lateral line scales 33 - 34, scales from lateral line to base of dorsal 4.5, scales from lateral line to base of pelvic 4.5, pre-dorsal scales 12 and circumpeduncular scales 14.

Morphometric Characters:

Standard length 1.20 - 1.24 (1.217), Head length 5.29 - 5.79 (5.476), Head breadth 6.23 - 6.69 (6.534), Head depth 6.92 - 8.00 (7.623), Gape of mouth 10.80 - 13.33 (12.248), Eye diameter 26.75 - 32.40 (30.046), Inter orbital distance 10.00 - 11.55 (10.977), Post orbital distance 12.00 - 14.73 (13.472), Inter nasal distance 12.86 - 18.00 (15.225), Snout length 9.47 - 10.80 (10.286), Body depth 5.29 - 6.29 (5.855), Body width 5.79 - 6.92 (6.251), Length of sucker 15.00 - 17.14

(16.105), Breadth of sucker 9.00 - 11.57 (10.105), Dorsal height 5.45 - 6.00 (5.785), Dorsal base 7.64 - 8.47 (8.069), Anal height 7.04 - 7.94 (7.319), Anal base 12.86 - 18.14 (14.351), Pectoral length 5.71 - 6.43 (6.031), Pelvic length 6.67 - 7.06 (6.813), Length of caudal fin 5.22 - 6.05 (5.483), Length of upper caudal lobe 5.22 - 6.05 (5.483), Length of lower caudal lobe 5.29 - 6.35 (5.621), Length of caudal peduncle 6.67 - 7.71 (7.115), Highest depth of caudal peduncle 8.47 - 9.73 (8.966), Least depth of caudal peduncle 8.53 - 9.73 (9.095), Pre dorsal distance 2.50 - 2.61 (2.573), Pre pectoral distance 5.00 - 5.79 (5.410), Pre pelvic distance 2.25 - 2.42 (2.322), Pre anal distance 1.53 - 1.62 (1.567), Distance between origin of pectoral & origin of pelvic 3.60 - 3.96 (3.757), Distance between origin of pelvic & origin of anal 4.23 - 4.86 (4.508), Distance between origin of pelvic & anus 6.48 - 7.50 (6.953), Distance between anus and origin of anal fin 12.46 - 13.38 (12.936).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 37. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. annandalei* Hora, 1921.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.187	80.374	83.465	1.141
Head length	18.262	17.284	18.889	0.559
Head breadth	15.304	14.953	16.049	0.436
Head depth	13.118	12.500	14.444	0.698
Gape of mouth	8.164	7.500	9.259	0.622
Eye diameter	3.328	3.086	3.738	0.227
Inter orbital distance	9.110	8.661	10.000	0.490
Post orbital distance	7.423	6.790	8.333	0.531
Inter nasal distance	6.568	5.556	7.778	0.717
Snout length	9.722	9.259	10.556	0.490
Body depth	17.081	15.888	18.898	1.011
Body width	15.997	14.444	17.284	0.938
Length of sucker	6.209	5.833	6.667	0.275
Breadth of sucker	9.896	8.642	11.111	0.826
Dorsal height	17.286	16.667	18.333	0.583

Dorsal base	12.393	11.811	13.084	0.415
Anal height	13.663	12.598	14.198	0.618
Anal base	6.968	5.512	7.778	0.815
Pectoral length	16.582	15.556	17.500	0.793
Pelvic length	14.677	14.173	15.000	0.319
Length of caudal fin	18.237	16.535	19.167	0.949
Length of upper caudal lobe	18.237	16.535	19.167	0.949
Length of lower caudal lobe	17.789	15.748	18.889	1.161
Length of caudal peduncle	14.055	12.963	15.000	0.828
Highest depth of caudal peduncle	11.153	10.280	11.811	0.571
Least depth of caudal peduncle	10.995	10.280	11.728	0.467
Pre dorsal distance	38.868	38.272	40.000	0.650
Pre pectoral distance	18.484	17.284	20.000	0.888
Pre pelvic distance	43.057	41.358	44.444	1.180
Pre anal distance	63.802	61.682	65.354	1.240
Distance between origin of pectoral & origin of pelvic	26.614	25.234	27.778	0.976
Distance between origin of pelvic & origin of anal	22.182	20.561	23.622	1.039
Distance between origin of pelvic & anus	14.382	13.333	15.432	0.737
Distance between anus and anal fin	7.731	7.477	8.025	0.213

Other Characteristics:

Body: Elongated, sub-cylindrical. Dorsal profile gently arched anteriorly, abdomen rounded.

Head: Moderate, snout prominent, smooth.

Eyes: Moderate, diameter 5.0 - 5.7 in length of head; placed in the middle of head excluding snout, not visible from below ventral surface; inter orbital space convex.

Mouth: Inferior, transverse, semicircular. Width of gape of mouth 1.8 - 2.4 in length of head. Lips thick, upper lip fringed, upper lip continuous with lower.

Barbels: Two pairs, a pair each of maxillary and rostral. Both pairs short.

Fins: Dorsal fin inserted near tip of snout than base of caudal and anterior to origin of ventral fin. Dorsal height longer than or equal to body depth. Pectoral fin shorter than head length but in one specimen it is equal to head. A sheath like small appendage present at the base of pelvic. Paired fins horizontal and not plaited. Anal fin short. Caudal forked with upper lobe slightly longer or equal to lower lobe.

Lateral Line: Present & complete

Scales: Moderate

Colour: Body colour varies from grayish yellow to grayish blue above, and lighter below. A few brick red scales in a row behind the operculum above pectoral & pelvic fins. Retina surrounded by a pink coloured streak. Fins: Dorsal and caudal pale with dark fin rays with orange to pinkish caudal fin edge. Pectoral, ventral & anal reddish.

Distribution: India: Eastern Himalayas, Darjeeling, Assam, Meghalaya. Elsewhere: Nepal, Bangladesh.

Remarks: The present samples are found to differ from *G. annandalei* as described by Menon (1954) in various morphometric characters: head length in total length 4.3 - 4.75 (versus 4.16 - 4.41 by Menon, 1954); head breadth in head length 1.07 - 1.25 (versus 1.15 - 1.39); inter-orbital width in length of head 1.86 - 2.10 (versus 2.10 - 2.88) and length of disc in length of head 2.80 - 3.17 (versus 3.25 - 3.89). The species is widely distributed throughout the drainages up to 745 m msl and forms an important fishery of the state.

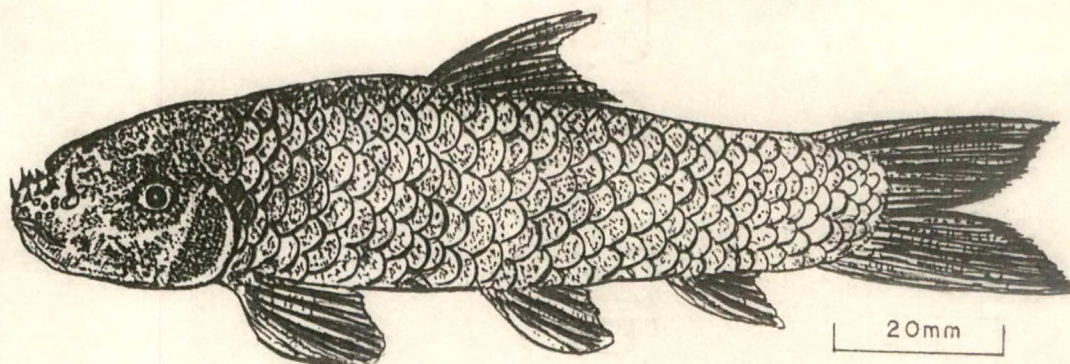
Table 38. Measurements (in mm) of *Garra annandalei* Hora, 1921.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	162.0	127.0	120.0	107.0	90.0	90.0	162.0	121.200
Standard length	133.0	106.0	98.0	86.0	75.0	75.0	133.0	99.600
Head length	28.0	23.0	22.0	20.0	17.0	17.0	28.0	22.000
Head breadth	26.0	19.0	18.0	16.0	14.0	14.0	26.0	18.600
Head depth	21.0	16.0	15.0	14.0	13.0	13.0	21.0	15.800
Gape of mouth	15.0	10.0	9.0	9.0	7.0	7.0	15.0	10.000
Eye diameter	5.0	4.0	4.0	4.0	3.0	3.0	5.0	4.000
Inter orbital distance	15.0	11.0	10.5	9.5	9.0	9.0	15.0	11.000
Post orbital distance	11.0	9.5	9.0	7.5	7.5	7.5	11.0	8.900
Inter nasal distance	9.0	8.0	8.0	7.0	7.0	7.0	9.0	7.800
Snout length	15.0	12.0	12.0	10.0	9.5	9.5	15.0	11.700
Body depth	28.0	24.0	20.0	17.0	15.0	15.0	28.0	20.800
Body width	28.0	21.0	19.0	17.0	13.0	13.0	28.0	19.600
Length of sucker	10.0	8.0	7.0	6.5	6.0	6.0	10.0	7.500
Breadth of sucker	14.0	12.0	12.0	11.0	10.0	10.0	14.0	11.800

Dorsal height	28.0	22.0	22.0	18.0	15.0	15.0	28.0	21.000
Dorsal base	20.0	15.0	15.0	14.0	11.0	11.0	20.0	15.000
Anal height	23.0	16.0	17.0	15.0	12.0	12.0	23.0	16.600
Anal base	12.0	7.0	8.0	8.0	7.0	7.0	12.0	8.400
Pectoral length	28.0	20.0	21.0	18.0	14.0	14.0	28.0	20.200
Pelvic length	24.0	18.0	18.0	16.0	13.0	13.0	24.0	17.800
Length of caudal fin	29.0	21.0	23.0	20.0	17.0	17.0	29.0	22.000
Length of upper caudal lobe	29.0	21.0	23.0	20.0	17.0	17.0	29.0	22.000
Length of lower caudal lobe	28.0	20.0	22.0	20.0	17.0	17.0	28.0	21.400
Length of caudal peduncle	21.0	19.0	18.0	15.0	12.0	12.0	21.0	17.000
Highest depth of caudal peduncle	19.0	15.0	13.0	11.0	10.0	10.0	19.0	13.600
Least depth of caudal peduncle	19.0	14.0	13.0	11.0	10.0	10.0	19.0	13.400
Pre dorsal distance	62.0	49.0	47.0	41.0	36.0	36.0	62.0	47.000
Pre pectoral distance	28.0	23.0	22.0	20.0	18.0	18.0	28.0	22.200
Pre pelvic distance	67.0	56.0	52.0	45.0	40.0	40.0	67.0	52.000
Pre anal distance	104.0	83.0	76.0	66.0	58.0	58.0	104.0	77.400
Distance between origin of pectoral & origin of pelvic	45.0	35.0	31.0	27.0	24.0	24.0	45.0	32.400
Distance between origin of pelvic & origin of anal	37.0	30.0	26.0	22.0	20.0	20.0	37.0	27.000
Distance between origin of pelvic & anus	25.0	19.0	17.0	15.0	12.0	12.0	25.0	17.600
Distance between anus and anal fin	13.0	10.0	9.0	8.0	7.0	7.0	13.0	9.400

17. *Garra gotyla gotyla* (Gray), 1832

(Plate XV-5 & XX-5)

Text Figure 17. *Garra gotyla gotyla* (Gray)1832. *Cyprinus gotyla* Gray, Ill. Ind., Zool. 1. pl 88, figs. 3, 3a

Previous records from Sikkim: Rishi khola, Rishi ; Dikchu khola; Khola river, Gangtok - Coll. Menon (Tilak, 1972); Rangit river (Bhutia & Acharya, 1987).

Present Records: TISTA DRAINAGE: Seti khola, SS Lower Lagyap 93 - 133 mm (16 exs.); Jali khola, SS Saramsa 82 - 169 mm (25 exs.); Rani khola, SS Saramsa 73 - 135 mm (7 exs.); FCC 32 No. 95 - 140 mm (9 exs.); Rin khola, SS Lower Dzongu 127 - 230 mm (10 exs.); Ghattay khola, SS Sirwani 50 - 136 mm (4 exs.); Rangpo khola, FCC Rorethang 102 - 182 mm (4 exs.); SS Rangpo 94 mm (1 ex.). RANGIT DRAINAGE: R. Rangit, FCC Tatopani 136 mm (1 ex.); SS Sikip 95 - 119 mm (3 exs.); SS Nayabazar 148 mm (1 ex.); Kalej khola, SS Legship 160 - 209 (4 exs.); Roathak khola, SS Rothak 114 - 132 mm (6 exs.); Rangbhang khola, SS Nayabazar 145 - 160 mm (4 exs.); local name: *Nakatua Buduna* .

Meristic Counts: D.iii.9; P.ii.15; V.i.8; A.i.6-7; C.19.

Lateral line scales 34, scales from base of dorsal to lateral line 4.5, scales from lateral line to base of pelvic 4.5, pre-dorsal scales 11 and scales around caudal peduncle 11.

Morphometric Characters:

Standard length 1.18 - 1.20 (1.189), Head length 4.67 - 5.40 (5.037), Head breadth 5.29 - 6.75 (6.081), Head depth 6.70 - 7.64 (7.202), Gape of mouth 8.74 - 12.27 (10.016), Eye diameter 25.43 - 32.86 (29.303), Inter orbital distance 9.57 - 10.70 (10.094), Post orbital distance 11.13 - 13.50 (12.607), Inter nasal distance 11.89 - 13.53 (12.730), Snout length 8.04 - 9.64 (8.706), Body depth 5.00 - 5.63 (5.218), Body width 5.23 - 6.69 (5.907), Length of sucker 8.74 - 11.89 (9.994),

Breadth of sucker 6.70 - 8.92 (7.743), Dorsal height 5.43 - 6.43 (5.976), Dorsal base 6.22 - 7.64 (6.953), Anal height 6.28 - 7.64 (6.978), Anal base 12.56 - 17.80 (14.629), Pectoral length 5.15 - 6.29 (5.779), Pelvic length 5.74 - 7.13 (6.535), Length of caudal fin 5.56 - 6.29 (5.755), Length of upper caudal lobe 5.56 - 6.57 (5.933), Length of lower caudal lobe 5.56 - 6.29 (5.755), Length of caudal peduncle 6.93 - 7.42 (7.107), Highest depth of caudal peduncle 7.94 - 8.52 (8.226), Least depth of caudal peduncle 8.74 - 10.45 (9.322), Pre dorsal distance 2.34 - 2.49 (2.420), Pre pectoral distance 4.94 - 5.23 (5.095), Pre pelvic distance 2.05 - 2.28 (2.133), Pre anal distance 1.44 - 1.68 (1.517), Distance between origin of pectoral & origin of pelvic 3.14 - 3.87 (3.439), Distance between origin of pelvic & origin of anal 4.34 - 4.82 (4.586), Distance between origin of pelvic & anus 5.74 - 7.94 (6.760), Distance between anus and origin of anal fin 10.70 - 20.10 (13.585).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 39. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. gotyla gotyla* (Gray), 1832.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	84.128	83.043	85.047	0.696
Head length	19.853	18.519	21.393	1.093
Head breadth	16.446	14.815	18.905	1.634
Head depth	13.886	13.084	14.925	0.737
Gape of mouth	9.984	8.148	11.443	1.158
Eye diameter	3.413	3.043	3.933	0.296
Inter orbital distance	9.907	9.346	10.448	0.383
Post orbital distance	7.932	7.407	8.980	0.568
Inter nasal distance	7.856	7.391	8.411	0.391
Snout length	11.487	10.370	12.438	0.743
Body depth	19.165	17.757	20.000	0.762
Body width	16.929	14.953	19.130	1.370
Length of sucker	10.006	8.411	11.443	0.994
Breadth of sucker	12.914	11.215	14.925	1.238
Dorsal height	16.732	15.556	18.408	0.997
Dorsal base	14.382	13.084	16.087	1.332

Anal height	14.330	13.084	15.920	1.003
Anal base	6.836	5.618	7.960	0.796
Pectoral length	17.304	15.888	19.403	1.265
Pelvic length	15.301	14.019	17.413	1.179
Length of caudal fin	17.376	15.888	17.978	0.767
Length of upper caudal lobe	16.855	15.217	17.978	1.099
Length of lower caudal lobe	17.376	15.888	17.978	0.767
Length of caudal peduncle	14.070	13.483	14.428	0.332
Highest depth of caudal peduncle	12.156	11.739	12.593	0.301
Least depth of caudal peduncle	10.727	9.565	11.443	0.703
Pre dorsal distance	41.318	40.187	42.786	0.876
Pre pectoral distance	19.628	19.130	20.225	0.403
Pre pelvic distance	46.883	43.781	48.889	1.712
Pre anal distance	65.903	59.701	69.565	3.302
Distance between origin of pectoral & origin of pelvic	29.082	25.871	31.852	2.046
Distance between origin of pelvic & origin of anal	21.803	20.741	23.043	0.814
Distance between origin of pelvic & anus	14.793	12.593	17.413	2.149
Distance between anus and anal fin	7.361	4.975	9.346	1.668

Other Characteristics:

Body: Elongated, sub-cylindrical. Dorsal profile convex, ventral almost straight. Abdomen rounded.

Head: Slightly depressed to convex. A well developed proboscis with lateral tubercular area present on the snout.

Eyes: Moderate, diameter 5.1 - 6.7 in length of head, placed in the posterior half of head, lateral, directed slightly upwards and outward, not visible from below ventral surface.

Mouth: Inferior, transverse, semicircular. Lips thick, fleshy, upper lip fringed & continuous with lower. A suctorial disc of semi cartilaginous pad present on the chin formed on the lower lip.

Barbels: A pair, each of maxillary and rostral.

Fins: Dorsal inserted ahead of pelvics, nearer tip of snout than caudal base. Dorsal height shorter than depth of body. Paired fins horizontally expanded and not plaited. Pectoral fin shorter than head length, does not reach pelvics. A sheath like scaly appendage present at the base of pelvic. Caudal fin forked with equal lobes but in one specimen lower lobe is longer than upper.

Lateral Line: Simple & complete

Colour: Body & head dark grayish and silvery beneath. Presence of a dark blue scale behind operculum. A row of few brick red & yellow scales present on the body behind operculum. Fins: Dorsal and caudal with dark fin rays tinged with peacock blue. Pectoral, ventral and anal lemon yellow with reddish edges.

Distribution: India: All along the Himalayas and peninsular India. Elsewhere: Bangladesh, Upper Burma, Nepal and Pakistan.

Remarks: The maximum size of the fish recorded during the present investigation is 230 mm but Datta Munshi (1988) writes the maximum length of 8 inches and Talwar & Jhingran (1991) 140 mm. The present species resembles *G. gotyla gotyla* as described by Menon (1954); yet it differs from it in some characters: head length in standard length 3.95 - 4.55 (versus 3.52 - 4.20, Menon 1954), inter orbital width in length of head 1.92 - 2.04 (versus 2.06 - 2.62); distance from ventral to anal fin in that between anterior origin of pelvic and anal 2.3 - 4.5 (versus 3.3 -7.3).

It is a common species occurring up to an elevation of 745 m.

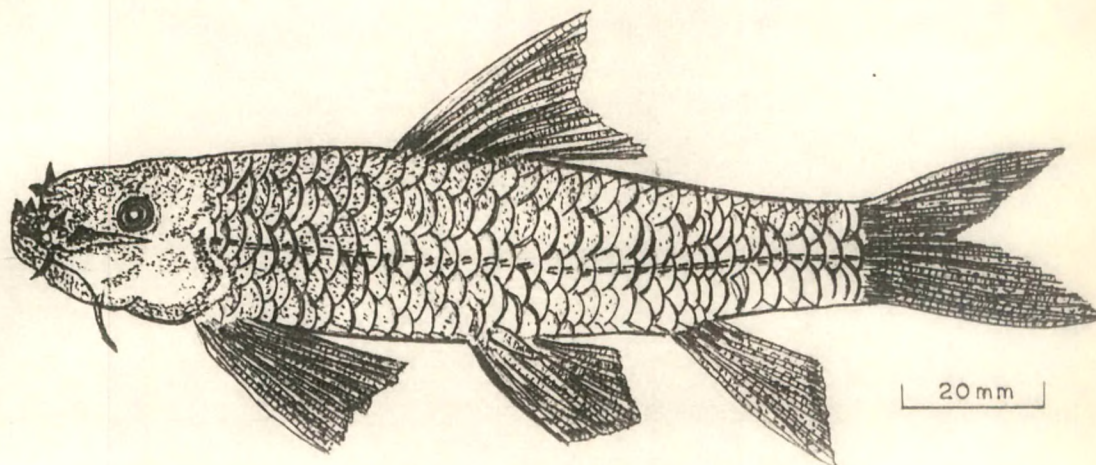
Table 40. Measurements (in mm) of *Garra gotyla gotyla* (Gray), 1832.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	89.0	107.0	135.0	201.0	230.0	89.0	230.0	152.400
Standard length	75.0	91.0	113.0	170.0	191.0	75.0	191.0	128.000
Head length	18.0	20.0	25.0	43.0	47.0	18.0	47.0	30.600
Head breadth	14.0	16.0	20.0	38.0	41.0	14.0	41.0	25.800
Head depth	13.0	14.0	18.0	30.0	31.0	13.0	31.0	21.200
Gape of mouth	9.0	10.0	11.0	23.0	25.0	9.0	25.0	15.600
Eye diameter	3.5	3.5	4.5	7.0	7.0	3.5	7.0	5.100
Inter orbital distance	9.0	10.0	13.0	21.0	23.0	9.0	23.0	15.200
Post orbital distance	8.0	8.0	10.0	16.0	18.0	8.0	18.0	12.000
Inter nasal distance	7.0	9.0	11.0	15.0	17.0	7.0	17.0	11.800
Snout length	10.0	12.0	14.0	25.0	28.0	10.0	28.0	17.800
Body depth	17.0	19.0	27.0	39.0	45.0	17.0	45.0	29.400
Body width	15.0	16.0	22.0	35.0	44.0	15.0	44.0	26.400
Length of sucker	9.0	9.0	13.0	23.0	24.0	9.0	24.0	15.600
Breadth of sucker	11.0	12.0	17.0	30.0	31.0	11.0	31.0	20.200

Dorsal height	15.0	17.0	21.0	37.0	39.0	15.0	39.0	25.800
Dorsal base	12.0	14.0	18.0	32.0	37.0	12.0	37.0	22.600
Anal height	12.0	14.0	20.0	32.0	33.0	12.0	33.0	22.200
Anal base	5.0	7.0	9.0	16.0	17.0	5.0	17.0	10.800
Pectoral length	16.0	17.0	22.0	39.0	39.0	16.0	39.0	26.600
Pelvic length	13.0	15.0	20.0	35.0	36.0	13.0	36.0	23.800
Length of caudal fin	16.0	17.0	24.0	35.0	41.0	16.0	41.0	26.600
Length of upper caudal lobe	16.0	17.0	24.0	35.0	35.0	16.0	35.0	25.400
Length of lower caudal lobe	16.0	17.0	24.0	35.0	41.0	16.0	41.0	26.600
Length of caudal peduncle	12.0	15.0	19.0	29.0	33.0	12.0	33.0	21.600
Highest depth of caudal peduncle	11.0	13.0	17.0	24.0	27.0	11.0	27.0	18.400
Least depth of caudal peduncle	10.0	11.0	15.0	23.0	22.0	10.0	23.0	16.200
Pre dorsal distance	37.0	43.0	55.0	86.0	95.0	37.0	95.0	63.200
Pre pectoral distance	18.0	21.0	26.0	40.0	44.0	18.0	44.0	29.800
Pre pelvic distance	42.0	50.0	66.0	88.0	110.0	42.0	110.0	71.200
Pre anal distance	59.0	72.0	90.0	120.0	160.0	59.0	160.0	100.200
Distance between origin of pectoral & origin of pelvic	26.0	30.0	43.0	52.0	70.0	26.0	70.0	44.200
Distance between origin of pelvic & origin of anal	19.0	23.0	28.0	45.0	53.0	19.0	53.0	33.600
Distance between origin of pelvic & anus	12.0	14.0	17.0	35.0	40.0	12.0	40.0	23.600
Distance between anus and anal fin	8.0	10.0	10.0	10.0	14.0	8.0	14.0	10.400

18. *Garra gotyla stenorhynchus* (Jerdon), 1849

(Plate XV-1 & XX-1)

Text Figure 18. *Garra gotyla stenorhynchus* (Jerdon)

1849. *Gonorhynchus stenorhynchus* Jerdon, Madras J. Lit. Sci., Madras, 15, p. 310

(Type locality, Bhawany River, Nilgiris).

Present records: TISTA DRAINAGE: Rani khola, SS Saramsa 99 - 145 mm (2 exs.); FCC 32 No. 103 - 150 mm (6 exs.); Seti khola, SS Lower Lagyap 130 - 134 mm (2 exs.); Kanaka chhu, FCC Sangkalang 113 - 143 mm (4 exs.); Dik chhu, SS Dikchu 110 - 213 mm (7 exs.); Confluence of Tista and Rani khola, SS Singtam 90 - 165 mm (4 exs.); Rangpo khola, FCC Rorethang 110 - 235 mm (21 exs.). RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 190 mm (1 ex.); FCC Tatopani 125 - 175 mm (11 exs.); SS Nayabazar 153 - 240 mm (3 exs.); Rimbi khola, SS Rimbi 120 - 182 mm (2 exs.); Kalej khola, SS Legship 145 mm (1 ex.); Rishi khola, SS Rishi 85 - 149 mm (3 exs.); Rangbhang khola, SS Nayabazar 110 - 150 mm (5 exs.); local name: *Nakatua buduna* .

Meristic Counts: D.ii.7; P.iii.12-15; V.ii.7; A.i.6; C.19.

Lateral line scales 36, scales from base of dorsal to lateral line 3.5, scales from lateral line to base of pelvic 2.5, pre-dorsal scales 11-12 and circumpeduncular scales 11 - 11.5.

Morphometric Characters:

Standard length 1.17 - 1.20 (1.188), Head length 4.75 - 5.56 (5.153), Head breadth 5.97 - 6.67 (6.357), Head depth 7.37 - 8.35 (7.837), Gape of mouth 8.04 - 9.33 (8.659), Eye diameter 28.00 - 36.92 (33.050), Inter orbital distance 9.95 - 11.43 (10.816), Post orbital distance 12.29 - 15.78 (13.729), Inter nasal distance 13.69 - 15.00 (14.151), Snout length 8.00 - 9.37 (8.754), Body

depth 5.97 - 6.85 (6.411), Body width 6.33 - 7.12 (6.792), Length of sucker 8.57 - 11.87 (10.141), Breadth of sucker 7.46 - 8.24 (7.824), Dorsal height 5.10 - 5.93 (5.514), Dorsal base 6.32 - 7.12 (6.797), Anal height 5.81 - 7.74 (6.763), Anal base 13.93 - 17.80 (14.988), Pectoral length 5.23 - 6.14 (5.703), Pelvic length 5.81 - 7.12 (6.408), Length of caudal fin 5.00 - 5.93 (5.397), Length of upper caudal lobe 5.36 - 5.93 (5.625), Length of lower caudal lobe 5.00 - 5.93 (5.397), Length of caudal peduncle 6.74 - 8.00 (7.258), Highest depth of caudal peduncle 8.36 - 9.60 (9.085). Least depth of caudal peduncle 9.09 - 9.60 (9.368), Pre dorsal distance 2.41 - 2.58 (2.517), Pre pectoral distance 4.86 - 5.56 (5.224), Pre pelvic distance 2.15 - 2.22 (2.193), Pre anal distance 1.51 - 1.55 (1.521), Distance between origin of pectoral & origin of pelvic 3.55 - 3.73 (3.631), Distance between origin of pelvic & origin of anal 4.38 - 4.90 (4.612), Distance between origin of pelvic & anus 5.97 - 7.12 (6.630), Distance between anus and origin of anal fin 11.67 - 21.82 (15.156).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 41. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. gotyla stenorrhynchus* (Jerdon), 1849.

CHARACTERS	MRI	RANGE		MEAN
		Min.	Max.	
Standard length	84.170	83.333	85.714	0.827
Head length	19.406	17.978	21.053	1.151
Head breadth	15.732	15.000	16.746	0.665
Head depth	12.760	11.972	13.571	0.619
Gape of mouth	11.548	10.714	12.440	0.625
Eye diameter	3.026	2.708	3.571	0.313
Inter orbital distance	9.245	8.750	10.048	0.439
Post orbital distance	7.284	6.338	8.134	0.580
Inter nasal distance	7.066	6.667	7.303	0.217
Snout length	11.424	10.674	12.500	0.712
Body depth	15.597	14.607	16.746	0.858
Body width	14.724	14.045	15.789	0.732
Length of sucker	9.861	8.427	11.667	1.422
Breadth of sucker	12.782	12.143	13.397	0.506
Dorsal height	18.137	16.854	19.617	0.956

Dorsal base	14.712	14.045	15.833	0.726
Anal height	14.787	12.921	17.225	1.454
Anal base	6.672	5.618	7.177	0.611
Pectoral length	17.536	16.292	19.139	0.925
Pelvic length	15.605	14.045	17.225	1.109
Length of caudal fin	18.530	16.854	20.000	1.184
Length of upper caudal lobe	17.779	16.854	18.660	0.581
Length of lower caudal lobe	18.530	16.854	20.000	1.184
Length of caudal peduncle	13.778	12.500	14.833	0.852
Highest depth of caudal peduncle	11.007	10.417	11.962	0.552
Least depth of caudal peduncle	10.675	10.417	11.005	0.195
Pre dorsal distance	39.732	38.732	41.429	1.045
Pre pectoral distance	19.144	17.978	20.574	0.888
Pre pelvic distance	45.593	44.944	46.411	0.554
Pre anal distance	65.765	64.583	66.429	0.672
Distance between origin of pectoral & origin of pelvic	27.539	26.794	28.169	0.532
Distance between origin of pelvic & origin of anal	21.681	20.417	22.857	0.887
Distance between origin of pelvic & anus	15.082	14.045	16.746	1.170
Distance between anus and anal fin	6.598	4.583	8.571	1.616

Other Characteristics:

Body: Elongated, sub-cylindrical. Dorsal slightly more convex, ventral flat up to pelvics with rounded abdomen.

Head: Moderate in size, slightly depressed. Proboscis well developed with lateral tubercular area.

Eyes: Moderate, diameter 5.2 - 7.5 in length of head placed 2.0 - 2.3 apart, placed in the posterior half of head. Eyes are placed laterally slightly upwards and outward not visible from below ventral surface.

Mouth: Inferior, transverse, semicircular. Lips thick, fleshy. Upper lip fringed and continuous with lower. A prominent suctorial disc of semi cartilaginous pad present on the chin formed on the lower lip.

Barbels: Two pairs, a pair each of maxillary & rostral.

Fins: Dorsal placed ahead of ventral at near tip of snout than caudal base; higher than depth of body. Paired fins horizontally expanded not plaited. Pectoral length shorter than head not reaching

pelvic. Presence of a scaly appendage. Caudal fin forked with equal lobes but in 3 specimens, lower lobe longer than upper.

Lateral Line: Simple & complete

Colour: Body and head dark greyish and silvery beneath. Presence of a dark blue scale at behind operculum. A few brick red and yellow scales present on the body behind operculum. Fins: Dorsal & Caudal with dark fin rays & peacock blue tinge. Pectoral, Ventral & Anal lemon- yellow with reddish edges.

Distribution: India: Cauvery and Krishna river systems, Western Ghats.

Remarks: The species is recorded for the first time from Sikkim drainages. It is the largest member found amongst *Garra* which is found to exhibit maximum size of 240 mm during the present investigation extending the previous records of 150 mm (Talwar & Jhingran, 1991).

It can be distinguished from *G. gotyla gotyla* from its body depth 5 or more than 5 times in standard length. The present samples show variations from *G. gotyla stenorhynchus* as described by Menon (1954) in respect of body depth in standard length 5.0 - 5.76 (versus 3.7 - 5.35); and the distance from vent to anal in that between anterior origins of pelvic and anal fins 2.66 - 4.5 (versus 3.2 - 9.00).

It is found in abundance upto 1065 m (msl) in both the drainages.

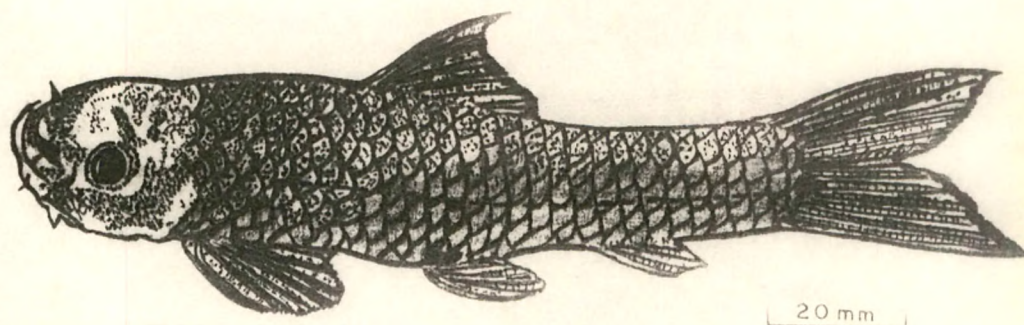
Table 42. Measurements (in mm) of *Garra gotyla stenorhynchus* (Jerdon), 1849.

CHARACTER	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	140.0	142.0	178.0	209.0	240.0	140.0	240.0	181.800
Standard length	120.0	119.0	150.0	175.0	200.0	119.0	200.0	152.800
Head length	26.0	27.0	32.0	44.0	49.0	26.0	49.0	35.600
Head breadth	21.0	22.0	27.0	35.0	39.0	21.0	39.0	28.800
Head depth	19.0	17.0	22.0	28.0	30.0	17.0	30.0	23.200
Gape of mouth	15.0	16.0	20.0	26.0	29.0	15.0	29.0	21.200
Eye diameter	5.0	4.5	5.0	6.0	6.5	4.5	6.5	5.400
Inter orbital distance	13.0	13.0	16.0	21.0	21.0	13.0	21.0	16.800
Post orbital distance	10.0	9.0	13.0	17.0	18.0	9.0	18.0	13.400
Inter nasal distance	10.0	10.0	13.0	15.0	16.0	10.0	16.0	12.800
Snout length	15.0	16.0	19.0	25.0	30.0	15.0	30.0	21.000
Body depth	23.0	21.0	26.0	35.0	37.0	21.0	37.0	28.400

Body width	20.0	20.0	25.0	33.0	37.0	20.0	37.0	27.000
Length of sucker	12.0	13.0	15.0	24.0	28.0	12.0	28.0	18.400
Breadth of sucker	17.0	18.0	22.0	28.0	32.0	17.0	32.0	23.400
Dorsal height	25.0	25.0	30.0	41.0	45.0	25.0	45.0	33.200
Dorsal base	20.0	20.0	25.0	32.0	38.0	20.0	38.0	27.000
Anal height	20.0	20.0	23.0	36.0	37.0	20.0	37.0	27.200
Anal base	10.0	9.0	10.0	15.0	17.0	9.0	17.0	12.200
Pectoral length	24.0	25.0	29.0	40.0	42.0	24.0	42.0	32.000
Pelvic length	22.0	21.0	25.0	36.0	39.0	21.0	39.0	28.600
Length of caudal fin	26.0	25.0	30.0	41.0	48.0	25.0	48.0	34.000
Length of upper caudal lobe	25.0	25.0	30.0	39.0	43.0	25.0	43.0	32.400
Length of lower caudal lobe	26.0	25.0	30.0	41.0	48.0	25.0	48.0	34.000
Length of caudal peduncle	19.0	19.0	26.0	31.0	30.0	19.0	31.0	25.000
Highest depth of caudal peduncle	15.0	16.0	19.0	25.0	25.0	15.0	25.0	20.000
Least depth of caudal peduncle	15.0	15.0	19.0	23.0	25.0	15.0	25.0	19.400
Pre dorsal distance	58.0	55.0	70.0	81.0	97.0	55.0	97.0	72.200
Pre pectoral distance	26.0	27.0	32.0	43.0	47.0	26.0	47.0	35.000
Pre pelvic distance	63.0	65.0	80.0	97.0	110.0	63.0	110.0	83.000
Pre anal distance	93.0	93.0	118.0	138.0	155.0	93.0	155.0	119.400
Distance between origin of pectoral & origin of pelvic	38.0	40.0	50.0	56.0	66.0	38.0	66.0	50.000
Distance between origin of pelvic & origin of anal	32.0	30.0	40.0	45.0	49.0	30.0	49.0	39.200
Distance between origin of pelvic & anus	20.0	20.0	25.0	35.0	39.0	20.0	39.0	27.800
Distance between anus and anal fin	12.0	11.0	13.0	10.0	11.0	10.0	13.0	11.400

19. *Garra lamta* (Hamilton), 1822

(Plate XV-4 & XX-6)

Text Figure 19. *Garra lamta* (Hamilton)

1822. *Cyprinus (Garra) lamta* Hamilton, (in part) Fish. Ganges, pp.343, 393

(Type locality, Tinau River at Butwal, Nepal).

Previous records from Sikkim: Chatra; Ranjeet river, Manjhitar; Rongni chhu, Martin (Tilak, 1972); river Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Seti khola, SS Lower Lagyap 83 -123 mm (8 exs.); Rani khola, SS Saramsa 80 - 125 mm (3 exs.); FCC 32 No. 55 - 125 mm (17 exs.); Ghattay khola, SS Sirwani 88 - 92 mm (3 exs.); Confluence of Tista and Rani khola, SS Singtam 94 - 132 mm (8 exs.); Rangpo khola, FCC Rorethang 85 - 125 mm (10 exs.); SS Rangpo 88 - 135 mm (8 exs.). RANGIT DRAINAGE: R. Rangit, FCC Tatopani 52 - 137 mm (2 exs.); SS Sikhhip 112 - 127 mm (2 exs.); SS Nayabazar 75- 120 mm (9 exs.); Kalej khola, SS Legship 63 mm (3 exs.); Roathak khola, SS Rothak 80 - 85 mm (3 exs.); Rangbhang khola, SS Nayabazar 100 - 106 mm (6 exs.); Confluence of Tista & Rangit, FCC Tista 79 - 125 mm (3 exs.); local name: *Nakatua Buduna* .

Meristic Counts: D.iii.8; P.ii.13; V.i.8; A.ii.5; C.19.

Lateral line scales 33 - 36, Scales from base of dorsal to lateral line 4.5, scales from lateral line to base of pelvic 4.5, pre-dorsal scales 12 and circumpeduncular scales 14.

Morphometric Characters:

Standard length 1.19 - 1.22 (1.201), Head length 5.11 - 5.71 (5.514), Head breadth 5.87 - 6.93 (6.460), Head depth 7.08 - 7.46 (7.276), Gape of mouth 10.22 - 12.18 (11.213), Eye diameter 26.29 - 33.50 (29.605), Inter orbital distance 10.00 - 12.13 (10.726), Post orbital distance 12.13 - 13.57 (13.125), Inter nasal distance 13.40 - 14.21 (13.831), Snout length 9.20 - 10.31 (9.756), Body depth 5.00 - 5.83 (5.393), Body width 5.40 - 6.47 (5.859), Length of sucker 13.14 -

14.92 (14.174), Breadth of sucker 9.05 - 10.72 (9.628), Dorsal height 5.41 - 6.09 (5.864), Dorsal base 6.57 - 8.82 (7.546), Anal height 6.93 - 9.50 (7.546), Anal base 13.14 - 19.40 (15.088), Pectoral length 5.75 - 6.38 (6.069), Pelvic length 6.57 - 7.05 (6.814), Length of caudal fin 5.11 - 5.94 (5.579), Length of upper caudal lobe 5.11 - 5.94 (5.579), Length of lower caudal lobe 5.11 - 5.94 (5.579), Length of caudal peduncle 6.09 - 7.50 (6.744), Highest depth of caudal peduncle 7.50 - 8.82 (8.071), Least depth of caudal peduncle 8.93 - 9.70 (9.257), Pre dorsal distance 2.44 - 2.68 (2.590), Pre pectoral distance 5.28 - 5.87 (5.608), Pre pelvic distance 2.11 - 2.25 (2.198), Pre anal distance 1.45 - 1.63 (1.549), Distance between origin of pectoral & origin of pelvic 3.13 - 3.68 (3.435), Distance between origin of pelvic & origin of anal 4.50 - 5.00 (4.790), Distance between origin of pelvic & anus 5.71 - 6.79 (6.178), Distance between anus and origin of anal fin 19.40 - 27.00 (23.069).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 43. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. lamta* (Hamilton), 1822.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.237	82.222	84.211	0.760
Head length	18.135	17.526	19.565	0.728
Head breadth	15.480	14.433	17.037	0.894
Head depth	13.745	13.402	14.130	0.308
Gape of mouth	8.918	8.209	9.783	0.505
Eye diameter	3.378	2.985	3.804	0.297
Inter orbital distance	9.323	8.247	10.000	0.641
Post orbital distance	7.619	7.368	8.247	0.325
Inter nasal distance	7.230	7.037	7.463	0.166
Snout length	10.250	9.701	10.870	0.391
Body depth	18.544	17.164	20.000	0.898
Body width	17.069	15.464	18.519	1.091
Length of sucker	7.055	6.701	7.609	0.378
Breadth of sucker	10.386	9.328	11.053	0.600
Dorsal height	17.054	16.418	18.478	0.747

Dorsal base	13.252	11.340	15.217	1.267
Anal height	13.251	10.526	14.433	1.442
Anal base	6.628	5.155	7.609	0.925
Pectoral length	16.477	15.672	17.391	0.674
Pelvic length	14.676	14.179	15.217	0.353
Length of caudal fin	17.923	16.842	19.565	0.995
Length of upper caudal lobe	17.923	16.842	19.565	0.995
Length of lower caudal lobe	17.923	16.842	19.565	0.995
Length of caudal peduncle	14.828	13.333	16.418	1.008
Highest depth of caudal peduncle	12.390	11.340	13.333	0.682
Least depth of caudal peduncle	10.802	10.309	11.194	0.338
Pre dorsal distance	38.614	37.313	41.053	1.280
Pre pectoral distance	17.831	17.037	18.947	0.753
Pre pelvic distance	45.505	44.444	47.423	1.173
Pre anal distance	64.541	61.194	69.072	2.627
Distance between origin of pectoral & origin of pelvic	29.108	27.174	31.959	1.623
Distance between origin of pelvic & origin of anal	20.878	20.000	22.222	0.734
Distance between origin of pelvic & anus	16.187	14.737	17.526	1.059
Distance between anus and anal fin	4.335	3.704	5.155	0.565

Other Characteristics:

Body: Elongated, sub-cylindrical. Dorsal slightly convex ventral almost straight abdominal edge rounded.

Head: Moderate, slightly depressed. Snout marked off by a transverse groove.

Eyes: Moderate diameter 4.8 - 6.0 in length of head, placed in the posterior half of head with slightly convex inter orbital space. Eyes placed laterally, slightly upwards and outward, not visible from below ventral surface.

Mouth: Inferior, transverse, semicircular. Lips thick, fleshy. Upper lip fringed and continuous with the lower. A suctorial disc of cartilaginous pad present on the chin formed on lower lip.

Barbels: Two pairs, a pair each of maxillary & rostral.

Fins: Dorsal ahead of pelvic nearer tip of snout than base of caudal. Dorsal height shorter than or equal to body depth. Paired fins horizontally expanded, not plaited. Pectorals shorter than head length, far from reaching pelvics. Pelvic fin shorter than pectoral. A scaly appendage. Anal does

not reach caudal which is deeply forked with equal lobes.

Lateral Line: Simple & complete

Colour: Dorsal yellowish grey above & lighter below. Retina surrounded by a streak of pink colour. A few red scales behind operculum present or absent. Fin: Dorsal pink, ventral and anal pale with pink outer margins; caudal with dark fin rays.

Distribution: India: Eastern Himalayas, Meghalaya, Assam, Arunachal Pradesh, Darjeeling & Kumaon Himalayas. Elsewhere: Nepal, Pakistan, Syria, Tenasserim provinces, Abyssinia, Aden.

Remarks: The present species differs from *G. lamta* described by Menon (1954); in head depth in length of head 1.26 - 1.38 (versus 1.43 - 1.77 Menon, 1954), distance from vent to anal in that between anterior origins of pelvic and anal 4.2 - 6.0 (versus 4.0 - 5.67) and length of caudal peduncle in length of head which is 1.09 - 1.3 (versus 1.36 - 2.13).

The species is available up to an elevation of 745 m (msl) in both the river systems.

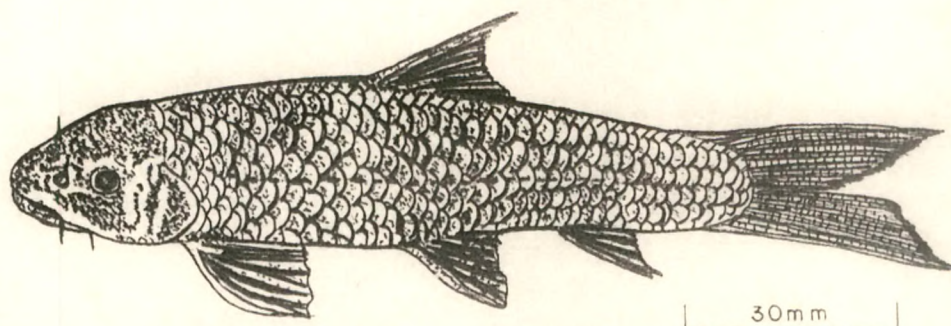
Table 44. Measurements (in mm) of *Garra lamta* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	135.0	134.0	97.0	95.0	92.0	92.0	135.0	110.600
Standard length	111.0	112.0	80.0	80.0	77.0	77.0	112.0	92.000
Head length	24.0	24.0	17.0	17.0	18.0	17.0	24.0	20.000
Head breadth	23.0	20.0	14.0	15.0	14.0	14.0	23.0	17.200
Head depth	19.0	18.0	13.0	13.0	13.0	13.0	19.0	15.200
Gape of mouth	12.0	11.0	8.5	8.5	9.0	8.5	12.0	9.800
Eye diameter	4.5	4.0	3.5	3.0	3.5	3.0	4.5	3.700
Inter orbital distance	13.0	12.0	8.0	9.5	9.0	8.0	13.0	10.300
Post orbital distance	10.0	10.0	8.0	7.0	7.0	7.0	10.0	8.400
Inter nasal distance	9.5	10.0	7.0	7.0	6.5	6.5	10.0	8.000
Snout length	14.0	13.0	10.0	9.5	10.0	9.5	14.0	11.300
Body depth	25.0	23.0	18.0	19.0	17.0	17.0	25.0	20.400
Body width	25.0	23.0	15.0	17.0	15.0	15.0	25.0	19.000
Length of sucker	10.0	9.0	6.5	6.5	7.0	6.5	10.0	7.800
Breadth of sucker	14.0	12.5	10.0	10.5	10.0	10.0	14.0	11.400
Dorsal height	23.0	22.0	16.0	16.0	17.0	16.0	23.0	18.800
Dorsal base	18.0	17.0	11.0	13.0	14.0	11.0	18.0	14.600

Anal height	19.0	19.0	14.0	10.0	12.0	10.0	19.0	14.800
Anal base	9.5	8.0	5.0	7.0	7.0	5.0	9.5	7.300
Pectoral length	23.0	21.0	16.0	15.0	16.0	15.0	23.0	18.200
Pelvic length	20.0	19.0	14.0	14.0	14.0	14.0	20.0	16.200
Length of caudal fin	25.0	23.0	17.0	16.0	18.0	16.0	25.0	19.800
Length of upper caudal lobe	25.0	23.0	17.0	16.0	18.0	16.0	25.0	19.800
Length of lower caudal lobe	25.0	23.0	17.0	16.0	18.0	16.0	25.0	19.800
Length of caudal peduncle	18.0	22.0	14.0	14.0	14.0	14.0	22.0	16.400
Highest depth of caudal peduncle	18.0	17.0	11.0	12.0	11.0	11.0	18.0	13.800
Least depth of caudal peduncle	15.0	15.0	10.0	10.0	10.0	10.0	15.0	12.000
Pre dorsal distance	52.0	50.0	37.0	39.0	35.0	35.0	52.0	42.600
Pre pectoral distance	23.0	23.0	17.0	18.0	17.0	17.0	23.0	19.600
Pre pelvic distance	60.0	60.0	46.0	44.0	41.0	41.0	60.0	50.200
Pre anal distance	88.0	82.0	67.0	61.0	58.0	58.0	88.0	71.200
Distance between origin of pectoral & origin of pelvic	40.0	38.0	31.0	27.0	25.0	25.0	40.0	32.200
Distance between origin of pelvic & origin of anal	30.0	28.0	20.0	19.0	19.0	19.0	30.0	23.200
Distance between origin of pelvic & anus	23.0	22.0	17.0	14.0	14.0	14.0	23.0	18.000
Distance between anus and anal fin	5.0	5.0	5.0	4.5	4.0	4.0	5.0	4.700

20. *Garra mcClellandi* (Jerdon), 1849

(Plate XV-3 & XX-3)

Text Figure 20. *Garra mcClellandi* (Jerdon)

1849. *Gonorhynchus mcClellandi* Jerdon, Madras Jour. Lit. Sci., Madras, 15 p. 309;
(Type locality, " Bowany River at the foot of the Neilgherries and also in the Manantoddy river").

Present records: TISTA DRAINAGE: Confluence of Tista and Rani khola, SS Singtam 115 - 138 mm (6 exs.); Rani khola, FCC 32 No. 153 - 160 mm (2 exs.); Ghattay khola, SS Sirwani, 116 - 120 mm (3 exs.); Rangpo khola, FCC Rorethang 45 - 136 mm (6 exs.); SS Rangpo 40 - 145 mm (15 exs.). RANGIT DRAINAGE: R. Rangit, FCC Tatopani 90 mm (1 ex.); SS Sikhip 40 - 131 mm (6 exs.); SS Nayabazar 38 - 144 mm (9 exs.); Kalej khola, SS Legship 125 mm (1 ex.); Rishi khola, SS Rishi 106 - 190 mm (4 exs.); Roathak khola, SS Rothak 31 - 147 mm (4 exs.); Rangbhang khola, SS Nayabazar 120 - 155 mm (7 exs.); Confluence of Tista & Rangit, FCC Tista 110 - 157 mm (2 exs.); local name: *Buduna* .

Meristic Counts: D.ii. 8; P.ii.13; V.i.8; A.ii.5; C.19.

Lateral line scales 35, Scales from base of dorsal to lateral line 4.5, scales from lateral line to base of pelvic 4.5, pre-dorsal scales 12 and circumpeduncular scales 14.

Morphometric Characters:

Standard length 1.19 - 1.22 (1.206), Head length 5.22 - 5.96 (5.637), Head breadth 6.67 - 7.42 (7.106), Head depth 7.45 - 8.29 (7.790), Gape of mouth 12.00 - 14.90 (13.438), Eye diameter 29.11 - 35.25 (30.737), Inter orbital distance 10.91 - 12.42 (11.689), Post orbital distance 13.10 - 15.13 (13.805), Inter nasal distance 14.56 - 17.53 (15.511), Snout length 9.31 - 11.46 (10.285), Body depth 5.14 - 6.41 (5.766), Body width 6.21 - 7.42 (6.691), Length of sucker 15.00 - 18.63 (16.432), Breadth of sucker 10.00 - 13.55 (11.326), Dorsal height 5.76 - 6.13 (5.959), Dorsal base

7.45 - 8.73 (7.980), Anal height 7.05 - 8.00 (7.364), Anal base 12.82 - 16.38 (14.396), Pectoral length 6.05 - 6.41 (6.242), Pelvic length 6.72 - 7.83 (7.249), Length of caudal fin 5.46 - 5.96 (5.695), Length of upper caudal lobe 5.46 - 5.96 (5.695), Length of lower caudal lobe 5.46 - 5.96 (5.695), Length of caudal peduncle 6.48 - 7.28 (6.839), Highest depth of caudal peduncle 8.28 - 9.40 (8.969), Least depth of caudal peduncle 9.23 - 10.08 (9.606), Pre dorsal distance 2.47 - 2.76 (2.568), Pre pectoral distance 5.46 - 5.96 (5.649), Pre pelvic distance 2.19 - 2.35 (2.287), Pre anal distance 1.54 - 1.59 (1.558), Distance between origin of pectoral & origin of pelvic 3.39 - 3.78 (3.629), Distance between origin of pelvic & origin of anal 4.62 - 4.85 (4.731), Distance between origin of pelvic & anus 6.71 - 7.56 (7.217), Distance between anus and origin of anal fin 11.00 - 14.10 (12.648).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 45. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. mcClellandi* (Jerdon), 1849.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.917	82.270	83.893	0.607
Head length	17.741	16.779	19.167	0.861
Head breadth	14.072	13.475	15.000	0.515
Head depth	12.837	12.057	13.423	0.531
Gape of mouth	7.442	6.711	8.333	0.545
Eye diameter	3.253	2.837	3.435	0.213
Inter orbital distance	8.555	8.054	9.167	0.390
Post orbital distance	7.244	6.612	7.634	0.363
Inter nasal distance	6.447	5.705	6.870	0.402
Snout length	9.722	8.725	10.744	0.694
Body depth	17.343	15.603	19.463	1.253
Body width	14.945	13.475	16.107	0.851
Length of sucker	6.086	5.369	6.667	0.509
Breadth of sucker	8.829	7.383	10.000	0.865
Dorsal height	16.781	16.312	17.355	0.336
Dorsal base	12.532	11.450	13.423	0.755

Anal height	13.579	12.500	14.184	0.600
Anal base	6.946	6.107	7.801	0.618
Pectoral length	16.021	15.603	16.529	0.308
Pelvic length	13.794	12.766	14.876	0.708
Length of caudal fin	17.560	16.779	18.321	0.612
Length of upper caudal lobe	17.560	16.779	18.321	0.612
Length of lower caudal lobe	17.560	16.779	18.321	0.612
Length of caudal peduncle	14.623	13.740	15.436	0.598
Highest depth of caudal peduncle	11.149	10.638	12.081	0.545
Least depth of caudal peduncle	10.410	9.917	10.833	0.405
Pre dorsal distance	38.946	36.242	40.496	1.537
Pre pectoral distance	17.702	16.779	18.321	0.549
Pre pelvic distance	43.719	42.500	45.638	1.080
Pre anal distance	64.199	62.810	65.000	0.819
Distance between origin of pectoral & origin of pelvic	27.557	26.446	29.530	1.090
Distance between origin of pelvic & origin of anal	21.138	20.611	21.667	0.429
Distance between origin of pelvic & anus	13.857	13.223	14.894	0.603
Distance between anus and anal fin	7.907	7.092	9.091	0.721

Other Characteristics:

Body: Elongated, sub-cylindrical. Dorsal profile slightly convex, ventral almost straight.

Head: Moderate, snout obtuse, smooth.

Eyes: Moderate, diameter 5.0 - 6 in length of head, placed in the middle of head excluding snout, not visible from below ventral surface.

Mouth: Inferior, transverse, semicircular; width of gape of mouth 2.3 - 2.5 in length of head. Lips thick, upper lip fringed, continuous with the lower.

Barbels: Four numbers, a pair each of maxillary and rostral.

Fins: Dorsal inserted nearer tip of snout than caudal, more towards ventral than pectoral. Dorsal height shorter than or equal to body depth. Paired fins horizontally expanded and not plaited. Pectoral fin shorter than head length not reaching pelvic. A sheath like small elongated appendage present at the base of pelvic. Caudal fin forked with upper caudal lobe slightly longer than lower in 2 specimens and equal in 3 specimens.

Lateral Line: Simple & complete

Colour: Body colour varies from grayish yellow to grayish blue above and lighter below. Head yellowish blue. A few brick red scales in a row behind the operculum above pectoral & pelvic fins. Retina surrounded by pinkish streak. Operculum silvery purple. Fins: Dorsal & Caudal pale with dark fin rays and outer margin of caudal fin rays orange to pinkish in colour. Pectoral, Ventral & Anal reddish.

Distribution: India: Cauvery drainage, Nilgiri hills, Meghalaya and Arunachal Pradesh.

Remarks: The species has been reported for the first time from the river systems of Sikkim during the present study. The present species resembles *G. annandalei* but differs in distance from vent to anal fin in that between anterior origins of pelvic and anal fins which is 2.27 - 4.0 (versus 1.92 - 3.30 Menon, 1954); lateral line scales 35 (vs. less than 35). It is a common species available round the year throughout the drainages of Sikkim up to an elevation of 745 m.

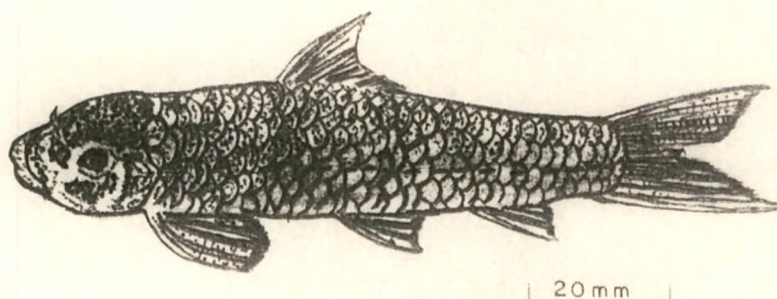
Table 46. Measurements (in mm) of *Garra mcClellandi* (Jerdon), 1849.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	120.0	121.0	131.0	141.0	149.0	120.0	149.0	132.400
Standard length	100.0	100.0	108.0	116.0	125.0	100.0	125.0	109.800
Head length	23.0	22.0	23.0	24.0	25.0	22.0	25.0	23.400
Head breadth	18.0	17.0	18.0	19.0	21.0	17.0	21.0	18.600
Head depth	16.0	15.0	17.0	17.0	20.0	15.0	20.0	17.000
Gape of mouth	10.0	9.0	10.0	10.0	10.0	9.0	10.0	9.800
Eye diameter	4.0	4.0	4.5	4.0	5.0	4.0	5.0	4.300
Inter orbital distance	11.0	10.0	11.5	12.0	12.0	10.0	12.0	11.300
Post orbital distance	9.0	8.0	10.0	10.0	11.0	8.0	11.0	9.600
Inter nasal distance	8.0	8.0	9.0	9.0	8.5	8.0	9.0	8.500
Snout length	12.0	13.0	13.0	13.0	13.0	12.0	13.0	12.800
Body depth	21.0	21.0	22.0	22.0	29.0	21.0	29.0	23.000
Body width	18.0	18.0	20.0	19.0	24.0	18.0	24.0	19.800
Length of sucker	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.000
Breadth of sucker	12.0	11.0	12.0	12.0	11.0	11.0	12.0	11.600
Dorsal height	20.0	21.0	22.0	23.0	25.0	20.0	25.0	22.200
Dorsal base	16.0	15.0	15.0	17.0	20.0	15.0	20.0	16.600

Anal height	15.0	17.0	18.0	20.0	20.0	15.0	20.0	18.000
Anal base	9.0	8.0	8.0	11.0	10.0	8.0	11.0	9.200
Pectoral length	19.0	20.0	21.0	22.0	24.0	19.0	24.0	21.200
Pelvic length	17.0	18.0	18.0	18.0	20.0	17.0	20.0	18.200
Length of caudal fin	21.0	22.0	24.0	24.0	25.0	21.0	25.0	23.200
Length of upper caudal lobe	21.0	22.0	24.0	24.0	25.0	21.0	25.0	23.200
Length of lower caudal lobe	21.0	22.0	24.0	24.0	25.0	21.0	25.0	23.200
Length of caudal peduncle	17.0	18.0	18.0	21.0	23.0	17.0	23.0	19.400
Highest depth of caudal peduncle	13.0	13.0	15.0	15.0	18.0	13.0	18.0	14.800
Least depth of caudal peduncle	13.0	12.0	13.0	15.0	16.0	12.0	16.0	13.800
Pre dorsal distance	48.0	49.0	52.0	54.0	54.0	48.0	54.0	51.400
Pre pectoral distance	21.0	22.0	24.0	25.0	25.0	21.0	25.0	23.400
Pre pelvic distance	51.0	52.0	57.0	62.0	68.0	51.0	68.0	58.000
Pre anal distance	78.0	76.0	85.0	91.0	95.0	76.0	95.0	85.000
Distance between origin of pectoral & origin of pelvic	32.0	32.0	36.0	39.0	44.0	32.0	44.0	36.600
Distance between origin of pelvic & origin of anal	26.0	25.0	27.0	30.0	32.0	25.0	32.0	28.000
Distance between origin of pelvic & anus	16.0	16.0	18.0	21.0	21.0	16.0	21.0	18.400
Distance between anus and anal fin	10.0	11.0	10.0	10.0	11.0	10.0	11.0	10.400

21. *Garra mullya* (Sykes), 1841

(Plate XV-6 & XX-4)

Text Figure 21. *Garra mullya* (Sykes)

1841. *Chondrostoma mullya* Sykes, Trans. Zool. Sci. Lond., London, 2, p. 359, pl. 62, fig. 3 (Type locality, " The Beema river at Dounde").

Present records: TISTA DRAINAGE: Rani khola, SS Saramsa, 109 - 129 mm (7 exs.), FCC 32 No. 91 - 106 mm (6 exs.), Seti khola, SS Lower Lagyap 84 - 122 mm (26 exs.); Rin khola, SS Lower Dzongu 106 - 140 mm (22 exs.); Kanaka chhu, FCC Passingdong 115 mm (1 ex.); Dik chhu SS Dikchu 79 - 120 mm (5 exs.); Ghattay khola, SS Sirwani 110 mm (1 ex.); Confluence of Tista & Rani khola, SS Singtam 102 - 156 mm (7 exs.); Rangpo khola, FCC Rorethang 105 - 165 mm (7 exs.); SS Rangpo 50 - 132 mm (8 exs.). RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 130 mm (1 ex.); SS Nayabazar 97 - 136 mm (3 exs.); Rimbi khola, SS Rimbi 83 - 105 mm (3 exs.); Kalej khola, SS Legship 80 mm (1 ex.); Roathak khola, SS Rothak 95 - 139 (6 exs.); Rangbhang khola, SS Nayabazar 80 - 106 mm (13 exs.); local name: *Nakatua Buduna*.

Meristic Counts: D.iii.8; P.ii.13; V.i.8; A.ii.5; C.19.

Lateral line scales 33 - 36, scales from base of dorsal to lateral line 4.5, scales from lateral line to base of pelvic 4.5, pre-dorsal scales 12 and circumpeduncular scales 14.

Morphometric Characters:

Standard length 1.19 - 1.22 (1.205), Head length 5.24 - 5.74 (5.494), Head breadth 6.00 - 7.33 (6.455), Head depth 7.29 - 9.43 (7.736), Gape of mouth 9.17 - 10.50 (10.057), Eye diameter 24.55 - 35.00 (28.540), Inter orbital distance 10.38 - 12.00 (11.130), Post orbital distance 12.75 - 15.88 (14.126), Inter nasal distance 12.75 - 14.67 (13.837), Snout length 9.17 - 10.38 (9.681), Body depth 6.11 - 7.76 (6.459), Body width 6.18 - 7.76 (6.664), Length of sucker 10.74 - 12.27 (11.308), Breadth of sucker 8.44 - 9.43 (8.846), Dorsal height 5.37 - 6.11 (5.725), Dorsal base 7.29 - 7.76 (7.473), Anal height 6.43 - 7.33 (6.962), Anal base 14.00 - 17.60 (15.417),

Pectoral length 5.67 - 6.00 (5.830), Pelvic length 6.38 - 7.33 (6.697), Length of caudal fin 4.78 - 5.28 (5.015), Length of upper caudal lobe 4.86 - 5.50 (5.101), Length of lower caudal lobe 4.78 - 5.28 (5.015), Length of caudal peduncle 6.47 - 7.50 (7.120), Highest depth of caudal peduncle 8.44 - 10.15 (9.120), Least depth of caudal peduncle 9.27 - 11.00 (9.858), Pre dorsal distance 2.44 - 2.68 (2.575), Pre pectoral distance 5.25 - 5.63 (5.446), Pre pelvic distance 2.14 - 2.37 (2.253), Pre anal distance 1.50 - 1.59 (1.537), Distance between origin of pectoral & origin of pelvic 3.46 - 4.08 (3.663), Distance between origin of pelvic & origin of anal 4.55 - 4.82 (4.630), Distance between origin of pelvic & anus 7.50 - 8.46 (7.893), Distance between anus and origin of anal fin 8.80 - 12.75 (11.107).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 47. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. mullya* (Sykes), 1841.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.000	81.905	83.704	0.631
Head length	18.203	17.424	19.091	0.595
Head breadth	15.492	13.636	16.667	1.063
Head depth	12.927	10.606	13.725	1.171
Gape of mouth	9.943	9.524	10.909	0.497
Eye diameter	3.504	2.857	4.074	0.482
Inter orbital distance	8.985	8.333	9.630	0.420
Post orbital distance	7.079	6.296	7.843	0.570
Inter nasal distance	7.227	6.818	7.843	0.425
Snout length	10.330	9.630	10.909	0.507
Body depth	15.483	12.879	16.364	1.324
Body width	15.005	12.879	16.190	1.151
Length of sucker	8.843	8.148	9.314	0.425
Breadth of sucker	11.305	10.606	11.852	0.402
Dorsal height	17.467	16.364	18.627	0.744
Dorsal base	13.381	12.879	13.725	0.297
Anal height	14.364	13.636	15.556	0.721

Anal base	6.486	5.682	7.143	0.573
Pectoral length	17.153	16.667	17.647	0.319
Pelvic length	14.932	13.636	15.686	0.759
Length of caudal fin	19.939	18.939	20.909	0.752
Length of upper caudal lobe	19.606	18.182	20.588	0.827
Length of lower caudal lobe	19.939	18.939	20.909	0.752
Length of caudal peduncle	14.045	13.333	15.455	0.743
Highest depth of caudal peduncle	10.964	9.848	11.852	0.676
Least depth of caudal peduncle	10.144	9.091	10.784	0.583
Pre dorsal distance	38.828	37.255	40.909	1.387
Pre pectoral distance	18.363	17.778	19.048	0.435
Pre pelvic distance	44.381	42.157	46.667	1.598
Pre anal distance	65.074	62.745	66.667	1.416
Distance between origin of pectoral & origin of pelvic	27.303	24.510	28.889	1.545
Distance between origin of pelvic & origin of anal	21.600	20.741	21.970	0.451
Distance between origin of pelvic & anus	12.670	11.818	13.333	0.618
Distance between anus and anal fin	9.003	7.843	11.364	1.252

Other Characteristics:

Body: Elongated, sub-cylindrical. Dorsal slightly convex, ventral almost straight with rounded abdominal edge.

Head: Moderate, slightly depressed. Snout marked off by deep transverse groove.

Eyes: Moderate, diameter 4.8 - 6.3 in length of head, placed in the posterior half of head, inter orbital space flat to convex. Eyes are situated laterally, slightly upwards and outward, not visible from below ventral surface.

Mouth: Inferior, transverse, semicircular lips thick, fleshy, upper lip fringed and continuous with lower. A suction disc of series cartilaginous pad present on the chin formed on lower lip.

Barbels: A pair each of maxillary and rostral.

Fins: Dorsal inserted ahead of pelvic, near tip of snout than base of caudal. Dorsal height larger than or equal to body depth. Paired fins horizontally expanded, not plated. Pectoral slightly shorter than head length, far from reaching ventral. Shorter than pectoral. Presence of a scaly appendage on the anal does not reach caudal deeply forked with equal lobes, lower lobe slightly longer than upper in for species.

Lateral Line: Simple & complete

Colour: Dorsal yellowish grey above and lighter below. Retina surrounded by a streak of pink colour. A few brick red scales behind operculum present or absent. Fins: Dorsal pink, Pectoral, Ventral & Anal pale with pink outer margins, Caudal with dark fin rays.

Distribution: India: Throughout India except Assam and the Himalaya.

Remarks: The species is recorded for the first time from Sikkim drainages. It is one of the most dominant species widely spread in both the drainages with in 240 m - 1065 m. Though the present species closely resembles *G. mullya* in most of the characters of Menon (1954), it is dissimilar from it in body depth in standard length 5.0 - 6.4 (versus 3.47 - 5.0 Menon, 1954), and distance from vent to anal fin in that between anterior origins of pelvic and anal fins 1.9 - 2.7 (versus 2.67 - 3.8).

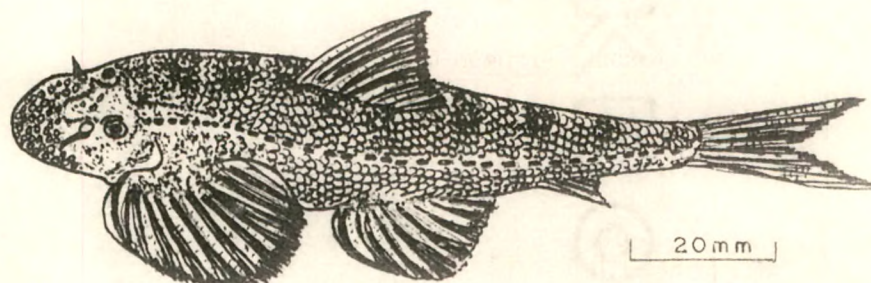
Table 48. Measurements (in mm) of *Garra mullya* (Sykes), 1841.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	135.0	132.0	110.0	105.0	102.0	102.0	135.0	116.800
Standard length	113.0	110.0	91.0	86.0	85.0	85.0	113.0	97.000
Head length	24.0	23.0	21.0	19.0	19.0	19.0	24.0	21.200
Head breadth	21.0	18.0	18.0	16.0	17.0	16.0	21.0	18.000
Head depth	18.0	14.0	15.0	14.0	14.0	14.0	18.0	15.000
Gape of mouth	13.0	13.0	12.0	10.0	10.0	10.0	13.0	11.600
Eye diameter	5.5	4.0	4.0	3.0	4.0	3.0	5.5	4.100
Inter orbital distance	13.0	11.0	10.0	9.5	9.0	9.0	13.0	10.500
Post orbital distance	8.5	9.0	7.5	8.0	8.0	7.5	9.0	8.200
Inter nasal distance	9.5	9.0	7.5	8.0	8.0	7.5	9.5	8.400
Snout length	13.0	13.0	12.0	11.0	11.0	11.0	13.0	12.000
Body depth	22.0	17.0	18.0	17.0	16.0	16.0	22.0	18.000
Body width	20.0	17.0	17.0	17.0	16.0	16.0	20.0	17.400
Length of sucker	11.0	12.0	10.0	9.0	9.5	9.0	12.0	10.300
Breadth of sucker	16.0	14.0	12.5	12.0	11.5	11.5	16.0	13.200
Dorsal height	24.0	23.0	18.0	18.0	19.0	18.0	24.0	20.400
Dorsal base	18.0	17.0	15.0	14.0	14.0	14.0	18.0	15.600
Anal height	21.0	18.0	15.0	15.0	15.0	15.0	21.0	16.800
Anal base	8.0	7.5	7.5	7.5	7.0	7.0	8.0	7.500

Pectoral length	23.0	22.0	19.0	18.0	18.0	18.0	23.0	20.000
Pelvic length	21.0	18.0	16.0	16.0	16.0	16.0	21.0	17.400
Length of caudal fin	26.0	25.0	23.0	21.0	21.0	21.0	26.0	23.200
Length of upper caudal lobe	26.0	24.0	22.0	21.0	21.0	21.0	26.0	22.800
Length of lower caudal lobe	26.0	25.0	23.0	21.0	21.0	21.0	26.0	23.200
Length of caudal peduncle	19.0	18.0	17.0	14.0	14.0	14.0	19.0	16.400
Highest depth of caudal peduncle	16.0	13.0	12.0	12.0	11.0	11.0	16.0	12.800
Least depth of caudal peduncle	14.0	12.0	11.0	11.0	11.0	11.0	14.0	11.800
Pre dorsal distance	54.0	50.0	45.0	40.0	38.0	38.0	54.0	45.400
Pre pectoral distance	24.0	24.0	20.0	20.0	19.0	19.0	24.0	21.400
Pre pelvic distance	60.0	57.0	50.0	49.0	43.0	43.0	60.0	51.800
Pre anal distance	87.0	86.0	73.0	70.0	64.0	64.0	87.0	76.000
Distance between origin of pectoral & origin of pelvic	39.0	36.0	30.0	30.0	25.0	25.0	39.0	32.000
Distance between origin of pelvic & origin of anal	28.0	29.0	24.0	23.0	22.0	22.0	29.0	25.200
Distance between origin of pelvic & anus	18.0	16.0	13.0	14.0	13.0	13.0	18.0	14.800
Distance between anus and anal fin	11.0	15.0	10.0	9.0	8.0	8.0	15.0	10.600

22. *Balitora brucei* Gray, 1832

(Plate XV-8 & XX-9)

Text Figure 22. *Balitora Brucei* Gray

1832. *Balitora brucei* Gray, Illustrations of Indian Zoology, 1 : pl. 88, fig 1

(Type locality, Priang river near Cherrapunji, Meghalaya).

Previous Records from Sikkim: R. Rangit (Bhutia & Acharya, 1987).

Present Records: RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 76 mm (1 ex.); SS Sikip 91 mm (1 ex.); SS Nayabazar 85 - 106 mm (3 ex.); Rishi khola, SS Rishi 114 mm (1 ex.); Roathak khola, SS Rothak 65 - 113 mm (2 ex.); Rangbhang khola, SS Nayabazar 75 mm (1 ex.);

local name: *Titay Machha*.

Meristic Counts: D.ii.7; P.i.9; V.ii.9; A.ii.5; C.17.

Lateral line scales 61 - 67, scales from lateral line to base of dorsal 7.5 - 8.5, scales from lateral line to base of pelvic 5.5, pre-dorsal scales 22, circumpeduncular scales 18.

Morphometric Characters:

Standard length 1.16 - 1.22 (1.194), Head length 5.61 - 5.89 (5.782), Head breadth 5.94 - 6.67 (6.307), Head depth 11.11 - 14.43 (11.974), Gape of mouth 14.29 - 20.36 (18.104), Eye diameter 50.00 - 67.33 (56.225), Inter orbital distance 11.22 - 12.67 (12.024), Post orbital distance 18.67 - 21.71 (20.114), Inter nasal distance 13.18 - 15.54 (14.600), Snout length 8.78 - 9.58 (9.248), Body depth 8.33 - 10.13 (9.197), Body width 5.26 - 6.33 (5.947), Dorsal height 5.61 - 6.08 (5.826), Dorsal base 7.58 - 9.18 (8.027), Anal height 10.10 - 11.69 (11.068), Anal base 15.20 - 18.67 (16.995), Pectoral length 4.15 - 4.75 (4.347), Pelvic length 5.33 - 6.50 (5.899), Length of caudal fin 5.69 - 6.33 (5.941), Length of upper caudal lobe 7.21 - 8.33 (7.622), Length of lower caudal lobe 5.69 - 6.33 (5.941), Length of caudal peduncle 5.94 - 6.67 (6.186), Highest depth of caudal peduncle 14.00 - 16.00 (15.194), Least depth of caudal peduncle 16.67 - 19.00 (18.142), Pre dorsal distance 2.50 - 2.67 (2.564), Pre pectoral distance 6.07 - 7.14 (6.630), Pre pelvic

distance 2.53 - 2.80 (2.645), Pre anal distance 1.53 - 1.62 (1.575), Distance between origin of pectoral & origin of pelvic 3.79 - 4.31 (4.097), Distance between origin of pelvic & origin of anal 3.48 - 3.80 (3.647), Distance between origin of pelvic & anus 4.31 - 4.55 (4.412), Distance between anus and anal fin 20.20 - 28.00 (23.964).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 49. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *B. brucei* Gray, 1832.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.782	82.143	86.139	1.438
Head length	17.295	16.964	17.822	0.344
Head breadth	15.857	15.000	16.832	0.713
Head depth	8.351	6.931	9.000	0.733
Gape of mouth	5.524	4.911	7.000	0.768
Eye diameter	1.779	1.485	2.000	0.195
Inter orbital distance	8.317	7.895	8.911	0.360
Post orbital distance	4.972	4.605	5.357	0.239
Inter nasal distance	6.849	6.436	7.589	0.447
Snout length	10.813	10.440	11.386	0.345
Body depth	10.873	9.868	12.000	0.869
Body width	16.816	15.789	19.000	1.175
Dorsal height	17.163	16.447	17.822	0.487
Dorsal base	12.458	10.891	13.187	0.887
Anal height	9.035	8.553	9.001	0.459
Anal base	5.884	5.357	6.579	0.433
Pectoral length	23.002	21.053	24.107	1.102
Pelvic length	16.951	15.385	18.750	1.277
Length of caudal fin	16.834	15.789	17.582	0.582
Length of upper caudal lobe	13.120	12.000	13.861	0.614
Length of lower caudal lobe	16.834	15.789	17.582	0.582
Length of caudal peduncle	16.167	15.000	16.832	0.631

Highest depth of caudal peduncle	6.581	6.250	7.143	0.301
Least depth of caudal peduncle	5.512	5.263	6.000	0.256
Pre dorsal distance	39.008	37.500	40.000	0.909
Pre pectoral distance	15.082	14.000	16.484	0.930
Pre pelvic distance	37.811	35.714	39.560	1.237
Pre anal distance	63.485	61.842	65.347	1.222
Distance between origin of pectoral & origin of pelvic	24.407	23.214	26.374	1.147
Distance between origin of pelvic & origin of anal	27.416	26.316	28.713	0.937
Distance between origin of pelvic & anus	22.667	21.978	23.214	0.444
Distance between anus and origin of anal fin	4.173	3.571	4.950	0.468

Other Characteristics:

Body: Elongated, moderately depressed anteriorly. The body tapers conically from the base of pelvic to caudal fin. Dorsal profile arched, ventral horizontal flat abdomen.

Head: Small gradually depressed anteriorly, slightly larger than broad, snout broad and depressed.

Eyes: Diameter 8.6 - 12.0 in length of head, located at the middle of posterior half of head. Inter orbital space is slightly convex, its width 2.0 - 2.1 in head length. Eyes are very small with circular pupil situated at the middle of posterior half of head, not visible from below ventral surface.

Mouth: Inferior, small, semicircular, width of gape of mouth 2.4 - 3.6 in length of head. Upper lip continuous with lower, papillated Jaws and palate without teeth.

Barbels: Two pairs of short, thick, rostral barbels and one pair of maxillary, slightly larger.

Fins: Dorsal fin arises above or rather slightly behind pelvic but nearer tip of snout than caudal base. Dorsal fin as high as the length of head. Paired fins are broad, horizontally placed, not plaited. Pectoral larger than head almost reaching to pelvic, its anterior rays are un-branched. Anal fin short 1.8 - 2.0 as high as dorsal. Caudal fin forked with larger lower lobe.

Lateral Line: Simple, distinct and complete.

Scales: Small

Colour: Body shiny green with 5-7 black patches along the dorsal surface from behind the head to base of caudal. Fins: Dorsal, pectoral, ventral & caudal pale with dark fin rays. Anal transparent.

Distribution: India: Eastern Himalayas, Darjeeling, Assam & Meghalaya. Elsewhere: Nepal, Bhutan and Bangladesh.

Remarks: It is a rare species exclusively confined to Rangit drainages within 340 m to 645 m

(msl). It becomes available during heavy monsoon when the rivers are highly turbid.

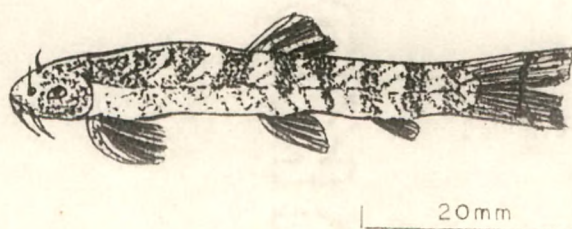
Table 50. Measurements (in mm) of *Balitora brucei* Gray, 1832.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	112.0	100.0	101.0	91.0	76.0	76.0	112.0	96.000
Standard length	92.0	84.0	87.0	75.0	64.0	64.0	92.0	80.400
Head length	19.0	17.0	18.0	16.0	13.0	13.0	19.0	16.600
Head breadth	17.0	15.0	17.0	15.0	12.0	12.0	17.0	15.200
Head depth	9.5	9.0	7.0	8.0	6.5	6.5	9.5	8.000
Gape of mouth	5.5	7.0	5.0	5.0	4.0	4.0	7.0	5.300
Eye diameter	2.0	2.0	1.5	1.5	1.5	1.5	2.0	1.700
Inter orbital distance	9.0	8.5	9.0	7.5	6.0	6.0	9.0	8.000
Post orbital distance	6.0	5.0	5.0	4.5	3.5	3.5	6.0	4.800
Inter nasal distance	8.5	6.5	6.5	6.5	5.0	5.0	8.5	6.600
Snout length	12.0	11.0	11.5	9.5	8.0	8.0	12.0	10.400
Body depth	13.0	12.0	10.0	10.0	7.5	7.5	13.0	10.500
Body width	19.0	19.0	16.0	15.0	12.0	12.0	19.0	16.200
Dorsal height	19.0	17.0	18.0	16.0	12.5	12.5	19.0	16.500
Dorsal base	13.5	13.0	11.0	12.0	10.0	10.0	13.5	11.900
Anal height	10.0	9.0	10.0	8.0	6.5	6.5	10.0	8.700
Anal base	6.0	5.5	6.0	5.5	5.0	5.0	6.0	5.600
Pectoral length	27.0	24.0	23.0	21.0	16.0	16.0	27.0	22.200
Pelvic length	21.0	18.0	17.0	14.0	12.0	12.0	21.0	16.400
Length of caudal fin	19.0	17.0	17.0	16.0	12.0	12.0	19.0	16.200
Length of upper caudal lobe	15.0	12.0	14.0	12.0	10.0	10.0	15.0	12.600
Length of lower caudal lobe	19.0	17.0	17.0	16.0	12.0	12.0	19.0	16.200
Length of caudal peduncle	18.0	15.0	17.0	15.0	12.5	12.5	18.0	15.500
Highest depth of caudal peduncle	7.0	6.5	6.5	6.5	5.0	5.0	7.0	6.300
Least depth of caudal peduncle	6.0	6.0	5.5	5.0	4.0	4.0	6.0	5.300
Pre dorsal distance	42.0	40.0	40.0	35.0	30.0	30.0	42.0	37.400
Pre pectoral distance	16.0	14.0	15.0	15.0	12.0	12.0	16.0	14.400

Pre pelvic distance	40.0	38.0	38.0	36.0	29.0	29.0	40.0	36.200
Pre anal distance	70.0	64.0	66.0	58.0	47.0	47.0	70.0	61.000
Distance between origin of pectoral & origin of pelvic	26.0	25.0	24.0	24.0	18.0	18.0	26.0	23.400
Distance between origin of pelvic & origin of anal	31.0	28.0	29.0	24.0	20.0	20.0	31.0	26.400
Distance between origin of pelvic & anus	26.0	23.0	23.0	20.0	17.0	17.0	26.0	21.800
Distance between anus and anal fin	4.0	4.0	5.0	4.0	3.0	3.0	5.0	4.000

23. *Noemacheilus beavani* Gunther, 1869

(Plate XVI-1)



Text Figure 23. *Noemacheilus beavani* Gunther

1869. *Noemacheilus beavani* Gunther, Cat. Fish. Brit. Mus.; 7, p. 350

(Type locality, Kossye River).

Present records: TISTA DRAINAGE: Dik chhu, SS Dikchu 35 - 56 mm (6 exs.); Ghattay khola, SS Sirwani 44 - 60 mm (11 exs.); RANGIT DRAINAGE: Kalej khola, SS Legship 21 - 55 mm (24 exs.); local name: *Gadela*.

Meristic Counts: D.iii.8; P.10; V.8; A.v.2; C.19

Morphometric Characters:

Standard length 1.18 - 1.20 (1.188), Head length 5.45 - 6.00 (5.604), Head breadth 5.87 - 6.80 (6.253), Head depth 7.33 - 9.27 (8.083), Gape of mouth 10.00 - 12.75 (11.411), Eye diameter 22.00 - 40.00 (28.959), Inter orbital distance 12.00 - 12.75 (12.392), Post orbital distance 11.00 - 12.75 (11.794), Inter nasal distance 14.67 - 17.00 (15.634), Snout length 9.17 - 11.33 (10.291), Maxillary barbel length 11.00 - 13.75 (12.581), Outer rostral barbel length 11.00 - 13.75 (12.581), Inner rostral barbel length 18.33 - 22.00 (19.795), Body depth 6.32 - 7.29 (6.752), Body width 6.00

- 7.33 (6.778), Dorsal height 5.89 - 6.67 (6.328), Dorsal base 7.47 - 8.80 (8.088), Anal height 7.06 - 8.00 (7.416), Anal base 10.20 - 12.00 (11.050), Pectoral length 5.22 - 5.87 (5.619), Pelvic length 6.00 - 6.29 (6.122), Length of caudal fin 5.60 - 6.29 (5.921), Length of caudal peduncle 8.00 - 9.23 (8.579), Highest depth of caudal peduncle 8.00 - 9.33 (8.574), Least depth of caudal peduncle 8.00 - 9.33 (8.574), Pre dorsal distance 2.20 - 2.24 (2.216), Pre pectoral distance 5.00 - 5.67 (5.330), Pre pelvic distance 2.00 - 2.24 (2.151), Pre anal distance 1.40 - 1.51 (1.463), Distance between origin of pectoral & origin of pelvic 3.33 - 3.73 (3.496), Distance between origin of pelvic & origin of anal 4.25 - 4.40 (4.328), Distance between origin of pelvic & anus 5.10 - 5.60 (5.312), Distance between anus and origin of anal fin 25.50 - 44.00 (29.877).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 51. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *N. beavani* Gunther, 1869.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	84.194	83.636	85.000	0.460
Head length	17.844	16.667	18.333	0.609
Head breadth	15.992	14.706	17.045	0.897
Head depth	12.372	10.784	13.636	1.063
Gape of mouth	8.763	7.843	10.000	0.796
Eye diameter	3.453	2.500	4.545	0.757
Inter orbital distance	8.070	7.843	8.333	0.172
Post orbital distance	8.479	7.843	9.091	0.524
Inter nasal distance	6.396	5.882	6.818	0.328
Snout length	9.717	8.824	10.909	0.946
Maxillary barbel length	7.948	7.273	9.091	0.630
Outer rostral barbel length	7.948	7.273	9.091	0.630
Inner rostral barbel length	5.052	4.545	5.455	0.328
Body depth	14.811	13.725	15.833	0.697
Body width	14.754	13.636	16.667	1.155
Dorsal height	15.803	15.000	16.964	0.654
Dorsal base	12.364	11.364	13.393	0.710

Anal height	13.484	12.500	14.167	0.552
Anal base	9.050	8.333	9.804	0.469
Pectoral length	17.798	17.045	19.167	0.741
Pelvic length	16.335	15.909	16.667	0.307
Length of caudal fin	16.889	15.909	17.857	0.748
Length of caudal peduncle	11.656	10.833	12.500	0.550
Highest depth of caudal peduncle	11.663	10.714	12.500	0.787
Least depth of caudal peduncle	11.663	10.714	12.500	0.787
Pre dorsal distance	45.130	44.643	45.455	0.305
Pre pectoral distance	18.761	17.647	20.000	0.902
Pre pelvic distance	46.494	44.643	50.000	1.967
Pre anal distance	68.335	66.071	71.667	1.980
Distance between origin of pectoral & origin of pelvic	28.603	26.786	30.000	1.309
Distance between origin of pelvic & origin of anal	23.106	22.727	23.529	0.325
Distance between origin of pelvic & anus	18.826	17.857	19.608	0.682
Distance between anus and anal fin	3.347	2.273	3.922	0.569

Other Characteristics:

Body: Elongate. The dorsal profile gradually rises from the snout to the origin of dorsal fin, and beyond the dorsal it descends slowly to the base of caudal; the ventral profile is lightly arched in the abdominal region.

Head: Moderate. Snout of moderate length, narrow anteriorly. Nostrils close to each other, situated closer to eye than tip of snout.

Eyes: Small, eye diameter 4.2 - 7.8 in length of head situated in the middle of head, not visible from ventral surface.

Mouth: Semicircular, width of gape of mouth 1.8 - 2.2 in length of head. Lips fleshy, furrowed, upper uninterrupted, lower interrupted in the middle. Dentiform process moderately developed.

Barbels: Four pairs of well developed barbels, a pair each of maxillary, nasal, two of rostral. Inner rostral shorter and outer rostral as long as maxillary.

Scales: Small inconspicuous, more prominent posteriorly, absent on ventral surface.

Skin: Smooth.

Fins: Dorsal fin short, less than head length, edge of dorsal straight. Origin of dorsal mid way between tip of snout & base of caudal bit in 2 specimens, dorsal nearer caudal base. Pelvic origin

of pelvic opposite or lightly behind dorsal. Pectoral extending more than half distance to pelvic. Pelvic slightly shorter than pectoral extending to anal opening. Anal fin not reaching base of caudal, caudal emarginate to slightly forked with pointed equal lobes.

Lateral Line: Complete

Colour: About 9 vertical bands, broader than interspaces; a dark band at base of caudal fin, a row of dark spots on dorsal, < shaped bands on caudal fin.

Distribution: India: Himalayas, North Bengal to Kumaon and Garhwal. Elsewhere: Nepal.

Remarks: The species is reported for the first time from Sikkim drainages. However, in the present study, it is found that its distribution is restricted to Dik chhu, Ghattay khola and Kalej khola only.

Variations have been observed in present specimens from those described by Menon (1987) as snout longer than post orbital length (vs. snout shorter than post orbital distance by menon, 1987), pectoral fin longer than head in certain specimens (vs. pectorals shorter than head). A distinct dark spot is present at the base of first two dorsal rays.

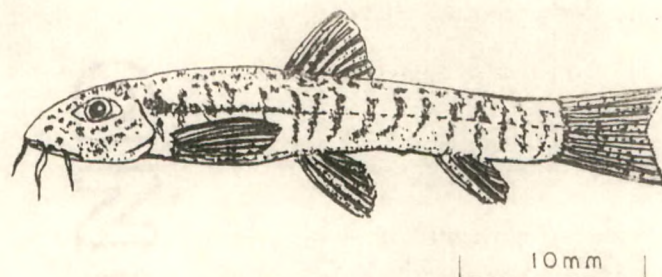
Table 52. Measurements (in mm) of *Noemacheilus beavani* Gunther, 1869.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	60.0	55.0	56.0	51.0	44.0	44.0	60.0	53.200
Standard length	51.0	46.0	47.0	43.0	37.0	37.0	51.0	44.800
Head length	11.0	10.0	10.0	8.5	8.0	8.0	11.0	9.500
Head breadth	10.0	9.0	8.5	7.5	7.5	7.5	10.0	8.500
Head depth	8.0	7.5	6.5	5.5	5.5	5.5	8.0	6.600
Gape of mouth	6.0	5.0	5.0	4.0	3.5	3.5	6.0	4.700
Eye diameter	1.5	1.5	2.0	2.0	2.0	1.5	2.0	1.800
Inter orbital distance	5.0	4.5	4.5	4.0	3.5	3.5	5.0	4.300
Post orbital distance	5.0	5.0	4.5	4.0	4.0	4.0	5.0	4.500
Inter nasal distance	4.0	3.5	3.5	3.0	3.0	3.0	4.0	3.400
Snout length	6.5	6.0	5.0	4.5	4.0	4.0	6.5	5.200
Maxillary barbel length	4.5	4.0	4.5	4.0	4.0	4.0	4.5	4.200
Outer rostral barbel length	4.5	4.0	4.5	4.0	4.0	4.0	4.5	4.200
Inner rostral barbel length	3.0	3.0	3.0	2.5	2.0	2.0	3.0	2.700
Body depth	9.5	8.0	8.5	7.0	6.5	6.5	9.5	7.900

Body width	10.0	8.5	8.0	7.0	6.0	6.0	10.0	7.900
Dorsal height	9.0	8.5	9.5	8.0	7.0	7.0	9.5	8.400
Dorsal base	7.5	6.5	7.5	6.5	5.0	5.0	7.5	6.600
Anal height	8.5	7.5	7.5	7.0	5.5	5.5	8.5	7.200
Anal base	5.0	5.0	5.0	5.0	4.0	4.0	5.0	4.800
Pectoral length	11.5	9.5	10.0	9.0	7.5	7.5	11.5	9.500
Pelvic length	10.0	9.0	9.0	8.5	7.0	7.0	10.0	8.700
Length of caudal fin	10.0	9.0	10.0	9.0	7.0	7.0	10.0	9.000
Length of caudal peduncle	6.5	6.5	7.0	6.0	5.0	5.0	7.0	6.200
Highest depth of caudal peduncle	7.5	6.5	6.0	5.5	5.5	5.5	7.5	6.200
Least depth of caudal peduncle	7.5	6.5	6.0	5.5	5.5	5.5	7.5	6.200
Pre dorsal distance	27.0	25.0	25.0	23.0	20.0	20.0	27.0	24.000
Pre pectoral distance	11.0	11.0	11.0	9.0	8.0	8.0	11.0	10.000
Pre pelvic distance	30.0	26.0	25.0	23.0	20.0	20.0	30.0	24.800
Pre anal distance	43.0	38.0	37.0	34.0	30.0	30.0	43.0	36.400
Distance between origin of pectoral & origin of pelvic	18.0	15.0	15.0	15.0	13.0	13.0	18.0	15.200
Distance between origin of pelvic & origin of anal	14.0	12.5	13.0	12.0	10.0	10.0	14.0	12.300
Distance between origin of pelvic & anus	11.5	10.0	10.0	10.0	8.5	8.5	11.5	10.000
Distance between anus and anal fin	2.0	2.0	2.0	2.0	1.0	1.0	2.0	1.800

24. *Noemacheilus carletoni* Fowler, 1924

(Plate XVI-2)

Text Figure 24. *Noemacheilus carletoni* Fowler

1924. *Noemacheilus carletoni* Fowler, Proc. Acad. nat. Sci. Philad. 76 : 68,
fig. 2 (Type locality : Kulu valley).

Present records: RANGIT DRAINAGE: Rimbi khola, SS Rimbi 36 mm (1 ex.); local name:
Gadela.

Meristic Counts: D.ii.8; P.i.9; V.i.6; A.ii.5; C.18

Morphometric Characters:

Standard length 1.20, Head length 4.50, Head breadth 6.55, Head depth 8.00, Gape of mouth 12.00, Eye diameter 36.00, Inter orbital distance 14.40, Post orbital distance 9.00, Inter nasal distance 14.40, Snout length 12.00, Maxillary Barbel length 9.00, Outer rostral barbel length 10.29, Inner rostral barbel length 18.00, Body depth 7.20, Body width 8.00, Dorsal height 6.55, Dorsal base 9.00, Anal height 7.20, Anal base 9.00, Pectoral length 6.55, Pelvic length 6.55, Length of caudal fin 6.00, Length of caudal peduncle 9.00, Highest depth of caudal peduncle 9.00, Least depth of caudal peduncle 9.00, Pre dorsal distance 2.00, Pre pectoral distance 4.50, Pre pelvic distance 2.12, Pre anal distance 1.50, Distance between origin of pectoral & origin of pelvic 4.24, Distance between origin of pelvic and origin of anal 4.24, Distance between origin of pelvic and anus 4.80

The ratio index and measurements of morphometric characters of the single specimen species is shown in the following combined table.

Table 53 & 54. Ratio Index and Measurements (in mm) of morphometric characters of *N. carletoni* Fowler, 1924.

CHARACTERS	NUMBER OF SPECIMENS	RATIO INDEX
	I	
Total length	36.0	100.000
Standard length	30.0	83.333
Head length	8.0	22.222
Head breadth	5.5	15.278
Head depth	4.5	12.500
Gape of mouth	3.0	8.333
Eye diameter	1.0	2.778
Inter orbital distance	2.5	6.944
Post orbital distance	4.0	11.111
Inter nasal distance	2.5	6.944
Snout length	3.0	8.333
Maxillary Barbel length	4.0	11.111
Outer rostral barbel length	3.5	9.722
Inner rostral barbel length	2.0	5.556
Body depth	5.0	13.889
Body width	4.5	12.500
Dorsal height	5.5	15.278
Dorsal base	4.0	11.111
Anal height	5.0	13.889
Anal base	4.0	11.111
Pectoral length	5.5	15.278
Pelvic length	5.5	15.278
Length of caudal fin	6.0	16.667
Length of caudal peduncle	4.0	11.111
Highest depth of caudal peduncle	4.0	11.111
Least depth of caudal peduncle	4.0	11.111
Pre dorsal distance	18.0	50.000
Pre pectoral distance	8.0	22.222
Pre pelvic distance	17.0	47.222
Pre anal distance	24.0	66.667

Distance between origin of pectoral & origin of pelvic	8.5	23.611
Distance between origin of pelvic & origin of anal	8.5	23.611
Distance between origin of pelvic & anus	7.5	20.833

Other Characteristics:

Body: Elongate, compressed, dorsal profile slightly convex, ventral horizontal and flat.

Head: Moderately long, narrower anteriorly. Snout shorter than post orbital length. Nostrils close to each other, situated closer to eye than tip of snout.

Eyes: Small, situated in the middle of head, not visible from ventral surface.

Mouth: Semicircular, width of gape of mouth 2-6 in length of head. Lips fleshy, moderately furrowed, upper uninterrupted, lower interrupted in the middle dentiform process moderately developed.

Barbels: Four pairs, a pair each of maxillary and nasal and two of rostral, inner rostral shorter than outer, outer extending to hind edge of eye, maxillary the longest.

Fins: Dorsal moderately high; edge of dorsal straight; its origin nearer caudal base than tip of snout. Pectoral shorter than head reaches half of distance of pelvic. Anal fin not reaching base of caudal. caudal very slightly emarginate posteriorly.

Lateral Line: Almost complete

Scales: Minute, distinct, most evident posteriorly.

Colour: Pale brownish, whitish below. About 17-18 transverse brownish bands broader than interspace on middle of sides neither extending to back or ventral side of body. Dorsal with 3 pale brownish bands across; a deep brown bar at caudal base; a black batch at dorsal origin.

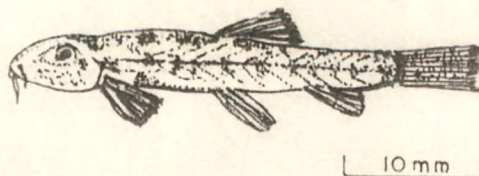
Distribution: India: Himachal Pradesh.

Remarks: The species is reported for the first time from Sikkim drainages. However, it is exclusively found to be present in Rimbi khola.

Variations recorded in present specimen from those described by Menon (1987) are : origin of pelvic slightly ahead of dorsal (vs. origin of pelvic opposite to dorsal by menon, 1987); pelvic fin equal to pectoral (vs. pelvic shorter than pectoral); caudal fin shorter than head (vs. caudal fin longer than head).

25. *Noemacheilus corica* (Hamilton), 1822

(Plate XVI-3)



Text Figure 25. *Noemacheilus corica* (Hamilton)

1822. *Cobitis corica* Hamilton - Buch., Fish. Ganges, p. 359, 395

(Type locality : Kosi River).

Present records: RANGIT DRAINAGE: Rimbi khola, SS Rimbi 32 mm (1 ex.); local name:
Gadela.

Meristic Counts: D.iii.8; P.11; V.i.7; A.ii.5; C.17.

Morphometric Characters:

Standard length 1.19, Head length 4.92, Head breadth 6.40, Head depth 8.00, Gape of mouth 12.80, Inter orbital distance 10.67, Post orbital distance 8.00, Inter nasal distance 16.00, Snout length 10.67, Maxillary Barbel length 12.80, Outer rostral barbel length 10.67, Inner rostral barbel length 21.33, Body depth 7.11, Body width 8.00, Dorsal height 6.40, Dorsal base 8.00, Anal height 6.40, Anal base 10.67, Pectoral length 5.33, Pelvic length 6.40, Length of caudal fin 5.82, Length of caudal peduncle 8.00, Highest depth of caudal peduncle 9.14, Least depth of caudal peduncle 9.14, Pre dorsal distance 2.13, Pre pectoral distance 4.57, Pre pelvic distance 2.13, Pre anal distance 1.52, Distance between origin of pectoral & origin of pelvic 3.56, Distance between origin of pelvic & origin of anal 4.57, Distance between origin of pelvic & anus 5.82, Distance between anus & origin of anal fin 32.00.

The ratio index and measurements of morphometric characters of the single specimen species is shown in the following combined table.

Table 55 & 56. Ratio Index and Measurements (in mm) of morphometric characters of *N. corica* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS	RATIO INDEX
Total length	32.0	100.000
Standard length	27.0	84.375
Head length	6.5	20.313
Head breadth	5.0	15.625
Head depth	4.0	12.500
Gape of mouth	2.5	7.813
Inter orbital distance	3.0	9.375
Post orbital distance	4.0	12.500
Inter nasal distance	2.0	6.250
Snout length	3.0	9.375
Maxillary Barbel length	2.5	7.813
Outer rostral barbel length	3.0	9.375
Inner rostral barbel length	1.5	4.688
Body depth	4.5	14.063
Body width	4.0	12.500
Dorsal height	5.0	15.625
Dorsal base	4.0	12.500
Anal height	5.0	15.625
Anal base	3.0	9.375
Pectoral length	6.0	18.750
Pelvic length	5.0	15.625
Length of caudal fin	5.5	17.188
Length of caudal peduncle	4.0	12.500
Highest depth of caudal peduncle	3.5	10.938
Least depth of caudal peduncle	3.5	10.938
Pre dorsal distance	15.0	46.875
Pre pectoral distance	7.0	21.875
Pre pelvic distance	15.0	46.875
Pre anal distance	21.0	65.625
Distance between origin of pectoral & origin of pelvic	9.0	28.125

Distance between origin of pelvic & origin of anal	7.0	21.875
Distance between origin of pelvic & anus	5.5	17.188
Distance between anus & origin of anal fin	1.0	3.125

Other Characteristics:

Body: Elongate, sub-cylindrical. Dorsal profile slightly arched; ventral almost straight and horizontal.

Head: Moderate, snout rounded. Nostrils close to each other, cluster to eye then tip of snout.

Eyes: Small, situated in the middle of head, not visible from ventral surface.

Mouth: Semicircular, width of gape of mouth 2-6 in length of head. Lips fleshy, poorly furrowed, upper uninterrupted, lower interrupted in the middle. Dentiform process well developed.

Barbels: Four pairs, a pair of maxillary and nasal and two of rostral, inner rostral shorter and outer rostral longest.

Fins: Dorsal fin small, slightly shorter than length of head, edge of dorsal slightly concave. Dorsal fin inserted nearer tip of snout than caudal base. Origin of pelvic slightly ahead of dorsal in the present specimen. Second branched ray of pectoral elongated. Pelvic slightly shorter than pectoral separated from anal opening by a short distance. Caudal fin shorter than head, forked, lobes pointed and equal.

Lateral Line: complete

Scales: Small, imbricate all over, more prominent posteriorly.

Colour: Yellowish with a row of eleven round to oval spots along lateral line on each side and a similar row along with the bank, and descending to between them; usually a silvery band along middle side.

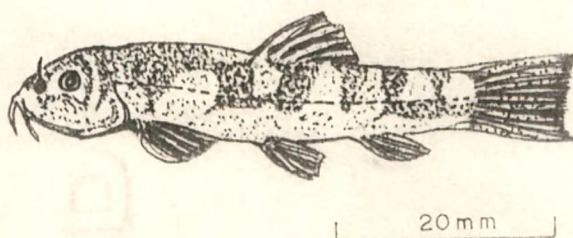
Distribution: India: All along the sub-Himalayan range, from Darjeeling and Kumaon to Himachal Pradesh and Punjab. Elsewhere: Nepal.

Remarks: The species is reported for the first time from Sikkim drainages. It is rare in occurrence and found only in Rimbi khola during the present study period.

Variations observed from those described by menon (1987) are : pectoral fin shorter than head (vs. pectoral longer than head - Menon, 1987); anal fin almost reaches base of caudal (vs. anal fin reaching caudal base).

26. *Noemacheilus devdevi* Hora, 1935

(Plate XVI-4)

Text Figure 26. *Noemacheilus devdevi* Hora

1935. *Noemacheilus devdevi* Hora, Rec. Indian Mus., 37, p.54 pl.3, fig. 506

(Type locality, Eastern Himalayas; small streams below Darjeeling and in Sikkim).

Previous records: Rongni chhu, Tardong, Coll. Unknown; Martin river, Martin, Coll. Unknown (Tilak, 1972); river Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Rangpo khola, SS Rangpo 25 - 44 mm (8 exs.). RANGIT DRAINAGE: R. Rangit, FCC Tatopani 42 mm (1 ex.); Kalej khola, SS Legship 39 - 44 mm (5 exs.); Roathak khola, SS Rothak 44 - 49 mm (3 exs.); local name: *Gadela*.

Meristic Counts: D.iii.8; P.19; V.i.6; A.ii.5; C.16.

Morphometric Characters:

Standard length 1.15 - 1.19 (1.175), Head length 4.67 - 5.18 (4.946), Head breadth 7.33 - 8.91 (7.902), Head depth 7.64 - 8.91 (8.535), Gape of mouth 16.33 - 19.50 (17.503), Eye diameter 28.00 - 32.67 (30.252), Inter orbital distance 17.60 - 21.00 (18.971), Post orbital distance 9.78 - 11.14 (10.638), Inter nasal distance 21.00 - 26.00 (22.956), Snout length 10.50 - 14.00 (11.713), Maxillary barbel length 17.60 - 21.00 (18.971), Outer rostral barbel length 17.60 - 21.00 (18.971), Inner rostral barbel length 26.00 - 32.67 (28.907), Body depth 7.54 - 8.80 (8.235), Body width 7.80 - 8.80 (8.219), Dorsal height 5.18 - 6.29 (5.809), Dorsal base 7.33 - 9.75 (8.122), Anal height 6.00 - 6.77 (6.400), Anal base 9.75 - 12.25 (10.579), Pectoral length 5.50 - 6.53 (5.872), Pelvic length 6.29 - 7.54 (6.792), Length of caudal fin 6.46 - 7.33 (6.798), Length of caudal peduncle 6.29 - 7.00 (6.594), Highest depth of caudal peduncle 8.91 - 10.50 (9.716), Least depth of caudal peduncle 8.91 - 10.50 (9.716), Pre dorsal distance 2.17 - 2.44 (2.292), Pre pectoral distance 4.89 - 5.44 (5.122), Pre pelvic distance 2.10 - 2.32 (2.235), Pre anal distance 1.53 - 1.66 (1.584), Distance between origin of pectoral & origin of pelvic 3.50 - 4.00 (3.784), Distance between origin of pelvic & origin of anal 5.16 - 5.87 (5.458), Distance between origin of pelvic & anus 5.50 - 6.46 (5.982), Distance

between anus and origin of anal fin 24.50 - 78.00 (34.207).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 57. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *N. devdevi* Hora, 1935.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	85.083	84.091	86.905	1.087
Head length	20.220	19.318	21.429	0.788
Head breadth	12.655	11.224	13.636	0.807
Head depth	11.717	11.224	13.095	0.696
Gape of mouth	5.713	5.128	6.122	0.337
Eye diameter	3.306	3.061	3.571	0.202
Inter orbital distance	5.271	4.762	5.682	0.359
Post orbital distance	9.400	8.974	10.227	0.452
Inter nasal distance	4.356	3.846	4.762	0.338
Snout length	8.537	7.143	9.524	0.867
Maxillary barbel length	5.271	4.762	5.682	0.359
Outer rostral barbel length	5.271	4.762	5.682	0.359
Inner rostral barbel length	3.459	3.061	3.846	0.255
Body depth	12.144	11.364	13.265	0.773
Body width	12.167	11.364	12.821	0.502
Dorsal height	17.216	15.909	19.318	1.235
Dorsal base	12.313	10.256	13.636	1.191
Anal height	15.626	14.773	16.667	0.635
Anal base	9.452	8.163	10.256	0.780
Pectoral length	17.030	15.306	18.182	1.027
Pelvic length	14.723	13.265	15.909	0.912
Length of caudal fin	14.711	13.636	15.476	0.690
Length of caudal peduncle	15.166	14.286	15.909	0.570
Highest depth of caudal peduncle	10.292	9.524	11.224	0.542
Least depth of caudal peduncle	10.292	9.524	11.224	0.542

Pre dorsal distance	43.623	40.909	46.154	1.727
Pre pectoral distance	19.522	18.367	20.455	0.754
Pre pelvic distance	44.741	43.182	47.727	1.587
Pre anal distance	63.137	60.227	65.476	1.784
Distance between origin of pectoral & origin of pelvic	26.428	25.000	28.571	1.249
Distance between origin of pelvic & origin of anal	18.322	17.045	19.388	0.831
Distance between origin of pelvic & anus	16.716	15.476	18.182	0.973
Distance between anus and anal fin	2.923	1.282	4.082	1.011

Other Characteristics:

Body: Slender, small-sized species, the dorsal profile slightly, ventral almost straight and horizontal. Ventral surface in front of anal opening flattened.

Head: Narrow, broadly pointed, depressed. Snout of moderate length, equal to post orbital distance. Nostril close to each other, situated closer to eye than to tip of snout, anterior tubular.

Eyes: Small, situated in the middle of head, not visible from ventral surface.

Mouth: Semicircular, width of gape of mouth 3.1 - 4.0 in total length. Lips moderately fleshy, poorly furrowed, upper uninterrupted, lower interrupted in the middle. Dentiform process moderately developed.

Barbels: Four pairs, well developed, inner rostral shorter, outer rostral and maxillary sub equal; outer rostral extending to margin of eye or falling a little shorter; maxillary extending to posterior border of eye.

Fins: Dorsal fin small, less than length of head; edge of dorsal almost straight. Pectoral shorter than length of head, extend for more than half distance to base of pelvic. Origin of pelvic almost opposite to that of dorsal. Pelvic shorter than pectoral reaches and opening. Anal fin not reaching base of caudal. Caudal elongate.

Lateral Line: Incomplete, terminating above pelvic fin.

Scales: Small, indistinct, move towards posterior part of body, absent on ventral surface.

Colour: Body olivaceous, paler below with 6 to 8 broad saddle shaped bands extending from back to sides; dorsal fin marked with two series of black spots at its rays.

Distribution: India: Eastern Himalayas.

Remarks: Origin of dorsal fin nearer to base of caudal than to tip of snout as described by Menon (1987) but in present specimens dorsal fin is equidistant between tip of snout and caudal base.

Menon (1987) writes a black spot at the base of caudal but in the present investigation, two black spots are found to be present at the base of caudal fin in all the specimens.

Table 58. Measurements (in mm) of *Noemacheilus devdevi* Hora, 1935.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	49.0	44.0	44.0	42.0	39.0	39.0	49.0	43.600
Standard length	42.0	37.0	37.0	36.5	33.0	33.0	42.0	37.100
Head length	9.5	8.5	9.0	9.0	8.0	8.0	9.5	8.800
Head breadth	5.5	5.5	6.0	5.5	5.0	5.0	6.0	5.500
Head depth	5.5	5.0	5.0	5.5	4.5	4.5	5.5	5.100
Gape of mouth	3.0	2.5	2.5	2.5	2.0	2.0	3.0	2.500
Eye diameter	1.5	1.5	1.5	1.5	1.2	1.2	1.5	1.440
Inter orbital distance	2.5	2.5	2.5	2.0	2.0	2.0	2.5	2.300
Post orbital distance	4.5	4.0	4.5	4.0	3.5	3.5	4.5	4.100
Inter nasal distance	2.0	2.0	2.0	2.0	1.5	1.5	2.0	1.900
Snout length	3.5	3.5	4.0	4.0	3.5	3.5	4.0	3.700
Maxillary barbel length	2.5	2.5	2.5	2.0	2.0	2.0	2.5	2.300
Outer rostral barbel length	2.5	2.5	2.5	2.0	2.0	2.0	2.5	2.300
Inner rostral barbel length	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.500
Body depth	6.5	5.0	5.0	5.0	5.0	5.0	6.5	5.300
Body width	6.0	5.0	5.5	5.0	5.0	5.0	6.0	5.300
Dorsal height	8.0	7.0	8.5	7.5	6.5	6.5	8.5	7.500
Dorsal base	6.5	5.5	6.0	5.0	4.0	4.0	6.5	5.400
Anal height	7.5	7.0	6.5	6.5	6.5	6.5	7.5	6.800
Anal base	4.0	4.5	4.0	4.0	4.0	4.0	4.5	4.100
Pectoral length	7.5	7.5	8.0	7.0	7.0	7.0	8.0	7.400
Pelvic length	6.5	6.5	7.0	6.0	6.0	6.0	7.0	6.400
Length of caudal fin	7.0	6.0	6.5	6.5	6.0	6.0	7.0	6.400
Length of caudal peduncle	7.0	6.5	7.0	6.5	6.0	6.0	7.0	6.600
Highest depth of caudal peduncle	5.5	4.5	4.5	4.0	4.0	4.0	5.5	4.500
Least depth of caudal peduncle	5.5	4.5	4.5	4.0	4.0	4.0	5.5	4.500
Pre dorsal distance	21.5	19.5	18.0	18.0	18.0	18.0	21.5	19.000
Pre pectoral distance	9.0	8.5	9.0	8.5	7.5	7.5	9.0	8.500

Pre pelvic distance	21.5	19.0	21.0	18.5	17.5	17.5	21.5	19.500
Pre anal distance	30.5	26.5	28.0	27.5	25.0	25.0	30.5	27.500
Distance between origin of pectoral & origin of pelvic	12.5	11.0	11.5	12.0	10.5	10.5	12.5	11.500
Distance between origin of pelvic & origin of anal	9.5	8.0	7.5	8.0	7.0	7.0	9.5	8.000
Distance between origin of pelvic & anus	8.5	7.0	8.0	6.5	6.5	6.5	8.5	7.300
Distance between anus and anal fin	2.0	1.0	1.5	1.5	0.5	0.5	2.0	1.300

27. *Noemacheilus kangjupkhulensis* Hora, 1921

(Plate XVI-5)



Text Figure 27. *Noemacheilus kangjupkhulensis* Hora

1921. *Noemacheilus kangjupkhulensis* Hora, Rec. Indian Mus., 22 : 202, pl.10, figs. 4, 4 a (Type locality, Manipur valley).

Present records: TISTA DRAINAGE: Dik chhu, SS Dikchu 30 mm (2 exs.). RANGIT DRAINAGE: R. Rangit, SS Nayabazar 33 mm (2 exs.); local name: *Gadela*.

Meristic Counts: D.ii.7; P.9; V.i.6; A.ii.5; C.16.

Morphometric Characters:

Standard length 1.18 - 1.25 (1.213), Head length 4.71 - 5.00 (4.853), Head breadth 6.00 - 6.60 (6.286), Head depth 8.25 - 8.57 (8.408), Gape of mouth 9.43 - 12.00 (10.560), Inter orbital distance 11.00 - 12.00 (11.478), Post orbital distance 11.00 - 12.00 (11.478), Inter nasal distance 13.20 - 15.00 (14.043), Snout length 11.00 - 12.00 (11.478), Maxillary barbel length 11.00 - 12.00 (11.478), Outer rostral barbel length 16.50 - 20.00 (18.082), Inner rostral barbel length 33.00 - 42.86 (37.288), Body depth 6.60 - 7.50 (7.021), Body width 6.60 - 7.50 (7.021), Dorsal height 5.50 - 6.00 (5.739), Dorsal base 7.33 - 7.50 (7.416), Anal height 6.60 - 7.50 (7.021), Anal base 9.43 - 10.00 (9.706), Pectoral length 5.50 - 6.67 (6.027), Pelvic length 6.60 - 7.50 (7.021), Length of

caudal fin 5.50 - 6.00 (5.739), Length of caudal peduncle 9.43 - 10.00 (9.706), Highest depth of caudal peduncle 9.43 - 10.00 (9.706), Least depth of caudal peduncle 9.43 - 10.00 (9.706), Pre dorsal distance 2.20 - 2.31 (2.253), Pre pectoral distance 4.71 - 5.00 (4.853), Pre pelvic distance 2.20 - 2.31 (2.253), Pre anal distance 1.43 - 1.43 (1.432), Distance between origin of pectoral & origin of pelvic 3.53 - 3.67 (3.597), Distance between origin of pelvic & origin of anal 4.71 - 5.00 (4.853), Distance between origin of pelvic & anus 5.50 - 6.00 (5.739).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 59. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *N. kangjupkhulensis* Hora, 1921.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.424	80.000	84.848	2.424
Head length	20.606	20.000	21.212	0.606
Head breadth	15.909	15.152	16.667	0.758
Head depth	11.894	11.667	12.121	0.227
Gape of mouth	9.470	8.333	10.606	1.136
Inter orbital distance	8.712	8.333	9.091	0.379
Post orbital distance	8.712	8.333	9.091	0.379
Inter nasal distance	7.121	6.667	7.576	0.455
Snout length	8.712	8.333	9.091	0.379
Maxillary barbel length	8.712	8.333	9.091	0.379
Outer rostral barbel length	5.530	5.000	6.061	0.530
Inner rostral barbel length	2.682	2.333	3.030	0.348
Body depth	14.242	13.333	15.152	0.909
Body width	14.242	13.333	15.152	0.909
Dorsal height	17.424	16.667	18.182	0.758
Dorsal base	13.485	13.333	13.636	0.152
Anal height	14.242	13.333	15.152	0.909
Anal base	10.303	10.000	10.606	0.303
Pectoral length	16.591	15.000	18.182	1.591
Pelvic length	14.242	13.333	15.152	0.909

Length of caudal fin	17.424	16.667	18.182	0.758
Length of caudal peduncle	10.303	10.000	10.606	0.303
Highest depth of caudal peduncle	10.303	10.000	10.606	0.303
Least depth of caudal peduncle	10.303	10.000	10.606	0.303
Pre dorsal distance	44.394	43.333	45.455	1.061
Pre pectoral distance	20.606	20.000	21.212	0.606
Pre pelvic distance	44.394	43.333	45.455	1.061
Pre anal distance	69.848	69.697	70.000	0.152
Distance between origin of pectoral & origin of pelvic	27.803	27.273	28.333	0.530
Distance between origin of pelvic & origin of anal	20.606	20.000	21.212	0.606
Distance between origin of pelvic & anus	17.424	16.667	18.182	0.758

Other Characteristics:

Body: Elongated, sub-cylindrical with dorsal profile slightly arched, ventral horizontal and flat throughout.

Head: Moderate, bluntly pointed, slightly depressed. Snout somewhat rounded, equal to post orbital distance. Nostril situated closer to eye than tip of snout, anterior not tubular.

Eyes: Small, dorsal-lateral in position, situated in the middle of head, not visible from ventral surface.

Mouth: Semicircular, width of gape of mouth 2.0 - 2.4 in total length of head. Lips fleshy, poorly furrowed, upper uninterrupted, lower interrupted in the middle. Dentiform process moderately developed.

Barbels: Four pairs, well developed barbels, a pair each of maxillary & nasal & two of rostral. Inner rostral shorter, maxillary the longest.

Fins: Dorsal small, less than length of head; edge of dorsal slightly concave, inserted slightly near base of caudal than tip of snout. Pelvic fin originates opposite to dorsal. Pectoral fin slightly shorter than head extends about half way of distance to pelvic. Pelvic shorter than pectoral. Anal not reaching base caudal. Caudal fin slightly shorter than head, truncate or slightly emarginate.

Lateral line: Incomplete ending before commencement of dorsal fin.

Skin: Smooth.

Scales: Minute, embedded, more numerous posteriorly.

Colour: 7 - 11 block bands separated by narrowed white ones, a black bar at base of caudal fin; a black spot at base of first three rays of dorsal fins; two black streaks radiating from eye to snout.

Distribution: India: Manipur and Burma.

Remarks: The species is reported for the first time from Sikkim rivers. However, its distribution is restricted to Dik chhu and river Rangit. In the present specimen, outer rostral barbel is shorter than maxillary but Menon (1987) has described outer rostral equal to maxillary.

Table 60. Measurements (in mm) of *Noemacheilus kangjupkhulensis* Hora, 1921.

CHARACTERS	NUMBER OF SPECIMENS		RANGE		MEAN
	I	II	Min.	Max.	
Total length	33.0	30.0	30.0	33.0	31.500
Standard length	28.0	24.0	24.0	28.0	26.000
Head length	7.0	6.0	6.0	7.0	6.500
Head breadth	5.0	5.0	5.0	5.0	5.000
Head depth	4.0	3.5	3.5	4.0	3.750
Gape of mouth	3.5	2.5	2.5	3.5	3.000
Inter orbital distance	3.0	2.5	2.5	3.0	2.750
Post orbital distance	3.0	2.5	2.5	3.0	2.750
Inter nasal distance	2.5	2.0	2.0	2.5	2.250
Snout length	3.0	2.5	2.5	3.0	2.750
Maxillary barbel length	3.0	2.5	2.5	3.0	2.750
Outer rostral barbel length	2.0	1.5	1.5	2.0	1.750
Inner rostral barbel length	1.0	0.7	0.7	1.0	0.850
Body depth	5.0	4.0	4.0	5.0	4.500
Body width	5.0	4.0	4.0	5.0	4.500
Dorsal height	6.0	5.0	5.0	6.0	5.500
Dorsal base	4.5	4.0	4.0	4.5	4.250
Anal height	5.0	4.0	4.0	5.0	4.500
Anal base	3.5	3.0	3.0	3.5	3.250
Pectoral length	6.0	4.5	4.5	6.0	5.250
Pelvic length	5.0	4.0	4.0	5.0	4.500
Length of caudal fin	6.0	5.0	5.0	6.0	5.500
Length of caudal peduncle	3.5	3.0	3.0	3.5	3.250
Highest depth of caudal peduncle	3.5	3.0	3.0	3.5	3.250
Least depth of caudal peduncle	3.5	3.0	3.0	3.5	3.250

Pre dorsal distance	15.0	13.0	13.0	15.0	14.000
Pre pectoral distance	7.0	6.0	6.0	7.0	6.500
Pre pelvic distance	15.0	13.0	13.0	15.0	14.000
Pre anal distance	23.0	21.0	21.0	23.0	22.000
Distance between origin of pectoral & origin of pelvic	9.0	8.5	8.5	9.0	8.750
Distance between origin of pelvic & origin of anal	7.0	6.0	6.0	7.0	6.500
Distance between origin of pelvic & anus	6.0	5.0	5.0	6.0	5.500

28. *Noemacheilus multifasciatus* Day, 1878

(Plate XVI-9)



Text Figure 28. *Noemacheilus multifasciatus* Day

1878. *Noemacheilus multifasciatus* Day (in part), *Fish. India*, p. 617, pl. 153, fig 7
(Type locality, Darjeeling and Assam).

Present records: TISTA DRAINAGE: Tista, FCC Passingdong 35 - 105 mm (11 exs.); Dik chhu, SS Dikchu 69 - 71 mm (5 exs.). RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 31- 47 mm (2 exs.); FCC Tatopani 27 - 56 mm (38 exs.); Rimbi khola, SS Rimbi 61 - 75 mm (20 exs.); Kalej khola, SS Legship 63 - 69 mm (32 exs.); Roathak khola, SS Rothak 21 - 64 mm (39 exs.); Rangbhang khola, SS Nayabazar 31 - 59 mm (2 exs.); local name: *Gadela*.

Meristic Counts: D.ii.7; P.12; V.8; A.i.5; C.16.

Morphometric Characters:

Standard length 1.12 - 1.17 (1.148), Head length 4.75 - 5.83 (5.366), Head breadth 6.33 - 7.14 (6.716), Head depth 8.33 - 8.88 (8.640), Gape of mouth 10.86 - 13.64 (11.707), Eye diameter 37.50 - 52.50 (44.186), Inter orbital distance 11.69 - 13.64 (12.958), Post orbital distance 10.13 - 12.50 (11.419), Inter nasal distance 14.20 - 16.67 (15.172), Snout length 10.13 - 11.83 (10.975),

Maxillary barbel length 13.64 - 19.09 (15.874), Outer rostral barbel length 12.50 - 19.09 (14.893), Inner rostral barbel length 18.75 - 23.33 (20.419), Body depth 7.24 - 8.08 (7.629), Body width 6.91 - 8.08 (7.469), Dorsal height 7.10 - 8.75 (7.653), Dorsal base 8.44 - 9.55 (9.223), Anal height 7.89 - 10.13 (8.725), Anal base 12.67 - 13.64 (13.183), Pectoral length 6.25 - 6.77 (6.462), Pelvic length 6.25 - 7.00 (6.737), Length of caudal fin 5.77 - 7.60 (6.698), Length of caudal peduncle 7.89 - 8.75 (8.255), Highest depth of caudal peduncle 8.44 - 9.38 (9.026), Least depth of caudal peduncle 8.44 - 9.38 (9.026), Pre dorsal distance 2.10 - 2.15 (2.129), Pre pectoral distance 4.90 - 5.56 (5.296), Pre pelvic distance 2.11 - 2.27 (2.207), Pre anal distance 1.38 - 1.50 (1.446), Distance between origin of pectoral & origin of pelvic 3.41 - 3.75 (3.543), Distance between origin of pelvic & origin of anal 3.62 - 4.41 (4.056), Distance between origin of pelvic & anus 4.38 - 5.36 (5.018), Distance between anus and origin of anal fin 25.33 - 30.00 (27.863).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 61. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *N. multifasciatus* Day, 1878.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	87.134	85.333	89.524	1.630
Head length	18.634	17.143	21.053	1.310
Head breadth	14.889	14.000	15.789	0.717
Head depth	11.574	11.268	12.000	0.292
Gape of mouth	8.542	7.333	9.211	0.661
Eye diameter	2.263	1.905	2.667	0.322
Inter orbital distance	7.717	7.333	8.553	0.448
Post orbital distance	8.757	8.000	9.868	0.695
Inter nasal distance	6.591	6.000	7.042	0.336
Snout length	9.111	8.451	9.868	0.529
Maxillary barbel length	6.299	5.238	7.333	0.704
Outer rostral barbel length	6.714	5.238	8.000	1.052
Inner rostral barbel length	4.897	4.286	5.333	0.410
Body depth	13.108	12.381	13.816	0.513
Body width	13.388	12.381	14.474	0.800

Dorsal height	13.068	11.429	14.085	0.976
Dorsal base	10.843	10.476	11.842	0.505
Anal height	11.461	9.868	12.676	0.930
Anal base	7.585	7.333	7.895	0.224
Pectoral length	15.476	14.762	16.000	0.425
Pelvic length	14.843	14.286	16.000	0.603
Length of caudal fin	14.930	13.158	17.333	1.546
Length of caudal peduncle	12.113	11.429	12.667	0.438
Highest depth of caudal peduncle	11.079	10.667	11.842	0.441
Least depth of caudal peduncle	11.079	10.667	11.842	0.441
Pre dorsal distance	46.960	46.479	47.619	0.448
Pre pectoral distance	18.884	18.000	20.395	0.833
Pre pelvic distance	45.307	44.000	47.368	1.124
Pre anal distance	69.160	66.667	72.381	1.913
Distance between origin of pectoral & origin of pelvic	28.223	26.667	29.333	0.920
Distance between origin of pelvic & origin of anal	24.653	22.667	27.619	1.709
Distance between origin of pelvic & anus	19.929	18.667	22.857	1.539
Distance between anus and anal fin	3.589	3.333	3.947	0.250

Other Characteristics:

Body: Elongate, dorsal profile slightly arched, the ventral profile straight and somewhat flattened in front of anus. Abdomen rounded.

Head: Short, snout somewhat rounded, almost equal to post orbital distance. Nostrils situated to superior margin of eye, separated by a flap bearing a well developed barbel. Anterior nostril not tubular.

Eyes: Small, dorsa-lateral in position, situated almost in the middle of head; not visible from the ventral surface.

Mouth: Semicircular, width of gape of mouth 1.8 - 2.4 in length of head. Nostrils situated nearer to superior margin of eye, separated by a flap bearing a well developed barbel; anterior nostril not tubular. Lips moderately fleshy, poorly furrowed, upper not interrupted, lower interrupted in the middle. Dentiform process well developed.

Barbels: Four pairs of well developed barbels, a pair of each of maxillary and nasal, and two of rostral. Inner rostral shorter than outer. Outer rostral equal to or longer than maxillary extending

to anterior margin of eye, maxillary extending to vertical posterior border of eye.

Scales: Small, indistinct, embedded in skin; absent on ventral side.

Skin: Smooth.

Lateral Line: Complete.

Fins: Dorsal fin small, less than length of head, edge of dorsal straight, anterior margin somewhat rounded. Origin of dorsal fin a little nearer to caudal base than tip of snout. Pectoral shorter than head. Origin of pelvic opposite or slightly before dorsal. Pelvic slightly shorter than pectoral, separated from anal opening by a considerable distance. Caudal fins slightly emarginate posteriorly.

Colour: Body marked with 14-16 vertical bands, broader than the interspaces. A black spot at the base of anterior dorsal rays; short dark streak on the outer rays of dorsal and caudal fins. The arrangement and the number of bands varies considerably, in some specimens the bands are split up especially in front of dorsal fin into a number of narrower bands.

Distribution: India: Eastern Himalayas. Elsewhere: Nepal.

Remarks: This species is recorded for the first time from Sikkim drainages. It is one of the most widely distributed species of the genus *Noemacheilus* Van Hasselt.

Pectoral extends only about half the distance to pelvic but Menon (1987) writes pectoral extends about two-thirds the distance to pelvic. Menon (1987) mentions caudal fin as long as or slightly shorter than head but it is found always shorter than head in the present specimens.

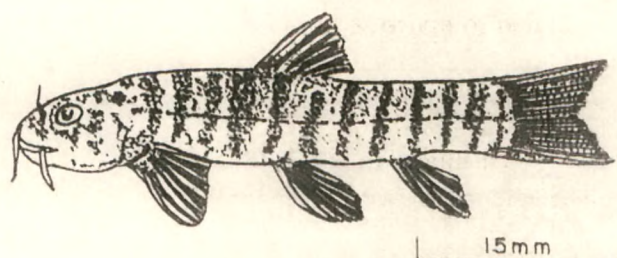
Table 62. Measurements (in mm) of *Noemacheilus multifasciatus* Day, 1878.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	105.0	76.0	75.0	75.0	71.0	71.0	105.0	80.400
Standard length	94.0	67.0	64.0	64.0	62.0	62.0	94.0	70.200
Head length	18.0	16.0	13.5	14.0	13.0	13.0	18.0	14.900
Head breadth	16.0	12.0	10.5	11.5	10.0	10.0	16.0	12.000
Head depth	12.0	9.0	8.5	9.0	8.0	8.0	12.0	9.300
Gape of mouth	9.5	7.0	5.5	6.5	6.0	5.5	9.5	6.900
Eye diameter	2.0	2.0	2.0	1.5	1.5	1.5	2.0	1.800
Inter orbital distance	8.0	6.5	5.5	5.5	5.5	5.5	8.0	6.200
Post orbital distance	8.5	7.5	6.5	6.0	6.5	6.0	8.5	7.000
Inter nasal distance	7.0	5.0	4.5	5.0	5.0	4.5	7.0	5.300
Snout length	9.0	7.5	7.0	7.0	6.0	6.0	9.0	7.300

Maxillary barbel length	5.5	4.5	5.0	5.5	4.5	4.5	5.5	5.000
Outer rostral barbel length	5.5	4.5	5.0	6.0	5.5	4.5	6.0	5.300
Inner rostral barbel length	4.5	3.5	4.0	4.0	3.5	3.5	4.5	3.900
Body depth	13.0	10.5	10.0	10.0	9.0	9.0	13.0	10.500
Body width	13.0	11.0	10.0	9.5	10.0	9.5	13.0	10.700
Dorsal height	12.0	10.0	9.5	10.5	10.0	9.5	12.0	10.400
Dorsal base	11.0	9.0	8.0	8.0	7.5	7.5	11.0	8.700
Anal height	12.0	7.5	8.5	9.0	9.0	7.5	12.0	9.200
Anal base	8.0	6.0	5.5	5.5	5.5	5.5	8.0	6.100
Pectoral length	15.5	12.0	11.5	12.0	11.0	11.0	15.5	12.400
Pelvic length	15.0	11.0	11.0	12.0	10.5	10.5	15.0	11.900
Length of caudal fin	14.0	10.0	11.5	13.0	11.0	10.0	14.0	11.900
Length of caudal peduncle	12.0	9.5	9.0	9.5	8.5	8.5	12.0	9.700
Highest depth of caudal peduncle	11.5	9.0	8.0	8.0	8.0	8.0	11.5	8.900
Least depth of caudal peduncle	11.5	9.0	8.0	8.0	8.0	8.0	11.5	8.900
Pre dorsal distance	50.0	36.0	35.0	35.0	33.0	33.0	50.0	37.800
Pre pectoral distance	20.0	15.5	13.5	14.0	13.0	13.0	20.0	15.200
Pre pelvic distance	47.0	36.0	34.0	33.0	32.0	32.0	47.0	36.400
Pre anal distance	76.0	53.0	51.0	50.0	49.0	49.0	76.0	55.800
Distance between origin of pectoral & origin of pelvic	28.0	22.0	22.0	21.0	20.0	20.0	28.0	22.600
Distance between origin of pelvic & origin of anal	29.0	19.0	17.5	17.0	17.5	17.0	29.0	20.000
Distance between origin of pelvic & anus	24.0	15.0	14.0	14.0	14.0	14.0	24.0	16.200
Distance between anus and anal fin	4.0	3.0	2.5	2.5	2.5	2.5	4.0	2.900

29. *Noemacheilus scaturigina* (McClelland), 1839

(Plate XVI-6)

Text Figure 29. *Noemacheilus scaturigina* (McClelland)

1839. *Cobitis* (*Schistura*) *scaturigina* McClelland, *Asiat. Res.* 19; 308, 443, pl. 53, fig. 6 (from a figure from Hamilton - Buchanan collection).

Present records: TISTA DRAINAGE: Dik chhu, SS Dikchu 40 - 51 mm (16 exs.), Rani khola, SS Saramsa 51 mm (1 ex.); Rangpo khola, SS Rangpo 40 - 51 mm (5 exs.). RANGIT DRAINAGE: R. Rangit, SS Nayabazar 31 - 60 mm (4 exs.); Kalej khola, SS Legship 45 - 51 mm (2 exs.); Roathak khola, SS Rothak 41 - 49 mm (3 exs.); local name: *Gadela*.

Meristic Counts: D.iii.8; P.10; V.8; A.i.5; C.19.

Morphometric Characters:

Standard length 1.18 - 1.21 (1.193), Head length 5.00 - 5.71 (5.357), Head breadth 6.00 - 7.29 (6.685), Head depth 7.50 - 9.27 (8.448), Gape of mouth 10.91 - 13.33 (11.926), Eye diameter 34.00 - 45.00 (38.481), Inter orbital distance 11.25 - 15.14 (13.332), Post orbital distance 11.43 - 12.86 (12.137), Inter nasal distance 15.00 - 17.67 (16.064), Snout length 10.00 - 11.33 (10.796), Maxillary barbel length 11.43 - 13.33 (12.685), Outer rostral barbel length 11.43 - 13.33 (12.685), Inner rostral barbel length 20.00 - 22.50 (20.778), Body depth 6.92 - 8.89 (7.795), Body width 6.92 - 8.89 (7.695), Dorsal height 5.71 - 8.00 (6.617), Dorsal base 7.85 - 10.60 (8.787), Anal height 7.07 - 8.57 (7.632), Anal base 10.00 - 13.25 (11.470), Pectoral length 5.37 - 6.15 (5.869), Pelvic length 6.32 - 6.67 (6.479), Length of caudal fin 5.67 - 6.15 (5.937), Length of caudal peduncle 8.00 - 10.00 (8.592), Highest depth of caudal peduncle 10.00 - 10.60 (10.155), Least depth of caudal peduncle 10.00 - 10.60 (10.155), Pre dorsal distance 2.07 - 2.25 (2.168), Pre pectoral distance 4.82 - 5.63 (5.095) Pre pelvic distance 2.07 - 2.35 (2.235), Pre anal distance 1.46 - 1.54 (1.494), Distance between origin of pectoral & origin of pelvic 3.33 - 4.00 (3.682), Distance between origin of pelvic & origin of anal 4.09 - 4.44 (4.294), Distance between origin of pelvic & anus 5.00 - 5.58 (5.293), Distance between anus and origin of anal fin 22.50 - 30.00 (26.011) .

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 63. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *N. scaturigina* (McClelland), 1839.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.841	82.353	85.000	1.171
Head length	18.666	17.500	20.000	0.811
Head breadth	14.958	13.725	16.667	1.120
Head depth	11.838	10.784	13.333	0.938
Gape of mouth	8.385	7.500	9.167	0.713
Eye diameter	2.599	2.222	2.941	0.258
Inter orbital distance	7.500	6.604	8.889	0.842
Post orbital distance	8.239	7.778	8.750	0.375
Inter nasal distance	6.225	5.660	6.667	0.407
Snout length	9.263	8.824	10.000	0.428
Maxillary barbel length	7.884	7.500	8.750	0.453
Outer rostral barbel length	7.884	7.500	8.750	0.453
Inner rostral barbel length	4.813	4.444	5.000	0.211
Body depth	12.829	11.250	14.444	1.036
Body width	12.996	11.250	14.444	1.036
Dorsal height	15.112	12.500	17.500	1.944
Dorsal base	11.380	9.434	12.745	1.380
Anal height	13.103	11.667	14.151	0.974
Anal base	8.719	7.547	10.000	0.800
Pectoral length	17.038	16.250	18.627	0.828
Pelvic length	15.434	15.000	15.833	0.329
Length of caudal fin	16.842	16.250	17.647	0.465
Length of caudal peduncle	11.639	10.000	12.500	0.876
Highest depth of caudal peduncle	9.848	9.434	10.000	0.220
Least depth of caudal peduncle	9.848	9.434	10.000	0.220
Pre dorsal distance	46.132	44.444	48.333	1.507

Pre pectoral distance	19.628	17.778	20.755	0.997
Pre pelvic distance	44.740	42.500	48.333	2.044
Pre anal distance	66.918	65.000	68.333	1.168
Distance between origin of pectoral & origin of pelvic	27.159	25.000	30.000	1.953
Distance between origin of pelvic & origin of anal	23.290	22.500	24.444	0.698
Distance between origin of pelvic & anus	18.894	17.925	20.000	0.683
Distance between anus and anal fin	3.845	3.333	4.444	0.358

Other Characteristics:

Body: Elongated with both dorsal & ventral profiles almost straight & horizontal. The ventral surface flattened in front of ventral fins.

Head: Moderate, snout somewhat equal to post orbital distance. Nostrils close to each other, situated closer to eye than tip of snout, anterior nostril slightly tubular.

Eyes: Small, situated in the middle of head, dorsa-lateral in position, not visible from the ventral surface.

Mouth: Semicircular, width of gape of mouth 2.0 - 2.5 in length of head. Lips moderately fleshy, poorly furrowed, upper un-interrupted, lower interrupted in the middle. Dentiform process moderately developed.

Barbels: Four pairs of well developed barbels, Inner rostral shorter, outer rostral as long as maxillary.

Scales: Small, imbricate, more prominent in the tail region, absent on the ventral surface.

Skin: Smooth.

Lateral Line: Complete.

Fins: Dorsal fin small, edge of dorsal straight. Pectoral separated from pelvic by a considerable distance. Pelvic shorter than pectoral. Anal fin not reaching base of caudal. Caudal fin emarginate slightly forked with equal pointed lobes.

Colour: Body greyish above, olivaceous below with 9 to 12 dark vertical bands, broader dorsally, narrowing down on sides not extending to ventral surface. A narrow black bar on base of the caudal fin with one or two series of dots forming a V - shaped pattern on the fin itself.

Distribution: India: Eastern sub-Himalayas. Elsewhere: Nepal.

Remarks: The species is recorded for the first time from the drainages of Sikkim. It is found to occur up to 700 m msl in both the drainages during the present investigations.

The present specimens have been observed to differ from those described by Menon (1987) in the following morphometric characters. Origin of dorsal is nearer caudal base in some specimens (vs. origin of dorsal equidistant Menon, 1987); origin of pelvic opposite or ahead of dorsal (vs. behind that of dorsal); pectoral and caudal shorter than head (vs. longer than head); a black bar at the base of anterior dorsal rays (vs. a black spot at the base of anterior dorsal rays).

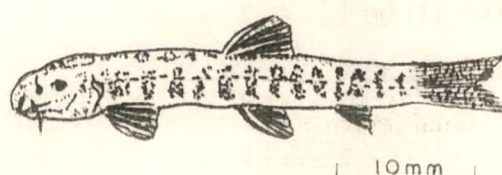
Table 64. Measurements (in mm) of *Noemacheilus scaturigina* (McClelland), 1839.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	60.0	53.0	51.0	45.0	40.0	40.0	60.0	49.800
Standard length	51.0	45.0	42.0	38.0	33.0	33.0	51.0	41.800
Head length	11.0	10.0	9.5	9.0	7.0	7.0	11.0	9.300
Head breadth	10.0	8.0	7.0	7.0	5.5	5.5	10.0	7.500
Head depth	7.5	6.0	5.5	6.0	4.5	4.5	7.5	5.900
Gape of mouth	5.5	4.0	4.5	4.0	3.0	3.0	5.5	4.200
Eye diameter	1.5	1.5	1.5	1.0	1.0	1.0	1.5	1.300
Inter orbital distance	4.0	3.5	4.0	4.0	3.0	3.0	4.0	3.700
Post orbital distance	5.0	4.5	4.0	3.5	3.5	3.5	5.0	4.100
Inter nasal distance	4.0	3.0	3.0	3.0	2.5	2.5	4.0	3.100
Snout length	5.5	5.0	4.5	4.0	4.0	4.0	5.5	4.600
Maxillary barbel length	4.5	4.0	4.0	3.5	3.5	3.5	4.5	3.900
Outer rostral barbel length	4.5	4.0	4.0	3.5	3.5	3.5	4.5	3.900
Inner rostral barbel length	3.0	2.5	2.5	2.0	2.0	2.0	3.0	2.400
Body depth	7.5	7.0	6.5	6.5	4.5	4.5	7.5	6.400
Body width	8.0	7.0	6.5	6.5	4.5	4.5	8.0	6.500
Dorsal height	7.5	7.0	8.0	7.5	7.0	7.0	8.0	7.400
Dorsal base	6.0	5.0	6.5	5.5	5.0	5.0	6.5	5.600
Anal height	7.0	7.5	7.0	5.5	5.5	5.5	7.5	6.500
Anal base	5.0	4.0	4.5	4.0	4.0	4.0	5.0	4.300
Pectoral length	10.0	9.0	9.5	7.5	6.5	6.5	10.0	8.500
Pelvic length	9.5	8.0	8.0	7.0	6.0	6.0	9.5	7.700
Length of caudal fin	10.0	9.0	9.0	7.5	6.5	6.5	10.0	8.400
Length of caudal peduncle	7.0	6.5	6.0	4.5	5.0	4.5	7.0	5.800

Highest depth of caudal peduncle	6.0	5.0	5.0	4.5	4.0	4.0	6.0	4.900
Least depth of caudal peduncle	6.0	5.0	5.0	4.5	4.0	4.0	6.0	4.900
Pre dorsal distance	29.0	24.0	23.0	20.0	19.0	19.0	29.0	23.000
Pre pectoral distance	12.0	11.0	10.0	8.0	8.0	8.0	12.0	9.800
Pre pelvic distance	29.0	24.0	22.0	20.0	17.0	17.0	29.0	22.400
Pre anal distance	41.0	36.0	34.0	30.0	26.0	26.0	41.0	33.400
Distance between origin of pectoral & origin of pelvic	18.0	14.0	13.0	13.0	10.0	10.0	18.0	13.600
Distance between origin of pelvic & origin of anal	14.0	12.0	12.0	11.0	9.0	9.0	14.0	11.600
Distance between origin of pelvic & anus	11.5	9.5	9.5	9.0	7.5	7.5	11.5	9.400
Distance between anus and anal fin	2.0	2.0	2.0	2.0	1.5	1.5	2.0	1.900

30. *Noemacheilus sikmaiensis* Hora, 1921

(Plate XVI-7)



Text Figure 30. *Noemacheilus sikmaiensis* Hora

1921. *Noemacheilus sikmaiensis* Hora, Rec. Indian Mus., 22 20, pl. 9, fig. 4, pl. 10, fig. 1, 1 a (Type locality : Simai stream, near Patel, Manipur).

Present records: TISTA DRAINAGE: Dik chhu, SS Dikchu 34 - 35 mm (2 ex.); RANGIT DRAINAGE: Rimbi khola, SS Rimbi 42 mm (1 ex.); local name: *Gadela*.

Meristic Counts: D.ii.8; P. 11-12 ; V.8; A.ii.5; C.19.

Morphometric Characters:

Standard length 1.18 - 1.21 (1.201), Head length 4.25 - 5.25 (4.794), Head breadth 5.83 - 6.46 (6.148), Head depth 7.78 - 8.50 (8.213), Gape of mouth 11.33 - 12.00 (11.660), Eye diameter 28.00 - 35.00 (32.018), Inter orbital distance 11.33 - 12.00 (11.660), Post orbital distance 8.50 - 11.67 (10.047), Inter nasal distance 13.60 - 17.50 (15.773), Snout length 11.33 - 12.00 (11.660), Maxillary barbel length 9.71 - 14.00 (11.535), Outer rostral barbel length 8.50 - 14.00 (10.378),

Inner rostral barbel length 17.00 - 21.00 (18.339), Body depth 7.00 - 7.56 (7.176), Body width 7.00 - 8.50 (7.711), Dorsal height 6.00 - 6.36 (6.178), Dorsal base 8.40 - 8.75 (8.547), Anal height 6.80 - 8.40 (7.336), Anal base 8.75 - 11.33 (10.075), Pectoral length 5.23 - 6.00 (5.519), Pelvic length 6.18 - 7.00 (6.704), Length of caudal fin 5.67 - 7.00 (6.491), Length of caudal peduncle 8.40 - 8.75 (8.547), Highest depth of caudal peduncle 8.40 - 8.75 (8.547), Least depth of caudal peduncle 8.40 - 8.75 (8.547), Pre dorsal distance 2.00 - 2.33 (2.211), Pre pectoral distance 4.86 - 5.25 (5.031), Pre pelvic distance 2.13 - 2.21 (2.174), Pre anal distance 1.48 - 1.52 (1.500), Distance between origin of pectoral & origin of pelvic 3.23 - 3.78 (3.489), Distance between origin of pelvic & origin of anal 4.38 - 4.86 (4.624), Distance between origin of pelvic & anus 5.83 - 6.18 (6.002), Distance between anus and origin of anal fin 34.00 - 42.00 (36.678).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 65. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *N. sikmaiensis* Hora, 1921.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.245	82.353	84.524	0.928
Head length	20.859	19.048	23.529	1.928
Head breadth	16.265	15.476	17.143	0.683
Head depth	12.176	11.765	12.857	0.485
Gape of mouth	8.576	8.333	8.824	0.200
Eye diameter	3.123	2.857	3.571	0.319
Inter orbital distance	8.576	8.333	8.824	0.200
Post orbital distance	9.953	8.571	11.765	1.339
Inter nasal distance	6.340	5.714	7.353	0.723
Snout length	8.576	8.333	8.824	0.200
Maxillary barbel length	8.669	7.143	10.294	1.288
Outer rostral barbel length	9.636	7.143	11.765	1.904
Inner rostral barbel length	5.453	4.762	5.882	0.493
Body depth	13.936	13.235	14.286	0.495
Body width	12.969	11.765	14.286	1.032
Dorsal height	16.186	15.714	16.667	0.389

Dorsal base	11.699	11.429	11.905	0.200
Anal height	13.632	11.905	14.706	1.233
Anal base	9.925	8.824	11.429	1.101
Pectoral length	18.119	16.667	19.118	1.051
Pelvic length	14.916	14.286	16.176	0.891
Length of caudal fin	15.406	14.286	17.647	1.585
Length of caudal peduncle	11.699	11.429	11.905	0.200
Highest depth of caudal peduncle	11.699	11.429	11.905	0.200
Least depth of caudal peduncle	11.699	11.429	11.905	0.200
Pre dorsal distance	45.238	42.857	50.000	3.367
Pre pectoral distance	19.879	19.048	20.588	0.635
Pre pelvic distance	46.004	45.238	47.059	0.771
Pre anal distance	66.676	65.714	67.647	0.789
Distance between origin of pectoral & origin of pelvic	28.665	26.471	30.952	1.831
Distance between origin of pelvic & origin of anal	21.625	20.588	22.857	0.937
Distance between origin of pelvic & anus	16.662	16.176	17.143	0.395
Distance between anus and anal fin	2.726	2.381	2.941	0.247

Other Characteristics:

Body: Elongate, dorsal profile raising gradually from snout to dorsal fin and beyond sloping gradually to caudal base. The ventral almost profile almost horizontal & straight.

Head: Moderate, slightly depressed. Snout of moderate length, somewhat rounded. Nostrils close to each other, situated closer to eye than tip of snout, a fold of skin provided with a sharp barbel like process separating the nostrils on each side.

Mouth: Semicircular, width of gape of mouth 2.2 - 2.6 in length of head. Lips thick, poorly furrowed, upper un-interrupted, lower notched in the middle; devoid of any papillae.

Barbels: Four pairs, a pair each of maxillary & nasal, and two pairs of rostral; inner rostral shorter, outer rostral longest extending to posterior margin of nostrils.

Scales: Minute, scattered all over the body except ventral surface.

Skin: Smooth.

Lateral Line: Incomplete extending up to a middle of anal fin.

Fins: Dorsal fin small, less than length of head; edge of dorsal straight. Insertion of pelvic slightly behind that of dorsal. Pelvic shorter than pectoral. Anal fin not reaching base of caudal. Caudal

fin shorter than head; not so deeply forked, lobes pointed and equal.

Colour: 12 - 13 black rings around body, separated by narrowed white ones; a black cross bar at caudal base, a black spot at base of first few dorsal rays. Dorsal fin with black bar in the middle; caudal fin dusky; rest unspotted.

Distribution: India: Manipur Valley & Meghalaya. Elsewhere: Burma.

Remarks: The species is reported for the first time from Sikkim drainages. It is a rare species, found confined to Dik chhu and river Rangit during the present investigation.

Variations have been found in the present specimens from those reported of Menon (1987) in: origin of dorsal fin is nearer caudal base than tip of snout (vs. origin of dorsal fin is equidistant between caudal base and tip of snout); pelvic does not reach anal opening (vs. pelvic reaching anal opening), caudal fin is not deeply forked and the lobes are equal (vs. caudal fin deeply forked with lower lobe longer than upper).

Table 66. Measurements (in mm) of *Noemacheilus sikmaiensis* Hora, 1921.

CHARACTERS	NUMBER OF SPECIMENS			RANGE		MEAN
	I	II	III	Min.	Max.	
Total length	42.0	35.0	34.0	34.0	42.0	37.000
Standard length	35.5	29.0	28.0	28.0	35.5	30.833
Head length	8.0	7.0	8.0	7.0	8.0	7.667
Head breadth	6.5	6.0	5.5	5.5	6.5	6.000
Head depth	5.0	4.5	4.0	4.0	5.0	4.500
Gape of mouth	3.5	3.0	3.0	3.0	3.5	3.167
Eye diameter	1.5	1.0	1.0	1.0	1.5	1.167
Inter orbital distance	3.5	3.0	3.0	3.0	3.5	3.167
Post orbital distance	4.0	3.0	4.0	3.0	4.0	3.667
Inter nasal distance	2.5	2.0	2.5	2.0	2.5	2.333
Snout length	3.5	3.0	3.0	3.0	3.5	3.167
Maxillary barbel length	3.0	3.0	3.5	3.0	3.5	3.167
Outer rostral barbel length	3.0	3.5	4.0	3.0	4.0	3.500
Inner rostral barbel length	2.0	2.0	2.0	2.0	2.0	2.000
Body depth	6.0	5.0	4.5	4.5	6.0	5.167
Body width	6.0	4.5	4.0	4.0	6.0	4.833
Dorsal height	7.0	5.5	5.5	5.5	7.0	6.000

31. *Noemacheilus spilopterus* (Cuvier & Valenciennes), 1828

(Plate XVI-8)

Text Figure 31. *Noemacheilus spilopterus* (Cuvier & Valenciennes)

1828. *Cobitis spilopterus* Cuv. and Val., xviii, p. 27, pl. 522

Present records: TISTA DRAINAGE: Dikchu khola, SS Dikchu 36 - 49 mm (29 exs.); local name: *Gadela*.

Meristic Counts: D.ii.7; P. 12 ; V. 8; A.i. 5; C.16.

Morphometric Characters:

Standard length 1.16 - 1.20 (1.185), Head length 4.59 - 5.44 (4.917), Head breadth 6.29 - 7.00 (6.565), Head depth 7.20 - 8.40 (7.766), Gape of mouth 12.00 - 15.60 (13.225), Inter orbital distance 10.50 - 13.00 (12.000), Post orbital distance 9.78 - 12.00 (10.579), Inter nasal distance 14.00 - 18.00 (16.174), Snout length 9.33 - 12.00 (10.541), Maxillary barbel length 13.00 - 14.67 (13.990), Outer rostral barbel length 10.89 - 12.00 (11.385), Inner rostral barbel length 14.00 - 18.00 (16.174), Body depth 6.53 - 7.20 (6.910), Body width 7.00 - 7.54 (7.228), Dorsal height 6.46 - 7.80 (6.919), Dorsal base 8.80 - 9.80 (9.320), Anal height 7.80 - 8.80 (8.219), Anal base 9.75 - 14.00 (11.518), Pectoral length 5.76 - 6.77 (6.278), Pelvic length 6.13 - 7.33 (6.570), Length of caudal fin 6.13 - 7.20 (6.697), Length of caudal peduncle 7.20 - 9.33 (8.212), Highest depth of caudal peduncle 8.00 - 9.75 (8.734), Least depth of caudal peduncle 8.00 - 9.75 (8.734), Pre dorsal distance 2.06 - 2.23 (2.137), Pre pectoral distance 4.50 - 5.44 (4.974), Pre pelvic distance 2.10 - 2.33 (2.180), Pre anal distance 1.45 - 1.51 (1.489), Distance between origin of pectoral & origin of pelvic 3.36 - 3.90 (3.570), Distance between origin of pelvic & origin of anal 4.19 - 4.45 (4.280), Distance between origin of pelvic & anus 4.94 - 5.87 (5.455), Distance between anus and origin of anal fin 19.50 - 28.00 (23.263).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 67. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *N. spilopterus* (Cuvier & Valenciennes), 1828.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	84.365	83.333	86.111	0.973
Head length	20.338	18.367	21.795	1.120
Head breadth	15.233	14.286	15.909	0.526
Head depth	12.876	11.905	13.889	0.673
Gape of mouth	7.561	6.410	8.333	0.751
Inter orbital distance	8.333	7.692	9.524	0.633
Post orbital distance	9.453	8.333	10.227	0.728
Inter nasal distance	6.183	5.556	7.143	0.569
Snout length	9.487	8.333	10.714	0.865
Maxillary barbel length	7.148	6.818	7.692	0.299
Outer rostral barbel length	8.783	8.333	9.184	0.373
Inner rostral barbel length	6.183	5.556	7.143	0.569
Body depth	14.471	13.889	15.306	0.509
Body width	13.836	13.265	14.286	0.358
Dorsal height	14.453	12.821	15.476	0.986
Dorsal base	10.730	10.204	11.364	0.458
Anal height	12.167	11.364	12.821	0.502
Anal base	8.682	7.143	10.256	1.147
Pectoral length	15.929	14.773	17.347	0.937
Pelvic length	15.220	13.636	16.327	0.875
Length of caudal fin	14.932	13.889	16.327	0.858
Length of caudal peduncle	12.177	10.714	13.889	1.057
Highest depth of caudal peduncle	11.450	10.256	12.500	0.747
Least depth of caudal peduncle	11.450	10.256	12.500	0.747
Pre dorsal distance	46.804	44.898	48.611	1.399
Pre pectoral distance	20.103	18.367	22.222	1.297
Pre pelvic distance	45.861	42.857	47.619	1.686
Pre anal distance	67.151	66.327	69.048	0.975
Distance between origin of pectoral & origin of pelvic	28.009	25.641	29.762	1.535

Distance between origin of pelvic & origin of anal	23.362	22.449	23.864	0.535
Distance between origin of pelvic & anus	18.331	17.045	20.238	1.050
Distance between anus and anal fin	4.299	3.571	5.128	0.518

Other Characteristics:

Body: Elongate, the dorsal profile slightly more convex than ventral. Abdominal edge rounded.

Head: Moderate. Snout of moderate length. Nostrils close to each other, situated closer to eye than tip of snout.

Eyes: Small, situated in the middle of head; not visible from ventral surface.

Mouth: Semicircular, width of gape of mouth 2.2 - 3.4 in length of head. Lips fleshy, furrowed, upper un-interrupted, lower interrupted in the middle. Dentiform process moderately developed.

Barbels: Four pairs of well developed barbels, a pair of each of maxillary and nasal, and two of rostral. Inner rostral shorter and outer rostral the longest.

Scales: Small, inconspicuous, more prominent posteriorly, absent on ventral surface.

Skin: Smooth.

Lateral Line: Complete.

Fins: Dorsal fin short, less than length of head, edge of dorsal straight. Origin of dorsal nearer to caudal base than tip of snout. Origin of pelvic slightly ahead of dorsal. Pectoral extending more than half distance to pelvic. Pelvic slightly shorter than pectoral extending to anal opening in 2 specimens but not reaching anal opening in 3 specimens. Anal fin not reaching base of caudal. Caudal rounded.

Colour: About 12 - 13 vertical bands, broader than interspaces, a dark band at the base of caudal fin. A black bar at the base of anterior dorsal rays.

Distribution: India: Assam.

Remarks: It is reported for the first time from Sikkim drainages. It is found to be a rare species confined to river Tista and Dik chhu.

Menon (1987) has not included this species in his monographic work. Jayaram (1979) has mentioned that three pairs of barbels present but in the present specimens, four pairs are found to be present.

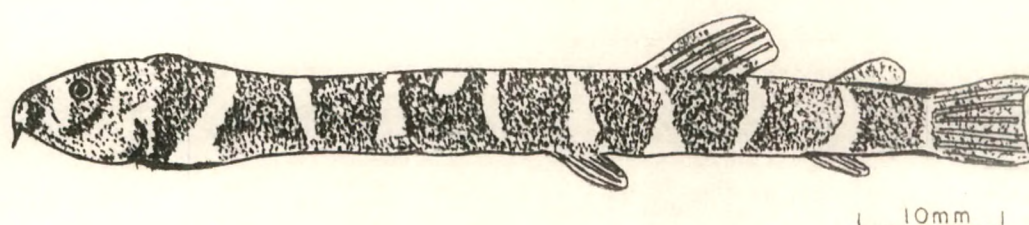
Table 68. Measurements (in mm) of *Noemacheilus spilopterus* (Cuvier & Valenciennes), 1828.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	49.0	44.0	42.0	39.0	36.0	36.0	49.0	42.000
Standard length	41.0	37.0	35.0	33.0	31.0	31.0	41.0	35.400
Head length	9.0	9.0	8.5	8.5	7.5	7.5	9.0	8.500
Head breadth	7.5	7.0	6.0	6.0	5.5	5.5	7.5	6.400
Head depth	6.5	5.5	5.0	5.0	5.0	5.0	6.5	5.400
Gape of mouth	4.0	3.5	3.5	2.5	2.5	2.5	4.0	3.200
Inter orbital distance	4.0	3.5	4.0	3.0	3.0	3.0	4.0	3.500
Post orbital distance	5.0	4.5	4.0	3.5	3.0	3.0	5.0	4.000
Inter nasal distance	3.0	2.5	3.0	2.5	2.0	2.0	3.0	2.600
Snout length	4.5	4.5	4.5	3.5	3.0	3.0	4.5	4.000
Maxillary barbel length	3.5	3.0	3.0	3.0	2.5	2.5	3.5	3.000
Outer rostral barbel length	4.5	4.0	3.5	3.5	3.0	3.0	4.5	3.700
Inner rostral barbel length	3.0	2.5	3.0	2.5	2.0	2.0	3.0	2.600
Body depth	7.5	6.5	6.0	5.5	5.0	5.0	7.5	6.100
Body width	6.5	6.0	6.0	5.5	5.0	5.0	6.5	5.800
Dorsal height	7.5	6.5	6.5	5.0	5.0	5.0	7.5	6.100
Dorsal base	5.0	5.0	4.5	4.0	4.0	4.0	5.0	4.500
Anal height	6.0	5.0	5.0	5.0	4.5	4.5	6.0	5.100
Anal base	3.5	3.5	3.5	4.0	3.5	3.5	4.0	3.600
Pectoral length	8.5	6.5	6.5	6.0	6.0	6.0	8.5	6.700
Pelvic length	8.0	6.0	6.5	6.0	5.5	5.5	8.0	6.400
Length of caudal fin	8.0	6.5	6.0	6.0	5.0	5.0	8.0	6.300
Length of caudal peduncle	6.0	5.5	4.5	4.5	5.0	4.5	6.0	5.100
Highest depth of caudal peduncle	5.5	5.0	5.0	4.0	4.5	4.0	5.5	4.800
Least depth of caudal peduncle	5.5	5.0	5.0	4.0	4.5	4.0	5.5	4.800
Pre dorsal distance	22.0	20.0	20.0	18.5	17.5	17.5	22.0	19.600
Pre pectoral distance	9.0	9.0	8.5	7.5	8.0	7.5	9.0	8.400
Pre pelvic distance	21.0	20.0	20.0	18.0	17.0	17.0	21.0	19.200
Pre anal distance	32.5	29.5	29.0	26.0	24.0	24.0	32.5	28.200

Distance between origin of pectoral & origin of pelvic	14.5	12.0	12.5	10.0	10.0	10.0	14.5	11.800
Distance between origin of pelvic & origin of anal	11.0	10.5	10.0	9.0	8.5	8.5	11.0	9.800
Distance between origin of pelvic & anus	9.0	7.5	8.5	7.0	6.5	6.5	9.0	7.700
Distance between anus and anal fin	2.0	2.0	1.5	2.0	1.5	1.5	2.0	1.800

32. *Acanthopthalmus pangia* (Hamilton), 1822

(Plate XVI-14)



Text Figure 32. *Acanthopthalmus pangia* (Hamilton)

1822. *Cobitis pangia* Ham. Buch., Fish Ganges, pp.355, 394;

(Type locality : North eastern parts of Bengal)

Present records: TISTA DRAINAGE: Rani khola, SS Saramsa 69 mm (1 ex.).

Meristic Counts: D.ii.6; P.10 ; V. 6; A.ii. 5; C.17.

Morphometric Characters:

Standard length 1.08, Head length 8.63, Head breadth 23.00, Head depth 13.80, Gape of mouth 46.00, Inter orbital distance 27.60, Post orbital distance 13.80, Inter nasal distance 46.00, Snout length 19.71, Body depth 13.80, Body width 23.00, Dorsal height 11.50, Dorsal base 17.25, Anal height 13.80, Anal base 17.25, Pectoral length 11.50, Pelvic length 17.25, Length of caudal fin 11.50, Length of caudal peduncle 6.90, Highest depth of caudal peduncle 15.33, Least depth of caudal peduncle 15.33, Pre dorsal distance 1.57, Pre pectoral distance 9.86, Pre pelvic distance 1.92, Pre anal distance 1.35, Distance between origin of pectoral & origin of pelvic 2.38, Distance between origin of pelvic & origin of anal 4.93, Distance between origin of pelvic & anus 5.75, Distance between anus and origin of anal fin 34.50.

The ratio index and measurements of morphometric characters of the single specimen species is shown in the following combined table.

Table 69 & 70. Ratio Index and Measurements (in mm) of morphometric characters of *A. pangia* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS	RATIO INDEX
	I	
Total length	69.0	100.000
Standard length	64.0	92.754
Head length	8.0	11.594
Head breadth	3.0	4.348
Head depth	5.0	7.246
Gape of mouth	1.5	2.174
Eye diameter	minute	minute
Inter orbital distance	2.5	3.623
Post orbital distance	5.0	7.246
Inter nasal distance	1.5	2.174
Snout length	3.5	5.072
Body depth	5.0	7.246
Body width	3.0	4.348
Dorsal height	6.0	8.696
Dorsal base	4.0	5.797
Anal height	5.0	7.246
Anal base	4.0	5.797
Pectoral length	6.0	8.696
Pelvic length	4.0	5.797
Length of caudal fin	6.0	8.696
Length of caudal peduncle	10.0	14.493
Highest depth of caudal peduncle	4.5	6.522
Least depth of caudal peduncle	4.5	6.522
Pre dorsal distance	44.0	63.768
Pre pectoral distance	7.0	10.145
Pre pelvic distance	36.0	52.174

Pre anal distance	51.0	73.913
Distance between origin of pectoral & origin of pelvic	29.0	42.029
Distance between origin of pelvic & origin of anal	14.0	20.290
Distance between origin of pelvic & anus	12.0	17.391
Distance between anus and origin of anal fin	2.0	2.899

Other Characteristics:

Body: Elongate and strongly compressed. Dorsal profile running parallel to ventral. Abdomen rounded.

Head: Short, cylindrical. Nostrils close to each other, anterior tabulated.

Eyes: Minute, superior, covered by skin; located in the anterior half of the head; not visible from below ventral surface.

Mouth: Small, width of gape of mouth 5.3 in length of head. Lips thick, the lower with two contiguous prolongations, or bilobate, continuous at angle of mouth with upper lip. A suborbital spine present. Jaws and palate without teeth.

Barbels: Six, a pair of rostral and two of maxillary.

Scales: Minute

Lateral Line: Complete.

Fins: Dorsal inserted in posterior half of body, nearer caudal base than tip of snout. Pectoral as long as the height of dorsal. Pelvic shorter than pectoral. Anal fin short, not continuous with the caudal, which is truncate.

Colour: Body with 9 distinct broad dark bands descending from dorsal surface to ventral, intricated with white spots in its middle. Dorsal fin dark with lighter margins. Pectoral, ventral and anal pale. Caudal with < shaped dark band.

Distribution: India: North east Bengal, Manipur. Elsewhere: Bangladesh, Burma & Indonesia.

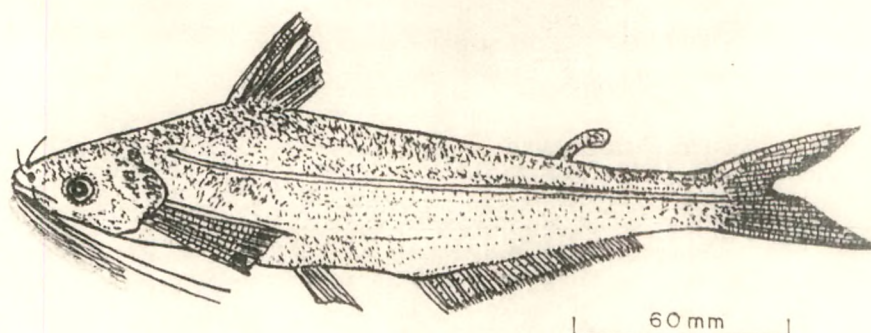
Remarks: This species is reported for the first time from Sikkim rivers. This stone loach is rare in occurrence. A single specimen could be collected from Rani khola during the present investigation.

Jayaram (1981) has mentioned that eyes are located in the middle of head but in the present specimen, eyes are found to be located in the anterior half of head.

The maximum size of the fish 65 mm reported by Talwar and Jhingran (1991) is extended to 69 mm in the present study.

33. *Clupisoma bhandarii* sp. nov.

(Plate XVIII-5 & XIX-3)

Text Figure 33. *Clupisoma bhandarii* sp. nov.

Materials examined: TISTA DRAINAGE: Confluence of Rani khola & Tista, SS Singtam 122 - 127 mm (2 exs.). RANGIT DRAINAGE: R. Rangit, FCC Tatopani 231 mm (1 ex.); SS Sikihip 147 mm (1 ex.); SS Nayabazar 247 - 275 mm (2 exs.); Rangbhang khola, SS Nayabazar 251 mm (1 ex.); **Local name:** *Jalkapoor*.

Diagnosis: Body elongate, compressed, almost herring shaped; whole of abdominal edge with the part between pelvic fins and vent keeled. Head moderate sized, oval, blunt. Snout rounded. Mouth subterminal, transverse, of moderate width, cleft extending to front edge of eye. Lips thin. Jaws equal. Teeth villiform in bands on jaws and palate. Four pairs of barbels; one pair each of maxillary, nasal and two of mandibular. Rayed dorsal fin inserted above near base of pectoral fin, with seven rays and a spine. A small adipose dorsal fin may be present or absent. Pectoral fins with 11 or 12 rays and a spine serrated along inner edge with antrorse teeth or smooth. Pelvic fins with six rays. Anal fin moderately long with 29 to 44 rays. Caudal fin deeply forked. Lateral line complete, simple.

Air bladder greatly reduced, thick walled, flat; closely applied to the ventral surface of anterior vertebrae.

Meristic Counts: D. i. 7; P. i. 11; V. i. 5; A 39 - 41; C.17.

Morphometric Characters:

Standard length 1.19 - 1.22 (1.209), Head length 5.77 - 6.23 (6.006), Head breadth 8.47 - 10.17 (9.149), Head depth 7.06 - 8.82 (8.020), Gape of mouth 11.55 - 15.44 (13.786), Eye diameter 40.67 - 61.75 (49.039), Inter orbital distance 10.58 - 12.45 (11.563), Post orbital distance 11.55 - 13.72 (12.771), Inter nasal distance 41.50 - 57.75 (47.273), Snout length 11.55 - 14.53 (13.194), Maxillary barbel length 2.82 - 4.98 (3.814), Outer mandibular barbel length 6.78 - 12.35

(9.145), Inner mandibular barbel length 7.47 - 10.38 (8.447), Nasal barbel length 12.70 - 21.00 (15.973), Body depth 5.04 - 7.18 (5.718), Body width 8.25 - 11.32 (9.330), Dorsal height 6.33 - 7.22 (6.737), Dorsal base 13.56 - 17.77 (15.154), Anal height 9.88 - 12.20 (10.843), Anal base 3.51 - 3.92 (3.678), Pectoral length 7.06 - 7.47 (7.247), Pelvic length 11.32 - 15.88 (13.449), Length of caudal fin 4.57 - 5.55 (5.059), Length of upper caudal lobe 4.66 - 6.10 (5.368), Length of lower caudal lobe 4.57 - 5.55 (5.059), Length of caudal peduncle 7.11 - 7.70 (7.473), Highest depth of caudal peduncle 11.86 - 14.35 (13.029), Least depth of caudal peduncle 13.11 - 16.27 (14.254), Pre dorsal distance 3.74 - 4.08 (3.904), Pre pectoral distance 4.88 - 5.78 (5.334), Pre pelvic distance 2.71 - 3.00 (2.871), Pre anal distance 2.14 - 2.26 (2.199), Distance between origin of pectoral & origin of pelvic 5.08 - 5.53 (5.371), Distance between origin of pelvic & origin of anal 8.25 - 9.77 (8.992), Distance between origin of pelvic & anus 10.83 - 12.70 (11.331), Distance between anus and origin of anal fin 46.20 - 63.50 (53.129).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 71. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *C. bhandarii* sp. nov.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.693	81.781	83.936	0.900
Head length	16.649	16.064	17.323	0.522
Head breadth	10.930	9.836	11.811	0.657
Head depth	12.469	11.336	14.173	0.997
Gape of mouth	7.254	6.478	8.661	0.760
Eye diameter	2.039	1.619	2.459	0.322
Inter orbital distance	8.649	8.032	9.449	0.508
Post orbital distance	7.830	7.287	8.661	0.497
Inter nasal distance	2.115	1.732	2.410	0.248
Snout length	7.579	6.883	8.661	0.719
Maxillary barbel length	26.220	20.080	35.433	6.315
Outer mandibular barbel length	10.935	8.097	14.754	2.454
Inner mandibular barbel length	11.838	9.639	13.386	1.398
Nasal barbel length	6.261	4.762	7.874	1.171

Body depth	17.489	13.934	19.838	2.260
Body width	10.718	8.835	12.121	1.166
Dorsal height	14.843	13.853	15.789	0.616
Dorsal base	6.599	5.628	7.377	0.605
Anal height	9.222	8.197	10.121	0.756
Anal base	27.189	25.506	28.514	1.144
Pectoral length	13.800	13.386	14.170	0.265
Pelvic length	7.435	6.299	8.835	0.918
Length of caudal fin	19.767	18.033	21.862	1.483
Length of upper caudal lobe	18.629	16.393	21.457	1.925
Length of lower caudal lobe	19.767	18.033	21.862	1.483
Length of caudal peduncle	13.381	12.987	14.056	0.369
Highest depth of caudal peduncle	7.675	6.967	8.434	0.568
Least depth of caudal peduncle	7.016	6.148	7.631	0.494
Pre dorsal distance	25.617	24.498	26.772	0.887
Pre pectoral distance	18.749	17.316	20.472	1.240
Pre pelvic distance	34.836	33.333	36.885	1.441
Pre anal distance	45.469	44.177	46.721	1.009
Distance between origin of pectoral & origin of pelvic	18.619	18.072	19.672	0.577
Distance between origin of pelvic & origin of anal	11.121	10.236	12.121	0.636
Distance between origin of pelvic & anus	8.825	7.874	9.237	0.487
Distance between anus and anal fin	1.882	1.575	2.165	0.232

Other Characteristics:

Body: Elongated, compressed, almost herring shaped. Abdominal edge keeled between pelvic and vent.

Head: Moderate, longer than broad. Head and body covered with soft skin.

Eyes: Moderate, diameter 7.0 - 9.9 in length of head, situated laterally almost in the middle of head, visible from below ventral surface.

Mouth: Subterminal, transverse, width of gape of mouth 2.0 - 2.5 in length of head, jaws equal. Cleft of mouth not reaching below orbit. Nostrils are very prominent.

Barbels: Eight numbers, a pair each of maxillary, nasal and two of mandibular. Nasal pair shortest. Outer mandibular 1.1 - 2.0 and inner mandibular 1.3 - 1.6 in length of head. Outer mandibular shorter than inner mandibular. Maxillary the longest.

Lateral Line: Complete, simple.

Fins: Rayed dorsal fin inserted in advance of ventral, near base of pectoral than ventral. Dorsal spine slender feebly, serrated along inner margin. Pectoral spine as long as or rather shorter than dorsal spine. Pectoral spine more stronger than dorsal, with serrations in its inner edge. A small adipose fin present both in young and adult specimens. Anal fin long but does not reach caudal. Caudal deeply forked with lower lobe longer.

Colour: Grayish along the back and brilliant silvery along the sides and abdomen.

Size: Largest specimen examined 275 mm.

Affinity: *Clupisoma bhandarii* apparently resembles *C. garua* in the nature of its abdominal edge and length of pectorals but it differs from the latter in maxillary barbels not reaching pelvic (versus maxillary barbels reaching pelvic in *garua*) and anal fin 39-42 (versus 29-36 in *garua*).

Further it can be clearly distinguished from *C. montana* in the nature of the abdominal edge which is keeled between pelvic and vent (versus abdominal edge rounded in *C. montana*).

Holotype: 202 mm SL, R. Rangit (Nayabazar), West Sikkim; Coll. P. Tamang, GUZ/F175.

Paratype: 2, 102 and 104 mm SL, Confluence of Rani khola & Tista (Singtam), East Sikkim; Coll. P. Tamang, GUZ/F176.

Etymology: The species *Clupisoma bhandarii* has been named after Shri Nar Bahadur Bhandari, the honourable Chief Minister of Sikkim, who has encouraged the investigator during her studies.

Distribution: Rivers Tista and Rangit in Sikkim.

Remarks: It is a rare species occurring in the lower stretches (240 m to 500 m elevation) of Tista, Rangit and Rangbhang khola from June to October.

It is an excellent food fish highly relished by the local folks.

Table 72. Measurements (in mm) of *Clupisoma bhandarii* sp. nov.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	249.0	247.0	231.0	127.0	122.0	122.0	249.0	195.200
Standard length	209.0	202.0	190.0	104.0	102.0	102.0	209.0	161.400
Head length	40.0	40.0	38.0	22.0	21.0	21.0	40.0	32.200
Head breadth	27.0	28.0	25.0	15.0	12.0	12.0	28.0	21.400
Head depth	32.0	28.0	27.0	18.0	15.0	15.0	32.0	24.000
Gape of mouth	17.0	16.0	16.0	11.0	9.0	9.0	17.0	13.800
Eye diameter	4.5	4.0	4.5	3.0	3.0	3.0	4.5	3.800

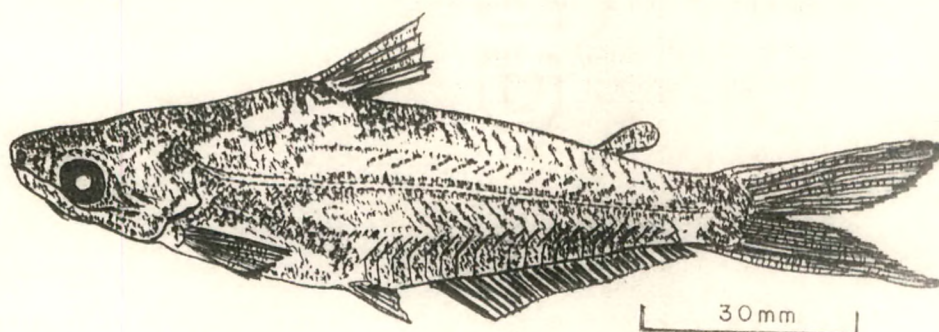
Inter orbital distance	20.0	22.0	20.0	12.0	10.0	10.0	22.0	16.800
Post orbital distance	20.0	18.0	18.0	11.0	9.0	9.0	20.0	15.200
Inter nasal distance	6.0	5.0	4.0	3.0	2.5	2.5	6.0	4.100
Snout length	18.0	17.0	16.0	11.0	10.0	10.0	18.0	14.400
Maxillary barbel length	50.0	50.0	54.0	45.0	39.0	39.0	54.0	47.600
Outer mandibular barbel length	22.0	20.0	24.0	16.0	18.0	16.0	24.0	20.000
Inner mandibular barbel length	24.0	27.0	28.0	17.0	16.0	16.0	28.0	22.400
Nasal barbel length	14.0	14.0	11.0	10.0	9.0	9.0	14.0	11.600
Body depth	47.0	49.0	44.0	20.0	17.0	17.0	49.0	35.400
Body width	22.0	29.0	28.0	13.0	13.0	13.0	29.0	21.000
Dorsal height	37.0	39.0	32.0	19.0	18.0	18.0	39.0	29.000
Dorsal base	16.0	16.0	13.0	9.0	9.0	9.0	16.0	12.600
Anal height	25.0	25.0	21.0	11.0	10.0	10.0	25.0	18.400
Anal base	71.0	63.0	65.0	35.0	32.0	32.0	71.0	53.200
Pectoral length	34.0	35.0	32.0	17.0	17.0	17.0	35.0	27.000
Pelvic length	22.0	19.0	18.0	8.0	8.0	8.0	22.0	15.000
Length of caudal fin	51.0	54.0	47.0	23.0	22.0	22.0	54.0	39.400
Length of upper caudal lobe	48.0	53.0	45.0	21.0	20.0	20.0	53.0	37.400
Length of lower caudal lobe	51.0	54.0	47.0	23.0	22.0	22.0	54.0	39.400
Length of caudal peduncle	35.0	33.0	30.0	17.0	16.0	16.0	35.0	26.200
Highest depth of caudal peduncle	21.0	20.0	18.0	9.0	8.5	8.5	21.0	15.300
Least depth of caudal peduncle	19.0	18.0	16.0	9.0	7.5	7.5	19.0	13.900
Pre dorsal distance	61.0	64.0	57.0	34.0	32.0	32.0	64.0	49.600
Pre pectoral distance	47.0	43.0	40.0	26.0	24.0	24.0	47.0	36.000
Pre pelvic distance	85.0	83.0	77.0	46.0	45.0	45.0	85.0	67.200
Pre anal distance	110.0	110.0	105.0	59.0	57.0	57.0	110.0	88.200
Distance between origin of pectoral & origin of pelvic	45.0	46.0	43.0	23.0	24.0	23.0	46.0	36.200

Distance between origin of pelvic & origin of anal	27.0	27.0	28.0	13.0	14.0	13.0	28.0	21.800
Distance between origin of pelvic & anus	23.0	22.0	21.0	10.0	11.0	10.0	23.0	17.400
Distance between anus and anal fin	5.0	5.0	5.0	2.0	2.0	2.0	5.0	3.800

Holotype - II, Paratype - IV & V.

34. *Pangasius pangasius* (Hamilton), 1822

(Plate XVI-13)



Text Figure 34. *Pangasius pangasius* (Hamilton)

1822. *Pimelodus pangasius* Hamilton, *Fish Ganges*, pp 163, 376

(Type locality : estuaries of Bengal)

Present records: Confluence of Tista and Rangit, FCC Tista 117 - 132 mm (2 exs.).

Meristic Counts: D.i.7; P.i.12 ; V.i.5; A.32; C.19.

Morphometric Characters:

Standard length 1.18 - 1.19 (1.186), Head length 4.68 - 4.71 (4.697), Head breadth 7.76 - 7.80 (7.782), Head depth 7.55 - 8.25 (7.884), Gape of mouth 11.14 - 12.00 (11.556), Eye diameter 15.60 - 17.60 (16.540), Inter orbital distance 8.80 - 9.00 (8.899), Post orbital distance 9.75 - 10.15 (9.948), Inter nasal distance 16.71 - 17.60 (17.146), Snout length 13.00 - 13.89 (13.432), Maxillary barbel length 12.00 - 13.00 (12.480), Mandibular barbel length 18.00 - 20.31 (19.084), Body depth 5.32 - 5.50 (5.408), Body width 8.36 - 9.43 (8.861), Dorsal height 5.85 - 6.00 (5.924), Dorsal base 16.50 - 16.71 (16.606), Anal height 8.36 - 9.43 (8.861), Anal base 3.83 - 3.90 (3.863), Pectoral length 6.50 - 6.95 (6.716), Pelvic length 9.43 - 9.75 (9.587), Length of caudal fin 5.85 - 6.00 (5.924), Length of upper caudal lobe 6.16 - 6.95 (6.529), Length of lower caudal lobe 5.85 - 6.00

(5.924), Length of caudal peduncle 7.33 - 8.07 (7.684), Highest depth of caudal peduncle 13.89 - 14.63 (14.251), Least depth of caudal peduncle 13.89 - 14.63 (14.251), Pre dorsal distance 2.925 - 2.933 (2.929), Pre pectoral distance 4.55 - 4.68 (4.615), Pre pelvic distance 2.60 - 2.75 (2.673), Pre anal distance 1.95 - 2.24 (2.084), Distance between origin of pectoral & origin of pelvic 5.09 - 5.74 (5.393), Distance between origin of pelvic & origin of anal 9.00 - 10.15 (9.542). Distance between origin of pelvic & anus 10.64 - 12.00 (11.277), Distance between anus and origin of anal fin 58.50 - 66.00 (62.024).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 73. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *P. pangasius* (Hamilton), 1822.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	84.305	83.761	84.848	0.544
Head length	21.290	21.212	21.368	0.078
Head breadth	12.850	12.821	12.879	0.029
Head depth	12.685	12.121	13.248	0.563
Gape of mouth	8.654	8.333	8.974	0.321
Eye diameter	6.046	5.682	6.410	0.364
Inter orbital distance	11.237	11.111	11.364	0.126
Post orbital distance	10.052	9.848	10.256	0.204
Inter nasal distance	5.832	5.682	5.983	0.151
Snout length	7.445	7.197	7.692	0.248
Maxillary barbel length	8.013	7.692	8.333	0.321
Mandibular barbel length	5.240	4.924	5.556	0.316
Body depth	18.493	18.182	18.803	0.311
Body width	11.286	10.606	11.966	0.680
Dorsal height	16.880	16.667	17.094	0.214
Dorsal base	6.022	5.983	6.061	0.039
Anal height	11.286	10.606	11.966	0.680
Anal base	25.889	25.641	26.136	0.248
Pectoral length	14.889	14.394	15.385	0.495

Pelvic length	10.431	10.256	10.606	0.175
Length of caudal fin	16.880	16.667	17.094	0.214
Length of upper caudal lobe	15.317	14.394	16.239	0.923
Length of lower caudal lobe	16.880	16.667	17.094	0.214
Length of caudal peduncle	13.015	12.393	13.636	0.622
Highest depth of caudal peduncle	7.017	6.838	7.197	0.180
Least depth of caudal peduncle	7.017	6.838	7.197	0.180
Pre dorsal distance	34.139	34.091	34.188	0.049
Pre pectoral distance	21.669	21.368	21.970	0.301
Pre pelvic distance	37.413	36.364	38.462	1.049
Pre anal distance	47.990	44.697	51.282	3.293
Distance between origin of pectoral & origin of pelvic	18.541	17.424	19.658	1.117
Distance between origin of pelvic & origin of anal	10.480	9.848	11.111	0.631
Distance between origin of pelvic & anus	8.868	8.333	9.402	0.534
Distance between anus and origin of anal fin	1.612	1.515	1.709	0.097

Other Characteristics:

Body: Elongate, compressed. Dorsal profile greatly arched, ventral profile abruptly tapering from the base of anal. Abdominal edge rounded.

Head: Moderate sized, blunt & smooth. Snout more or less prominent, rounded.

Eyes: Large, eye diameter 15.6 - 17.6 in length of head, behind corner of mouth, partly on the lower surface of the head, visible from below ventral surface.

Mouth: Subterminal, horizontal, width of gape of mouth 11.0 - 12.0 in length of head. Upper jaw slightly longer. Lips thin, jaws subterminal.

Teeth: Villiform in bands on jaws in four patches on palate, separate or variously united.

Barbels: Two pairs, a pair each of maxillary and mandibular; maxillary pair longer.

Scales: Minute

Skin: Smooth.

Lateral Line: Complete, Simple.

Fins: Rayed dorsal fin inserted above last quarter of pectoral fin. Adipose dorsal fin short, posteriorly free. Pectoral shorter than head length with a strongly serrated spine. Pelvic reaches the anal fin. Anal fin long but does not reach the caudal. Caudal deeply forked with longer lower lobe.

Colour: Dorsal and sides dark; lighter beneath. All the fins are dark in colour.

Distribution: India: Uttar Pradesh, Bihar, Darjeeling, West Bengal, Assam, Orissa, Madhya Pradesh, Madras. Elsewhere: Pakistan, Bangladesh, Burma, Thailand, Malaysia, Vietnam, Indonesia.

Remarks: The species is reported for the first time in Sikkim drainages. Jayaram (1981) has mentioned that head exceptionally granulated but head is found to be smooth in the present specimens. It is not a common species and is confined mostly to the lower reaches.

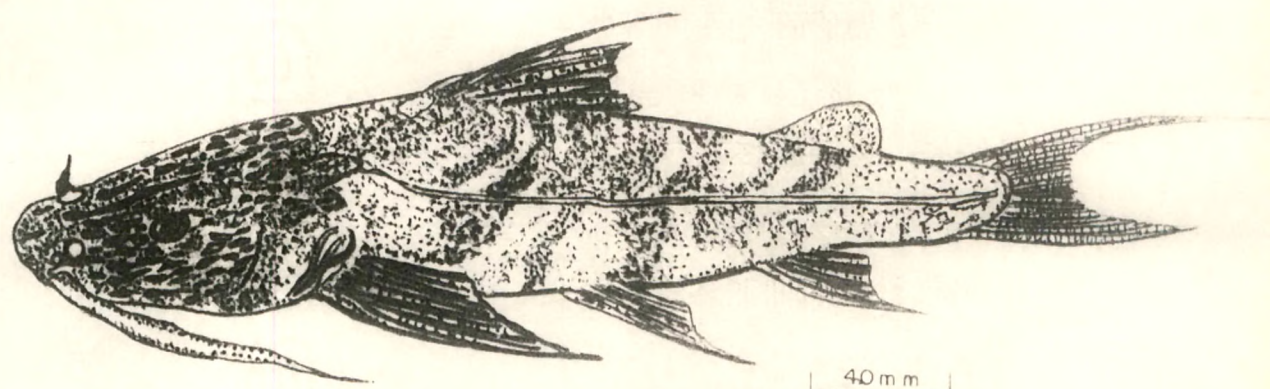
Table 74. Measurements (in mm) of *Pangasius pangasius* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS		RANGE		MEAN
	I	II	Min.	Max.	
Total length	132.0	117.0	117.0	132.0	124.500
Standard length	112.0	98.0	98.0	112.0	105.000
Head length	28.0	25.0	25.0	28.0	26.500
Head breadth	17.0	15.0	15.0	17.0	16.000
Head depth	16.0	15.5	15.5	16.0	15.750
Gape of mouth	11.0	10.5	10.5	11.0	10.750
Eye diameter	7.5	7.5	7.5	7.5	7.500
Inter orbital distance	15.0	13.0	13.0	15.0	14.000
Post orbital distance	13.0	12.0	12.0	13.0	12.500
Inter nasal distance	7.5	7.0	7.0	7.5	7.250
Snout length	9.5	9.0	9.0	9.5	9.250
Maxillary barbel length	11.0	9.0	9.0	11.0	10.000
Mandibular barbel length	6.5	6.5	6.5	6.5	6.500
Body depth	24.0	22.0	22.0	24.0	23.000
Body width	14.0	14.0	14.0	14.0	14.000
Dorsal height	22.0	20.0	20.0	22.0	21.000
Dorsal base	8.0	7.0	7.0	8.0	7.500
Anal height	14.0	14.0	14.0	14.0	14.000
Anal base	34.5	30.0	30.0	34.5	32.250
Pectoral length	19.0	18.0	18.0	19.0	18.500
Pelvic length	14.0	12.0	12.0	14.0	13.000
Length of caudal fin	22.0	20.0	20.0	22.0	21.000

Length of upper caudal lobe	19.0	19.0	19.0	19.0	19.000
Length of lower caudal lobe	22.0	20.0	20.0	22.0	21.000
Length of caudal peduncle	18.0	14.5	14.5	18.0	16.250
Highest depth of caudal peduncle	9.5	8.0	8.0	9.5	8.750
Least depth of caudal peduncle	9.5	8.0	8.0	9.5	8.750
Pre dorsal distance	45.0	40.0	40.0	45.0	42.500
Pre pectoral distance	29.0	25.0	25.0	29.0	27.000
Pre pelvic distance	48.0	45.0	45.0	48.0	46.500
Pre anal distance	59.0	60.0	59.0	60.0	59.500
Distance between origin of pectoral & origin of pelvic	23.0	23.0	23.0	23.0	23.000
Distance between origin of pelvic & origin of anal	13.0	13.0	13.0	13.0	13.000
Distance between origin of pelvic & anus	11.0	11.0	11.0	11.0	11.000
Distance between anus and origin of anal fin	2.0	2.0	2.0	2.0	2.000

35. *Bagarius bagarius* (Hamilton), 1822

(Plate XVIII-2)

Text Figure 35. *Bagarius bagarius* (Hamilton)

1822. *Pimelodus bagarius* Hamilton - Buch., Fish of Ganges : pp. 186, 378, pl. 7, fig 62

(Type locality : Ganges river and its tributaries)

Previous records: R. Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Confluence of Tista and Rani khola, SS Singtam 161 - 305 mm (3 exs.); RANGIT DRAINAGE: R. Rangit, SS Nayabazar 830 - 1130 mm (2 exs.); local name: *Gonch*.

Meristic Counts: D.i.6; P.i.12; V.i.14; A.i.11; C.17.

Morphometric Characters:

Standard length 1.16 - 1.35 (1.233), Head length 3.73 - 4.61 (4.020), Head breadth 3.23 - 5.19 (4.266), Head depth 4.52 - 8.26 (6.240), Gape of mouth 6.44 - 8.06 (6.838), Eye diameter 50.83 - 94.17 (69.680), Inter orbital distance 10.52 - 14.56 (11.860), Post orbital distance 7.60 - 10.00 (8.617), Inter nasal distance 15.25 - 18.86 (16.258), Snout length 7.31 - 9.88 (8.057), Maxillary barbel length 4.04 - 5.98 (4.979), Outer mandibular barbel length 11.88 - 15.96 (13.748), Inner mandibular barbel length 17.27 - 25.42 (21.676), Nasal barbel length 50.83 - 80.50 (60.642), Body depth 4.23 - 7.32 (5.347), Body width 5.35 - 5.95 (5.571), Dorsal height 4.13 - 7.26 (5.702), Dorsal base 8.26 - 13.17 (10.020), Anal height 6.33 - 8.38 (7.146), Anal base 7.92 - 25.15 (9.745), Pectoral length 3.06 - 8.30 (4.834), Pelvic length 6.33 - 11.86 (8.166), Length of caudal fin 3.77 - 8.74 (5.153), Length of caudal peduncle 6.93 - 12.99 (10.010), Highest depth of caudal peduncle 8.69 - 17.89 (12.712), Least depth of caudal peduncle 12.28 - 21.79 (17.947), Pre dorsal distance 2.79 - 3.61 (3.149), Pre pectoral distance 3.80 - 4.74 (4.188), Pre pelvic distance 2.18 - 2.75 (2.387), Pre anal distance 1.54 - 1.89 (1.715), Distance between origin of pectoral & origin of

pelvic 4.04 - 5.65 (4.749), Distance between origin of pelvic & origin of anal 5.14 - 8.47 (6.148), Distance between origin of pelvic & anus 6.10 - 9.47 (7.373), Distance between anus and origin of anal fin 23.75 - 101.67 (49.367).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 75. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *B. bagarius* (Hamilton), 1822.

CHARACTERS	MRI	RANGES		SD
		Min.	Max.	
Standard length	81.088	74.071	86.230	4.903
Head length	24.876	21.687	26.842	1.782
Head breadth	23.443	19.255	30.973	4.067
Head depth	16.027	12.105	22.124	3.745
Gape of mouth	14.642	12.410	15.528	1.161
Eye diameter	1.435	1.062	1.967	0.314
Inter orbital distance	8.432	6.867	9.508	0.897
Post orbital distance	11.605	10.000	13.158	1.233
Inter nasal distance	6.151	5.301	6.557	0.440
Snout length	12.412	10.120	13.684	1.322
Maxillary barbel length	20.083	16.726	24.737	2.854
Outer mandibular barbel length	7.274	6.265	8.421	0.710
Inner mandibular barbel length	4.613	3.934	5.789	0.648
Nasal barbel length	1.649	1.242	1.967	0.240
Body depth	18.702	13.665	23.628	3.584
Body width	17.950	16.814	18.689	0.722
Dorsal height	17.537	13.770	24.211	3.724
Dorsal base	9.980	7.590	12.105	1.681
Anal height	13.993	11.928	15.789	1.250
Anal base	10.261	3.976	12.632	3.227
Pectoral length	20.687	12.048	32.632	7.499
Pelvic length	12.246	8.434	15.789	2.490
Length of caudal fin	19.407	11.446	26.549	5.434

Length of caudal peduncle	9.990	7.699	14.426	2.305
Highest depth of caudal peduncle	7.866	5.590	11.504	2.152
Least depth of caudal peduncle	5.572	4.590	8.142	1.315
Pre dorsal distance	31.754	27.711	35.789	2.950
Pre pectoral distance	23.880	21.084	26.316	1.839
Pre pelvic distance	41.891	36.386	45.789	3.356
Pre anal distance	58.303	53.012	64.737	3.898
Distance between origin of pectoral & origin of pelvic	21.057	17.699	24.737	2.850
Distance between origin of pelvic & origin of anal	16.266	11.801	19.474	2.575
Distance between origin of pelvic & anus	13.564	10.559	16.393	2.313
Distance between anus and anal fin	2.026	0.984	4.211	1.129

Other Characters:

Body: Rather elongated. Dorsal profile convex, ventral flat.

Head: Large, greatly depressed, naked bluntly conical in shape anteriorly; longer than broad in smaller specimens and broader than long in larger specimens. Snout conical in shape.

Eyes: Small, subcutaneous, dorsally placed at posterior half of head, not visible from below ventral surface.

Mouth: Wide, gape of mouth 1.6 - 1.75 in head length; crescentic in shape. Lips thick.

Teeth: Sharp, unequal in size in bands on jaws; palate edentate.

Barbels: Four pairs, one pair of maxillary, nasal, and two of mandibular. Maxillary with broad bases, extend up to the pectoral base; nasal pair the shortest.

Skin: Smooth

Lateral Line: Simple & Complete.

Fins: Rayed dorsal inserted nearer origin of adipose dorsal than tip of snout; pectoral fin with a spine serrated on inner edge and also with a soft prolongation; pelvic fin situated behind the posterior half of dorsal fin. Caudal fin deeply forked.

Colour: Body brown with darkly pigmented bands or blotches. Caudal fin light yellowish-grey, paired fins with black spots.

Distribution: India: Ganga river and its tributaries. Elsewhere: Pakistan, Nepal, Bangladesh, Burma, Malaysia.

Remarks: This is the largest species known to occur in the lower stretches of both the Tista and

the Rangit drainages (up to 400 m msl). The largest growth of the fish recorded from Rangit is 62 kg. Though the flesh is not much relished by the people, it contributes as an important fishery of the state.

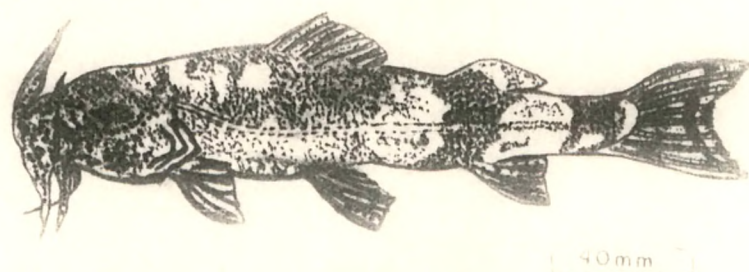
Table 76. Measurements (in mm) of *Bagarius bagarius* (Hamilton), 1822.

CHARACTERS	NUMBER OF SPECIMENS					RANGES		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	305.0	190.0	161.0	830.0	1130.0	161.0	1130.0	523.200
Standard length	263.0	159.0	123.0	706.0	837.0	123.0	837.0	417.600
Head length	80.0	51.0	40.0	180.0	280.0	40.0	280.0	126.200
Head breadth	65.0	41.0	31.0	200.0	350.0	31.0	350.0	137.400
Head depth	47.0	23.0	20.0	150.0	250.0	20.0	250.0	98.000
Gape of mouth	47.0	29.0	25.0	103.0	165.0	47.0	165.0	73.800
Eye diameter	6.0	3.0	2.0	11.0	12.0	2.0	12.0	6.800
Inter orbital distance	29.0	17.0	14.0	57.0	92.0	14.0	92.0	41.800
Post orbital distance	35.0	25.0	17.0	83.0	145.0	17.0	145.0	61.000
Inter nasal distance	20.0	12.0	10.0	44.0	72.0	20.0	72.0	31.600
Snout length	41.0	26.0	21.0	84.0	133.0	21.0	133.0	61.000
Maxillary barbel length	64.0	47.0	33.0	145.0	189.0	33.0	189.0	95.600
Outer mandibular barbel length	21.0	16.0	12.0	52.0	83.0	12.0	83.0	36.800
Inner mandibular barbel length	12.0	11.0	7.0	35.0	54.0	7.0	54.0	23.800
Nasal barbel length	6.0	3.0	2.0	14.0	20.0	2.0	20.0	9.000
Body depth	59.0	30.0	22.0	175.0	267.0	22.0	267.0	110.600
Body width	57.0	35.0	28.0	153.0	190.0	28.0	190.0	92.600
Dorsal height	42.0	46.0	30.0	122.0	185.0	30.0	185.0	85.000
Dorsal base	34.0	23.0	17.0	63.0	96.0	17.0	96.0	46.600
Anal height	44.0	30.0	22.0	99.0	160.0	22.0	160.0	71.000
Anal base	38.0	24.0	17.0	33.0	132.0	17.0	132.0	48.800
Pectoral length	57.0	62.0	41.0	100.0	165.0	41.0	165.0	85.000
Pelvic length	38.0	30.0	22.0	70.0	123.0	22.0	123.0	56.600
Length of caudal fin	50.0	35.0	39.0	95.0	300.0	35.0	300.0	103.800

Length of caudal peduncle	44.0	18.0	15.0	75.0	87.0	15.0	87.0	47.800
Highest depth of caudal peduncle	21.0	12.0	9.0	75.0	130.0	9.0	130.0	49.400
Least depth of caudal peduncle	14.0	9.0	8.0	45.0	92.0	8.0	92.0	33.600
Pre dorsal distance	103.0	68.0	52.0	230.0	330.0	52.0	330.0	156.600
Pre pectoral distance	75.0	50.0	40.0	175.0	255.0	40.0	255.0	119.000
Pre pelvic distance	129.0	87.0	72.0	302.0	455.0	72.0	455.0	209.000
Pre anal distance	180.0	123.0	90.0	440.0	665.0	90.0	665.0	299.600
Distance between origin of pectoral & origin of pelvic	71.0	47.0	35.0	148.0	200.0	35.0	200.0	100.200
Distance between origin of pelvic & origin of anal	53.0	37.0	19.0	128.0	195.0	19.0	195.0	86.400
Distance between origin of pelvic & anus	50.0	28.0	17.0	92.0	170.0	17.0	170.0	71.400
Distance between anus and anal fin	3.0	8.0	3.0	13.0	17.0	3.0	17.0	8.800

36. *Laguvia ribeiroi ribeiroi* Hora, 1921

(Plate XVI-12)



Text Figure 36. *Laguvia ribeiroi ribeiroi* Hora

1921. *Laguvia ribeiroi ribeiroi* Hora, Rec. Indian Mus., 22, p. 739

(Type locality : Khoila river, a tributary of Tista river at Jalpaiguri, North Bengal)

Present records: RANGIT DRAINAGE: R. Rangit, SS Nayabazar 30 - 53 mm (11 exs.); Rangbhang khola, SS Nayabazar 27 - 53 mm (12 exs.); local name: *Gona Machha*.

Meristic Counts: D.i.6; P.i.6-8; V.i.5; A.10;

Morphometric Characters:

Standard length 1.18 - 1.25 (1.209), Head length 4.25 - 4.82 (4.434), Head breadth 4.59 - 5.30 (4.831), Head depth 5.88 - 6.63 (6.214), Gape of mouth 9.40 - 12.75 (10.829), Inter orbital distance 11.14 - 13.25 (12.232), Post orbital distance 9.75 - 11.78 (10.610), Inter nasal distance 17.00 - 26.50 (19.918), Snout length 6.71 - 7.69 (7.156), Maxillary barbel length 5.57 - 7.69 (6.589), Outer mandibular barbel length 7.23 - 8.83 (7.850), Inner mandibular barbel length 9.40 - 14.29 (11.373), Nasal barbel length 23.50 - 26.50 (25.257), Body depth 5.22 - 6.38 (5.985), Body width 5.88 - 7.14 (6.372), Length of sucker 6.38 - 7.83 (6.978), Breadth of sucker 5.88 - 7.29 (6.555), Dorsal height 6.71 - 8.33 (7.361), Dorsal base 5.57 - 7.14 (6.270), Anal height 5.88 - 7.14 (6.320), Anal base 7.80 - 10.00 (8.387), Pectoral length 4.88 - 6.63 (5.930), Pelvic length 7.57 - 10.20 (8.251), Length of caudal fin 4.88 - 7.14 (5.808), Length of caudal peduncle 5.88 - 6.71 (6.329), Highest depth of caudal peduncle 11.11 - 17.67 (12.946), Least depth of caudal peduncle 12.50 - 17.67 (14.053), Pre dorsal distance 2.60 - 3.00 (2.842), Pre pectoral distance 4.27 - 5.10 (4.680), Pre pelvic distance 2.17 - 2.44 (2.332), Pre anal distance 1.56 - 1.82 (1.677), Distance between origin of pectoral & origin of pelvic 3.57 - 4.27 (3.935), Distance between origin of pelvic & origin of anal 5.00 - 6.38 (5.585), Distance between origin of pelvic & anus 9.75 - 12.75 (10.859), Distance between anus and origin of anal fin 9.64 - 12.50 (10.650).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 77. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *L. ribeiroi ribeiroi* Hora, 1921.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.740	80.189	85.106	1.692
Head length	22.553	20.755	23.529	1.048
Head breadth	20.702	18.868	21.795	1.107
Head depth	16.094	15.094	17.021	0.687
Gape of mouth	9.234	7.843	10.638	1.141
Inter orbital distance	8.175	7.547	8.974	0.507
Post orbital distance	9.425	8.491	10.256	0.618
Inter nasal distance	5.021	3.774	5.882	0.693
Snout length	13.975	13.000	14.894	0.617

Maxillary barbel length	15.177	13.000	17.949	1.996
Outer mandibular barbel length	12.739	11.321	13.830	0.972
Inner mandibular barbel length	8.793	7.000	10.638	1.358
Nasal barbel length	3.959	3.774	4.255	0.166
Body depth	16.708	15.686	19.149	1.261
Body width	15.694	14.000	17.021	1.090
Length of sucker	14.330	12.766	15.686	1.003
Breadth of sucker	15.256	13.725	17.021	1.204
Dorsal height	13.586	12.000	14.894	0.965
Dorsal base	15.950	14.000	17.949	1.396
Anal height	15.822	14.000	17.021	1.069
Anal base	11.923	10.000	12.821	1.035
Pectoral length	16.863	15.094	20.513	1.929
Pelvic length	12.120	9.804	13.208	1.222
Length of caudal fin	17.218	14.000	20.513	2.294
Length of caudal peduncle	15.800	14.894	17.000	0.708
Highest depth of caudal peduncle	7.725	5.660	9.000	1.198
Least depth of caudal peduncle	7.116	5.660	8.000	0.927
Pre dorsal distance	35.185	33.333	38.462	1.899
Pre pectoral distance	21.369	19.608	23.404	1.576
Pre pelvic distance	42.878	41.026	46.000	2.059
Pre anal distance	59.614	54.902	64.000	3.081
Distance between origin of pectoral & origin of pelvic	25.413	23.404	28.000	1.521
Distance between origin of pelvic & origin of anal	17.905	15.686	20.000	1.485
Distance between origin of pelvic & anus	9.209	7.843	10.256	0.908
Distance between anus and anal fin	9.390	8.000	10.377	0.959

Other Characteristics:

Body: Short, compressed dorsa-laterally. Dorsal profile more convex than ventral. Abdomen sub-cylindrical.

Head: Moderate, depressed, slightly longer than broad. Snout semicircular and broad.

Eyes: Minute, located on the posterior half of head; not visible from below ventral surface. Inter orbital width 2.5 - 3.0 in length of head.

Mouth: Subterminal, transverse, width of gape of mouth 2.2 - 3.0 in length of head. Lips thick, fleshy; upper jaws the longer.

Teeth: Villiform in bands on jaws, palate edentate.

Barbels: Four pairs, a pair each of maxillary, nasal & two of mandibular. Maxillary and outer mandibular barbels annulated and almost reach the origin of pelvics; nasal very short. Maxillary barbels with broad bases. Gill membranes free from each other but united narrowly with isthmus.

Skin: Smooth

Lateral Line: Complete and Simple.

Fins: Dorsal fin inserted above last quarter of pectoral and is 1.5 - 1.8 in length of head. Dorsal spine strong, sharp and finely serrated. Adipose dorsal short, posteriorly free. Pectoral fin finely serrated along inner margin with antrorse teeth. Paired fins horizontally expanded, not plaited. Anal fin slightly higher than rayed dorsal inserted below adipose dorsal. Caudal fin truncate or emarginate; its free posterior border is semicircular.

Colour: Dark along sides and above and pale beneath. Body speckled with black dots. Two broad yellowish bands on body, one between rayed dorsal and another behind the adipose dorsal. Caudal fin banded with yellow stripes.

Distribution: India: Tista river system, Bihar, Madhya Pradesh, Uttar Pradesh; Elsewhere: Nepal, Bangladesh.

Remarks: The species is reported for the first from river Rangit and Rangbhang khola of Sikkim at 340 m msl. Two different populations of *Laguvia* (i) with pelvic fin equidistant from tip of snout and base of caudal and (ii) pelvic fin nearer tip of snout have been grouped together under the same species *L. ribeiroi ribeiroi* on the basis of their serrated dorsal spine. The fish is caught by cast net especially during monsoon along with larger fish.

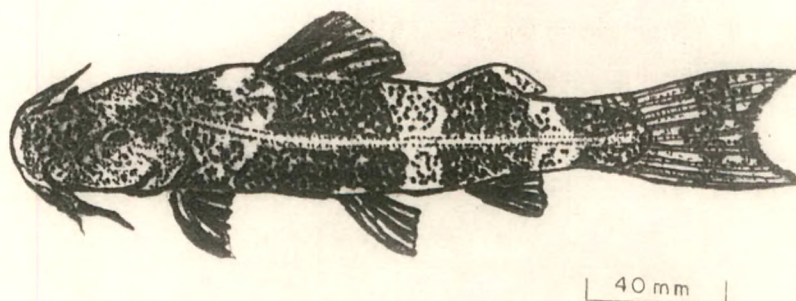
Table 78. Measurements (in mm) of *Laguvia ribeiroi ribeiroi* Hora, 1921.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	47.0	50.0	51.0	53.0	39.0	39.0	53.0	48.000
Standard length	40.0	42.0	42.0	42.5	32.0	32.0	42.5	39.700
Head length	11.0	11.0	12.0	11.0	9.0	9.0	12.0	10.800
Head breadth	10.0	10.0	11.0	10.0	8.5	8.5	11.0	9.900
Head depth	8.0	8.0	8.0	8.0	6.5	6.5	8.0	7.700
Gape of mouth	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.400

Eye diameter	minute							
Inter orbital distance	4.0	4.0	4.0	4.0	3.5	3.5	4.0	3.900
Post orbital distance	4.5	4.5	5.0	4.5	4.0	4.0	5.0	4.500
Inter nasal distance	2.5	2.5	3.0	2.0	2.0	2.0	3.0	2.400
Snout length	7.0	6.5	7.0	7.5	5.5	5.5	7.5	6.700
Maxillary barbel length	8.0	6.5	7.5	7.0	7.0	6.5	8.0	7.200
Outer mandibular barbel length	6.5	6.0	7.0	6.0	5.0	5.0	7.0	6.100
Inner mandibular barbel length	5.0	3.5	5.0	4.0	3.5	3.5	5.0	4.200
Nasal barbel length	2.0	2.0	2.0	2.0	1.5	1.5	2.0	1.900
Body depth	9.0	8.0	8.0	8.5	6.5	6.5	9.0	8.000
Body width	8.0	7.0	8.0	8.0	6.5	6.5	8.0	7.500
Length of sucker	6.0	7.0	8.0	8.0	5.5	5.5	8.0	6.900
Breadth of sucker	8.0	8.0	7.0	7.5	6.0	6.0	8.0	7.300
Dorsal height	7.0	6.0	7.0	7.0	5.5	5.5	7.0	6.500
Dorsal base	8.0	7.0	8.0	8.0	7.0	7.0	8.0	7.600
Anal height	8.0	7.0	8.5	8.5	6.0	6.0	8.5	7.600
Anal base	6.0	5.0	6.0	6.5	5.0	5.0	6.5	5.700
Pectoral length	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.000
Pelvic length	6.0	6.0	5.0	7.0	5.0	5.0	7.0	5.800
Length of caudal fin	8.0	7.0	8.0	10.0	8.0	7.0	10.0	8.200
Length of caudal peduncle	7.0	8.5	8.0	8.5	6.0	6.0	8.5	7.600
Highest depth of caudal peduncle	3.5	4.5	4.5	3.0	3.0	3.0	4.5	3.700
Least depth of caudal peduncle	3.0	4.0	4.0	3.0	3.0	3.0	4.0	3.400
Pre dorsal distance	17.0	17.0	17.0	18.0	15.0	15.0	18.0	16.800
Pre pectoral distance	11.0	10.0	10.0	11.0	9.0	9.0	11.0	10.200
Pre pelvic distance	21.0	23.0	21.0	22.0	16.0	16.0	23.0	20.600
Pre anal distance	29.0	32.0	28.0	31.0	23.0	23.0	32.0	28.600
Distance between origin of pectoral & origin of pelvic	11.0	14.0	13.0	13.0	10.0	10.0	14.0	12.200
Distance between origin of pelvic & origin of anal	8.0	10.0	8.0	10.0	7.0	7.0	10.0	8.600
Distance between origin of pelvic & anus	4.0	5.0	4.0	5.0	4.0	4.0	5.0	4.400
Distance between anus and anal fin	4.0	4.0	5.0	5.5	4.0	4.0	5.5	4.500

37. *Laguvia ribeiroi jorethangensis* sub. sp. nov.

(Plate XVI-15 & XIX-5)



Text Figure 37. *Laguvia ribeiroi jorethangensis* sub. sp. nov.

Materials examined: RANGIT DRAINAGE: R. Rangit, FCC Jorethang 35 - 53 mm (7 exs.); Rangbhang khola, SS Nayabazar 46 - 52 mm (5 exs.); local name: *Gona Machha*

Diagnosis: Body short, compressed. Abdomen sub-cylindrical. Head small, slightly depressed, covered with skin. Snout semicircular, broad. Mouth subterminal, transverse, wide. Eyes minute, dorsal, in middle of head. Lips thick fleshy. Jaws sub-equal. Teeth villiform in bands on jaws, palate edentate. Ventral surface of body corrugated or with faint V shaped groove forming an inconspicuous adhesive apparatus, but not so well developed or prominent as in *Glyptothorax*. Four pairs of barbels, one each of maxillary, nasal and two of mandibular, maxillary barbels with broad bases; barbels may or may not be annulated. Gill membranes free from each other, but united narrowly with isthmus. Rayed dorsal fin inserted above last quarter of pectoral fin with 5 or 6 rays and spine. Adipose dorsal short, posteriorly free. Pectoral fins with six to eight rays and a spine serrated along inner edge with antrose teeth. Pelvic fin with six rays. Anal fin short, with nine or ten rays. Paired fins not plaited. Caudal fin truncate or slightly emarginate, its free position of posterior border semicircular. Lateral line complete, simple.

Meristic Counts: D.i.6; P.i.6-8; V.i.5; A.10.

Morphometric Characters:

Standard length 1.18 - 1.21 (1.201), Head length 4.33 - 4.68 (4.475), Head breadth 4.82 - 5.47 (5.122), Head depth 5.89 - 6.57 (6.279), Gape of mouth 13.00 - 17.67 (14.751), Inter orbital distance 11.78 - 13.14 (12.557), Post orbital distance 10.40 - 11.78 (11.153), Inter nasal distance 20.80 - 24.00 (21.885), Snout length 6.63 - 7.43 (7.175), Maxillary barbel length 5.89 - 7.43 (6.795), Outer mandibular barbel length 6.63 - 8.67 (7.508), Inner mandibular barbel length 10.60 - 13.14 (11.984), Nasal barbel length 20.80 - 32.00 (25.308), Body depth 5.65 - 6.57 (6.053), Body width 5.89 - 6.86 (6.291), Length of sucker 5.78 - 6.57 (6.137), Breadth of sucker 5.89 - 6.57

(6.279), Dorsal height 6.40 - 7.43 (6.966), Dorsal base 5.89 - 7.38 (6.715), Anal height 5.89 - 6.50 (6.194), Anal base 7.57 - 8.73 (8.097), Pectoral length 5.33 - 6.50 (5.827), Pelvic length 7.07 - 8.00 (7.497), Length of caudal fin 5.20 - 6.13 (5.712), Length of caudal peduncle 5.89 - 6.86 (6.447), Highest depth of caudal peduncle 10.40 - 13.25 (12.256), Least depth of caudal peduncle 13.00 - 15.33 (14.351), Pre dorsal distance 2.67 - 3.07 (2.853), Pre pectoral distance 4.00 - 5.20 (4.475), Pre pelvic distance 2.08 - 2.19 (2.128), Pre anal distance 1.58 - 1.66 (1.609), Distance between origin of pectoral & origin of pelvic 3.06 - 3.83 (3.358), Distance between origin of pelvic & origin of anal 5.75 - 6.63 (5.969), Distance between origin of pelvic & anus 11.50 - 13.00 (11.943), Distance between anus and origin of anal fin 9.20 - 10.67 (10.030).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 79. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *L. ribeiroi jorethangensis sub. sp. nov.*

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.246	82.609	84.906	0.870
Head length	22.344	21.346	23.077	0.680
Head breadth	19.522	18.269	20.755	0.806
Head depth	15.927	15.217	16.981	0.742
Gape of mouth	6.779	5.660	7.692	0.695
Inter orbital distance	7.963	7.609	8.491	0.371
Post orbital distance	8.966	8.491	9.615	0.444
Inter nasal distance	4.569	4.167	4.808	0.263
Snout length	13.938	13.462	15.094	0.630
Maxillary barbel length	14.716	13.462	16.981	1.196
Outer mandibular barbel length	13.320	11.538	15.094	1.287
Inner mandibular barbel length	8.344	7.609	9.434	0.671
Nasal barbel length	3.951	3.125	4.808	0.706
Body depth	16.520	15.217	17.708	1.023
Body width	15.895	14.583	16.981	0.868
Length of sucker	16.295	15.217	17.308	0.789
Breadth of sucker	15.927	15.217	16.981	0.742

Dorsal height	14.355	13.462	15.625	0.873
Dorsal base	14.892	13.542	16.981	1.203
Anal height	16.144	15.385	16.981	0.656
Anal base	12.350	11.458	13.208	0.734
Pectoral length	17.163	15.385	18.750	1.076
Pelvic length	13.340	12.500	14.151	0.549
Length of caudal fin	17.506	16.304	19.231	0.977
Length of caudal peduncle	15.510	14.583	16.981	0.792
Highest depth of caudal peduncle	8.159	7.547	9.615	0.781
Least depth of caudal peduncle	6.968	6.522	7.692	0.451
Pre dorsal distance	35.045	32.609	37.500	1.764
Pre pectoral distance	22.345	19.231	25.000	2.311
Pre pelvic distance	46.994	45.652	48.077	0.955
Pre anal distance	62.134	60.377	63.462	1.292
Distance between origin of pectoral & origin of pelvic	29.781	26.087	32.692	2.174
Distance between origin of pelvic & origin of anal	16.754	15.094	17.391	0.870
Distance between origin of pelvic & anus	8.373	7.692	8.696	0.364
Distance between anus and anal fin	9.971	9.375	10.870	0.562

Other Characteristics:

Body: Short, compressed dorsa-laterally. Dorsal profile more convex than ventral. Abdomen sub-cylindrical.

Head: Moderate, depressed, slightly longer than broad. Snout semicircular and broad.

Eyes: Minute, located dorsa-laterally on the posterior half of head; not visible from below ventral surface. Inter orbital width 2.6 - 3.0 in length of head.

Mouth: Subterminal, transverse, width of gape of mouth 2.7 - 4.0 in length of head. Lips thick, fleshy with longer upper jaw.

Teeth: Villiform in bands on jaw, palate edentate.

Barbels: Four pairs, a pair each of maxillary, nasal & two of mandibular. Maxillary and outer mandibular barbels annulated and almost reach the origin of pelvics; nasal very short. Maxillary barbels with broad bases. Gill membranes free from each other but united narrowly with isthmus.

Skin: Smooth

Lateral Line: Present, complete and simple.

Fins: Dorsal fin inserted above last quarter of pectoral with six rays which is 1.4 - 1.7 in length of head. Dorsal spine strong, sharp and finely serrated. Adipose dorsal short, posteriorly free. Pectoral fin finely serrated along inner margin with antrorse teeth. Paired fins horizontally expanded, not plaited. Anal fin slightly higher than rayed dorsal inserted below adipose dorsal. Caudal fin truncate or slightly emarginate; its free posterior border is semicircular.

Colour: Dark along sides and above and pale beneath. Body speckled with black dots. Two broad yellowish bands on body, one between rayed dorsal and adipose dorsal, and another behind the adipose dorsal. Caudal fin banded with yellow stripes.

Size: Largest specimen examined 53 mm.

Affinity: The present specimen resembles *Laguvia ribeiroi ribeiroi* in most of its morphometric and meristic counts and nature of dorsal spine but it can be readily distinguished from the latter by the pelvic fin which is distinctly nearer caudal base than tip of snout (versus equidistant in *L. ribeiroi ribeiroi*).

Holotype: 40 mm SL, R. Rangit (Jorethang), South Sikkim; Coll. P. Tamang, GUZ/F177.

Paratype: 2, 43 and 38 mm SL, Rangbhang khola (Nayabazar), West Sikkim; Coll. P. Tamang, GUZ/F178.

Etymology: The species *L. ribeiroi jorethangensis* has been named after Jorethang - one of the important towns of Sikkim, the place from where it is collected for the first time.

Distribution: River Rangit and Rangbhang khola of Sikkim

Remarks: The fish is restricted to river Rangit and Rangbhang khola (340 m msl). It is caught mostly during the monsoon by cast net along with other larger fish.

Table 80. Measurements (in mm) of *Laguvia ribeiroi jorethangensis* sub. sp. nov.

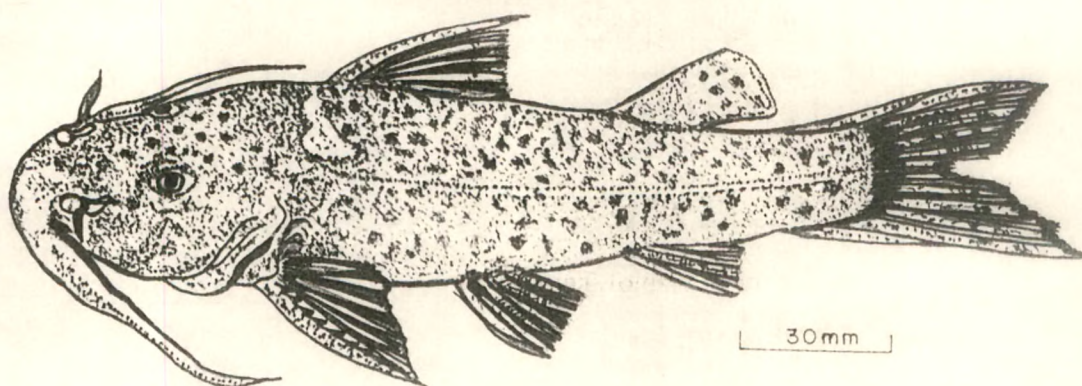
CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	53.0	52.0	52.0	48.0	46.0	46.0	53.0	50.200
Standard length	45.0	43.0	43.0	40.0	38.0	38.0	45.0	41.800
Head length	12.0	11.1	12.0	11.0	10.0	10.0	12.0	11.220
Head breadth	11.0	10.0	9.5	9.5	9.0	9.0	11.0	9.800
Head depth	9.0	8.0	8.0	8.0	7.0	7.0	9.0	8.000
Gape of mouth	3.0	4.0	3.5	3.5	3.0	3.0	4.0	3.400
Eye diameter	minute							
Inter orbital distance	4.5	4.0	4.0	4.0	3.5	3.5	4.5	4.000

Post orbital distance	4.5	5.0	4.5	4.5	4.0	4.0	5.0	4.500
Inter nasal distance	2.5	2.5	2.5	2.0	2.0	2.0	2.5	2.300
Snout length	8.0	7.0	7.0	6.5	6.5	6.5	8.0	7.000
Maxillary barbel length	9.0	7.0	7.5	7.0	6.5	6.5	9.0	7.400
Outer mandibular barbel length	8.0	6.0	7.5	6.0	6.0	6.0	8.0	6.700
Inner mandibular barbel length	5.0	4.0	4.5	4.0	3.5	3.5	5.0	4.200
Nasal barbel length	2.5	2.5	2.0	1.5	1.5	1.5	2.5	2.000
Body depth	9.0	9.0	8.0	8.5	7.0	7.0	9.0	8.300
Body width	9.0	8.5	8.5	7.0	7.0	7.0	9.0	8.000
Length of sucker	9.0	8.5	9.0	7.5	7.0	7.0	9.0	8.200
Breadth of sucker	9.0	8.0	8.0	8.0	7.0	7.0	9.0	8.000
Dorsal height	8.0	7.0	7.0	7.5	6.5	6.5	8.0	7.200
Dorsal base	9.0	8.0	7.5	6.5	6.5	6.5	9.0	7.500
Anal height	9.0	8.0	8.0	8.0	7.5	7.5	9.0	8.100
Anal base	7.0	6.5	6.0	5.5	6.0	5.5	7.0	6.200
Pectoral length	9.0	9.0	8.0	9.0	8.0	8.0	9.0	8.600
Pelvic length	7.5	7.0	6.5	6.5	6.0	6.0	7.5	6.700
Length of caudal fin	9.0	10.0	9.0	8.5	7.5	7.5	10.0	8.800
Length of caudal peduncle	9.0	8.0	8.0	7.0	7.0	7.0	9.0	7.800
Highest depth of caudal peduncle	4.0	5.0	4.0	4.0	3.5	3.5	5.0	4.100
Least depth of caudal peduncle	3.5	4.0	3.5	3.5	3.0	3.0	4.0	3.500
Pre dorsal distance	18.0	18.0	19.0	18.0	15.0	15.0	19.0	17.600
Pre pectoral distance	11.0	13.0	10.0	12.0	10.0	10.0	13.0	11.200
Pre pelvic distance	25.0	25.0	24.0	23.0	21.0	21.0	25.0	23.600
Pre anal distance	32.0	33.0	33.0	30.0	28.0	28.0	33.0	31.200
Distance between origin of pectoral & origin of pelvic	16.0	16.0	17.0	14.0	12.0	12.0	17.0	15.000
Distance between origin of pelvic & origin of anal	8.0	9.0	9.0	8.0	8.0	8.0	9.0	8.400
Distance between origin of pelvic & anus	4.5	4.5	4.0	4.0	4.0	4.0	4.5	4.200
Distance between anus and anal fin	5.5	5.0	5.0	4.5	5.0	4.5	5.5	5.000

Holotype - IV, Paratype - III & V.

38. *Glyptothorax basnetti* sp. nov.

(Plate XVII-4 & XIX-4)

Text Figure 38. *Glyptothorax basnetti* sp. nov.

Materials examined: TISTA DRAINAGE: Rangpo khola, FCC Rorethang 203 - 360 mm (5 exs.); RANGIT DRAINAGE: R. Rangit, FCC Tatopani 390 mm (1 ex.); SS Sikhip 237 mm (1 ex.); SS Nayabazar 225 - 255 mm (3 exs.); Rangbhang khola, SS Nayabazar 160 - 240 mm (2 exs.); Confluence of Tista & Rangit, FCC Tista 199 - 282 mm (2 exs.); local name: *Dhodray*.

Diagnosis: Body elongate, moderately or greatly depressed. Body smooth or rough with granules. Abdomen slightly flat to rounded. Head small, covered with thick skin, depressed. Snout conical. Mouth inferior, transverse, narrow. Eyes dorsal, small, not visible from below ventral surface. Lips thick, fleshy, papillated for adhesion. Jaws sub-equal, upper jaw the longer. Teeth villiform in jaws; palate edentate. The ventral surface of body always provided with a U or V - shaped thoracic adhesive apparatus, which is composed of longitudinal folds of skin. Four pairs of barbels; one pair each of maxillary, nasal and two of mandibular, maxillary pair with broad base. Gill membranes united with each other and also with the isthmus.

Rayed dorsal fin inserted above half of pectoral fin with five to seven rays and a spine. Adipose dorsal free posteriorly. Pectoral fin with 6 to 11 rays and a spine, strong, broad, serrated with antrorse teeth along inner edge. Paired fins may be plaited below. Anal fin short, with 7 to 14 rays. Caudal fin deeply forked. Lateral line complete and simple.

Meristic Counts: D. i. 6; P. i. 9-10; V. i. 5; A. 9-11; C. 17.

Morphometric Characters:

Standard length 1.16 - 1.23 (1.196), Head length 4.10 - 4.42 (4.182), Head breadth 4.29 - 5.93 (5.076), Head depth 6.32 - 8.00 (7.267), Gape of mouth 6.92 - 8.29 (7.680), Eye diameter 45.00 - 56.40 (51.098), Inter orbital distance 16.15 - 18.09 (17.120), Post orbital distance 9.23 -

10.67 (9.922), Inter nasal distance 20.00 - 22.11 (20.858), Snout length 7.83 - 8.40 (8.157), Maxillary barbel length 4.98 - 5.38 (5.253), Outer mandibular barbel length 9.00 - 12.35 (10.310), Inner mandibular barbel length 15.65 - 21.00 (19.127), Nasal barbel length 15.31 - 18.80 (17.227), Body depth 5.64 - 6.67 (6.135), Body width 6.00 - 7.37 (6.901), Length of sucker 9.00 - 10.67 (9.799), Breadth of sucker 9.23 - 12.44 (10.980), Dorsal height 6.03 - 7.78 (7.053), Dorsal base 10.44 - 12.31 (11.325), Anal height 6.03 - 7.05 (6.536), Anal base 7.96 - 12.31 (9.535), Pectoral length 5.10 - 5.88 (5.615), Pelvic length 8.00 - 8.89 (8.483), Length of caudal fin 4.71 - 5.81 (5.431), Length of upper caudal lobe 5.90 - 6.96 (6.182), Length of lower caudal lobe 5.16 - 6.00 (5.637), Length of caudal peduncle 6.56 - 7.27 (6.948), Highest depth of caudal peduncle 11.61 - 14.21 (12.730), Least depth of caudal peduncle 13.43 - 16.58 (15.611), Pre dorsal distance 2.86 - 3.13 (3.008), Pre pectoral distance 3.79 - 4.85 (4.397), Pre pelvic distance 2.00 - 2.35 (2.182), Pre anal distance 1.53 - 1.78 (1.676), Distance between origin of pectoral & origin of pelvic 3.66 - 3.81 (3.739), Distance between origin of pelvic & origin of anal 6.00 - 6.67 (6.367), Distance between origin of pelvic & anus 7.66 - 8.55 (8.123), Distance between anus and origin of anal fin 26.25 - 33.17 (30.209).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 81. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. basnetti* sp. nov.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.643	81.250	86.111	1.765
Head length	23.911	22.613	24.375	0.655
Head breadth	19.702	16.875	23.333	2.197
Head depth	13.761	12.500	15.833	1.188
Gape of mouth	13.021	12.060	14.444	0.823
Eye diameter	1.957	1.773	2.222	0.153
Inter orbital distance	5.841	5.528	6.190	0.246
Post orbital distance	10.079	9.375	10.833	0.577
Inter nasal distance	4.794	4.523	5.000	0.174
Snout length	12.260	11.905	12.778	0.327
Maxillary barbel length	19.036	18.571	20.101	0.570

Outer mandibular barbel length	9.699	8.095	11.111	1.197
Inner mandibular barbel length	5.228	4.762	6.389	0.588
Nasal barbel length	5.805	5.319	6.533	0.402
Body depth	16.299	15.000	17.730	1.157
Body width	14.491	13.568	16.667	1.120
Length of sucker	10.205	9.375	11.111	0.722
Breadth of sucker	9.107	8.040	10.833	0.928
Dorsal height	14.179	12.857	16.583	1.417
Dorsal base	8.830	8.125	9.574	0.613
Anal height	15.300	14.184	16.583	0.940
Anal base	10.487	8.125	12.563	1.452
Pectoral length	17.808	17.021	19.598	0.934
Pelvic length	11.788	11.250	12.500	0.449
Length of caudal fin	18.412	17.222	21.250	1.497
Length of upper caudal lobe	16.176	14.375	16.944	0.923
Length of lower caudal lobe	17.741	16.667	19.375	0.945
Length of caudal peduncle	14.393	13.750	15.238	0.526
Highest depth of caudal peduncle	7.855	7.035	8.611	0.609
Least depth of caudal peduncle	6.406	6.030	7.447	0.526
Pre dorsal distance	33.249	31.915	35.000	1.020
Pre pectoral distance	22.742	20.625	26.389	2.114
Pre pelvic distance	45.830	42.553	50.000	2.684
Pre anal distance	59.650	56.250	65.278	3.164
Distance between origin of pectoral & origin of pelvic	26.744	26.250	27.305	0.414
Distance between origin of pelvic & origin of anal	15.707	15.000	16.667	0.643
Distance between origin of pelvic & anus	12.310	11.702	13.056	0.543
Distance between anus and anal fin	3.310	3.015	3.810	0.313

Other Characteristics

Body: Elongated and cylindrical. Ventral profile flat up to anal opening, dorsal convex.

Head: Large, flat, always greater than depth of the body. It is conical and blunt anteriorly.

Eyes: Small, opaque, sub-cutaneous, situated at the posterior half of head; not visible from below ventral surface.

Mouth: Inferior, transverse and crescent - shaped, upper jaw the longer. Lips are thick, fleshy and papillate, continuous at the angles of mouth.

Barbels: Four pairs, nasal and inner mandibular short. Maxillary the longest and extends up to operculum.

Skin: Smooth, devoid of tuberculations or granulations. Longer specimen with scabrous skin.

Lateral Line: Faint, complete.

Adhesive apparatus: A well developed heart-shaped adhesive apparatus encircling a deep central pit present on the ventral surface of the body.

Fins: Dorsal with a smooth spine which becomes strong and bony in larger specimens; its length always greater than the depth of the body. The origin of the dorsal fin behind the posterior half of the pectorals and more towards adipose dorsal than tip of snout. Pectorals not plaited, presence of a strong spine with sharp serrations on its inner edge. Fins are horizontally expanded and far from reaching pelvics; adipose dorsal moderate in size, posteriorly free. Pelvic fin situated midway between dorsal and adipose dorsal, extends up to anal opening. Caudal fin deeply forked with longer lower lobe.

Colour: Grayish above with cloud like spots all over, sides silvery with black spots and pale below. A saddle shaped yellow structure present at the origin of dorsal fin. All the fins are reddish in colour in alive condition except adipose dorsal which is yellowish, presence of yellowish bands with black spots at their free ends. The periphery of adhesive apparatus blood red in colour.

Size: Largest specimen examined 390 mm.

Affinity: The present species resembles *Glyptothorax cavia* in skin character, nature of dorsal spine, structure of the adhesive apparatus and occipital process. But it can be readily separated from it in respect of anal fin rays which 9 - 11 (versus 12 in *cavia*), depth of body 4.5 - 5.6 (versus 5.9 to 6.6 in *cavia*), and least height of caudal peduncle in its length 1.9 - 2.4 (versus 2.5 in *cavia*).

Holotype: 130 mm SL, Rangbhang khola (Nayabazar), West Sikkim; Coll. P. Tamang, GUZ/F179.

Paratype: 2, 175 and 310 mm SL, Rangpo khola (Rorethang), East Sikkim; Coll. P. Tamang, GUZ/F180.

Etymology: This species has been named *Glyptothorax basnetti* after the name of Dr. B. S. Basnett, President Sikkim Science Society cum Secretary, Department of Agriculture, Government of Sikkim who enabled the scholar to undertake the project and complete it successfully.

Distribution: Rangpo khola, Rangit drainage, Rangbhang khola, Confluence of Tista and Rangit.

Remarks: It occurs at the lower reaches of both Tista and Rangit drainages from March to October

confining its territory to Rangpo khola, river Rangit, Rangbhang khola and confluence of Tista and Rangit. This is one of the largest members of the genus *Glyptothorax* Blyth.

Table 82. Measurements (in mm) of *Glyptothorax basnetti* sp. nov.

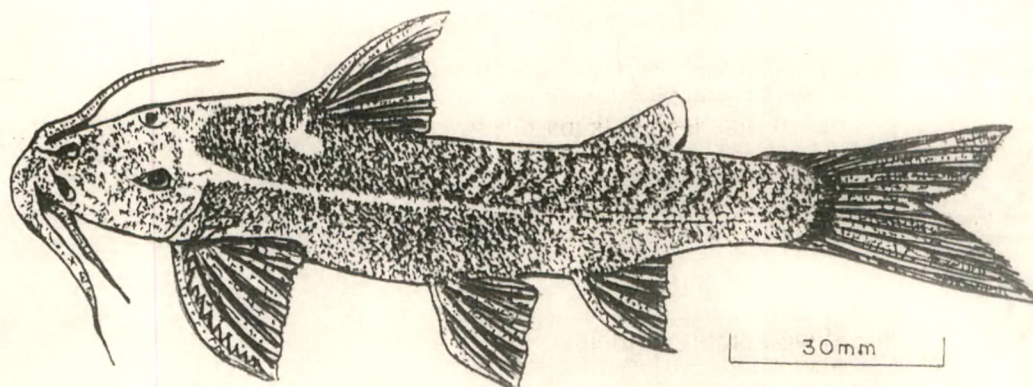
CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	360.0	282.0	210.0	199.0	160.0	160.0	360.0	242.200
Standard length	310.0	240.0	175.0	164.0	130.0	130.0	310.0	203.800
Head length	87.0	68.0	51.0	45.0	39.0	39.0	87.0	58.000
Head breadth	84.0	57.0	42.0	36.0	27.0	27.0	84.0	49.200
Head depth	57.0	37.0	30.0	26.0	20.0	20.0	57.0	34.000
Gape of mouth	52.0	36.0	28.0	24.0	20.0	20.0	52.0	32.000
Eye diameter	8.0	5.0	4.0	4.0	3.0	3.0	8.0	4.800
Inter orbital distance	21.0	17.0	13.0	11.0	9.0	9.0	21.0	14.200
Post orbital distance	39.0	30.0	21.0	19.0	15.0	15.0	39.0	24.800
Inter nasal distance	17.0	14.0	10.0	9.0	8.0	8.0	17.0	11.600
Snout length	46.0	34.0	25.0	24.0	20.0	20.0	46.0	29.800
Maxillary barbel length	67.0	54.0	39.0	40.0	30.0	30.0	67.0	46.000
Outer mandibular barbel length	40.0	31.0	17.0	19.0	14.0	14.0	40.0	24.200
Inner mandibular barbel length	23.0	14.0	10.0	10.0	8.0	8.0	23.0	13.000
Nasal barbel length	21.0	15.0	12.0	13.0	9.0	9.0	21.0	14.000
Body depth	63.0	50.0	34.0	30.0	24.0	24.0	63.0	40.200
Body width	60.0	40.0	30.0	27.0	22.0	22.0	60.0	35.800
Length of sucker	40.0	31.0	21.0	19.0	15.0	15.0	40.0	25.200
Breadth of sucker	39.0	25.0	19.0	16.0	14.0	14.0	39.0	22.600
Dorsal height	48.0	37.0	27.0	33.0	24.0	24.0	48.0	33.800
Dorsal base	30.0	27.0	18.0	19.0	13.0	13.0	30.0	21.400
Anal height	53.0	40.0	31.0	33.0	26.0	26.0	53.0	36.600
Anal base	40.0	30.0	21.0	25.0	13.0	13.0	40.0	25.800
Pectoral length	64.0	48.0	36.0	39.0	28.0	28.0	64.0	43.000
Pelvic length	45.0	33.0	24.0	24.0	18.0	18.0	45.0	28.800
Length of caudal fin	62.0	49.0	37.0	37.0	34.0	34.0	62.0	43.800

Length of upper caudal lobe	61.0	46.0	35.0	33.0	23.0	23.0	61.0	39.600
Length of lower caudal lobe	65.0	48.0	35.0	35.0	31.0	31.0	65.0	42.800
Length of caudal peduncle	53.0	40.0	32.0	28.0	22.0	22.0	53.0	35.000
Highest depth of caudal peduncle	31.0	24.0	16.0	14.0	12.0	12.0	31.0	19.400
Least depth of caudal peduncle	22.0	21.0	13.0	12.0	10.0	10.0	22.0	15.600
Pre dorsal distance	120.0	90.0	70.0	65.0	56.0	56.0	120.0	80.200
Pre pectoral distance	95.0	60.0	50.0	43.0	33.0	33.0	95.0	56.200
Pre pelvic distance	180.0	120.0	100.0	90.0	70.0	70.0	180.0	112.000
Pre anal distance	235.0	170.0	120.0	118.0	90.0	90.0	235.0	146.600
Distance between origin of pectoral & origin of pelvic	95.0	77.0	57.0	53.0	42.0	42.0	95.0	64.800
Distance between origin of pelvic & origin of anal	60.0	44.0	34.0	30.0	24.0	24.0	60.0	38.400
Distance between origin of pelvic & anus	47.0	33.0	27.0	24.0	19.0	19.0	47.0	30.000
Distance between anus and anal fin	11.0	10.0	8.0	6.0	5.0	5.0	11.0	8.000

Holotype - V, Paratype - I & III.

39. *Glyptothorax bhutiai* sp. nov.

(Plate XVII-8 & XIX-6)

Text Figure 39. *Glyptothorax bhutiai* sp. nov.

Materials examined: TISTA DRAINAGE: R. Tista, SS Singtam 134 mm (1 ex.); Rangpo khola, FCC Rorethang 115 - 136 mm (2 exs.); RANGIT DRAINAGE: R. Rangit, SS Nayabazar/Jorethang 91 mm (1 ex.); Kalej khola, SS Legship 132 - 155 mm (3 exs.); Rishi khola, SS Rishi 135 mm (1 ex.); Confluence of Tista & Rangit, FCC Tista 135 mm (1 ex.); local name: *Kahray*.

Diagnosis: Body elongate, moderately or greatly depressed. Body skin smooth or rough with granulations or tuberculations. Dorsal profile gently arched. Head small, covered with thick skin, depressed; Snout conical, not pointed; jaws sub-equal, upper jaw the longer; lips thick, fleshy, papillated. Ventral surface of body provided with an adhesive apparatus with or without a central pit or depression on thorax. Mouth inferior, transverse, narrow. Teeth villiform in jaws; palate edentate. Eyes dorsal, small. Four pairs of barbels; one pair each of maxillary, nasal and two of mandibular; maxillary pair with broad bases. Gill membranes united with each other and also with isthmus. Branchiostegals 6 to 10.

Rayed dorsal fin with five to seven rays and a spine. Adipose dorsal short, high posteriorly free. Pectoral fin with 6 to 11 rays and a spine, strong, broad, serrated with antrorse teeth along inner edge. Fins may be enveloped in skin. Pelvic fins with 6 rays. Paired fins may be plaited below. Anal fin short, with 7 to 14 rays. Caudal fin deeply forked. Lateral line complete and simple. Air bladder enclosed in bone.

Meristic Counts: D.i.6; P.i.9-10; V.i.5; A.9-12;

Morphometric Characters:

Standard length 1.23 - 1.28 (1.261), Head length 5.35 - 6.14 (5.784), Head breadth 6.09 - 7.05 (6.658), Head depth 7.88 - 9.64 (8.920), Gape of mouth 13.00 - 14.09 (13.586), Eye diameter

38.29 - 54.00 (47.415), Inter orbital distance 18.20 - 19.38 (19.041), Post orbital distance 13.00 - 14.89 (13.867), Inter nasal distance 22.75 - 28.00 (25.450), Snout length 10.11 - 11.25 (10.582), Maxillary barbel length 5.00 - 5.58 (5.286), Outer mandibular barbel length 9.69 - 13.00 (10.619), Inner mandibular barbel length 16.75 - 18.20 (17.217), Nasal barbel length 16.88 - 19.14 (17.876), Body depth 7.50 - 7.88 (7.681), Body width 8.38 - 9.10 (8.720), Length of sucker 8.44 - 10.11 (8.891), Breadth of sucker 11.17 - 15.17 (12.116), Dorsal height 5.35 - 6.43 (5.797), Dorsal base 9.10 - 9.69 (9.520), Anal height 5.69 - 6.43 (6.104), Anal base 7.58 - 9.00 (8.294), Pectoral length 5.35 - 5.96 (5.680), Pelvic length 6.70 - 7.58 (7.171), Length of caudal fin 4.43 - 5.19 (4.617), Length of upper caudal lobe 4.67 - 5.63 (4.979), Length of lower caudal lobe 4.43 - 5.19 (4.617), Length of caudal peduncle 5.58 - 6.14 (5.786), Highest depth of caudal peduncle 10.31 - 12.27 (11.170), Least depth of caudal peduncle 12.18 - 15.17 (13.512), Pre dorsal distance 3.37 - 3.72 (3.579), Pre pectoral distance 5.35 - 6.20 (5.814), Pre pelvic distance 2.60 - 2.80 (2.678), Pre anal distance 1.84 - 1.90 (1.879), Distance between origin of pectoral & origin of pelvic 4.22 - 4.67 (4.487), Distance between origin of pelvic & origin of anal 6.07 - 6.70 (6.280), Distance between origin of pelvic & anus 7.94 - 10.33 (9.417), Distance between anus and origin of anal fin 19.14 - 27.00 (21.116).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 83. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. bhutiai* sp. nov.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	79.287	78.022	81.481	1.207
Head length	17.289	16.296	18.681	0.790
Head breadth	15.019	14.194	16.418	0.819
Head depth	11.211	10.370	12.687	0.777
Gape of mouth	7.360	7.097	7.692	0.219
Eye diameter	2.109	1.852	2.612	0.277
Inter orbital distance	5.252	5.161	5.495	0.123
Post orbital distance	7.211	6.716	7.692	0.326
Inter nasal distance	3.929	3.571	4.396	0.293
Snout length	9.450	8.889	9.890	0.388

Maxillary barbel length	18.918	17.910	20.000	0.737
Outer mandibular barbel length	9.417	7.692	10.323	0.897
Inner mandibular barbel length	5.808	5.495	5.970	0.167
Nasal barbel length	5.594	5.224	5.926	0.248
Body depth	13.019	12.687	13.333	0.224
Body width	11.468	10.989	11.940	0.360
Length of sucker	11.247	9.890	11.852	0.713
Breadth of sucker	8.253	6.593	8.955	0.861
Dorsal height	17.250	15.556	18.681	1.127
Dorsal base	10.504	10.323	10.989	0.246
Anal height	16.384	15.556	17.582	0.665
Anal base	12.057	11.111	13.187	0.762
Pectoral length	17.605	16.774	18.681	0.706
Pelvic length	13.945	13.187	14.935	0.773
Length of caudal fin	21.657	19.259	22.581	1.218
Length of upper caudal lobe	20.085	17.778	21.429	1.317
Length of lower caudal lobe	21.657	19.259	22.581	1.218
Length of caudal peduncle	17.283	16.296	17.910	0.544
Highest depth of caudal peduncle	8.953	8.148	9.701	0.502
Least depth of caudal peduncle	7.401	6.593	8.209	0.650
Pre dorsal distance	27.940	26.866	29.670	0.967
Pre pectoral distance	17.199	16.129	18.681	1.201
Pre pelvic distance	37.338	35.714	38.462	0.950
Pre anal distance	53.212	52.597	54.478	0.679
Distance between origin of pectoral & origin of pelvic	22.287	21.429	23.704	0.771
Distance between origin of pelvic & origin of anal	15.923	14.935	16.484	0.611
Distance between origin of pelvic & anus	10.619	9.677	12.593	1.133
Distance between anus and anal fin	4.736	3.704	5.224	0.602

Other Characteristics

Body: Elongated, laterally compressed. Dorsal profile gently arched anteriorly, abdomen round.

Head: Large, flat and conical anteriorly, 1.1 times as long as broad. Head covered with small tile-like uniform granulations.

Eyes: Small with circular pupil, situated at the commencement of the posterior half of head. Inter-orbital space slightly convex and 3.1 in length of head.

Mouth: Inferior, transverse. Width of gape of mouth 2.26 in length of head. Upper jaw the longer with papillated lips.

Barbels: Eight in number, inner mandibular and nasal short. Maxillary with broad bases reach almost half of pectorals.

Sucker: Distinct, 1.3 times as long as broad and 1.5 times in length of head.

Skin: Rough with fine granulations.

Lateral Line: Complete and simple.

Fins: Dorsal inserted midway between tip of snout and adipose with a strong spine serrated internally. Paired fins not plaited. Pectorals with sharp serrations do not reach pelvics. Ventral placed nearer rayed dorsal than adipose, extends slightly beyond anal opening. Anal ahead of adipose dorsal. Caudal deeply forked with longer lower lobe.

Colour: Body dark grayish, lighter beneath. Pectoral, ventral, anal & caudal fins including adhesive apparatus reddish in alive specimens. Dorsal fin reddish with black stripes/bands; adipose dorsal yellowish.

Size: Largest specimen examined 155 mm.

Affinity: The new species apparently resembles *G. gracilis* in nature of adhesive apparatus, paired fins, height of rayed dorsal in relation to body depth, position of anal fin and caudal fin lobe. But it can be readily distinguished from *G. gracilis* in body depth which is 5.91 - 6.17 in standard length (versus 5.0 - 5.5 in *G. gracilis*), pectorals not reaching pelvics (versus pectoral reaches pelvic fin in *G. gracilis*), and anal fin rays 9-12 (versus A. 14 in *G. gracilis*).

Holotype: 105 mm SL, Tista river (Singtam), East Sikkim; Coll. P. Tamang, GUZ/F181.

Paratype: 2, 122 & 123 mm SL, Kalej khola (Legship), West Sikkim; Coll. P. Tamang, GUZ/F182.

Etymology: This species has been named *Glyptothorax bhutiai* after the name of Mr. K. P. Bhutia, Joint Director of Fisheries, Government of Sikkim, who constantly supported the investigator throughout the course of study.

Distribution: River Tista, Rangpo khola, river Rangit, Kalej khola, Rishi khola and confluence of Tista and Rangit.

Remarks: The maximum size recorded is 155 mm. It is available in the lower elevations (525 m sl) of both the Tista and Rangit drainages from early monsoon to post monsoon.

Table 84. Measurements (in mm) of *Glyptothorax bhutiai* sp. nov.

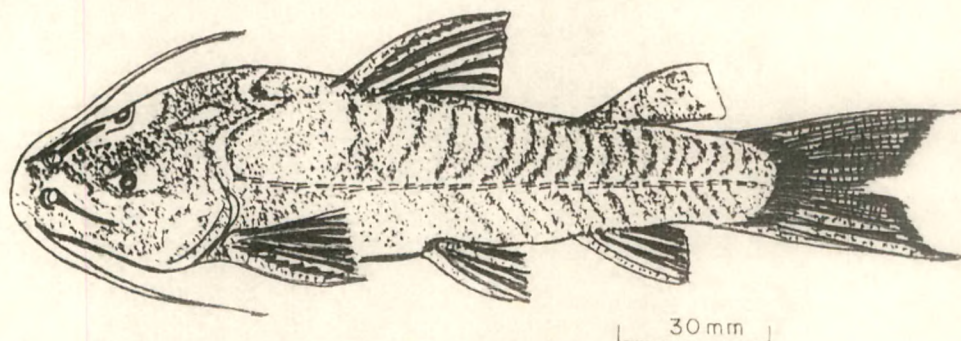
CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	155.0	134.0	135.0	91.0	154.0	91.0	155.0	133.800
Standard length	123.0	105.0	110.0	71.0	122.0	71.0	123.0	106.200
Head length	27.0	23.0	22.0	17.0	26.0	17.0	27.0	23.000
Head breadth	22.0	22.0	20.0	14.0	22.0	14.0	22.0	20.000
Head depth	17.0	17.0	14.0	10.0	17.0	10.0	17.0	15.000
Gape of mouth	11.0	10.0	10.0	7.0	11.0	7.0	11.0	9.800
Eye diameter	3.0	3.5	2.5	2.0	3.0	2.0	3.5	2.800
Inter orbital distance	8.0	7.0	7.0	5.0	8.0	5.0	8.0	7.000
Post orbital distance	11.0	9.0	10.0	7.0	11.0	7.0	11.0	9.600
Inter nasal distance	6.0	5.5	5.0	4.0	5.5	4.0	6.0	5.200
Snout length	15.0	13.0	12.0	9.0	14.0	9.0	15.0	12.600
Maxillary barbel length	31.0	24.0	25.0	17.0	30.0	17.0	31.0	25.400
Outer mandibular barbel length	16.0	13.0	13.0	7.0	15.0	7.0	16.0	12.800
Inner mandibular barbel length	9.0	8.0	8.0	5.0	9.0	5.0	9.0	7.800
Nasal barbel length	9.0	7.0	8.0	5.0	8.5	5.0	9.0	7.500
Body depth	20.0	17.0	18.0	12.0	20.0	12.0	20.0	17.400
Body width	18.0	16.0	15.0	10.0	18.0	10.0	18.0	15.400
Length of sucker	18.0	15.0	16.0	9.0	18.0	9.0	18.0	15.200
Breadth of sucker	13.0	12.0	12.0	6.0	13.0	6.0	13.0	11.200
Dorsal height	28.0	22.0	21.0	17.0	27.0	17.0	28.0	23.000
Dorsal base	16.0	14.0	14.0	10.0	16.0	10.0	16.0	14.000
Anal height	25.0	22.0	21.0	16.0	25.0	16.0	25.0	21.800
Anal base	18.0	17.0	15.0	12.0	18.0	12.0	18.0	16.000
Pectoral length	26.0	24.0	24.0	17.0	26.0	17.0	26.0	23.400
Pelvic length	23.0	18.0	18.0	12.0	23.0	12.0	23.0	18.800
Length of caudal fin	35.0	30.0	26.0	20.0	34.0	20.0	35.0	29.000
Length of upper caudal lobe	33.0	27.0	24.0	18.0	33.0	18.0	33.0	27.000
Length of lower caudal lobe	35.0	30.0	26.0	20.0	34.0	20.0	35.0	29.000
Length of caudal peduncle	27.0	24.0	22.0	16.0	26.5	16.0	27.0	23.100

Highest depth of caudal peduncle	14.0	13.0	11.0	8.0	14.0	8.0	14.0	12.000
Least depth of caudal peduncle	12.0	11.0	9.0	6.0	12.0	6.0	12.0	10.000
Pre dorsal distance	43.0	36.0	38.0	27.0	42.0	27.0	43.0	37.200
Pre pectoral distance	25.0	25.0	22.0	17.0	25.0	17.0	25.0	22.800
Pre pelvic distance	58.0	51.0	50.0	35.0	55.0	35.0	58.0	49.800
Pre anal distance	82.0	73.0	72.0	48.0	81.0	48.0	82.0	71.200
Distance between origin of pectoral & origin of pelvic	34.0	30.0	32.0	20.0	33.0	20.0	34.0	29.800
Distance between origin of pelvic & origin of anal	24.0	22.0	22.0	15.0	23.0	15.0	24.0	21.200
Distance between origin of pelvic & anus	15.0	15.0	17.0	9.0	15.0	9.0	17.0	14.200
Distance between anus and anal fin	8.0	7.0	5.0	4.0	8.0	4.0	8.0	6.400

Holotype - II, Paratype - I & V.

40. *Glyptothorax conirostrae* (Steindachner), 1867

(Plate XVII-6)



Text Figure 40. *Glyptothorax conirostrae* (Steindachner)

1867. *Glyptosternum conirostrae* Steindachner, S. B. K. Acad. Wiss., Wien., 53, part 1, p. 532, pl. v, fig. 2; pl. vi, fig. 2. (type locality, Simla)

Present records: RANGIT DRAINAGE: R. Rangit, SS Nayabazar 172 - 220 mm (2 exs.); FCC Melli 135 mm (1 ex.); local name: *Kahray*.

Meristic Counts: D.i.6; P.i.9; V.i.5; A.9; C.17.

Morphometric Characters:

Standard length 1.15 - 1.22 (1.187), Head length 4.30 - 4.40 (4.349), Head breadth 5.64 - 5.93 (5.782), Head depth 8.15 - 8.60 (8.368), Gape of mouth 8.19 - 8.46 (8.324), Eye diameter 48.89 - 49.14 (49.016), Inter orbital distance 18.33 - 19.11 (18.714), Post orbital distance 10.12 - 11.00 (10.540), Inter nasal distance 19.11 - 20.00 (19.545), Snout length 8.60 - 9.17 (8.874), Maxillary barbel length 5.55 - 5.95 (5.740), Outer mandibular barbel length 11.58 - 12.29 (11.922), Inner mandibular barbel length 24.57 - 27.50 (25.953), Nasal barbel length 17.20 - 20.00 (18.495), Body depth 6.67 - 6.88 (6.772), Body width 6.47 - 7.48 (6.938), Length of sucker 9.17 - 10.75 (9.895), Breadth of sucker 12.29 - 12.94 (12.605), Dorsal height 6.14 - 6.47 (6.302), Dorsal base 10.12 - 12.22 (11.071), Anal height 6.11 - 6.37 (6.238), Anal base 7.82 - 9.57 (8.604), Pectoral length 5.24 - 5.38 (5.306), Pelvic length 7.82 - 8.15 (7.980), Length of caudal fin 4.49 - 4.91 (4.692), Length of upper caudal lobe 5.55 - 5.79 (5.666), Length of lower caudal lobe 5.21 - 5.50 (5.352), Length of caudal peduncle 7.17 - 7.59 (7.370), Highest depth of caudal peduncle 12.94 - 14.33 (13.602), Least depth of caudal peduncle 16.92 - 17.20 (17.060), Pre dorsal distance 3.06 - 3.07 (3.063), Pre pectoral distance 4.91 - 5.37 (5.130), Pre pelvic distance 2.20 - 2.23 (2.217), Pre anal distance 1.69 - 1.72 (1.706), Distance between origin of pectoral & origin of pelvic 3.37 - 3.67 (3.513), Distance between origin of pelvic & origin of anal 6.11 - 6.88 (6.473), Distance between origin of pelvic & anus 7.33 - 8.19 (7.738), Distance between anus and origin of anal fin 24.44 - 34.40 (28.580).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is shown in the following table.

Table 85. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. conirostrae* (Steindachner), 1867.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	84.223	81.818	86.628	2.405
Head length	22.992	22.727	23.256	0.264
Head breadth	17.294	16.860	17.727	0.433
Head depth	11.950	11.628	12.273	0.322
Gape of mouth	12.014	11.818	12.209	0.196
Eye diameter	2.040	2.035	2.045	0.005
Inter orbital distance	5.344	5.233	5.455	0.111

Post orbital distance	9.487	9.091	9.884	0.396
Inter nasal distance	5.116	5.000	5.233	0.116
Snout length	11.268	10.909	11.628	0.359
Maxillary barbel length	17.421	16.818	18.023	0.603
Outer mandibular barbel length	8.388	8.140	8.636	0.248
Inner mandibular barbel length	3.853	3.636	4.070	0.217
Nasal barbel length	5.407	5.000	5.814	0.407
Body depth	14.767	14.535	15.000	0.233
Body width	14.413	13.372	15.455	1.041
Length of sucker	10.106	9.302	10.909	0.803
Breadth of sucker	7.933	7.727	8.140	0.206
Dorsal height	15.867	15.455	16.279	0.412
Dorsal base	9.033	8.182	9.884	0.851
Anal height	16.031	15.698	16.364	0.333
Anal base	11.623	10.455	12.791	1.168
Pectoral length	18.848	18.605	19.091	0.243
Pelvic length	12.532	12.273	12.791	0.259
Length of caudal fin	21.311	20.349	22.273	0.962
Length of upper caudal lobe	17.648	17.273	18.023	0.375
Length of lower caudal lobe	18.684	18.182	19.186	0.502
Length of caudal peduncle	13.568	13.182	13.953	0.386
Highest depth of caudal peduncle	7.352	6.977	7.727	0.375
Least depth of caudal peduncle	5.862	5.814	5.909	0.048
Pre dorsal distance	32.643	32.558	32.727	0.085
Pre pectoral distance	19.493	18.636	20.349	0.856
Pre pelvic distance	45.111	44.767	45.455	0.344
Pre anal distance	58.615	58.140	59.091	0.476
Distance between origin of pectoral & origin of pelvic	28.462	27.273	29.651	1.189
Distance between origin of pelvic & origin of anal	15.449	14.535	16.364	0.914
Distance between origin of pelvic & anus	12.923	12.209	13.636	0.714
Distance between anus and origin of anal fin	3.499	2.907	4.091	0.592

Other Characteristics:

Body: Elongate, cylindrical, ventral profile flat and horizontal, dorsal convex.

Head: Large, flat and conical in shape, 1.3 times as long as broad.

Eyes: Small, located just behind the middle of head, not visible from below ventral surface. Inter-orbital space convex 4.1 - 4.4 times in length of head.

Mouth: Inferior, transverse and crescentic; width of gape of mouth 1.9 in length of head. Upper jaw the longer and fringed. Lips thick, fleshy and papillated, continuous at angles of mouth.

Barbels: Four pairs, a pair of nasal and maxillary and two of mandibular; inner mandibular the shortest. Maxillary pair with broad bases crosses the origin of pectorals.

Sucker: Triangular anteriorly, without a distinct central pit, 2.0 - 2.5 in length of head.

Skin: Smooth, without tuberculations or granulations.

Lateral Line: Fine, simple & complete.

Fins: Rayed dorsal fin inserted nearer adipose dorsal than tip of snout. Dorsal spine strong, smooth, as high as or higher than body depth. Adipose moderate in size, fleshy, posteriorly free. Pectorals 1.2 times in length of head; spine strong with about 13 denticulations internally, extends up to ventral fin. Ventral placed midway between rayed dorsal and adipose dorsal, extends up to anal opening but does not reach anal. Paired fins not plaited. Caudal deeply forked.

Colour: Body brownish with black spots. Fins yellowish with black spots; adipose dorsal yellowish red in colour.

Distribution: India: Kangra valley, Punjab, Mahananda river, Silliguri, North Bengal. Elsewhere: China.

Remarks: This species is reported for the first time from Sikkim drainages. It is very rare and restricted in occurrence. Only two specimens could be collected during monsoon from R. Rangit at Melli - Jorethang belt.

Differences have been found from Day's (1878) and Jayaram's (1979) descriptions in the number of anal fin rays which is A.i.9 (versus A ii 9-10 by Day & Jayaram); maxillary barbel just crosses the origin of pectorals but Day (1878) mentions that it extends to middle of head. Rayed dorsal fin as high as or higher than body depth and body depth 5.5 in standard length (versus rayed dorsal fin higher than body depth and body depth 4.5 in standard length by Jayaram, 1981). Maximum size of the species reported by Talwar and Jhingran (1991) is 140 mm which is extended to 220 mm in the present communication.

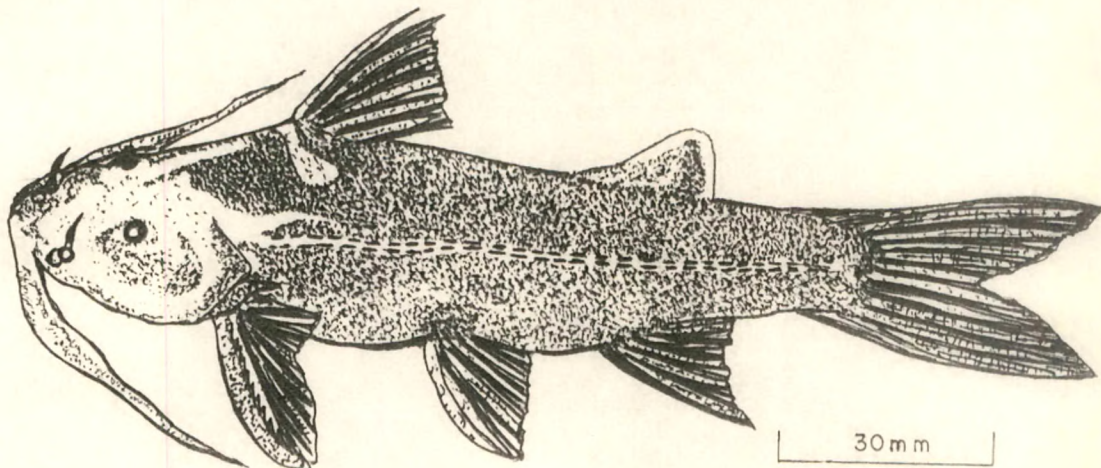
Table 86. Measurements (in mm) of *Glyptothorax conirostrae* (Steindachner), 1867.

CHARACTERS	NUMBER OF SPECIMENS		RANGE		MEAN
	I	II	Min.	Max.	
Total length	220.0	172.0	172.0	220.0	196.000
Standard length	180.0	149.0	149.0	180.0	164.500
Head length	50.0	40.0	40.0	50.0	45.000
Head breadth	39.0	29.0	29.0	39.0	34.000
Head depth	27.0	20.0	20.0	27.0	23.500
Gape of mouth	26.0	21.0	21.0	26.0	23.500
Eye diameter	4.5	3.5	3.5	4.5	4.000
Inter orbital distance	12.0	9.0	9.0	12.0	10.500
Post orbital distance	20.0	17.0	17.0	20.0	18.500
Inter nasal distance	11.0	9.0	9.0	11.0	10.000
Snout length	24.0	20.0	20.0	24.0	22.000
Maxillary barbel length	37.0	31.0	31.0	37.0	34.000
Outer mandibular barbel length	19.0	14.0	14.0	19.0	16.500
Inner mandibular barbel length	8.0	7.0	7.0	8.0	7.500
Nasal barbel length	11.0	10.0	10.0	11.0	10.500
Body depth	33.0	25.0	25.0	33.0	29.000
Body width	34.0	23.0	23.0	34.0	28.500
Length of sucker	24.0	16.0	16.0	24.0	20.000
Breadth of sucker	17.0	14.0	14.0	17.0	15.500
Dorsal height	34.0	28.0	28.0	34.0	31.000
Dorsal base	18.0	17.0	17.0	18.0	17.500
Anal height	36.0	27.0	27.0	36.0	31.500
Anal base	23.0	22.0	22.0	23.0	22.500
Pectoral length	42.0	32.0	32.0	42.0	37.000
Pelvic length	27.0	22.0	22.0	27.0	24.500
Length of caudal fin	49.0	35.0	35.0	49.0	42.000
Length of upper caudal lobe	38.0	31.0	31.0	38.0	34.500
Length of lower caudal lobe	40.0	33.0	33.0	40.0	36.500
Length of caudal peduncle	29.0	24.0	24.0	29.0	26.500
Highest depth of caudal peduncle	17.0	12.0	12.0	17.0	14.500
Least depth of caudal peduncle	13.0	10.0	10.0	13.0	11.500

Pre dorsal distance	72.0	56.0	56.0	72.0	64.000
Pre pectoral distance	41.0	35.0	35.0	41.0	38.000
Pre pelvic distance	100.0	77.0	77.0	100.0	88.500
Pre anal distance	130.0	100.0	100.0	130.0	115.000
Distance between origin of pectoral & origin of pelvic	60.0	51.0	51.0	60.0	55.500
Distance between origin of pelvic & origin of anal	36.0	25.0	25.0	36.0	30.500
Distance between origin of pelvic & anus	30.0	21.0	21.0	30.0	25.500
Distance between anus and origin of anal fin	9.0	5.0	5.0	9.0	7.000

41. *Glyptothorax deyi* sp. nov.

(Plate XVII-7 & XIX - 2)



Text Figure 41. *Glyptothorax deyi* sp. nov.

Materials examined: TISTA DRAINAGE: Ghattay khola, SS Sirwani 128 mm (1 ex.); RANGIT DRAINAGE: R. Rangit, FCC Tatopani 164 - 173 mm (2 exs.); SS Nayabazar/Jorethang 147 - 165 mm (2 exs.); Rangbhang khola, SS Nayabazar 142 - 158 mm (2 exs.); local name: *Kahray*.

Diagnosis: Body elongate, moderately or greatly depressed. Body smooth or rough with granules. Abdomen slightly flat to rounded. Head small, covered with thick skin, depressed. Snout conical. Mouth inferior, transverse, narrow. Eyes dorsal, small, not visible from below ventral surface. Lips thick, fleshy, papillated for adhesion. Jaws sub-equal, upper jaw the longer. Teeth villiform in jaws;

palate edentate. The ventral surface of body always provided with a U or V - shaped thoracic adhesive apparatus, which is composed of longitudinal folds of skin. Four pairs of barbels; one pair each of maxillary, nasal and two of mandibular, maxillary pair with broad base. Gill membranes united with each other and also with the isthmus.

Rayed dorsal fin inserted above half of pectoral fin with five to seven rays and a spine. Adipose dorsal free posteriorly. Pectoral fin with 6 to 11 rays and a spine, strong, broad, serrated with antrorse teeth along inner edge. Paired fins may be plaited below. Anal fin short, with 7 to 14 rays. Caudal fin deeply forked. Lateral line complete and simple.

Meristic Counts: D.i.6; P.i.10; V.i.5; A.i.9; C.17.

Morphometric Characters:

Standard length 1.23 - 1.27 (1.244), Head length 5.25 - 5.68 (5.512), Head breadth 6.00 - 6.74 (6.219), Head depth 7.17 - 8.10 (7.602), Gape of mouth 12.80 - 14.73 (13.475), Eye diameter 42.00 - 54.00 (46.252), Inter orbital distance 15.78 - 18.38 (17.217), Post orbital distance 12.91 - 15.00 (14.271), Inter nasal distance 21.85 - 28.44 (25.622), Snout length 9.80 - 10.80 (10.332), Maxillary barbel length 4.71 - 5.33 (5.074), Outer mandibular barbel length 9.17 - 10.80 (9.923), Inner mandibular barbel length 16.50 - 21.33 (18.744), Nasal barbel length 18.38 - 25.60 (21.324), Body depth 5.32 - 5.88 (5.547), Body width 6.60 - 7.36 (7.026), Length of sucker 8.53 - 8.88 (8.651), Breadth of sucker 11.00 - 12.46 (11.627), Dorsal height 5.82 - 6.48 (6.037), Dorsal base 9.17 - 10.80 (9.658), Anal height 5.88 - 6.45 (6.161), Anal base 8.10 - 9.14 (8.483), Pectoral length 5.26 - 5.57 (5.432), Pelvic length 6.88 - 7.53 (7.311), Length of caudal fin 4.44 - 4.92 (4.713), Length of upper caudal lobe 4.44 - 5.25 (4.897), Length of lower caudal lobe 4.50 - 4.92 (4.809), Length of caudal peduncle 5.33 - 5.69 (5.506), Highest depth of caudal peduncle 10.13 - 11.79 (10.790), Least depth of caudal peduncle 11.83 - 14.22 (13.068), Pre dorsal distance 3.37 - 3.67 (3.487), Pre pectoral distance 5.25 - 6.40 (5.826), Pre pelvic distance 2.45 - 2.68 (2.552), Pre anal distance 1.79 - 1.97 (1.879), Distance between origin of pectoral & origin of pelvic 3.97 - 4.30 (4.155), Distance between origin of pelvic & origin of anal 6.11 - 7.53 (6.560), Distance between origin of pelvic & anus 7.86 - 9.19 (8.676), Distance between anus and origin of anal fin 18.38 - 28.40 (22.675).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 87. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. deyi* sp. nov.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	80.366	78.873	81.633	0.885
Head length	18.141	17.606	19.048	0.489
Head breadth	16.080	14.844	16.667	0.637
Head depth	13.154	12.346	13.939	0.625
Gape of mouth	7.421	6.790	7.813	0.370
Eye diameter	2.162	1.852	2.381	0.190
Inter orbital distance	5.808	5.442	6.338	0.400
Post orbital distance	7.007	6.667	7.746	0.388
Inter nasal distance	3.903	3.516	4.577	0.387
Snout length	9.679	9.259	10.204	0.340
Maxillary barbel length	19.709	18.750	21.212	0.838
Outer mandibular barbel length	10.078	9.259	10.909	0.535
Inner mandibular barbel length	5.335	4.688	6.061	0.484
Nasal barbel length	4.689	3.906	5.442	0.529
Body depth	18.028	17.007	18.788	0.745
Body width	14.233	13.580	15.152	0.515
Length of sucker	11.559	11.268	11.728	0.168
Breadth of sucker	8.601	8.025	9.091	0.362
Dorsal height	16.563	15.432	17.188	0.633
Dorsal base	10.354	9.259	10.909	0.612
Anal height	16.231	15.493	17.007	0.587
Anal base	11.788	10.938	12.346	0.496
Pectoral length	18.410	17.969	19.014	0.354
Pelvic length	13.679	13.281	14.545	0.450
Length of caudal fin	21.217	20.313	22.535	0.959
Length of upper caudal lobe	20.420	19.048	22.535	1.237
Length of lower caudal lobe	20.794	20.313	22.222	0.720
Length of caudal peduncle	18.163	17.576	18.750	0.483
Highest depth of caudal peduncle	9.268	8.485	9.877	0.609
Least depth of caudal peduncle	7.652	7.031	8.451	0.517

Pre dorsal distance	28.679	27.273	29.688	0.860
Pre pectoral distance	17.166	15.625	19.048	1.099
Pre pelvic distance	39.183	37.324	40.816	1.345
Pre anal distance	53.230	50.704	55.758	1.854
Distance between origin of pectoral & origin of pelvic	24.065	23.239	25.170	0.682
Distance between origin of pelvic & origin of anal	15.243	13.281	16.364	1.036
Distance between origin of pelvic & anus	11.526	10.884	12.727	0.717
Distance between anus and anal fin	4.410	3.521	5.442	0.695

Other Characteristics:

Body: Long, cylindrical. Dorsal profile more convex; ventral profile abruptly narrowed from anal fin base; abdomen rounded.

Head: Large, flat, conical before, 1.12 as long as broad. Skin covered with tile-like granulations.

Eyes: Small with circular pupils, located at the middle of head excluding snout. Inter orbital space slightly convex, 3.1 in length of head.

Mouth: Inferior, transverse. Width of gape of mouth 2.4 in head length. Upper jaw the longer. Lips fleshy and papillated.

Barbels: Four pairs, a pair each of maxillary, nasal and two of mandibular. Nasal and inner mandibular short. Maxillary with broad bases runs up to the anterior half of pectorals. Inner mandibular only half the length of outer pair.

Sucker: Distinct with horizontal folds of skin. It is triangular anteriorly, 1.37 as long as broad and 1.56 in head length.

Skin: Rough with fine granulations.

Lateral Line: Simple, complete.

Fins: Dorsal with a serrated spine, shorter than depth of body; inserted midway between tip of snout and caudal base. Paired fins not plaited below. Pectorals with sharply serrated spine, as long as or longer than length of head. It runs up to the middle of rayed dorsal but does not reach pelvics. Ventral nearer rayed dorsal than adipose. Anal ahead of adipose. Caudal fin deeply forked with slightly longer lower lobe.

Colour: Body dark greyish above and lighter beneath. Pectoral, ventral, anal, caudal and adhesive apparatus blood red in colour. Dorsal fin reddish with dark bands; adipose yellowish.

Size: Largest specimen examined 173 mm.

Affinity: The present species resembles *Glyptothorax trilineatus* in nature of adhesive apparatus and height of dorsal fin in body depth and position of anal fin but it can be readily distinguished from *trilineatus* by the depth of body in standard length which is 4.2 - 4.8 (versus 5.3 - 6.0 in *trilineatus*). Besides nasal barbel is shorter than that of *trilineatus*.

Holotype: 103 mm SL, Ghattay khola (Sirwani), East Sikkim; Coll. P. Tamang, GUZ/F183.

Paratype: 2, 120 and 133 mm SL, river Rangit (Nayabazar/Jorethang), West/South Sikkim; Coll. P. Tamang, GUZ/F184.

Etymology: This new species is named *Glyptothorax deyi* after the name of Professor Subhas Chandra Dey, Head of the Department of Zoology, Gauhati University, Assam, under whose able guidance the present project has been carried out.

Distribution: Ghattay khola, river Rangit and Rangbhang khola of Sikkim.

Remarks: It is confined to Ghattay khola, river Rangit and Rangbhang khola and is caught throughout monsoon.

Table 88. Measurements (in mm) of *Glyptothorax deyi* sp. nov.

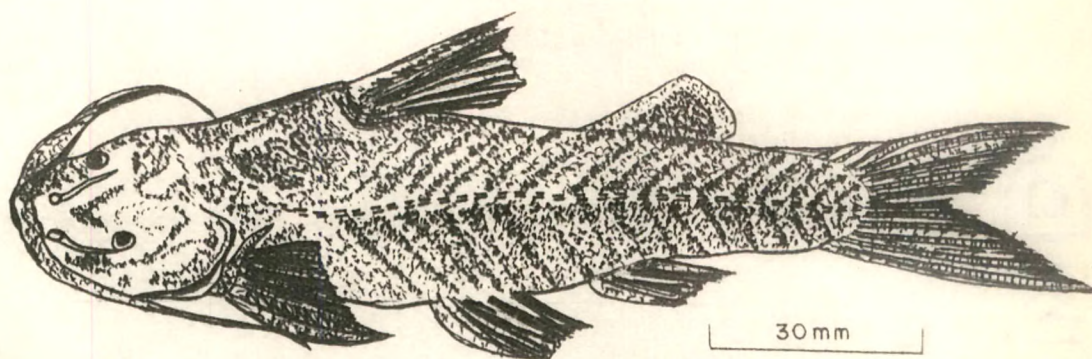
CHARACTERS	NUMBER OF SPECIMENS					RANGE		SD
	I	II	III	IV	V	Min.	Max.	
Total length	165.0	162.0	147.0	142.0	128.0	128.0	165.0	148.800
Standard length	133.0	130.0	120.0	112.0	103.0	103.0	133.0	119.600
Head length	30.0	29.0	28.0	25.0	23.0	23.0	30.0	27.000
Head breadth	27.0	27.0	24.0	23.0	19.0	19.0	27.0	24.000
Head depth	23.0	20.0	20.0	19.0	16.0	16.0	23.0	19.600
Gape of mouth	12.0	11.0	11.0	11.0	10.0	10.0	12.0	11.000
Eye diameter	3.5	3.0	3.5	3.0	3.0	3.0	3.5	3.200
Inter orbital distance	9.0	9.0	8.0	9.0	8.0	8.0	9.0	8.600
Post orbital distance	11.0	11.0	10.0	11.0	9.0	9.0	11.0	10.400
Inter nasal distance	6.0	6.0	6.0	6.5	4.5	4.5	6.5	5.800
Snout length	16.0	15.0	15.0	14.0	12.0	12.0	16.0	14.400
Maxillary barbel length	35.0	31.0	29.0	28.0	24.0	24.0	35.0	29.400
Outer mandibular barbel length	18.0	15.0	15.0	14.0	13.0	13.0	18.0	15.000
Inner mandibular barbel length	10.0	9.0	8.0	7.0	6.0	6.0	10.0	8.000
Nasal barbel length	8.0	7.0	8.0	7.0	5.0	5.0	8.0	7.000

Body depth	31.0	28.0	25.0	26.0	24.0	24.0	31.0	26.800
Body width	25.0	22.0	21.0	20.0	18.0	18.0	25.0	21.200
Length of sucker	19.0	19.0	17.0	16.0	15.0	15.0	19.0	17.200
Breadth of sucker	15.0	13.0	13.0	12.0	11.0	11.0	15.0	12.800
Dorsal height	28.0	25.0	24.0	24.0	22.0	22.0	28.0	24.600
Dorsal base	18.0	15.0	16.0	15.0	13.0	13.0	18.0	15.400
Anal height	27.0	27.0	25.0	22.0	20.0	20.0	27.0	24.200
Anal base	20.0	20.0	17.0	17.0	14.0	14.0	20.0	17.600
Pectoral length	30.0	30.0	27.0	27.0	23.0	23.0	30.0	27.400
Pelvic length	24.0	22.0	20.0	19.0	17.0	17.0	24.0	20.400
Length of caudal fin	34.0	36.0	30.0	32.0	26.0	26.0	36.0	31.600
Length of upper caudal lobe	33.0	34.0	28.0	32.0	25.0	25.0	34.0	30.400
Length of lower caudal lobe	34.0	36.0	30.0	29.0	26.0	26.0	36.0	31.000
Length of caudal peduncle	29.0	30.0	27.0	25.0	24.0	24.0	30.0	27.000
Highest depth of caudal peduncle	14.0	16.0	14.0	14.0	11.0	11.0	16.0	13.800
Least depth of caudal peduncle	12.0	13.0	11.0	12.0	9.0	9.0	13.0	11.400
Pre dorsal distance	45.0	47.0	43.0	40.0	38.0	38.0	47.0	42.600
Pre pectoral distance	28.0	28.0	28.0	24.0	20.0	20.0	28.0	25.600
Pre pelvic distance	67.0	63.0	60.0	53.0	49.0	49.0	67.0	58.400
Pre anal distance	92.0	87.0	80.0	72.0	66.0	66.0	92.0	79.400
Distance between origin of pectoral & origin of pelvic	40.0	38.0	37.0	33.0	31.0	31.0	40.0	35.800
Distance between origin of pelvic & origin of anal	27.0	25.0	23.0	22.0	17.0	17.0	27.0	22.800
Distance between origin of pelvic & anus	21.0	18.0	16.0	17.0	14.0	14.0	21.0	17.200
Distance between anus and anal fin	7.0	8.0	8.0	5.0	5.0	5.0	8.0	6.600

Holotype - V, Paratype - I & III.

42. *Glyptothorax gracilis* (Gunther), 1861

(Plate XVII-3)

Text Figure 42. *Glyptothorax gracilis* (Gunther)

1861. *Glyptothorax gracile* Gunther, Cat. Fish. Brit. Mus., 5, p.186, (type locality, Nepal).

Previous records from Sikkim: Rangit river, Manjhitar, Coll. B. L. Chaudhuri 1913 (Tilak, 1972).

Present records: TISTA DRAINAGE: Confluence of Tista & Rani khola, SS Singtam 95 mm (1 ex.); Rangpo khola, SS Rangpo 141 mm (1 ex.); RANGIT DRAINAGE: R. Rangit, FCC Tatopani 127 - 164 mm (4 exs.); SS Nayabazar/Jorethang 95 - 158 mm (3 exs.); local name: *Kahray*.

Meristic Counts: D.i.6; P.i.9-10; V.i.5; A.9-12; C.17.

Morphometric Characters:

Standard length 1.21 - 1.27 (1.252), Head length 5.53 - 6.09 (5.708), Head breadth 6.56 - 6.87 (6.719), Head depth 7.29 - 9.60 (8.325), Gape of mouth 11.67 - 14.00 (12.663), Eye diameter 42.00 - 51.00 (46.369), Inter orbital distance 15.00 - 19.13 (16.917), Post orbital distance 12.80 - 17.00 (14.675), Inter nasal distance 23.33 - 28.00 (24.926), Snout length 9.55 - 10.77 (10.106), Maxillary barbel length 4.78 - 6.18 (5.483), Outer mandibular barbel length 8.73 - 11.67 (9.909), Inner mandibular barbel length 16.11 - 21.54 (17.761), Nasal barbel length 16.00 - 22.57 (18.113), Body depth 5.88 - 6.86 (6.414), Body width 6.95 - 8.32 (7.883), Length of sucker 8.32 - 9.55 (8.963), Breadth of sucker 10.77 - 12.00 (11.312), Dorsal height 5.46 - 6.58 (5.855), Dorsal base 8.75 - 10.20 (9.540), Anal height 5.83 - 7.18 (6.262), Anal base 7.38 - 10.00 (8.376), Pectoral length 5.10 - 5.85 (5.414), Pelvic length 7.29 - 7.90 (7.562), Length of caudal fin 4.38 - 6.08 (4.799), Length of upper caudal lobe 4.77 - 6.58 (5.233), Length of lower caudal lobe 4.38 - 6.08 (4.799), Length of caudal peduncle 5.45 - 6.38 (5.764), Highest depth of caudal peduncle 9.88 - 11.67 (10.918), Least depth of caudal peduncle 12.15 - 15.30 (13.581), Pre dorsal distance 3.28 -

3.64 (3.444), Pre pectoral distance 5.46 - 6.32 (5.790), Pre pelvic distance 2.51 - 3.10 (2.677), Pre anal distance 1.82 - 2.06 (1.899), Distance between origin of pectoral & origin of pelvic 4.16 - 4.38 (4.276), Distance between origin of pelvic & origin of anal 6.00 - 6.67 (6.250), Distance between origin of pelvic & anus 7.90 - 9.56 (8.516), Distance between anus and origin of anal fin 19.20 - 26.25 (21.136).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 89. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. gracilis* (Gunther), 1861.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	79.899	79.048	82.911	1.508
Head length	17.520	16.429	18.095	0.568
Head breadth	14.882	14.557	15.238	0.268
Head depth	12.012	10.417	13.725	1.097
Gape of mouth	7.897	7.143	8.571	0.511
Eye diameter	2.157	1.961	2.381	0.140
Inter orbital distance	5.911	5.229	6.667	0.497
Post orbital distance	6.814	5.882	7.813	0.761
Inter nasal distance	4.012	3.571	4.286	0.250
Snout length	9.895	9.286	10.476	0.480
Maxillary barbel length	18.238	16.190	20.915	1.677
Outer mandibular barbel length	10.091	8.571	11.458	0.982
Inner mandibular barbel length	5.630	4.643	6.209	0.582
Nasal barbel length	5.521	4.430	6.250	0.708
Body depth	15.591	14.583	16.993	0.878
Body width	12.686	12.025	14.379	0.863
Length of sucker	11.157	10.476	12.025	0.549
Breadth of sucker	8.840	8.333	9.286	0.353
Dorsal height	17.079	15.190	18.301	1.120
Dorsal base	10.482	9.804	11.429	0.578
Anal height	15.970	13.924	17.143	1.126

Anal base	11.938	10.000	13.542	1.243
Pectoral length	18.470	17.089	19.608	0.893
Pelvic length	13.223	12.658	13.725	0.405
Length of caudal fin	20.837	16.456	22.857	2.247
Length of upper caudal lobe	19.108	15.190	20.952	2.013
Length of lower caudal lobe	20.837	16.456	22.857	2.247
Length of caudal peduncle	17.350	15.686	18.354	0.917
Highest depth of caudal peduncle	9.159	8.571	10.127	0.579
Least depth of caudal peduncle	7.363	6.536	8.228	0.557
Pre dorsal distance	29.038	27.451	30.476	1.139
Pre pectoral distance	17.271	15.823	18.301	0.973
Pre pelvic distance	37.360	32.292	39.869	2.622
Pre anal distance	52.651	48.571	54.902	2.158
Distance between origin of pectoral & origin of pelvic	23.385	22.857	24.051	0.446
Distance between origin of pelvic & origin of anal	16.000	15.000	16.667	0.598
Distance between origin of pelvic & anus	11.742	10.458	12.658	0.952
Distance between anus and anal fin	4.731	3.810	5.208	0.507

Other Characteristics:

Body: Elongated, cylindrical; dorsal profile more arched than ventral with round abdomen. Depth of body 5.0 - 5.5 in standard length.

Head: Large, flat and conical anteriorly, 1.1 times as long as broad. Skin is rough with tile-like uniform granulations.

Eyes: Diameter 8.1 in length of head, inter-orbital space is slightly convex and 3 times in total length. Eyes are small with circular pupil, situated in the commencement of the posterior half of head.

Mouth: Inferior, transverse. Width of gape of mouth 2.2 in head length. Upper jaw the longer. Lips papillated. Snout conical but not pointed.

Barbels: Eight in number, inner mandibular short and nasal short. Maxillary with broad bases reaches almost half of pectorals; inner mandibular pair only half the length of outer pair.

Sucker: Well marked, 1.2 times as long as broad. It is triangular anteriorly.

Skin: Rough with fine granulations.

Lateral Line: Simple, complete.

Fins: Dorsal fin higher than body depth and inserted nearer tip of snout than adipose dorsal. Dorsal spine serrated along its inner margin. Paired fins not plaited. Pectorals with serrated spine, slightly longer than length of head, does not reach pelvics. Ventral placed more towards rayed dorsal than adipose dorsal. Anal as high as or slightly shorter than dorsal, inserted slightly ahead of adipose dorsal. Caudal deeply forked with longer lower lobe.

Colour: Body dark and lighter beneath. Fins and sucker reddish in alive specimens. Dorsal fin with black stripes.; adipose yellowish red in colour.

Distribution: India: Sikkim; Elsewhere: Nepal.

Remarks: The species was earlier reported only from Rangit river (Tilak, 1972). Its distribution is extended to Rangpo khola and Tista & rani khola confluence during the present study and is caught by cast net with the first shower of the monsoon.

Jayaram (1979) has mentioned that the anal fin rays 14 in number but it is 9-12 in the present specimens. Further the maximum size of the fish 123 mm (Jayaram, 1979) and 127 mm (Talwar and Jhingran, 1991) has been extended to 164 mm in the present investigation.

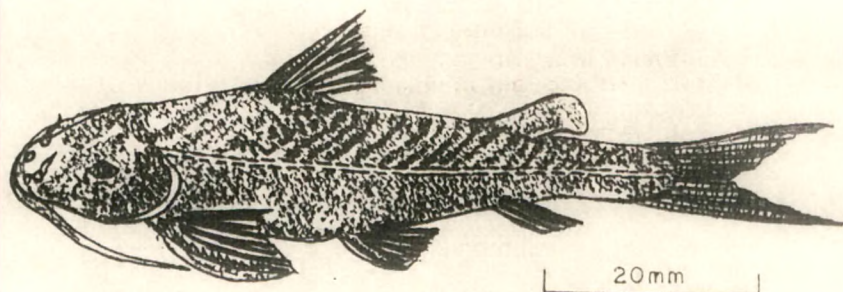
Table 90. Measurements (in mm) of *Glyptothorax gracilis* (Gunther), 1861.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	158.0	153.0	140.0	105.0	96.0	96.0	158.0	130.400
Standard length	131.0	121.0	111.0	83.0	76.0	76.0	131.0	104.400
Head length	28.0	27.0	23.0	19.0	17.0	17.0	28.0	22.800
Head breadth	23.0	23.0	21.0	16.0	14.0	14.0	23.0	19.400
Head depth	18.0	21.0	17.0	13.0	10.0	10.0	21.0	15.800
Gape of mouth	12.0	12.0	10.0	9.0	8.0	8.0	12.0	10.200
Eye diameter	3.5	3.0	3.0	2.5	2.0	2.0	3.5	2.800
Inter orbital distance	9.0	8.0	8.0	7.0	6.0	6.0	9.0	7.600
Post orbital distance	10.0	9.0	9.0	8.0	7.5	7.5	10.0	8.700
Inter nasal distance	6.5	6.0	5.0	4.5	4.0	4.0	6.5	5.200
Snout length	15.0	15.0	13.0	11.0	10.0	10.0	15.0	12.800
Maxillary barbel length	27.0	32.0	27.0	17.0	17.0	17.0	32.0	24.000
Outer mandibular barbel length	15.0	16.0	12.0	11.0	11.0	11.0	16.0	13.000
Inner mandibular barbel length	8.5	9.5	6.5	6.5	5.5	5.5	9.5	7.300

Nasal barbel length	7.0	9.5	7.0	6.0	6.0	6.0	9.5	7.100
Body depth	24.0	26.0	21.0	17.0	14.0	14.0	26.0	20.400
Body width	19.0	22.0	17.0	13.0	12.0	12.0	22.0	16.600
Length of sucker	19.0	17.0	15.0	11.0	11.0	11.0	19.0	14.600
Breadth of sucker	14.0	14.0	13.0	9.0	8.0	8.0	14.0	11.600
Dorsal height	24.0	28.0	24.0	19.0	16.0	16.0	28.0	22.200
Dorsal base	17.0	15.0	14.0	12.0	10.0	10.0	17.0	13.600
Anal height	22.0	24.0	23.0	18.0	16.0	16.0	24.0	20.600
Anal base	20.0	17.0	14.0	13.0	13.0	13.0	20.0	15.400
Pectoral length	27.0	30.0	25.0	20.0	18.0	18.0	30.0	24.000
Pelvic length	20.0	21.0	18.0	14.0	13.0	13.0	21.0	17.200
Length of caudal fin	26.0	33.0	30.0	24.0	21.0	21.0	33.0	26.800
Length of upper caudal lobe	24.0	30.0	28.0	22.0	19.0	19.0	30.0	24.600
Length of lower caudal lobe	26.0	33.0	30.0	24.0	21.0	21.0	33.0	26.800
Length of caudal peduncle	29.0	24.0	25.0	18.0	17.0	17.0	29.0	22.600
Highest depth of caudal peduncle	16.0	14.0	12.0	9.0	9.0	9.0	16.0	12.000
Least depth of caudal peduncle	13.0	10.0	10.0	8.0	7.0	7.0	13.0	9.600
Pre dorsal distance	45.0	42.0	40.0	32.0	29.0	29.0	45.0	37.600
Pre pectoral distance	25.0	28.0	23.0	19.0	17.0	17.0	28.0	22.400
Pre pelvic distance	60.0	61.0	54.0	40.0	31.0	31.0	61.0	49.200
Pre anal distance	85.0	84.0	74.0	51.0	51.0	51.0	85.0	69.000
Distance between origin of pectoral & origin of pelvic	38.0	36.0	33.0	24.0	22.0	22.0	38.0	30.600
Distance between origin of pelvic & origin of anal	26.0	24.0	21.0	17.0	16.0	16.0	26.0	20.800
Distance between origin of pelvic & anus	20.0	16.0	15.0	13.0	12.0	12.0	20.0	15.200
Distance between anus and anal fin	8.0	7.0	7.0	4.0	5.0	4.0	8.0	6.200

43. *Glyptothorax sinense manipurensis* Menon, 1954

(Plate XVII-1)

Text Figure 43. *Glyptothorax sinense manipurensis* Menon

1954. *Glyptothorax manipurensis* Menon, A.G.K., Rec. Indian Mus., 52, p.23.

text fig. (Type locality : Barak river, Karong, Manipur)

Present records: TISTA DRAINAGE: Dik chhu, SS Dikchu 217 - 257 mm (2 exs.); Rangpo khola, SS Rangpo 74 - 160 mm (2 exs.); local name: *Kahray*.

Meristic Counts: D.i.6; P.i.10; V.i.5 - 6; A.i.9 - 11; C.17.

Morphometric Characters:

Standard length 1.21 - 1.26 (1.229), Head length 4.63 - 5.43 (5.006), Head breadth 5.84 - 6.67 (6.205), Head depth 7.79 - 10.33 (8.973), Gape of mouth 8.68 - 10.00 (9.338), Eye diameter 48.22 - 57.11 (51.768), Inter orbital distance 14.80 - 19.77 (17.770), Post orbital distance 11.38 - 14.47 (12.657), Inter nasal distance 18.50 - 31.00 (24.230), Snout length 9.18 - 10.67 (9.814), Maxillary barbel length 4.82 - 5.47 (5.132), Outer mandibular barbel length 9.04 - 11.38 (9.951), Inner mandibular barbel length 14.80 - 17.13 (15.813), Nasal barbel length 17.78 - 25.70 (21.216), Body depth 7.40 - 9.41 (8.438), Body width 8.22 - 9.43 (8.877), Length of sucker 8.22 - 10.85 (9.977), Breadth of sucker 9.25 - 14.47 (12.119), Dorsal height 6.17 - 6.76 (6.535), Dorsal base 10.57 - 12.76 (11.908), Anal height 6.67 - 7.75 (7.320), Anal base 8.71 - 10.85 (9.387), Pectoral length 5.33 - 5.86 (5.613), Pelvic length 6.96 - 7.48 (7.290), Length of caudal fin 4.63 - 5.05 (4.824), Length of upper caudal lobe 5.29 - 5.52 (5.394), Length of lower caudal lobe 4.11 - 5.24 (4.871), Length of caudal peduncle 5.59 - 6.40 (5.989), Highest depth of caudal peduncle 13.45 - 16.00 (14.493), Least depth of caudal peduncle 14.80 - 17.78 (16.261), Pre dorsal distance 3.36 - 3.74 (3.540), Pre pectoral distance 4.93 - 5.56 (5.275), Pre pelvic distance 2.47 - 2.58 (2.537), Pre anal distance 1.78 - 1.81 (1.800), Distance between origin of pectoral & origin of pelvic 4.28 - 4.63 (4.450), Distance between origin of pelvic & origin of anal 5.29 - 5.35 (5.316), Distance between origin of pelvic & anus 6.73 - 7.75 (7.338), Distance between anus and origin of anal fin

16.00 - 24.67 (19.886).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 91. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. sinense manipurensis* Menon, 1954.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	81.341	79.375	82.879	1.301
Head length	19.975	18.433	21.622	1.130
Head breadth	16.116	15.000	17.121	0.752
Head depth	11.144	9.677	12.838	1.339
Gape of mouth	10.709	10.000	11.521	0.551
Eye diameter	1.932	1.751	2.074	0.128
Inter orbital distance	5.627	5.058	6.757	0.691
Post orbital distance	7.901	6.912	8.784	0.675
Inter nasal distance	4.127	3.226	5.405	0.851
Snout length	10.190	9.375	10.895	0.673
Maxillary barbel length	19.486	18.288	20.737	0.947
Outer mandibular barbel length	10.049	8.784	11.060	0.874
Inner mandibular barbel length	6.324	5.837	6.757	0.334
Nasal barbel length	4.714	3.891	5.625	0.616
Body depth	11.851	10.625	13.514	1.073
Body width	11.265	10.599	12.162	0.675
Length of sucker	10.023	9.217	12.162	1.236
Breadth of sucker	8.251	6.912	10.811	1.511
Dorsal height	15.302	14.786	16.216	0.548
Dorsal base	8.397	7.834	9.459	0.627
Anal height	13.662	12.903	15.000	0.802
Anal base	10.653	9.217	11.486	0.888
Pectoral length	17.817	17.051	18.750	0.618
Pelvic length	13.718	13.364	14.375	0.390
Length of caudal fin	20.730	19.816	21.622	0.733

Length of upper caudal lobe	18.539	18.125	18.919	0.294
Length of lower caudal lobe	20.530	19.066	24.324	2.194
Length of caudal peduncle	16.698	15.625	17.899	0.859
Highest depth of caudal peduncle	6.900	6.250	7.432	0.423
Least depth of caudal peduncle	6.150	5.625	6.757	0.411
Pre dorsal distance	28.247	26.728	29.730	1.066
Pre pectoral distance	18.956	17.972	20.270	0.953
Pre pelvic distance	39.422	38.710	40.541	0.755
Pre anal distance	55.552	55.253	56.250	0.407
Distance between origin of pectoral & origin of pelvic	22.471	21.622	23.346	0.736
Distance between origin of pelvic & origin of anal	18.810	18.677	18.919	0.100
Distance between origin of pelvic & anus	13.628	12.903	14.865	0.760
Distance between anus and anal fin	5.029	4.054	6.250	0.902

Other Characteristics:

Body: Elongated. Both the profiles horizontal, dorsal gently arched anteriorly.

Head: Large, flattened, always greater than depth of the body, more enlarged in adult specimens. It is broad and blunt anteriorly. Head longer than broad.

Eyes: Minute, situated on the commencement of the posterior half of head, not visible from below ventral surface.

Mouth: Inferior, Crescentic. Width of gape of mouth 8.6 to 10 in head length. Upper jaw the longer. Lips thick, fleshy, papillated and continuous at angles of mouth.

Barbels: Four pairs, nasal the shortest. Maxillary barbels with broad bases extend beyond the base of pectorals.

Sucker: Distinct, triangular, 1.2 times as long as broad.

Skin: Smooth without granulations or tuberculations.

Lateral Line: A distinct white lateral line extends behind operculum to base of caudal.

Fins: Dorsal with a strong spine, sharply serrated in its inner edge, always greater than depth of the body; inserted nearer tip of snout than adipose dorsal. The origin of the dorsal fin behind posterior half of pectorals. Adipose dorsal posteriorly free, placed more towards caudal fin than dorsal fin. Pectorals plaited below, fleshy with a serrated spine, horizontally expanded, far from reaching pelvics. Pelvics situated nearer dorsal fin than adipose dorsal and extends up to anal opening. Caudal fin deeply forked with slightly longer lower lobe.

Colour: Body dark above and lighter below. Dorsal fin banded with yellow markings. Pectoral, ventral, anal and caudal fin dark in colour with pale free ends.

Distribution: India: Manipur valley, Barak river, Karong.

Remarks: This species is recorded for the first time from Sikkim drainages. It is confined to Dik chhu, Rangpo khola and is caught throughout the monsoon season. A well marked white band extends dorsally from behind the dorsal fin base to caudal fin base and is a distinguishing feature of the species. The maximum length of the fish 94.5 (Jayaram, 1979) and 126 mm (Talwar & Jhingran, 1991) is extended to 257 mm in the present study.

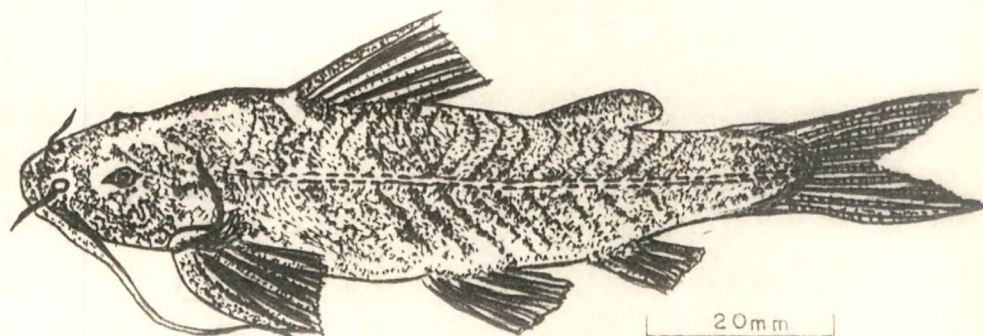
Table 92. Measurements (in mm) of *Glyptothorax sinense manipurensis* Menon, 1954.

CHARACTERS	NUMBER OF SPECIMENS				RANGE		MEAN
	I	II	III	IV	Min.	Max.	
Total length	257.0	217.0	160.0	74.0	74.0	257.0	177.000
Standard length	213.0	178.0	127.0	60.0	60.0	213.0	144.500
Head length	51.0	40.0	32.0	16.0	16.0	51.0	34.750
Head breadth	44.0	35.0	24.0	12.0	12.0	44.0	28.750
Head depth	31.0	21.0	16.0	9.5	9.5	31.0	19.375
Gape of mouth	27.0	25.0	16.0	8.0	8.0	27.0	19.000
Eye diameter	4.5	4.5	3.0	1.5	1.5	4.5	3.375
Inter orbital distance	13.0	11.0	9.0	5.0	5.0	13.0	9.500
Post orbital distance	20.0	15.0	13.0	6.5	6.5	20.0	13.625
Inter nasal distance	9.0	7.0	7.0	4.0	4.0	9.0	6.750
Snout length	28.0	21.0	15.0	8.0	8.0	28.0	18.000
Maxillary barbel length	47.0	45.0	32.0	14.0	14.0	47.0	34.500
Outer mandibular barbel length	25.0	24.0	17.0	6.5	6.5	25.0	18.125
Inner mandibular barbel length	15.0	14.0	10.0	5.0	5.0	15.0	11.000
Nasal barbel length	10.0	10.0	9.0	3.5	3.5	10.0	8.125
Body depth	29.0	26.0	17.0	10.0	10.0	29.0	20.500
Body width	30.0	23.0	17.0	9.0	9.0	30.0	19.750
Length of sucker	24.0	20.0	15.0	9.0	9.0	24.0	17.000
Breadth of sucker	20.0	15.0	12.0	8.0	8.0	20.0	13.750
Dorsal height	38.0	33.0	24.0	12.0	12.0	38.0	26.750
Dorsal base	21.0	17.0	13.0	7.0	7.0	21.0	14.500

Anal height	34.0	28.0	24.0	10.0	10.0	34.0	24.000
Anal base	29.0	20.0	17.0	8.5	8.5	29.0	18.625
Pectoral length	46.0	37.0	30.0	13.0	13.0	46.0	31.500
Pelvic length	35.0	29.0	23.0	10.0	10.0	35.0	24.250
Length of caudal fin	52.0	43.0	34.0	16.0	16.0	52.0	36.250
Length of upper caudal lobe	48.0	40.0	29.0	14.0	14.0	48.0	32.750
Length of lower caudal lobe	49.0	42.0	31.0	18.0	18.0	49.0	35.000
Length of caudal peduncle	46.0	37.0	25.0	12.0	12.0	46.0	30.000
Highest depth of caudal peduncle	18.0	15.0	10.0	5.5	5.5	18.0	12.125
Least depth of caudal peduncle	16.0	13.0	9.0	5.0	5.0	16.0	10.750
Pre dorsal distance	73.0	58.0	45.0	22.0	22.0	73.0	49.500
Pre pectoral distance	50.0	39.0	29.0	15.0	15.0	50.0	33.250
Pre pelvic distance	102.0	84.0	62.0	30.0	30.0	102.0	69.500
Pre anal distance	142.0	120.0	90.0	41.0	41.0	142.0	98.250
Distance between origin of pectoral & origin of pelvic	60.0	50.0	35.0	16.0	16.0	60.0	40.250
Distance between origin of pelvic & origin of anal	48.0	41.0	30.0	14.0	14.0	48.0	33.250
Distance between origin of pelvic & anus	35.0	28.0	21.0	11.0	11.0	35.0	23.750
Distance between anus and anal fin	11.0	12.0	10.0	3.0	3.0	12.0	9.000

44. *Glyptothorax sinense sikkimensis* sub. sp. nov.

(Plate XVII-5 & XIX -1)

Text Figure 44. *Glyptothorax sinense sikkimensis* sub. sp. nov.

Materials examined: RANGIT DRAINAGE: Rangbhang khola, SS Nayabazar 160 - 162 mm (2 exs.); local name: *Kahray*

Diagnosis: Body elongate, moderately or greatly depressed. Body skin smooth or rough with granulations or tuberculations. Dorsal profile gently arched. Head small, covered with thick skin, depressed; snout conical, not pointed; jaws sub-equal, upper jaw the longer; lips thick, fleshy, papillated. Ventral surface of body provided with an adhesive apparatus with or without a central pit or depression on thorax. Mouth inferior, transverse, narrow. Teeth villiform in jaws; palate edentate. Eyes dorsal, small. Four pairs of barbels; one pair each of maxillary, nasal and two of mandibular; maxillary pair with broad bases. Gill membranes united with each other and also isthmus. Branchiostegals 6 -10.

Rayed dorsal fin with five to seven rays and a spine. Adipose dorsal short, high, posteriorly free. Pectoral fins with 6 to 11 rays and a spine, strong, broad serrated with antrorse teeth along inner edge. Fins may be enveloped in skin. Pelvic fins with 6 rays. Paired fins may be plaited below. Anal fin short, with 7 to 14 rays. Caudal fin deeply forked. Lateral line complete, simple.

Meristic Counts: D.i.6; P.i.10; V.i.5; A.i.10; C.17.

Morphometric Characters:

Standard length 1.20 - 1.21 (1.206), Head length 5.06 - 5.71 (5.369), Head breadth 6.00 - 6.96 (6.443), Head depth 8.53 - 8.89 (8.704), Gape of mouth 8.53 - 10.67 (9.477), Eye diameter 53.33 - 64.80 (58.510), Inter orbital distance 16.20 - 18.82 (17.414), Post orbital distance 12.46 - 14.55 (13.423), Inter nasal distance 20.25 - 22.86 (21.475), Snout length 9.53 - 11.43 (10.393), Maxillary barbel length 4.63 - 4.85 (4.736), Outer mandibular barbel length 8.53 - 10.00 (9.205), Inner mandibular barbel length 14.55 - 14.73 (14.636), Nasal barbel length 22.86 - 23.14 (22.999),

Body depth 6.75 - 7.62 (7.158), Body width 6.23 - 6.67 (6.441), Length of sucker 10.80 - 11.43 (11.105), Breadth of sucker 11.57 - 12.31 (11.928), Dorsal height 6.00 - 6.96 (6.443), Dorsal base 10.80 - 12.31 (11.505), Anal height 6.75 - 7.27 (7.002), Anal base 9.53 - 10.67 (10.066), Pectoral length 5.23 - 5.93 (5.554), Pelvic length 6.96 - 7.04 (7.000), Length of caudal fin 4.63 - 4.85 (4.736), Length of upper caudal lobe 5.23 - 5.71 (5.459), Length of lower caudal lobe 4.76 - 5.16 (4.955), Length of caudal peduncle 14.55 - 14.73 (14.636), Highest depth of caudal peduncle 16.00 - 16.20 (16.099), Pre dorsal distance 3.38 - 3.64 (3.501), Pre pectoral distance 5.59 - 6.40 (5.965), Pre pelvic distance 2.42 - 2.67 (2.536), Pre anal distance 1.72 - 1.84 (1.779), Distance between origin of pectoral & origin of pelvic 3.77 - 4.10 (3.928), Distance between origin of pelvic & origin of anal 5.06 - 5.71 (5.369), Distance between origin of pelvic & anus 6.48 - 7.27 (6.854), Distance between anus and origin of anal fin 22.86 - 23.14 (22.999).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 93. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. sinense sikkimensis sub. sp. nov.*

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	82.917	82.500	83.333	0.417
Head length	18.627	17.500	19.753	1.127
Head breadth	15.521	14.375	16.667	1.146
Head depth	11.489	11.250	11.728	0.239
Gape of mouth	10.552	9.375	11.728	1.177
Eye diameter	1.709	1.543	1.875	0.166
Inter orbital distance	5.743	5.313	6.173	0.430
Post orbital distance	7.450	6.875	8.025	0.575
Inter nasal distance	4.657	4.375	4.938	0.282
Snout length	9.622	8.750	10.494	0.872
Maxillary barbel length	21.115	20.625	21.605	0.490
Outer mandibular barbel length	10.864	10.000	11.728	0.864
Inner mandibular barbel length	6.833	6.790	6.875	0.042
Nasal barbel length	4.348	4.321	4.375	0.027
Body depth	13.970	13.125	14.815	0.845

Body width	15.525	15.000	16.049	0.525
Length of sucker	9.005	8.750	9.259	0.255
Breadth of sucker	8.383	8.125	8.642	0.258
Dorsal height	15.521	14.375	16.667	1.146
Dorsal base	8.692	8.125	9.259	0.567
Anal height	14.282	13.750	14.815	0.532
Anal base	9.934	9.375	10.494	0.559
Pectoral length	18.005	16.875	19.136	1.130
Pelvic length	14.286	14.198	14.375	0.089
Length of caudal fin	21.115	20.625	21.605	0.490
Length of upper caudal lobe	18.318	17.500	19.136	0.818
Length of lower caudal lobe	20.181	19.375	20.988	0.806
Length of caudal peduncle	6.833	6.790	6.875	0.042
Highest depth of caudal peduncle	6.211	6.173	6.250	0.039
Pre dorsal distance	28.565	27.500	29.630	1.065
Pre pectoral distance	16.763	15.625	17.901	1.138
Pre pelvic distance	39.429	37.500	41.358	1.929
Pre anal distance	56.200	54.375	58.025	1.825
Distance between origin of pectoral & origin of pelvic	25.459	24.375	26.543	1.084
Distance between origin of pelvic & origin of anal	18.627	17.500	19.753	1.127
Distance between origin of pelvic & anus	14.591	13.750	15.432	0.841
Distance between anus and origin of anal fin	4.348	4.321	4.375	0.027

Other Characteristics:

Body: Elongated and cylindrical. Dorsal convex slightly, more convex than ventral.

Head: Large, flat and blunt anteriorly. Head length is always greater than depth of the body.

Eyes: Small, placed dorsally at the commencement of the posterior half of head; interorbital space slightly convex.

Mouth: Inferior, crescentic in shape, upper jaw the longer. Lips are thick, fleshy and papillated, continuous at angles of mouth.

Barbels: Four pairs, nasal the shortest. Maxillary pair the longest with broad bases which half of pectorals.

Adhesive apparatus: Triangular, 1.07 times as long as broad without a distinct central pit.

Skin: Smooth without tuberculations or granulations.

Lateral Line: A distinct white lateral line extends from behind the operculum to caudal fin base.

Fins: Dorsal inserted nearer to tip of snout than adipose dorsal, behind the posterior half of head. Dorsal height greater than depth of body. Adipose dorsal more towards caudal base than dorsal. Pectorals plaited below, with a serrated spine, horizontally expanded and far from reaching pelvics. Pelvics located nearer dorsal than adipose dorsal, extending up to anal opening. Caudal fin deeply forked with slightly longer lower lobe.

Colour: Body dark above and lighter below. Fins are dark with lighter free ends.

Size: Largest specimen examined 162 mm.

Affinity: *G. sinense sikkimensis* morphology resembles *G. s. manipurensis* and *G. s. sinense* in skin character, fin formula, longitudinal bands on body, structure of adhesive apparatus etc. But it differs from the former in (1) weak dorsal spine in *G.s. sikkimensis* (versus strong dorsal spine in *G. s. manipurensis*); (2) head length 5.06 - 5.71 in total length in *G.s. sikkimensis*(versus 4.62 - 5.42 in *G.s. manipurensis*).

It can be readily distinguished from *G.s. sinense* in (1) smooth dorsal spine in *G.s. sikkimensis* (versus dorsal spine serrated in *G.s. sinense*) and (2) paired fins plaited in *G.s. sikkimensis*(versus not plaited in *G. s. sinense*).

Holotype: 132 mm SL, Rangbhang khola (Nayabazar), West Sikkim; Coll. P. Tamang, GUZ/F185.

Paratype: 1, 135 mm SL, Rangbhang khola (Nayabazar), West Sikkim, Coll. P. Tamang, GUZ/F186.

Etymology: This species *Glyptothorax sinense sikkimensis* is named after Sikkim, the state where it is found.

Distribution: Rangbhang khola of Sikkim.

Remarks: This taxonomic group is rare in occurrence, confined to Rangbhang khola and is available mostly during monsoon.

Table 94. Measurements (in mm) of *Glyptothorax sinense sikkimensis* sub. sp. nov.

CHARACTERS	NUMBER OF SPECIMENS		RANGE		MEAN
	I	II	Min.	Max.	
Total length	162.0	160.0	160.0	162.0	161.000
Standard length	135.0	132.0	132.0	135.0	133.500
Head length	32.0	28.0	28.0	32.0	30.000
Head breadth	27.0	23.0	23.0	27.0	25.000

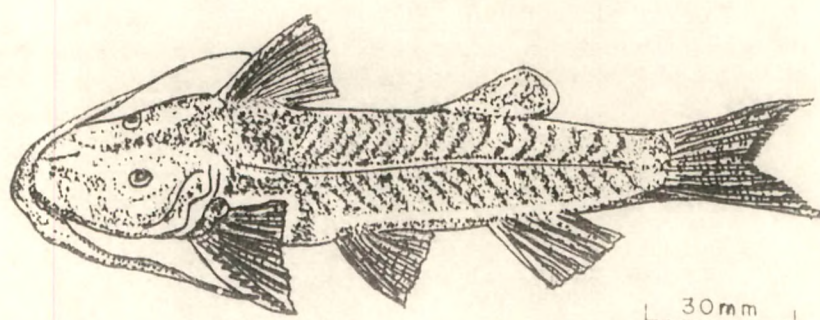
Head depth	19.0	18.0	18.0	19.0	18.500
Gape of mouth	19.0	15.0	15.0	19.0	17.000
Eye diameter	2.5	3.0	2.5	3.0	2.750
Inter orbital distance	10.0	8.5	8.5	10.0	9.250
Post orbital distance	13.0	11.0	11.0	13.0	12.000
Inter nasal distance	8.0	7.0	7.0	8.0	7.500
Snout length	17.0	14.0	14.0	17.0	15.500
Maxillary barbel length	35.0	33.0	33.0	35.0	34.000
Outer mandibular barbel length	19.0	16.0	16.0	19.0	17.500
Inner mandibular barbel length	11.0	11.0	11.0	11.0	11.000
Nasal barbel length	7.0	7.0	7.0	7.0	7.000
Body depth	24.0	21.0	21.0	24.0	22.500
Body width	26.0	24.0	24.0	26.0	25.000
Length of sucker	15.0	14.0	14.0	15.0	14.500
Breadth of sucker	14.0	13.0	13.0	14.0	13.500
Dorsal height	27.0	23.0	23.0	27.0	25.000
Dorsal base	15.0	13.0	13.0	15.0	14.000
Anal height	24.0	22.0	22.0	24.0	23.000
Anal base	17.0	15.0	15.0	17.0	16.000
Pectoral length	31.0	27.0	27.0	31.0	29.000
Pelvic length	23.0	23.0	23.0	23.0	23.000
Length of caudal fin	35.0	33.0	33.0	35.0	34.000
Length of upper caudal lobe	31.0	28.0	28.0	31.0	29.500
Length of lower caudal lobe	34.0	31.0	31.0	34.0	32.500
Length of caudal peduncle	11.0	11.0	11.0	11.0	11.000
Highest depth of caudal peduncle	10.0	10.0	10.0	10.0	10.000
Pre dorsal distance	48.0	44.0	44.0	48.0	46.000
Pre pectoral distance	29.0	25.0	25.0	29.0	27.000
Pre pelvic distance	67.0	60.0	60.0	67.0	63.500
Pre anal distance	94.0	87.0	87.0	94.0	90.500
Distance between origin of pectoral & origin of pelvic	43.0	39.0	39.0	43.0	41.000
Distance between origin of pelvic & origin of anal	32.0	28.0	28.0	32.0	30.000

Distance between origin of pelvic & anus	25.0	22.0	22.0	25.0	23.500
Distance between anus and origin of anal fin	7.0	7.0	7.0	7.0	7.000

Holotype - II, Paratype - I.

45. *Glyptothorax trilineatus* Blyth, 1860

(Plate XVII-2)



Text Figure 45. *Glyptothorax trilineatus* Blyth

1860. *Glyptothorax trilineatus* Blyth, *J. Asiat. Soc. Beng.*, 29, p.134.

(Type locality, Tenasserim).

Present records: TISTA DRAINAGE: R. Tista, SS Singtam 141 mm (1 ex.); Ghattay khola, SS Sirwani 130 mm (1 ex.); Rangpo khola, FCC Rorethang 147 mm (1 ex.); SS Rangpo 152 - 157 mm (2 ex.); RANGIT DRAINAGE: R. Rangit, FCC Tatopani 129 - 160 mm (2 ex.); SS Nayabazar/Jorethang 160 mm (1 ex.); local name: *Kahray*.

Meristic Counts: D.i.6; P.i.10; V.i.5; A.i.9; C.17.

Morphometric Characters:

Standard length 1.23 - 1.26 (1.246), Head length 5.71 - 5.96 (5.835), Head breadth 6.15 - 6.74 (6.395), Head depth 7.59 - 8.93 (8.249), Gape of mouth 12.90 - 14.09 (13.349), Eye diameter 43.00 - 64.00 (48.583), Inter orbital distance 16.13 - 19.14 (17.686), Post orbital distance 14.11 - 15.50 (14.535), Inter nasal distance 22.33 - 26.67 (25.257), Snout length 10.31 - 11.21 (10.793), Maxillary barbel length 4.91 - 5.38 (5.109), Outer mandibular barbel length 10.00 - 12.90 (10.710), Inner mandibular barbel length 16.13 - 22.86 (18.216), Nasal barbel length 14.89 - 17.78 (16.108), Body depth 5.61 - 6.38 (6.085), Body width 7.05 - 7.62 (7.429), Length of sucker 7.85 - 8.89 (8.450), Breadth of sucker 10.67 - 12.90 (11.726), Dorsal height 5.38 - 6.54 (6.001), Dorsal base

9.24 - 10.31 (9.698), Anal height 6.09 - 6.74 (6.273), Anal base 7.62 - 8.38 (8.087), Pectoral length 4.96 - 5.81 (5.381), Pelvic length 6.70 - 7.48 (7.189), Length of caudal fin 4.62 - 5.06 (4.798), Length of upper caudal lobe 4.85 - 5.41 (5.063), Length of lower caudal lobe 4.62 - 5.06 (4.798), Length of caudal peduncle 5.16 - 5.96 (5.547), Highest depth of caudal peduncle 9.92 - 11.21 (10.615), Least depth of caudal peduncle 12.31 - 14.09 (13.130), Pre dorsal distance 3.39 - 3.72 (3.512), Pre pectoral distance 5.52 - 5.81 (5.610), Pre pelvic distance 2.43 - 2.62 (2.532), Pre anal distance 1.79 - 1.91 (1.847), Distance between origin of pectoral & origin of pelvic 4.03 - 4.57 (4.218), Distance between origin of pelvic & origin of anal 5.93 - 6.79 (6.415), Distance between origin of pelvic & anus 7.62 - 9.24 (8.777), Distance between anus and origin of anal fin 15.70 - 26.80 (22.500).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 95. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *G. trilineatus* Blyth, 1860.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	80.244	79.104	81.250	0.856
Head length	17.138	16.774	17.500	0.234
Head breadth	15.638	14.839	16.250	0.472
Head depth	12.123	11.194	13.178	0.785
Gape of mouth	7.491	7.097	7.752	0.223
Eye diameter	2.058	1.563	2.326	0.281
Inter orbital distance	5.654	5.224	6.202	0.337
Post orbital distance	6.880	6.452	7.090	0.225
Inter nasal distance	3.959	3.750	4.478	0.263
Snout length	9.266	8.917	9.701	0.275
Maxillary barbel length	19.573	18.605	20.382	0.634
Outer mandibular barbel length	9.337	7.752	10.000	0.806
Inner mandibular barbel length	5.490	4.375	6.202	0.669
Nasal barbel length	6.208	5.625	6.716	0.355
Body depth	16.433	15.672	17.834	0.734
Body width	13.461	13.125	14.194	0.384

Length of sucker	11.834	11.250	12.739	0.502
Breadth of sucker	8.528	7.752	9.375	0.564
Dorsal height	16.663	15.287	18.605	1.100
Dorsal base	10.311	9.701	10.828	0.398
Anal height	15.942	14.839	16.418	0.575
Anal base	12.366	11.940	13.125	0.410
Pectoral length	18.583	17.197	20.149	1.048
Pelvic length	13.911	13.376	14.925	0.543
Length of caudal fin	20.842	19.745	21.642	0.641
Length of upper caudal lobe	19.751	18.471	20.625	0.759
Length of lower caudal lobe	20.842	19.745	21.642	0.641
Length of caudal peduncle	18.027	16.774	19.380	0.948
Highest depth of caudal peduncle	9.421	8.917	10.078	0.428
Least depth of caudal peduncle	7.616	7.097	8.125	0.338
Pre dorsal distance	28.477	26.875	29.457	0.881
Pre pectoral distance	17.825	17.197	18.125	0.331
Pre pelvic distance	39.501	38.125	41.085	1.013
Pre anal distance	54.155	52.239	55.814	1.181
Distance between origin of pectoral & origin of pelvic	23.705	21.875	24.841	1.114
Distance between origin of pelvic & origin of anal	15.587	14.729	16.875	0.769
Distance between origin of pelvic & anus	11.394	10.828	13.125	0.875
Distance between anus and anal fin	4.445	3.731	6.369	0.987

Other Characteristics:

Body: Elongated. Dorsal profile curved anteriorly, round abdomen.

Head: Large, flat and conical before; 1.1 times as long as broad. Skin covered with small uniform tile-like granulations, smooth in few specimens.

Eyes: Diameter 8.4 in length of head; inter orbital space slightly convex and 3.03 in length of head.

Mouth: Inferior, transverse. Width of gape of mouth 2.33 in length of head. Upper jaw the longer, lips fleshy and papillated. Snout conical.

Barbels: Four pairs, a pair each of maxillary, nasal and two of mandibular. Inner mandibular shorter. Maxillary with broad bases reaches anterior half of pectorals; nasal extends up to anterior

border of eyes.

Sucker: Well marked, composed of longitudinal folds of skin, triangular anteriorly. It is 1.38 as broad as long and 1.44 in length of head.

Skin: Rough with fine granulations.

Lateral Line: Simple, complete.

Fins: Dorsal midway between tip of snout and adipose dorsal with serrations along its margin. Dorsal height less than depth of body. Paired fin not plaited. Pectorals with sharp denticulations, as long as or slightly longer than length of head. Pelvic towards rayed dorsal, extends up to anal opening. Anal ahead of adipose, slightly shorter than dorsal height. Caudal deeply forked with slightly longer lower lobe.

Colour: Body dark grayish above and lighter below. Pectoral, ventral, anal and caudal fins and sucker reddish. Dorsal reddish with black bands; adipose yellowish.

Distribution: India: Manipur, Barak river of Assam; Elsewhere: Burma, Thailand.

Remarks The species is reported for the first time from Sikkim drainages. It occurs in the lower stretches of river Tista, Ghattay khola, Rangpo khola and river Rangit.

One of the distinguishing features of the species is the presence of two white stripes, first from origin of rayed dorsal to base of caudal and second from eye or upper end of gill opening along lateral line to mid base of caudal fin.

Table 96. Measurements (in mm) of *Glyptothorax trilineatus* Blyth, 1860.

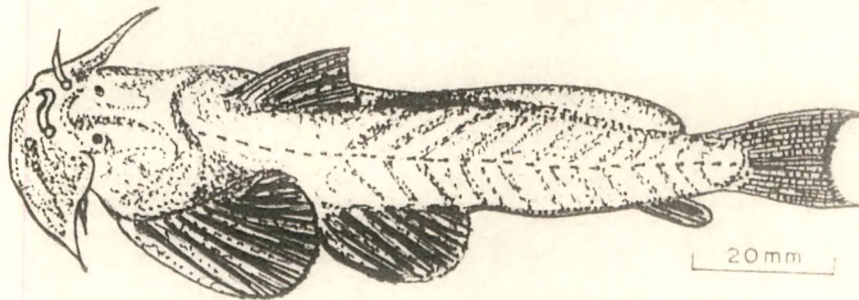
CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	160.0	157.0	155.0	134.0	129.0	129.0	160.0	147.000
Standard length	130.0	127.0	123.0	106.0	104.0	104.0	130.0	118.000
Head length	28.0	27.0	26.0	23.0	22.0	22.0	28.0	25.200
Head breadth	26.0	25.0	23.0	21.0	20.0	20.0	26.0	23.000
Head depth	19.0	18.0	20.0	15.0	17.0	15.0	20.0	17.800
Gape of mouth	12.0	12.0	11.0	10.0	10.0	10.0	12.0	11.000
Eye diameter	2.5	3.5	3.0	3.0	3.0	2.5	3.5	3.000
Inter orbital distance	9.0	8.5	9.0	7.0	8.0	7.0	9.0	8.300
Post orbital distance	11.0	11.0	10.0	9.5	9.0	9.0	11.0	10.100

Inter nasal distance	6.0	6.0	6.0	6.0	5.0	5.0	6.0	5.800
Snout length	15.0	14.0	14.0	13.0	12.0	12.0	15.0	13.600
Maxillary barbel length	31.0	32.0	30.0	27.0	24.0	24.0	32.0	28.800
Outer mandibular barbel length	16.0	15.0	15.0	13.0	10.0	10.0	16.0	13.800
Inner mandibular barbel length	7.0	8.0	9.0	8.0	8.0	7.0	9.0	8.000
Nasal barbel length	9.0	10.0	9.5	9.0	8.0	8.0	10.0	9.100
Body depth	26.0	28.0	25.0	21.0	21.0	21.0	28.0	24.200
Body width	21.0	21.0	22.0	18.0	17.0	17.0	22.0	19.800
Length of sucker	18.0	20.0	18.0	16.0	15.0	15.0	20.0	17.400
Breadth of sucker	15.0	14.0	13.0	11.0	10.0	10.0	15.0	12.600
Dorsal height	27.0	24.0	25.0	22.0	24.0	22.0	27.0	24.400
Dorsal base	17.0	17.0	16.0	13.0	13.0	13.0	17.0	15.200
Anal height	26.0	25.0	23.0	22.0	21.0	21.0	26.0	23.400
Anal base	21.0	19.0	19.0	16.0	16.0	16.0	21.0	18.200
Pectoral length	29.0	27.0	28.0	27.0	25.0	25.0	29.0	27.200
Pelvic length	22.0	21.0	21.0	20.0	18.0	18.0	22.0	20.400
Length of caudal fin	34.0	31.0	32.0	29.0	27.0	27.0	34.0	30.600
Length of upper caudal lobe	33.0	29.0	30.0	27.0	26.0	26.0	33.0	29.000
Length of lower caudal lobe	34.0	31.0	32.0	29.0	27.0	27.0	34.0	30.600
Length of caudal peduncle	29.0	27.0	26.0	25.0	25.0	25.0	29.0	26.400
Highest depth of caudal peduncle	15.0	14.0	14.0	13.0	13.0	13.0	15.0	13.800
Least depth of caudal peduncle	13.0	12.0	11.0	10.0	10.0	10.0	13.0	11.200
Pre dorsal distance	43.0	45.0	45.0	38.0	38.0	38.0	45.0	41.800
Pre pectoral distance	29.0	27.0	28.0	24.0	23.0	23.0	29.0	26.200
Pre pelvic distance	61.0	62.0	62.0	52.0	53.0	52.0	62.0	58.000
Pre anal distance	86.0	86.0	84.0	70.0	72.0	70.0	86.0	79.600
Distance between origin of pectoral & origin of pelvic	35.0	39.0	37.0	31.0	32.0	31.0	39.0	34.800

Distance between origin of pelvic & origin of anal	27.0	25.0	24.0	20.0	19.0	19.0	27.0	23.000
Distance between origin of pelvic & anus	21.0	17.0	17.0	15.0	14.0	14.0	21.0	16.800
Distance between anus and anal fin	7.0	10.0	6.0	5.0	5.0	5.0	10.0	6.600

46. *Euchiloglanis hodgarti* (Hora), 1923

(Plate XV-9 & XX-7)



Text Figure 46. *Euchiloglanis hodgarti* (Hora)

1923. *Glyptosternum hodgarti* Hora, Rec. Indian Mus., 25, p. 38.

(Type locality : Pharping, Nepal)

Previous records from Sikkim: Samdong, 4.8 km down of Chakung, W. Sikkim, (Coll. Menon; Tilak, 1972).

Present records: TISTA DRAINAGE: Yumthang chhu, SS Chungthang 30 - 110 mm (69 exs.); Rani khola, SS Saramsa 42 - 120 mm (13 exs.); Kanaka chhu, FCC Passingdong 73 - 109 mm (5 exs.); RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 87 - 105 mm (4 exs.); SS Sikhip 80 - 106 mm (2 exs.); Rimbi khola, SS Rimbi 50 - 99 mm (21 exs.); local name: *Lulay machha*.

Meristic Counts: D.i.7; P.i.15; V.i.5; A.i.4; C.17.

Morphometric Characters:

Standard length 1.10 - 1.24 (1.164), Head length 4.43 - 5.33 (4.903), Head breadth 5.17 - 6.59 (5.796), Head depth 8.27 - 11.20 (9.631), Gape of mouth 10.25 - 14.00 (11.502), Inter orbital distance 12.40 - 17.23 (14.566), Post orbital distance 7.75 - 10.18 (9.210), Inter nasal distance 15.50 - 22.80 (19.019), Snout length 8.86 - 10.36 (9.664), Maxillary barbel length 4.96 - 5.33 (5.113), Outer mandibular barbel length 12.40 - 22.40 (16.251), Inner mandibular barbel length 41.00 - 74.67 (50.241), Nasal barbel length 11.11 - 15.50 (13.074), Body depth 6.89 - 10.18

(8.711), Body width 7.14 - 8.14 (7.681), Dorsal height 6.83 - 8.62 (7.549), Dorsal base 8.63 - 12.67 (10.332), Anal height 7.75 - 9.91 (8.703), Anal base 10.33 - 12.67 (11.864), Pectoral length 3.65 - 4.56 (4.165), Pelvic length 5.86 - 6.71 (6.227), Length of caudal fin 6.83 - 8.86 (8.073), Length of caudal peduncle 10.33 - 16.29 (13.595), Highest depth of caudal peduncle 12.40 - 18.67 (15.107), Pre dorsal distance 3.26 - 4.07 (3.590), Pre pectoral distance 5.64 - 6.59 (6.206), Pre pelvic distance 2.78 - 3.11 (2.887), Pre anal distance 1.33 - 1.49 (1.410), Distance between origin of pectoral & origin of pelvic 4.55 - 5.09 (4.774), Distance between origin of pelvic & origin of anal 2.33 - 2.71 (2.568), Distance between origin of pelvic & anus 2.44 - 2.95 (2.720).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 97. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *E. hodgarti* (Hora), 1923.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	85.890	80.357	91.000	4.170
Head length	20.394	18.750	22.581	1.396
Head breadth	17.255	15.179	19.355	1.390
Head depth	10.384	8.929	12.097	1.022
Gape of mouth	8.694	7.143	9.756	1.023
Inter orbital distance	6.865	5.804	8.065	0.814
Post orbital distance	10.858	9.821	12.903	1.095
Inter nasal distance	5.258	4.386	6.452	0.765
Snout length	10.347	9.649	11.290	0.659
Maxillary barbel length	19.558	18.750	20.175	0.505
Outer mandibular barbel length	6.153	4.464	8.065	1.143
Inner mandibular barbel length	1.990	1.339	2.439	0.416
Nasal barbel length	7.649	6.452	9.000	0.905
Body depth	11.480	9.821	14.516	1.699
Body width	13.020	12.281	14.000	0.624
Dorsal height	13.246	11.607	14.634	1.125
Dorsal base	9.679	7.895	11.585	1.270
Anal height	11.491	10.088	12.903	1.115

Anal base	8.429	7.895	9.677	0.662
Pectoral length	24.012	21.930	27.419	1.947
Pelvic length	16.059	14.912	17.073	0.895
Length of caudal fin	12.387	11.290	14.634	1.281
Length of caudal peduncle	7.356	6.140	9.677	1.237
Highest depth of caudal peduncle	6.620	5.357	8.065	0.906
Pre dorsal distance	27.852	24.561	30.645	2.088
Pre pectoral distance	16.113	15.179	17.742	0.862
Pre pelvic distance	34.641	32.143	36.000	1.379
Pre anal distance	70.905	66.964	75.000	2.953
Distance between origin of pectoral & origin of pelvic	20.947	19.643	22.000	0.940
Distance between origin of pelvic & origin of anal	38.937	36.842	43.000	2.369
Distance between origin of pelvic & anus	36.761	33.871	41.000	2.757

Other Characteristics:

Body: Elongate, sub-cylindrical. Dorsal slightly arched posteriorly, ventrally flat upto pelvics, with rounded abdomen.

Head: Depressed, moderate in size. Snout broadly rounded.

Eyes: Minute, situated laterally in the middle of the head, not visible from below ventral surface.

Mouth: Ventral, transverse, width of gape of mouth 2.1 - 2.6 in length of head. Lips thick, fleshy, papillated ; upper lip not continuous with lower.

Barbels: Four pairs, a pair each of maxillary, nasal & two of mandibular. Maxillary pair wide and spread long with broad bases. their ventral surface of outer halves with striated pads of adhesive skin.

Skin: Smooth.

Lateral Line: Straight. simple & complete.

Fins: Rayed dorsal fin without spine, inserted above half of pectoral fin. Adipose dorsal long, posteriorly united with the caudal. Paired fins broad and plaited. Pectoral extends beyond the origin of pelvics. Outer rays of paired fins soft, their inner halves vertical, outer halves horizontal. Anal fin short. Caudal fin obliquely truncate or somewhat rounded.

Colour: Brownish yellow above and pale beneath. Fins : brownish with lighter outer margins.

Distribution: India: Tista valley, Kurseong, Darjeeling, Abor hills, Meghalaya, Arunachal Pradesh. Elsewhere: Nepal, Bangladesh

Remarks: This catfish inhabits torrential streams and is the only indigenous species found to occur up to an elevation of 1640 m (msl). Variations have been observed in caudal peduncle 1.0 - 1.6 as long as deep (vs. 1.0 - 1.2 Jayaram, 1979) and adipose dorsal fin 2.84 - 4.0 times dorsal fin base (vs. 3.25 - 4.20 as described by Jayaram (1979). It is reported to grow to a length of 57.5 mm (Jayaram, 1979) and 65 mm (Talwar & Jhingran, 1991) which is extended to 120 mm in the present study.

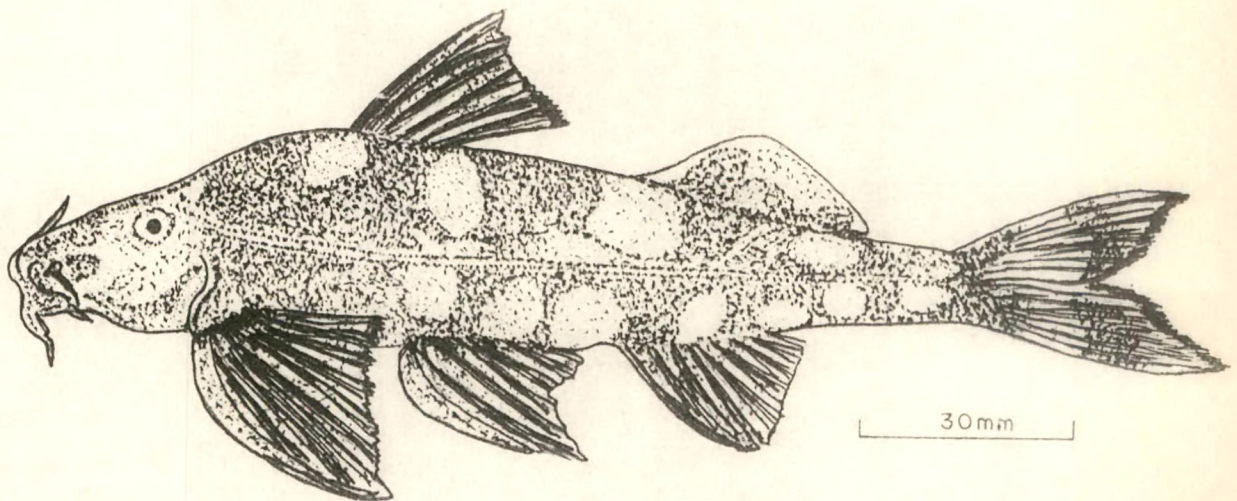
Table 98. Measurements (in mm) of *Euchiloglanis hodgarti* (Hora), 1923.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	100.0	114.0	112.0	82.0	62.0	62.0	114.0	94.000
Standard length	91.0	93.0	90.0	72.0	55.0	55.0	93.0	80.200
Head length	20.0	22.0	21.0	17.5	14.0	14.0	22.0	18.900
Head breadth	18.0	19.0	17.0	14.0	12.0	12.0	19.0	16.000
Head depth	10.0	12.0	10.0	8.5	7.5	7.5	12.0	9.600
Gape of mouth	9.0	9.0	8.0	8.0	6.0	6.0	9.0	8.000
Inter orbital distance	7.0	7.0	6.5	6.0	5.0	5.0	7.0	6.300
Post orbital distance	10.5	11.5	11.0	9.0	8.0	8.0	11.5	10.000
Inter nasal distance	5.5	5.0	5.0	4.5	4.0	4.0	5.5	4.800
Snout length	10.0	11.0	11.0	9.0	7.0	7.0	11.0	9.600
Maxillary barbel length	20.0	23.0	21.0	16.0	12.0	12.0	23.0	18.400
Outer mandibular barbel length	6.0	7.0	5.0	5.0	5.0	5.0	7.0	5.600
Inner mandibular barbel length	2.0	2.0	1.5	2.0	1.5	1.5	2.0	1.800
Nasal barbel length	9.0	9.5	8.0	6.0	4.0	4.0	9.5	7.300
Body depth	12.0	11.5	11.0	9.0	9.0	9.0	12.0	10.500
Body width	14.0	14.0	14.0	11.0	8.0	8.0	14.0	12.200
Dorsal height	14.0	14.0	13.0	12.0	8.5	8.5	14.0	12.300
Dorsal base	9.5	9.0	10.0	9.5	6.5	6.5	10.0	8.900
Anal height	12.0	11.5	11.5	10.0	8.0	8.0	12.0	10.600
Anal base	8.0	9.0	9.0	7.0	6.0	6.0	9.0	7.800
Pectoral length	24.0	25.0	25.0	20.0	17.0	17.0	25.0	22.200
Pelvic length	17.0	17.0	17.0	14.0	10.0	10.0	17.0	15.000

Length of caudal fin	13.0	13.0	13.0	12.0	7.0	7.0	13.0	11.600
Length of caudal peduncle	6.5	7.0	8.0	6.0	6.0	6.0	8.0	6.700
Highest depth of caudal peduncle	7.0	7.5	6.0	5.0	5.0	5.0	7.5	6.100
Pre dorsal distance	28.0	28.0	30.0	24.0	19.0	19.0	30.0	25.800
Pre pectoral distance	16.0	18.0	17.0	13.0	11.0	11.0	18.0	15.000
Pre pelvic distance	36.0	39.0	36.0	29.0	22.0	22.0	39.0	32.400
Pre anal distance	75.0	78.0	75.0	60.0	44.0	44.0	78.0	66.400
Distance between origin of pectoral & origin of pelvic	22.0	23.0	22.0	18.0	13.0	13.0	23.0	19.600
Distance between origin of pelvic & origin of anal	43.0	42.0	42.0	33.0	23.0	23.0	43.0	36.600
Distance between origin of pelvic & anus	41.0	40.0	39.0	32.0	21.0	21.0	41.0	34.600
Distance between anus and anal fin	0.5	0.5	1.0					

47. *Pseudecheneis sulcatus* (McClelland), 1842

(Plate XV-7 & XX-8)



Text Figure 47. *Pseudecheneis sulcatus* (McClelland)

1842. *Glyptosternum sulcatus* McClelland, Calcutta I. Nat. Hist., 2, p. 587; pl. 6
(Type locality : Khasi hills)

Previous records from Sikkim: Khola river, near Gangtok, Indo-Swiss Sikkim expedition 1959 (Tilak, 1972); R. Rangit (Bhutia & Acharya, 1987).

Present records: TISTA DRAINAGE: Rani khola, SS Saramsa 100 mm (1 ex.); FCC 32 No. 105 - 112 mm (5 exs.); Jali khola, SS Saramsa 100 - 130 mm (2 exs.); Seti khola, SS Lower Lagyap 100 - 150 mm (5 exs.); Rin khola, SS Lower Dzongu 89 - 127 mm (5 exs.); Kanaka chhu, FCC Passingdong 136 - 145 mm (7 exs.); Dik chhu, SS Dikchu 75 - 132 mm (11 exs.); Ghattay khola, SS Sirwani 66 - 140 mm (7 exs.); Confluence of Tista & Rani khola, SS Singtam 65 - 124 mm (3 exs.); Rangpo khola, FCC Rorethang 65 - 109 mm (10 exs.); SS Rangpo 50 - 155 mm (15 exs.); RANGIT DRAINAGE: R. Rangit, SS Lower Tashiding 80 - 135 mm (6 exs.); SS Sikhip 85 - 147 mm (8 exs.); FCC Tatopani 157 - 196 mm (2 exs.); SS Nayabazar 75 - 131 mm (9 exs.); Rimbi khola, SS Rimbi 85 - 150 mm (17 exs.); Kalej khola, SS Legship 97 - 100 mm (2 exs.); Rishi khola, SS Rishi 125 mm (1 ex.); Roathak khola, SS Rothak 60 - 12 mm (3 exs.); Rangbhang khola, SS Nayabazar 122 - 152 mm (11 exs.); Confluence of Tista & Rangit, FCC Tista 81 - 97 mm (3 exs.); local name: *Kabray*.

Meristic Counts: D.i.6; P.13; V.5; A.8 - 9; C.17.

Morphometric Characters:

Standard length 1.17 - 1.23 (1.195), Head length 6.20 - 6.44 (6.300), Head breadth 6.20 - 6.44 (6.300), Head depth 7.75 - 9.05 (8.437), Gape of mouth 17.71 - 25.00 (22.100), Eye diameter 95.00 - 157.00 (114.729), Inter orbital distance 16.57 - 21.11 (18.663), Post orbital distance 16.57 - 19.63 (18.267), Inter nasal distance 21.43 - 24.80 (23.123), Snout length 8.86 - 10.55 (9.491), Maxillary barbel length 9.50 - 12.50 (10.918), Outer mandibular barbel length 19.00 - 24.80 (21.587), Inner mandibular barbel length 37.50 - 41.33 (38.906), Nasal barbel length 21.11 - 31.00 (26.931), Body depth 5.90 - 7.50 (6.682), Body width 6.36 - 8.33 (7.074), Length of sucker 6.25 - 6.83 (6.588), Breadth of sucker 8.26 - 10.09 (8.588), Dorsal height 5.77 - 6.70 (6.095), Dorsal base 9.24 - 10.56 (9.806), Anal height 5.36 - 6.53 (6.014), Anal base 8.72 - 10.00 (9.042), Pectoral length 4.17 - 4.77 (4.542), Pelvic length 5.14 - 5.90 (5.522), Length of caudal fin 5.43 - 6.25 (5.717), Length of upper caudal lobe 6.13 - 6.82 (6.484), Length of lower caudal lobe 5.43 - 6.25 (5.717), Length of caudal peduncle 4.17 - 4.63 (4.374), Highest depth of caudal peduncle 13.05 - 15.47 (14.217), Least depth of caudal peduncle 16.53 - 19.00 (17.869), Pre dorsal distance 3.26 - 3.52 (3.340), Pre pectoral distance 6.13 - 6.82 (6.436), Pre pelvic distance 3.00 - 3.22 (3.126), Pre anal distance 1.84 - 1.97 (1.923), Distance between origin of pectoral & origin of pelvic 4.14 - 5.23 (4.860), Distance between origin of pelvic & origin of anal 4.42 - 5.77 (4.754), Distance between origin of pelvic & anus 4.64 - 5.77 (5.136), Distance between anus and origin of anal fin

47.50 - 116.00 (63.903).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 99. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *P. sulcatus* (McClelland), 1842.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.696	81.579	85.333	1.212
Head length	15.872	15.517	16.129	0.209
Head breadth	15.872	15.517	16.129	0.209
Head depth	11.853	11.053	12.903	0.670
Gape of mouth	4.525	4.000	5.645	0.580
Eye diameter	0.872	0.637	1.053	0.147
Inter orbital distance	5.358	4.737	6.034	0.567
Post orbital distance	5.474	5.096	6.034	0.332
Inter nasal distance	4.325	4.032	4.667	0.228
Snout length	10.537	9.483	11.290	0.645
Maxillary barbel length	9.159	8.000	10.526	0.832
Outer mandibular barbel length	4.632	4.032	5.263	0.400
Inner mandibular barbel length	2.570	2.419	2.667	0.086
Nasal barbel length	3.713	3.226	4.737	0.550
Body depth	14.967	13.333	16.935	1.485
Body width	14.136	12.000	15.726	1.430
Length of sucker	15.178	14.650	16.000	0.501
Breadth of sucker	11.644	9.914	12.105	0.866
Dorsal height	16.407	14.919	17.333	0.811
Dorsal base	10.198	9.474	10.828	0.535
Anal height	16.627	15.323	18.667	1.137
Anal base	11.059	10.000	11.465	0.536
Pectoral length	22.018	20.968	24.000	1.118
Pelvic length	18.108	16.935	19.474	0.964
Length of caudal fin	17.493	16.000	18.421	0.850

Length of upper caudal lobe	15.422	14.667	16.316	0.530
Length of lower caudal lobe	17.493	16.000	18.421	0.850
Length of caudal peduncle	22.862	21.579	24.000	0.827
Highest depth of caudal peduncle	7.034	6.466	7.661	0.439
Least depth of caudal peduncle	5.596	5.263	6.048	0.284
Pre dorsal distance	29.939	28.448	30.667	0.807
Pre pectoral distance	15.538	14.655	16.316	0.727
Pre pelvic distance	31.988	31.034	33.333	0.826
Pre anal distance	51.995	50.667	54.211	1.265
Distance between origin of pectoral & origin of pelvic	20.576	19.108	24.138	1.820
Distance between origin of pelvic & origin of anal	21.034	17.333	22.632	1.934
Distance between origin of pelvic & anus	19.470	17.333	21.552	1.366
Distance between anus and anal fin	1.565	0.862	2.105	0.439

Other Characteristics:

Body: Elongate, cylindrical. The body tapers conically from the front of the dorsal fin to caudal fin. Dorsal profile highly arched than ventral; abdomen rounded.

Head: Short, depressed anteriorly. The width of the head equals its length. Snout broad.

Eyes: Minute, diameter 15.0 - 25.0 in length of head with circular pupil. Eyes are placed dorsa-laterally at the posterior half of head, not visible from below ventral surface. Inter orbital space convex 2.5 - 3.3 in length of head.

Mouth: Inferior, transverse, small. Width of gape of mouth 2.8 - 4.0 in head length. Lips thick, fleshy and papillated, continuous around mouth. Jaws sub-equal. Teeth somewhat flattened with truncated apices in small patches on jaws; palate edentate.

Barbels: Eight in number, a pair each of maxillary, nasal and two of mandibular. Maxillary pair the longest with broad bases; outer mandibular half of maxillary.

Sucker: A broad, oval adhesive apparatus composed of 13-15 transverse folds present on the thorax between the pectoral fins.

Skin: Smooth .

Lateral Line: Simple, complete.

Fins: Rayed dorsal fin inserted above last quarter of pectoral fin with six rays and a soft spine. Adipose posteriorly free, base of adipose as long as that of the interspace between the two fins. Pectoral fins fully expanded of which inner third vertical, outer two-thirds horizontal with 13 rays

extending to behind base of pelvics; its spine broad and enveloped in skin. Pelvic fins shorter than pectorals with six rays, outer pelvic fin rays with serrated skin ventrally. Anal fin as high as rayed dorsal. Caudal fin forked with longer lower lobe.

Colour: Body grayish brown with some irregular yellow blotches and lighter below. Fins pale with black bands and yellow outer margin.

Distribution: India: Meghalaya - Khasi hills, Assam, Arunachal Pradesh, North Bengal-Darjeeling. Elsewhere: Nepal, Bangladesh.

Remarks: It is one of the most dominant species widely distributed throughout the drainages of Sikkim up to an altitude of 1065 m msl and contributes as an important commercial fishery of the state. Presence of adhesive apparatus in the form of transverse folds is the distinguishing feature of the species indicating its preference to fast flowing waters in high gradients. The maximum size reported to be 180 mm by Jayaram (1979) is extended to 196 mm in the present study.

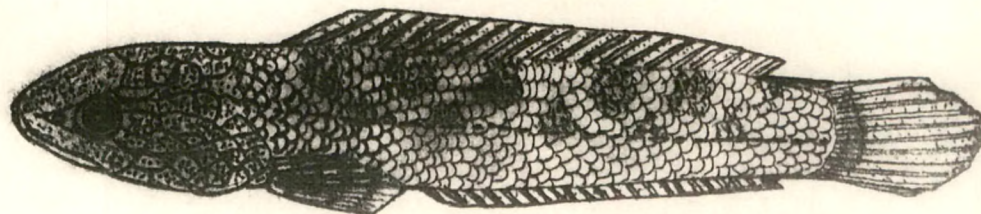
Table 100. Measurements (in mm) of *Pseudecheneis sulcatus* (McClelland), 1842.

CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	190.0	157.0	124.0	116.0	75.0	75.0	190.0	132.400
Standard length	155.0	132.0	104.0	97.0	64.0	64.0	155.0	110.400
Head length	30.0	25.0	20.0	18.0	12.0	12.0	30.0	21.000
Head breadth	30.0	25.0	20.0	18.0	12.0	12.0	30.0	21.000
Head depth	21.0	19.0	16.0	13.0	9.0	9.0	21.0	15.600
Gape of mouth	8.0	7.0	7.0	5.0	3.0	3.0	8.0	6.000
Eye diameter	2.0	1.0	1.0	1.0	0.8	0.8	2.0	1.150
Inter orbital distance	9.0	7.5	6.5	7.0	4.5	4.5	9.0	6.900
Post orbital distance	10.0	8.0	7.0	7.0	4.0	4.0	10.0	7.200
Inter nasal distance	8.5	6.5	5.0	5.0	3.5	3.5	8.5	5.700
Snout length	21.0	16.0	14.0	11.0	8.0	8.0	21.0	14.000
Maxillary barbel length	20.0	14.0	11.0	11.0	6.0	6.0	20.0	12.400
Outer mandibular barbel length	10.0	7.0	5.0	5.5	3.5	3.5	10.0	6.200
Inner mandibular barbel length	5.0	4.0	3.0	3.0	2.0	2.0	5.0	3.400
Nasal barbel length	9.0	6.0	4.0	4.0	2.5	2.5	9.0	5.100
Body depth	27.0	26.0	21.0	16.0	10.0	10.0	27.0	20.000

Body width	28.0	24.0	19.5	15.0	9.0	9.0	28.0	19.100
Length of sucker	29.0	23.0	19.0	17.0	12.0	12.0	29.0	20.000
Breadth of sucker	23.0	19.0	15.0	11.5	9.0	9.0	23.0	15.500
Dorsal height	32.0	26.0	18.5	19.0	13.0	13.0	32.0	21.700
Dorsal base	18.0	17.0	12.0	12.0	8.0	8.0	18.0	13.400
Anal height	32.0	25.0	19.0	19.0	14.0	14.0	32.0	21.800
Anal base	19.0	18.0	14.0	13.0	8.5	8.5	19.0	14.500
Pectoral length	40.0	34.0	26.0	26.0	18.0	18.0	40.0	28.800
Pelvic length	37.0	28.0	21.0	22.0	13.0	13.0	37.0	24.200
Length of caudal fin	35.0	27.0	22.0	21.0	12.0	12.0	35.0	23.400
Length of upper caudal lobe	31.0	24.0	19.0	18.0	11.0	11.0	31.0	20.600
Length of lower caudal lobe	35.0	27.0	22.0	21.0	12.0	12.0	35.0	23.400
Length of caudal peduncle	41.0	36.0	29.0	26.0	18.0	18.0	41.0	30.000
Highest depth of caudal peduncle	14.0	11.0	9.5	7.5	5.0	5.0	14.0	9.400
Least depth of caudal peduncle	10.0	9.0	7.5	6.5	4.0	4.0	10.0	7.400
Pre dorsal distance	57.0	47.0	38.0	33.0	23.0	23.0	57.0	39.600
Pre pectoral distance	31.0	25.0	20.0	17.0	11.0	11.0	31.0	20.800
Pre pelvic distance	61.0	49.0	40.0	36.0	25.0	25.0	61.0	42.200
Pre anal distance	103.0	80.0	65.0	60.0	38.0	38.0	103.0	69.200
Distance between origin of pectoral & origin of pelvic	37.0	30.0	25.0	28.0	15.0	15.0	37.0	27.000
Distance between origin of pelvic & origin of anal	43.0	33.0	27.0	26.0	13.0	13.0	43.0	28.400
Distance between origin of pelvic & anus	38.0	30.0	24.0	25.0	13.0	13.0	38.0	26.000
Distance between anus and anal fin	4.0	3.0	2.0	1.0	1.0	1.0	4.0	2.200

48. *Channa orientalis* Schneider, 1801

(Plate XIV-6)



20 mm

Text Figure 48. *Channa orientalis* Schneider1801. *Channa orientalis* Schneider, Syst. Ichth. Bluch, p. 496;

(Type locality : India)

Previous records from Sikkim: R. Rangit (Bhutia & Acharya, 1987).**Present records:** RANGIT DRAINAGE: R. Rangit, SS Nayabazar 90 - 183 mm (7 exs.); Roathak khola, SS Rothak 200 mm (1 ex.); Rangbhang khola, SS Nayabazar 90 - 225 mm (4 exs.); local name: *Hilay*.**Meristic Counts:** D. 2 -3/27 -30; P. 1/12; V.1/5; A. 2-3/15-19; C. 10-12.

L.l. 37 -40; L.tr. 3-4/6-7. Pre dorsal scales 5.

Morphometric Characters:

Standard length 1.18 - 1.22 (1.201), Head length 3.97 - 4.12 (4.057), Head breadth 6.25 - 6.81 (6.480), Head depth 8.24 - 9.27 (8.926), Gape of mouth 10.23 - 11.00 (10.575), Eye diameter 20.60 - 32.14 (25.348), Inter orbital distance 11.44 - 12.64 (12.077), Post orbital distance 5.92 - 6.44 (6.237), Inter nasal distance 14.71 - 22.50 (18.099), Snout length 13.73 - 16.35 (15.398), Body depth 6.62 - 7.72 (7.225), Body width 7.72 - 8.69 (8.108), Dorsal height 9.36 - 11.92 (10.882), Dorsal base 1.93 - 2.07 (2.002), Anal height 12.12 - 14.30 (13.445), Anal base 3.09 - 3.33 (3.181), Pectoral length 6.06 - 6.95 (6.438), Pelvic length 13.00 - 15.44 (14.177), Length of caudal fin 5.15 - 5.79 (5.509), Length of caudal peduncle 11.00 - 11.58 (11.368), Highest depth of caudal peduncle 10.30 - 11.44 (10.733), Least depth of caudal peduncle 10.30 - 11.58 (11.096), Pre dorsal distance 3.39 - 3.66 (3.523), Pre pectoral distance 3.68 - 3.81 (3.753), Pre pelvic distance 3.23 - 3.39 (3.310), Pre anal distance 2.17 - 2.42 (2.284), Distance between origin of pectoral & origin of pelvic 9.93 - 11.92 (11.180), Distance between origin of pelvic & origin of anal 6.50 - 8.18 (7.618), Distance between origin of pelvic & anus 7.94 - 9.93 (9.125), Distance between anus and origin of anal fin 35.75 - 75.00 (48.129).

The Mean \pm Standard Deviation (SD) of ratio index with Range (Min. & Max.) values of morphometric characters of the species is purported in the following table.

Table 101. Mean Ratio Index (MRI) \pm Standard Deviation (SD) with Range values of morphometric characters of *C. orientalis* Schneider, 1801.

CHARACTERS	MRI	RANGE		SD
		Min.	Max.	
Standard length	83.270	82.014	84.444	0.890
Head length	24.651	24.272	25.175	0.331
Head breadth	15.431	14.685	16.000	0.480
Head depth	11.204	10.791	12.136	0.494
Gape of mouth	9.456	9.091	9.778	0.254
Eye diameter	3.945	3.111	4.854	0.554
Inter orbital distance	8.280	7.914	8.738	0.322
Post orbital distance	16.032	15.534	16.889	0.462
Inter nasal distance	5.525	4.444	6.796	0.751
Snout length	6.494	6.115	7.282	0.442
Body depth	13.840	12.950	15.108	0.744
Body width	12.334	11.511	12.950	0.513
Dorsal height	9.189	8.392	10.680	0.810
Dorsal base	49.950	48.201	51.799	1.491
Anal height	7.438	6.993	8.252	0.446
Anal base	31.433	30.070	32.374	0.806
Pectoral length	15.532	14.388	16.505	0.688
Pelvic length	7.054	6.475	7.692	0.408
Length of caudal fin	18.152	17.266	19.424	0.920
Length of caudal peduncle	8.797	8.633	9.091	0.174
Highest depth of caudal peduncle	9.317	8.738	9.712	0.374
Least depth of caudal peduncle	9.013	8.633	9.712	0.382
Pre dorsal distance	28.383	27.338	29.496	0.899
Pre pectoral distance	26.644	26.222	27.184	0.309
Pre pelvic distance	30.215	29.496	30.935	0.556
Pre anal distance	43.789	41.333	46.154	1.527

Distance between origin of pectoral & origin of pelvic	8.945	8.392	10.072	0.586
Distance between origin of pelvic & origin of anal	13.126	12.230	15.385	1.154
Distance between origin of pelvic & anus	10.959	10.072	12.587	0.852
Distance between anus and origin of anal fin	2.078	1.333	2.797	0.470

Other Characteristics:

Body: Elongate, sub-cylindrical anteriorly. Both the profiles horizontal and run almost parallel to each other. Abdomen rounded.

Head: Fairly long, depressed with plate like scales. Snout somewhat obtuse.

Eyes: Moderate in size, eye diameter 5.0 - 8.0 in length of head, lateral in position and placed in the anterior part of head, not visible from below ventral surface.

Mouth: Opening moderate, width of gape of mouth 2.5 - 2.7 in length of head, extending to below orbit. Maxillary reaches to below hind border of eye. Lips moderate. Jaws equal.

Barbels: A pair of nasal barbels present.

Teeth: On jaws and palate, in the lower jaw, the inner row of teeth is widely separated and conical in form. Vomer also bear teeth.

Opercular openings: Wide, membranes of two sides connected beneath isthmus.

Accessory respiratory organ: In the form of a bony laminae present in a cavity of suprabranchial chamber.

Scales: On the head are broad plate like and irregular. A row of twelve or thirteen pre-dorsal scales and a row of four to five scales between the orbit and the angle of the pre opercle.

Lateral Line: Present, complete, curves downwards after 12th scale.

Fins: Dorsal fin long, inserted almost above pectoral and is without spine. Pectorals shorter than head length, reaches anal opening. Pelvic half or less than half of pectorals, does not reach anal opening. Anal fin long. Both dorsal and ventral fin free from caudal. Caudal fin rounded.

Colour: Blackish, dark dorsally, gradually getting fainter beneath. Dorsal, caudal and anal fins slate coloured with orange margins. Pectoral fin with deep blue base, transversely alternately barred with dark and light stripes.

Distribution: India: Throughout India. Elsewhere: Nepal, Sri Lanka, Bangladesh, Burma, Pakistan.

Remarks: It is a rare species confined to river Rangit, Rangbhang and Roathak (240 to 380 m msl) and is caught during monsoon. *Channa gachua* is a synonym of the species.

Table 102. Measurements (in mm) of *Channa orientalis* Schneider, 1801.

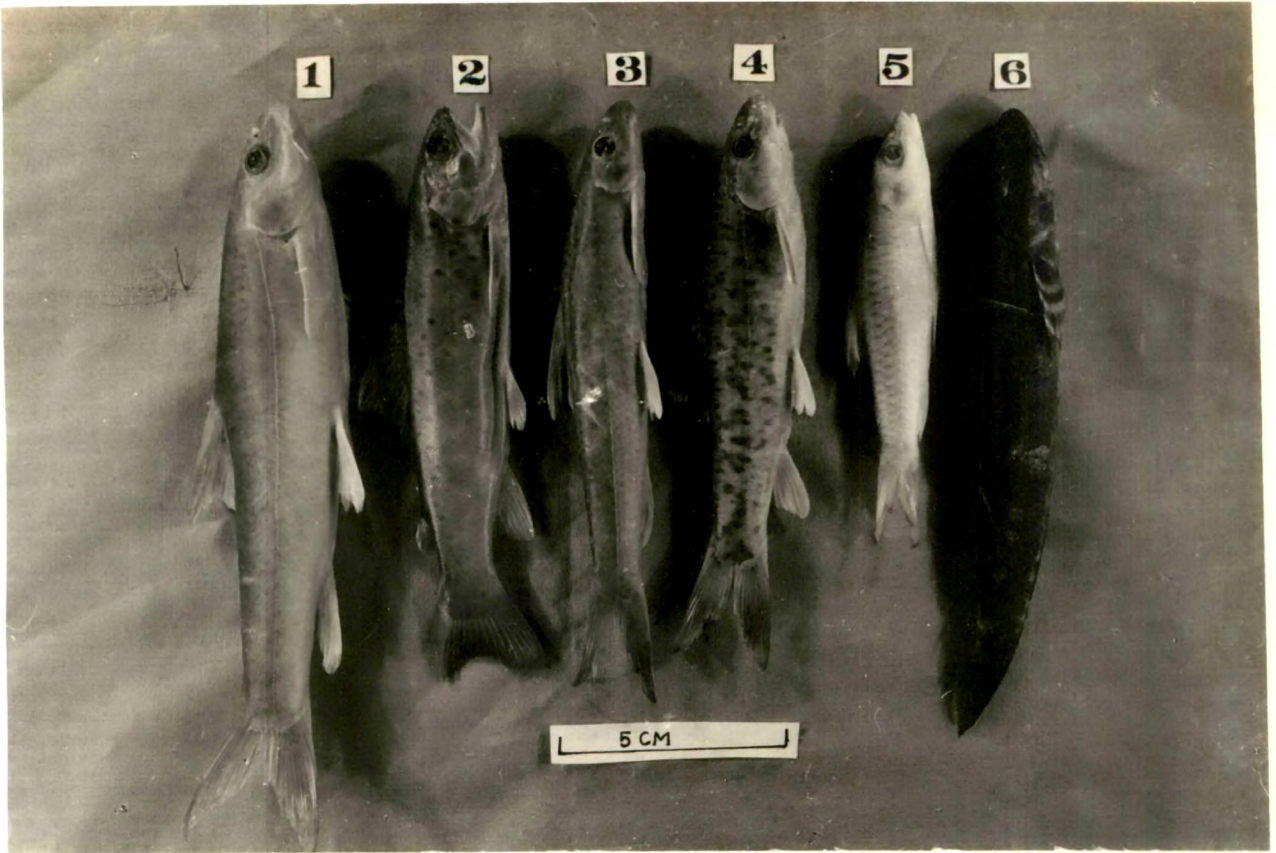
CHARACTERS	NUMBER OF SPECIMENS					RANGE		MEAN
	I	II	III	IV	V	Min.	Max.	
Total length	225.0	143.0	139.0	139.0	103.0	103.0	225.0	149.800
Standard length	190.0	120.0	114.0	116.0	85.0	85.0	190.0	125.000
Head length	56.0	36.0	34.0	34.0	25.0	25.0	56.0	37.000
Head breadth	36.0	21.0	21.0	22.0	16.0	16.0	36.0	23.200
Head depth	25.0	16.0	15.0	15.0	12.5	12.5	25.0	16.700
Gape of mouth	22.0	13.0	13.0	13.0	10.0	10.0	22.0	14.200
Eye diameter	7.0	5.5	5.5	5.5	5.0	5.0	7.0	5.700
Inter orbital distance	19.0	12.0	11.0	11.0	9.0	9.0	19.0	12.400
Post orbital distance	38.0	23.0	22.0	22.0	16.0	16.0	38.0	24.200
Inter nasal distance	10.0	8.0	7.5	7.5	7.0	7.0	10.0	8.000
Snout length	15.0	9.0	8.5	8.5	7.5	7.5	15.0	9.700
Body depth	31.0	19.0	18.0	21.0	14.5	14.5	31.0	20.700
Body width	27.0	18.0	16.0	18.0	13.0	13.0	27.0	18.400
Dorsal height	20.0	12.0	12.0	13.0	11.0	11.0	20.0	13.600
Dorsal base	116.0	71.0	67.0	72.0	50.0	50.0	116.0	75.200
Anal height	17.0	10.0	10.0	10.0	8.5	8.5	17.0	11.100
Anal base	72.0	43.0	45.0	44.0	32.0	32.0	72.0	47.200
Pectoral length	35.0	22.0	22.0	20.0	17.0	17.0	35.0	23.200
Pelvic length	16.0	11.0	9.0	10.0	7.0	7.0	16.0	10.600
Length of caudal fin	43.0	25.0	27.0	24.0	18.0	18.0	43.0	27.400
Length of caudal peduncle	20.0	13.0	12.0	12.0	9.0	9.0	20.0	13.200
Highest depth of caudal peduncle	21.0	13.0	13.5	13.5	9.0	9.0	21.0	14.000
Least depth of caudal peduncle	20.0	13.0	12.0	13.5	9.0	9.0	20.0	13.500
Pre dorsal distance	62.0	42.0	41.0	38.0	29.0	29.0	62.0	42.400
Pre pectoral distance	59.0	38.0	37.0	37.0	28.0	28.0	59.0	39.800
Pre pelvic distance	67.0	44.0	43.0	41.0	31.0	31.0	67.0	45.200

Pre anal distance	93.0	66.0	61.0	61.0	45.0	45.0	93.0	65.200
Distance between origin of pectoral & origin of pelvic	20.0	12.0	12.0	14.0	9.0	9.0	20.0	13.400
Distance between origin of pelvic & origin of anal	28.0	22.0	18.0	17.0	13.0	13.0	28.0	19.600
Distance between origin of pelvic & anus	24.0	18.0	15.0	14.0	11.0	11.0	24.0	16.400
Distance between anus and origin of anal fin	3.0	4.0	3.0	3.0	2.0	2.0	4.0	3.000

Explanation of Plate XIV

Photographs of the ichthyospecies of Sikkim drainages.

1. *Schizopyge progastus* (McClelland); 2. *Salmo trutta fario* Linnaeus; 3. *Crossocheilus latius latius* (Hamilton); 4. *Schizothorax richardsonii* (Gray); 5. *Tor putitora* (Hamilton); 6. *Channa orientalis* Schneider; 7. *Acrossocheilus hexagonolepis* (McClelland); 8. *Semiplotus semiplotus* (McClelland); 9. *Barilius Bendelisis chedra* (Hamilton); 10. *Barilius bendelisis bendelisis* (Hamilton); 11. *Barilius vagra* (Hamilton).

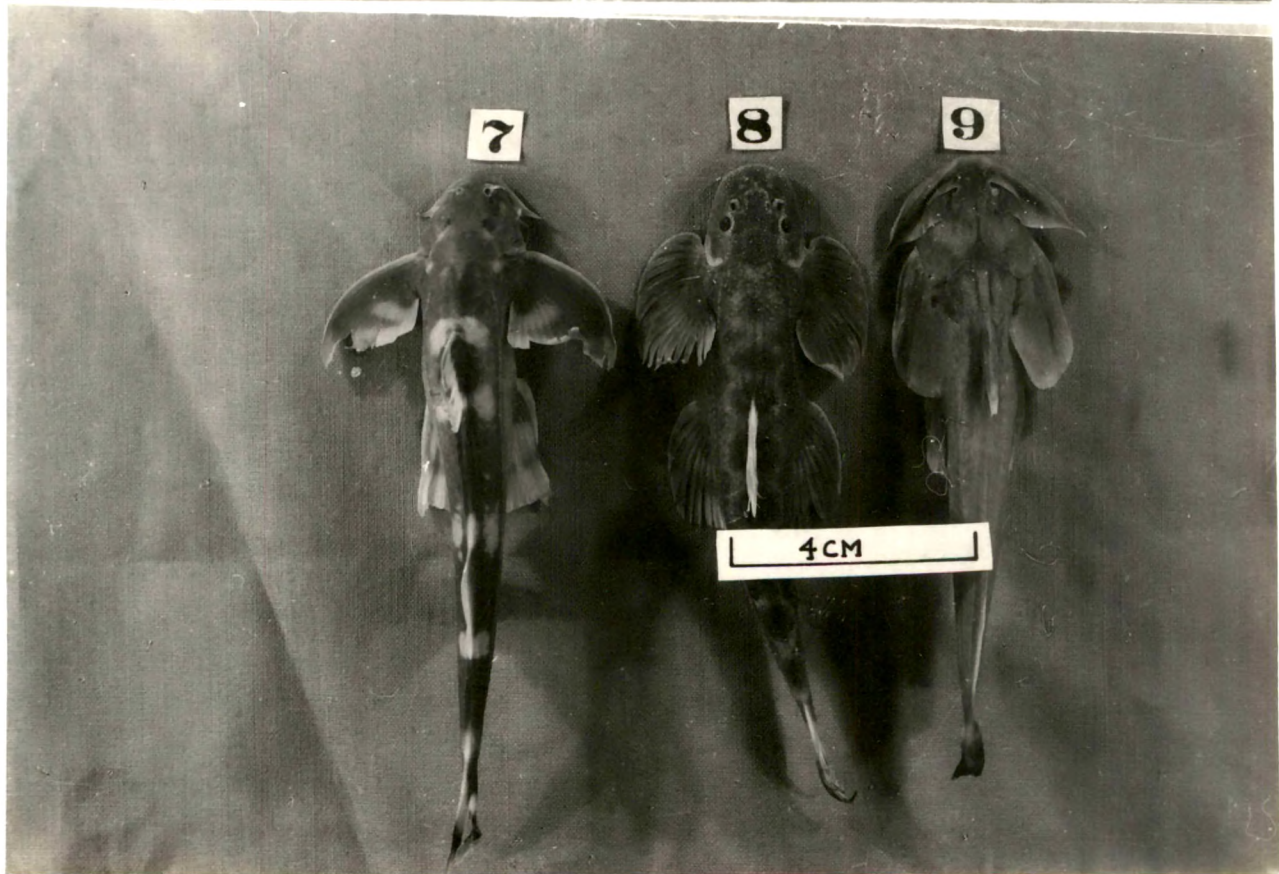
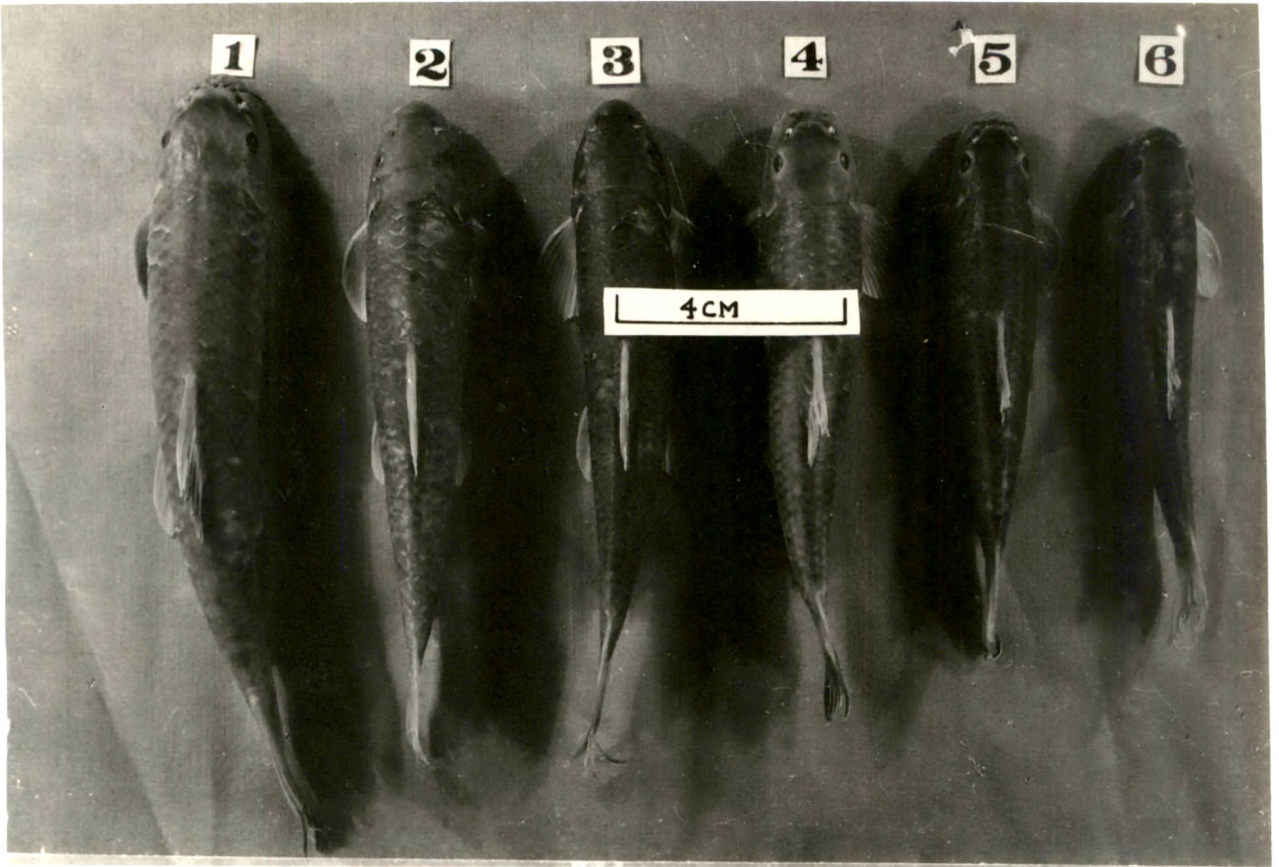


Explanation of Plate XV

Photographs of the ichthyospecies of Sikkim drainages

(continued).

1. *Garra gotyla stenorhynchus* (Jerdon); 2. *Garra annandalei* Hora;
3. *Garra mcClellandi* (Jerdon); 4. *Garra lamta* (Hamilton); 5. *Garra gotyla gotyla* (Gray); 6. *Garra mullya* (Sykes); 7. *Pseudecheneis sulcatus* (McClelland); 8. *Balitora brucei* Gray; 9. *Euchiloglanis hodgarti* (Hora).

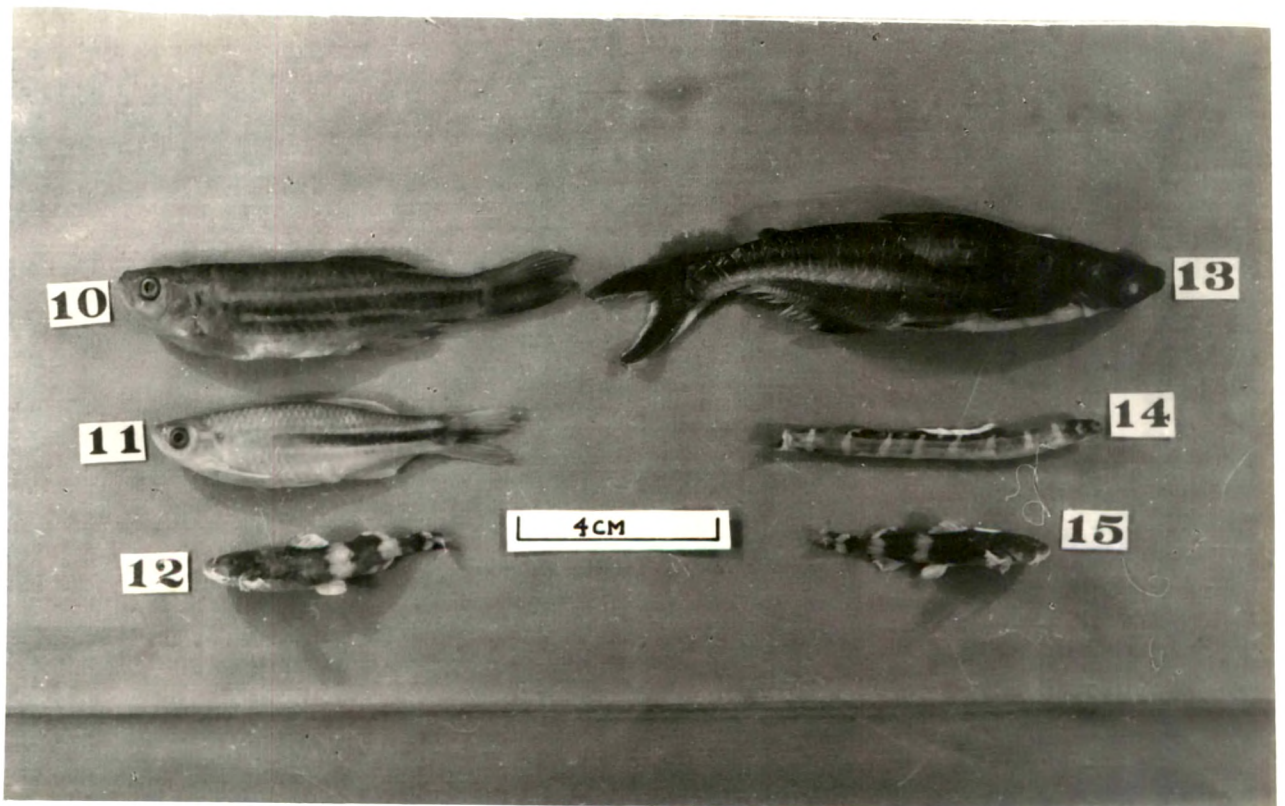
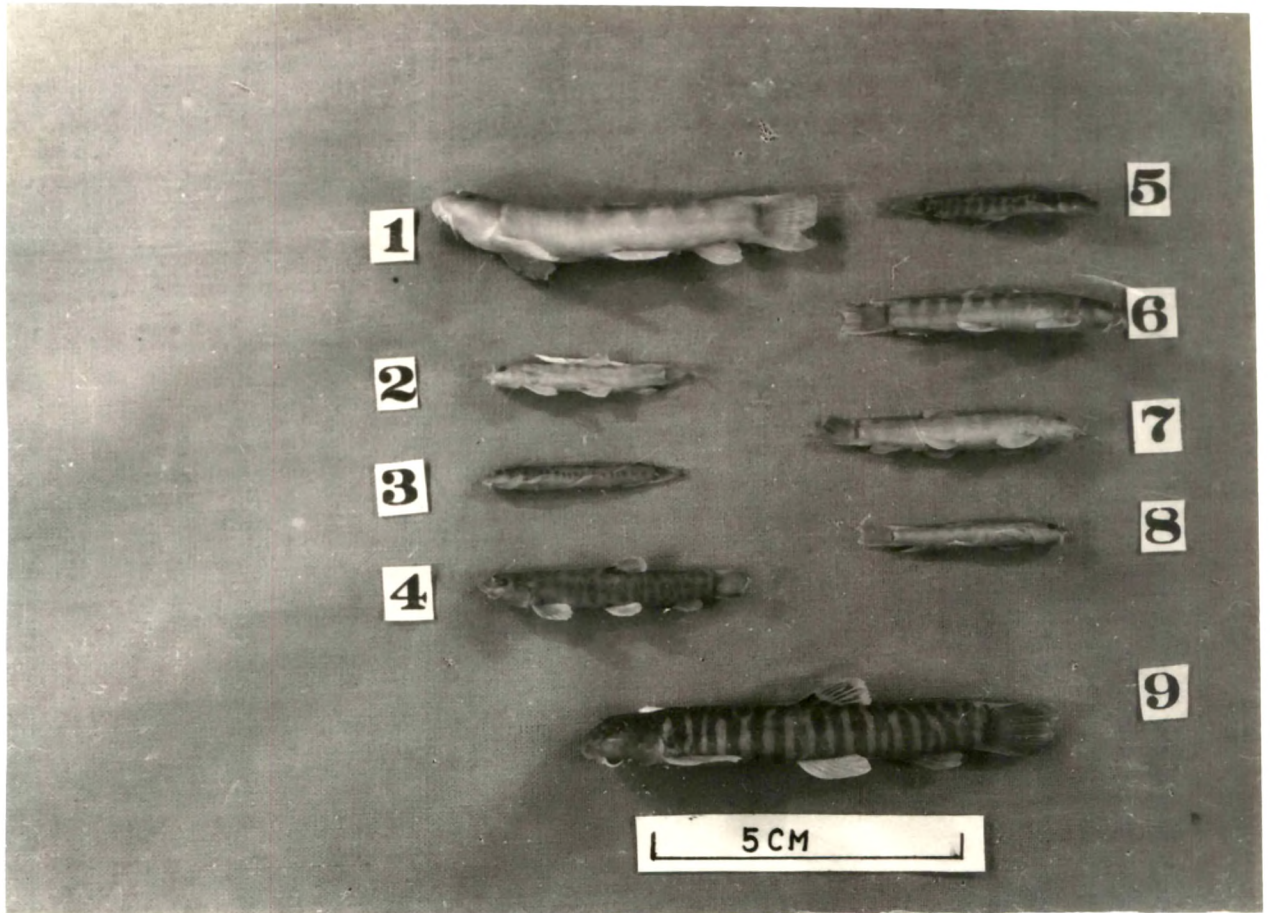


Explanation of Plate XVI

Photographs of the ichthyospecies of Sikkim drainages

(continued).

1. *Noemacheilus beavani* Gunther; 2. *Noemacheilus carletoni* Fowler; 3. *Noemacheilus corica* (Hamilton); 4. *Noemacheilus devdevi* Hora; 5. *Noemacheilus kangjupkhulensis* Hora; 6. *Noemacheilus scaturigina* (McClelland); 7. *Noemacheilus sikmaiensis* Hora; 8. *Noemacheilus spilopterus* (Cuv. & Val.); 9. *Noemacheilus multifasciatus* Day; 10. *Danio aequipinnatus* (McClelland); 11. *Danio naganensis* Chaudhuri; 12. *Laguvia ribeiroi ribeiroi* (Hora); 13. *Pangasius pangasius* (Hamilton); 14. *Acanthopthalmus pangia* Hamilton; 15. *Laguvia ribeiroi jorethangensis* sub. sp. nov.

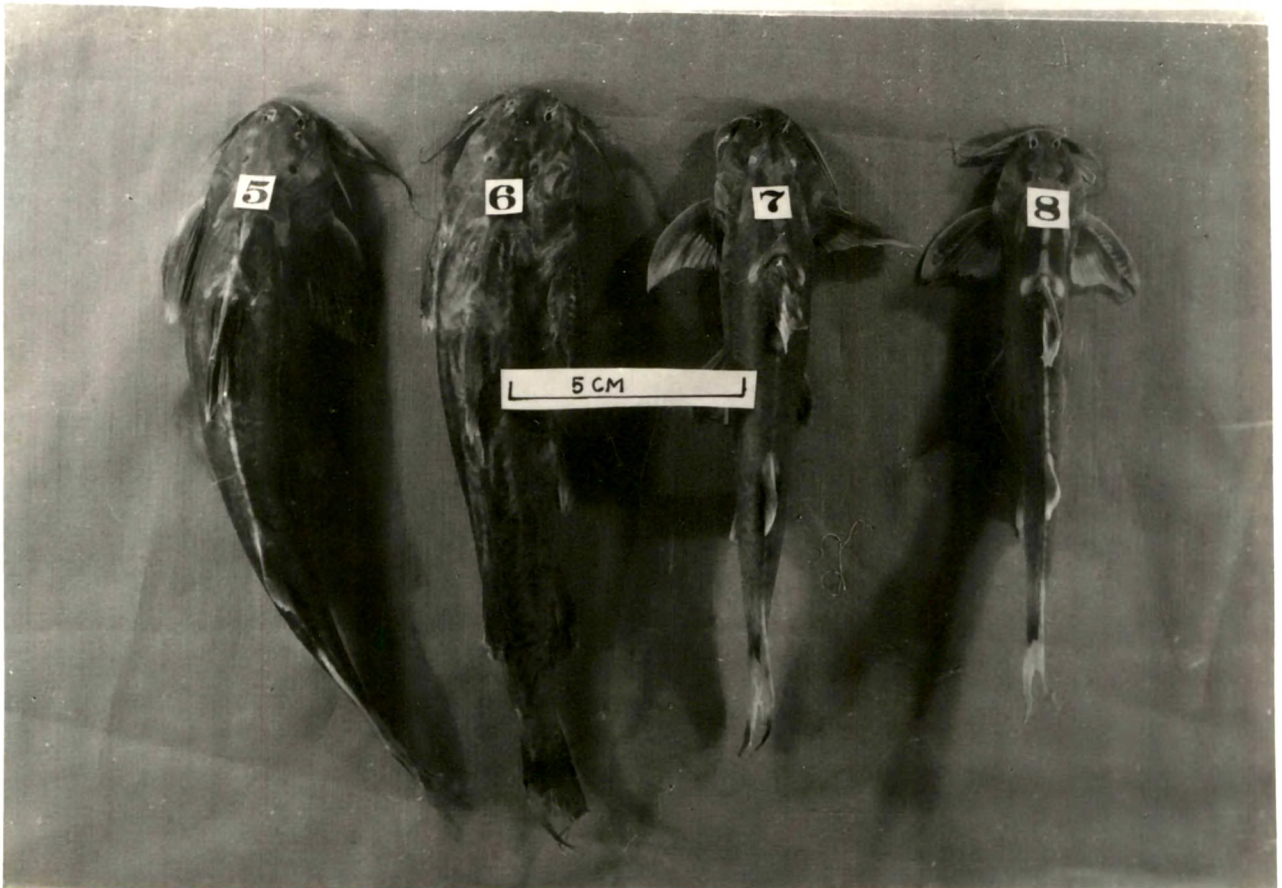
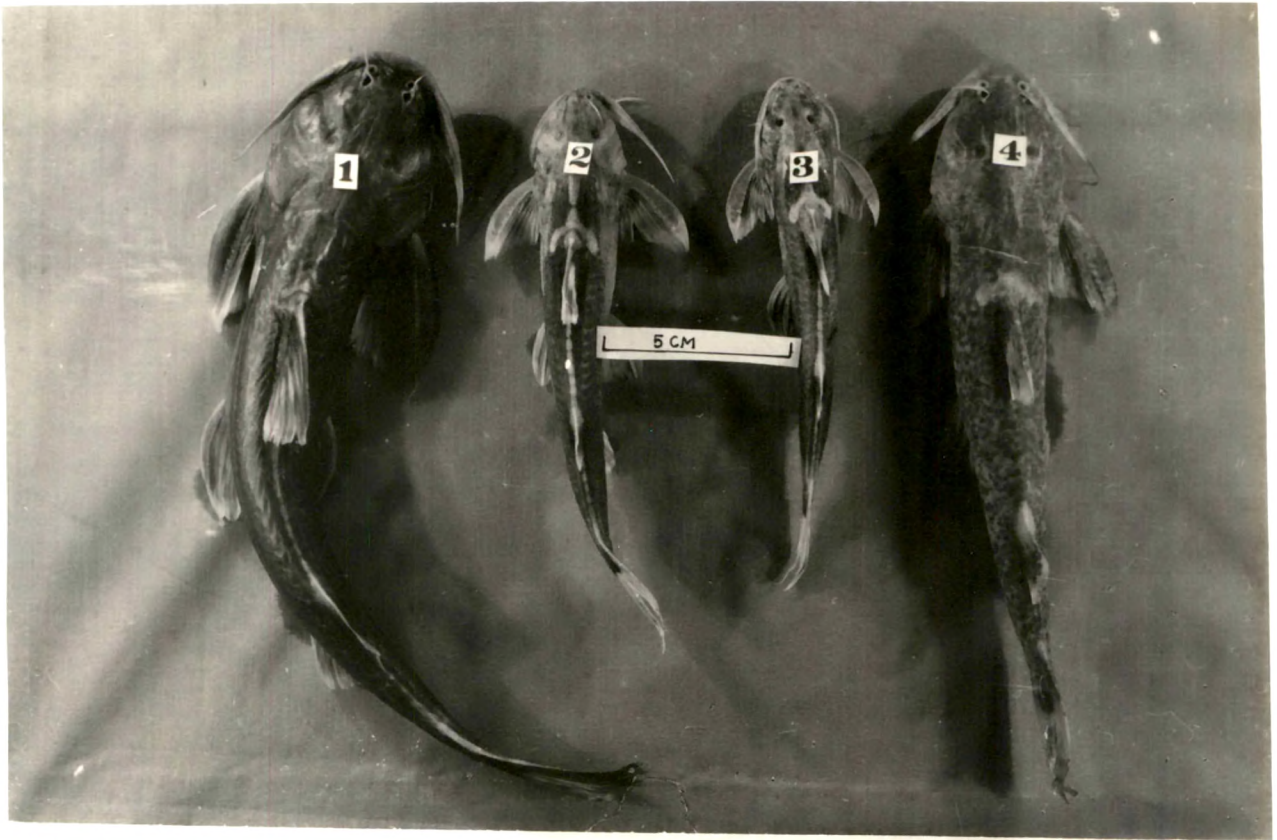


Explanation of Plate XVII

Photographs of the ichthyospecies of Sikkim drainages

(continued).

1. *Glyptothorax sinense manipurensis* Menon; 2. *Glyptothorax trilineatus* Blyth; 3. *Glyptothorax gracilis* (Gunther); 4. *Glyptothorax basnetti* sp. nov.; 5. *Glyptothorax sinense sikkimensis* sub. sp. nov.; 6. *Glyptothorax conirostrae* (Steindachner); 7. *Glyptothorax deyi* sp. nov.; 8. *Glyptothorax bhutiai* sp. nov.



Explanation of Plate XVIII

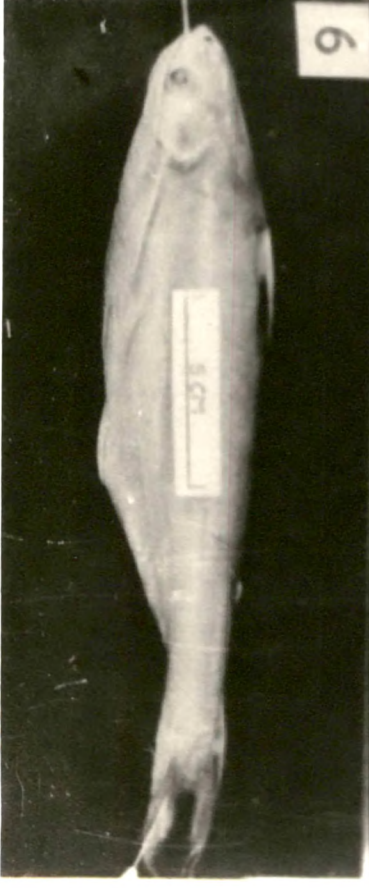
Photographs of the ichthyospecies of Sikkim drainages

(continued).

1. *Anguilla bengalensis* (Gray); 2. *Bagarius bagarius* (Hamilton); 3. *Labeo pangusia* (Hamilton); 4. *Labeo dero* (Hamilton); 5. *Clupisoma bhandarii* sp. nov.



1



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4



3

Explanations of Plate XIX

Photographs of the ventral view of new species and sub-species of Sikkim drainages.

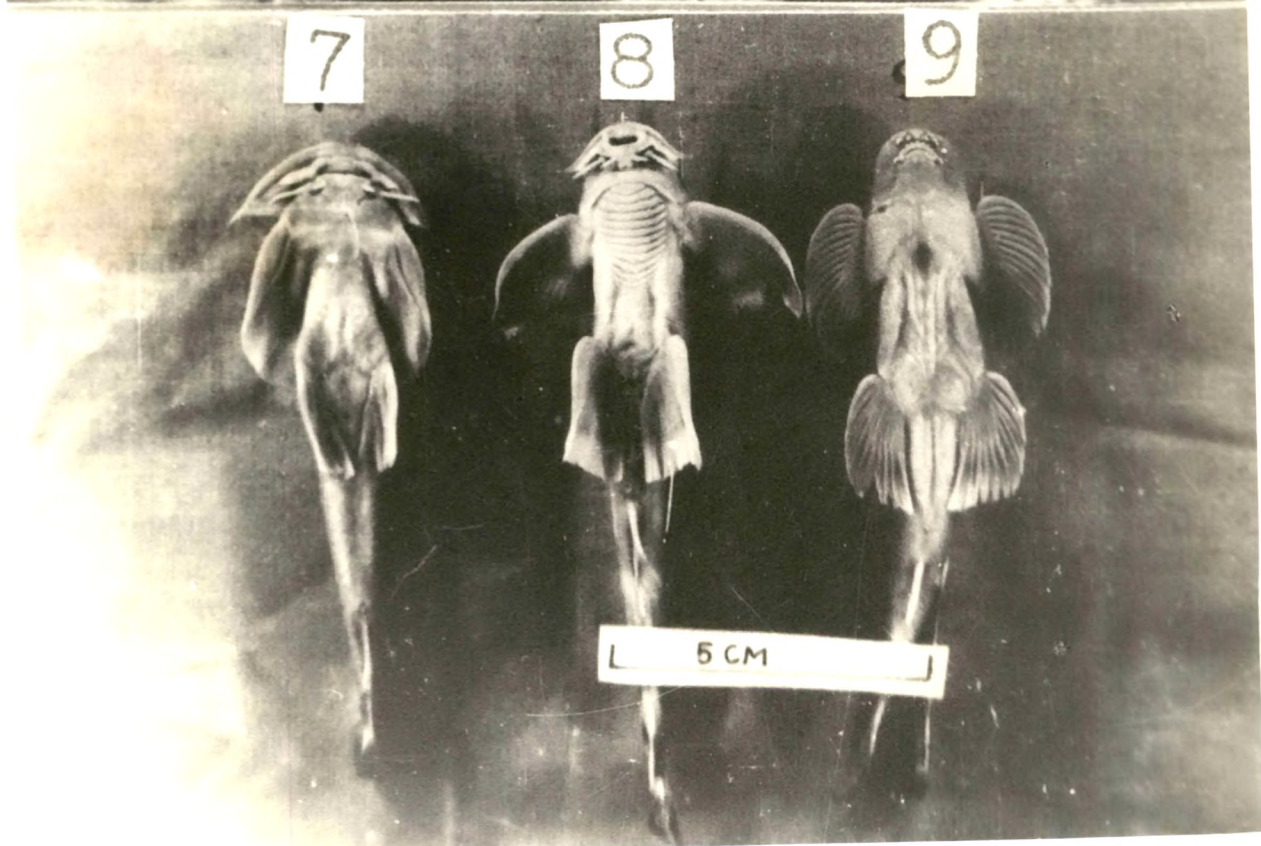
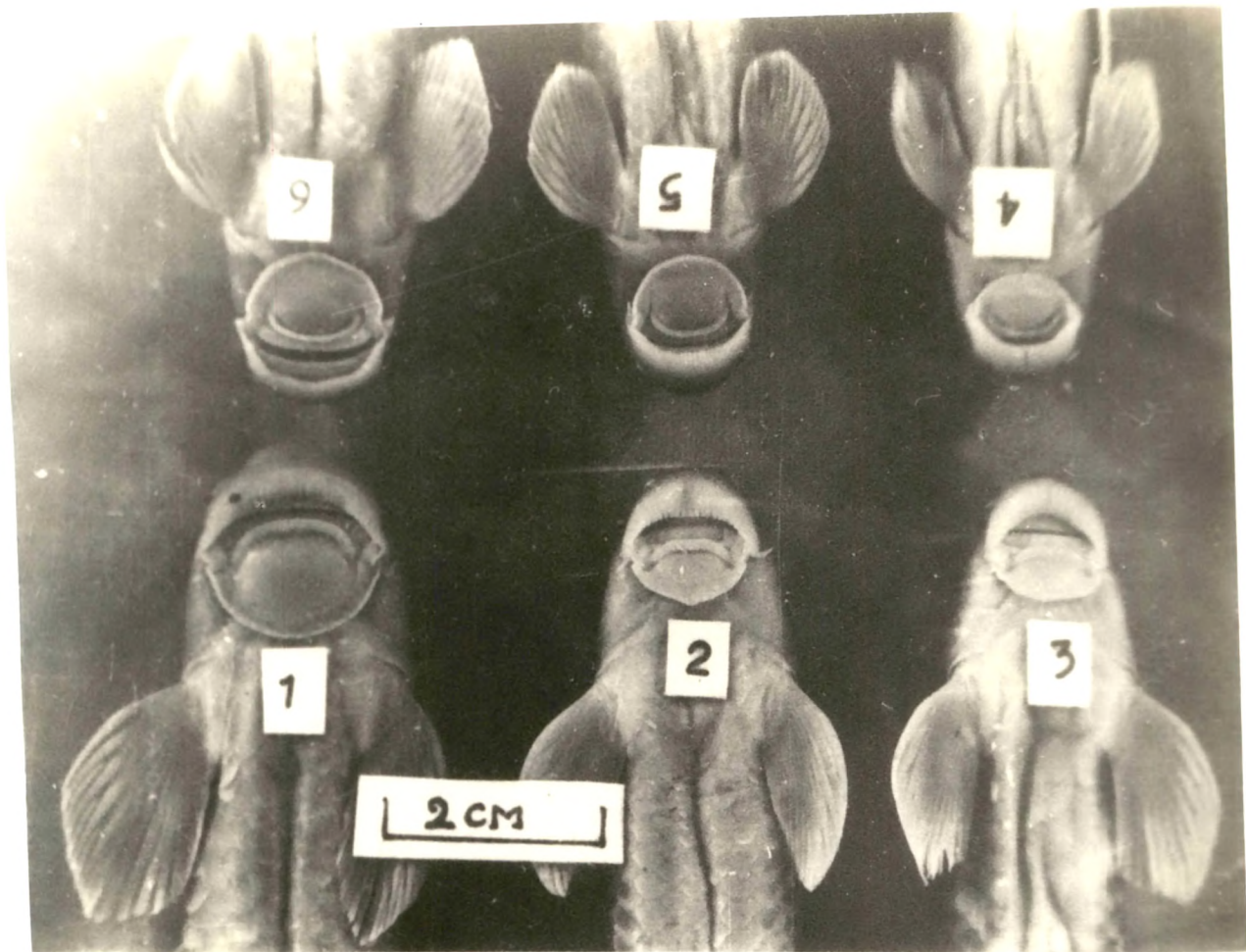
1. *Glyptothorax sinense sikkimensis* sub. sp. nov.;
2. *Glyptothorax dey* sp. nov.;
3. *Clupisoma bhandarii* sp. nov.;
4. *Glyptothorax basnetti* sp. nov.;
5. *Laguvia ribeiroi jorethangensis* sub. sp. nov. (dorsal & ventral);
6. *Glyptothorax bhutiai* sp. nov.



Explanations of Plate XX

Photographs of the ventral view of ichthyospecies of Sikkim drainages
(continued).

1. *Garra gotyla stenorhynchus* (Jerdon); 2. *Garra annandalei* Hora;
3. *Garra mcClellandi* (Jerdon); 4. *Garra mullya* (Sykes); 5. *Garra gotyla gotyla* (Gray); 6. *Garra lamta* (Hamilton); 7. *Euchiloglanis hodgarti* (Hora); 8. *Pseudecheneis sulcatus* (McClelland); 9. *Balitora brucei* Gray.



CHAPTER SEVEN

FISH GEOGRAPHY OF SIKKIM

CHAPTER SEVEN

FISH GEOGRAPHY OF SIKKIM

The elevation of Sikkim drainages ranges from 5300 m in the mountainous alpine zone to 310 m in the subtropical zone. The ichthyofaunas inhabiting different gradients therefore, portray a unique feature in their distributional set up. Besides, the fish fauna includes primary and peripheral forms and significantly contains the Extra-Indian as well as both North and South Indian species.

For brevity and better understanding of their geographical trend, the exotic species, *Salmo trutta fario* Linnaeus also recorded in the drainages has been excluded from the purview of present elucidation.

ZOOGEOGRAPHICAL CLASSIFICATION

Considering the principles on the zoogeographical classification of fish put forward by Nicholas (1928), Myers (1949), Darlington (1957) and De Beaufort *et al* (1964) the fish fauna of Sikkim drainages have been classified into Primary fresh water form and Peripheral fresh water group.

Primary Fresh Water Fish

This group contains 46 species under 21 genera belonging to 7 families. Generalized list of fish is as follows:

Schizopyge includes 1 sp., *Schizothorax* 1 sp., *Danio* 2 spp., *Barilius* 2 spp., *Semiplotus* 1 sp., *Labeo* 2 spp., *Acrossocheilus* 1 sp., *Tor* 1 sp., *Crossocheilus* 1 sp., *Garra* 6 spp., *Balitora* 1 sp., *Noemacheilus* 9 spp., *Acanthopthalmus* 1 sp., *Clupisoma* 1 sp., *Pangasius* 1 sp., *Bagarius* 1 sp., *Laguvia* 2 spp., *Glyptothorax* 8 spp., *Euchiloglanis* 1 sp., *Pseudecheneis* 1 sp., and *Channa* 1 sp..

Peripheral Fresh Water Fish

This group includes a single species of *Anguilla*.

DISTRIBUTION TREND

The distributional trend of the fish fauna of Sikkim has been studied under four principal approaches. They are (1) Inter-drainage distribution, (2) Overlapping species with Indian drainages, (3) Extra-Indian distribution and (4) Distribution on Ichthyological division. Each of these aspects

as observed in the present drainages has been elucidated hereunder.

1. Inter-Drainage Distribution

The zoogeographical trend of 47 species recorded in the Tista and the Rangit drainages during the investigation periods has been purported in Table 103. Based on species abundance, the drainages of Sikkim are found in the order Rangit > Tista > Rangbhang > Rangpo > Confluence of Tista and Rangit > Roathak > Kalej khola > Rani khola > Ghattay khola & Rishi khola > Dik chhu > Rin khola and Rimbi khola > Jali khola > Yumthang chhu & Bakcha chhu.

It becomes evident from Table 103 that of 47 fish species recorded, 7 of them are of widely distributed forms while 9 are restricted in particular river system and remaining 31 are available in more than one river.

1.1 Widely distributed species

The species of this group are *Schizopyge progastus*, *Schizothorax richardsonii*, *Acrossocheilus hexagonolepis*, *Crossocheilus latius latius*, *Garra annandalei*, *G. mullya* and *Pseudecheneis sulcatus*.

1.2 Species of the Tista drainages

Schizopyge progastus, *Schizothorax richardsonii*, *Danio aequipinnatus*, *D. naganensis*, *Barilius bendelisis bendelisis*, *B. bendelisis chedra*, *B. vagra*, *Semiplotus semiplotus*, *Labeo dero*, *Acrossocheilus hexagonolepis*, *Tor putitora*, *Crossocheilus latius latius*, *Garra annandalei*, *G. goryla goryla*, *G. goryla stenorhynchus*, *G. lamta*, *G. mcClellandi*, *G. mullya*, *Noemacheilus beavani*, *N. devdevi*, *N. kangjupkhulensis*, *N. multifasciatus*, *N. scaturigina*, *N. sikmaiensis*, *N. spilopterus*, *Acanthopthalmus pangia*, *Clupisoma bhandarii*, *Pangasius pangasius*, *Bagarius bagarius*, *Glyptothorax basnetti*, *G. bhutiai*, *G. deyi*, *G. gracilis*, *G. sinense manipurensis*, *G. trilineatus*, *Euchiloglanis hodgarti* and *Pseudecheneis sulcatus*.

1.3 Species of the Rangit drainages

Anguilla bengalensis, *Schizopyge progastus*, *Schizothorax richardsonii*, *Danio aequipinnatus*, *Danio naganensis*, *Barilius bendelisis*, *B. bendelisis chedra*, *B. vagra*, *Semiplotus semiplotus*, *Labeo dero*, *L. pangusia*, *Acrossocheilus hexagonolepis*, *Tor putitora*, *Crossocheilus latius latius*, *Garra annandalei*, *G. goryla goryla*, *G. goryla stenorhynchus*, *G. lamta*, *G. mcClellandi*, *G. mullya*, *Balitora brucei*, *Noemacheilus beavani*, *N. carletoni*, *N. corica*, *N. devdevi*, *N. kangjupkhulensis*, *N. multifasciatus*, *N. scaturigina*, *N. sikmaiensis*, *Clupisoma bhandarii*, *Pangasius pangasius*, *Bagarius bagarius*, *Laguvia ribeiroi ribeiroi*, *L. ribeiroi jorethangensis*, *Glyptothorax basnetti*, *G. bhutiai*, *G. conirostrae*, *G. deyi*, *G. gracilis*, *G. sinense sikkimensis*, *G. trilineatus*, *Euchiloglanis hodgarti*, *Pseudecheneis sulcatus* and *Channa orientalis*.

1.4 Species of the twin drainage

Schizopyge progastus, *Schizothorax richardsonii*, *Danio aequipinnatus*, *Danio naganensis*, *Barilius bendelisis*, *B. bendelisis chedra*, *B. vagra*, *Semiplotus semiplotus*, *Labeo dero*, *Acrossocheilus hexagonolepis*, *Tor putitora*, *Crossocheilus latius latius*, *Garra annandalei*, *G. gotyla gotyla*, *G. gotyla stenorhynchus*, *G. lamta*, *G. McClellandi*, *G. mullya*, *Noemacheilus beavani*, *N. devdevi*, *N. kangjupkhulensis*, *N. multifasciatus*, *N. scaturigina*, *N. sikmaiensis*, *Clupisoma bhandarii*, *Pangasius pangasius*, *Bagarius bagarius*, *Glyptothorax basnetti*, *G. bhutiai*, *G. deyi*, *G. gracilis*, *G. trilineatus*, *Euchiloglanis hodgarti* and *Pseudecheneis sulcatus*.

1.5 Endemic species of a river

The following observation reports the fish species restricted to a particular river of Sikkim drainages investigated.

DIK CHHU:	<i>Noemacheilus spilopterus</i>
RANI KHOLA:	<i>Acanthopthalmus pangia</i>
RANGIT:	<i>Anguilla bengalensis</i> , <i>Labeo pangusia</i>
RIMBI KHOLA:	<i>Noemacheilus carletoni</i> , <i>Noemacheilus corica</i>
RANGBHANG KHOLA:	<i>Glyptothorax sinense sikkimensis</i> sub. sp. nov.

2. Altitudinal Distribution

Altitudinally the distribution of the ichthyospecies may be categorized as follows:

2.1 Species of Gradient Zone I (1001 m - 1700 m)

1. *Schizothorax richardsonii*, 2. *Garra gotyla stenorhynchus*, 3. *G. mullya*, 4. *Noemacheilus carletoni*, 5. *N. corica*, 6. *N. multifasciatus*, 7. *N. sikmaiensis*, 8. *Euchiloglanis hodgarti* and 9. *Pseudecheneis sulcatus*.

2.2 Species of Gradient Zone II (500 m - 1000 m)

1. *Schizopyge progastus*, 2. *Schizothorax richardsonii*, 3. *Danio aequipinnatus*, 4. *D. naganensis*, 5. *Barilius bendelisis bendelisis*, 6. *B. bendelisis chedra*, 7. *B. vagra*, 8. *Semiplotus semiplotus*, 9. *Labeo dero*, 10. *Labeo pangusia*, 11. *Acrossocheilus hexagonolepis*, 12. *Tor putitora*, 13. *Crossocheilus latius latius*, 14. *Garra annandalei*, 15. *G. gotyla gotyla*, 16. *G. gotyla stenorhynchus*, 17. *G. lamta*, 18. *G. McClellandi*, 19. *G. mullya*, 20. *Balitora Brucei*, 21. *Noemacheilus beavani*, 22. *N. devdevi*, 23. *N. kangjupkhulensis*, 24. *N. multifasciatus*, 25. *N. scaturigina*, 26. *N. sikmaiensis*, 27. *N. spilopterus*, 28. *Acanthopthalmus pangia*, 29. *Glyptothorax basnetti*, 30. *G. bhutiai*, 31. *G. gracilis*, 32. *G. sinense manipurensis*, 33. *G. trilineatus*, 34. *Euchiloglanis hodgarti* and 35. *Pseudecheneis sulcatus*.

2.3 Species of Gradient Zone III (below 500 metres)

1. *Schizopyge progastus*, 2. *Schizothorax richardsonii*, 3. *Danio aequipinnatus*, 4. *Barilius bendelisis bendelisis*, 5. *B. bendelisis chedra*, 6. *B. vagra*, 7. *Semiplotus semiplotus*, 8. *Labeo dero*, 9. *L. pangusia*, 10. *Acrossocheilus hexagonolepis*, 11. *Tor putitora*, 12. *Crossocheilus latius latius*, 13. *Garra annandalei*, 14. *G. gotyla gotyla*, 15. *G. gotyla stenorhynchus*, 16. *G. lamta*, 17. *G. mcClellandi*, 18. *G. mullya*, 19. *Noemacheilus beavani*, 20. *N. devdevi*, 21. *N. multifasciatus*, 22. *N. scaturigina*, 23. *Clupisoma bhandarii*, 24. *Pangasius pangasius*, 25. *Bagarius bagarius*, 26. *Laguvia ribeiroi ribeiroi*, 27. *L. ribeiroi jorethangensis*, 28. *Glyptothorax hasnetti*, 29. *G. bhutiai*, 30. *G. conirostrae*, 31. *G. deyi*, 32. *G. gracilis*, 33. *G. sinense sikkimensis*, 34. *G. trilineatus*, 35. *Euchiloglanis hodgarti*, 36. *Pseudecheneis sulcatus* and 37. *Channa orientalis*.

3. Indian and Extra- Indian distribution

3.1 Widely Distributed Species

A single species of *Channa orientalis* is known to occur widely in all parts of India, Nepal, Bangladesh, Pakistan, Sri Lanka, Burma and Malaysia. Fishes of different sub-divisions are as follows:

- i) Present in India, Nepal, Bangladesh, Burma and Malaysia but absent in Pakistan and Sri Lanka: *Acrossocheilus hexagonolepis*.
- ii) Present in India, Nepal, Bangladesh, Pakistan, Burma and Malaysia but absent in Sri Lanka: *Bagarius bagarius*
- iii) Present in India, Nepal, Bangladesh, Pakistan, Sri Lanka and Burma but absent in Malaysia: *Barilius bendelisis bendelisis*.
- iv) Present in India, Nepal, Bangladesh, Pakistan and Burma but absent in Sri Lanka and Malaysia: *Labeo dero*
- v) Present in India, Nepal, Bangladesh, Pakistan but absent in Sri Lanka, Burma and Malaysia: *Crossocheilus latius latius* and *Garra gotyla gotyla*.
- vi) Present in India, Bangladesh, Pakistan, Sri Lanka, Burma and absent in Nepal and Malaysia: *Danio aequipinnatus*.

3.2 Species of Northern India

Out of 47 species recorded from Sikkim, as many as 24 species are of North - India element (Table 105) and thereby exhibits presence of 51.06 % of North Indian species in the drainages.

3.3 Species of Southern India

Only 13 species (27.65 %) of the fish population of Sikkim are distributed in South-Indian rivers.

3.4 Extra - Indian Distribution

From Table 105, it will be seen that the fish fauna of Sikkim drainages also contains species those are known to occur in Extra- Indian territories. Notably, the population includes 23 species of fish of Nepal, 20 species of Bangladesh, 15 species of Pakistan, 14 species of Burma, 8 species of Sri Lanka and 4 species of Malaysia.

4. Species of the Himalayas

This group contains 27 species, which are true hill stream dwellers and are found along the hilly tracts or the foot hills of the Himalayas. Zoogeographically they are significant due to their specialized nature of the dwelling habit.

The Himalayan rivers, according to Burrad and Hayden (1933) are divided into four groups (or sections), the Eastern Himalayas which includes the rivers between Brahmaputra and the Tista; the Nepal Himalayas between Tista and the Kali; the next group between Kali and the Sutlej as of the Kumaon Himalayas and the fourth between Sutlej and the rivers west of it as of the Punjab Himalayas.

The analysis of 27 species from their known distribution is as follows:

Group I Found in all fours sections of Himalayas: *Schizothorax richardsonii* and *Schizopyge progastus*.

Group II Found in Eastern Nepal and Kumaon Himalayas: *Garra lamta*, *Noemacheilus beavani*, *N. corica*, *Laguvia ribeiroi ribeiroi*.

Group III Found in Eastern and Nepal Himalayas: *Semiplotus semiplotus*, *Tor putitora*, *Garra annandalei*, *Balitora brucei*, *Noemacheilus multifasciatus*, *Euchiloglanis hodgarti*, *Pseudecheneis sulcatus*.

Group IV Endemic in Eastern Himalayas: *Danio naganensis*, *Noemacheilus devdevi*, *N. kangjupkhulensis*, *N. scaturigina*, *N. sikmaiensis*, *N. spilopterus*, *Clupisoma bhandarii* sp. nov., *Laguvia ribeiroi jorethangensis* sub. sp. nov., *Glyptothorax basnetti* sp. nov., *G. bhutiai* sp. nov., *G. deyi* sp. nov., *G. sinense sikkimensis* sub. sp. nov., *G. trilineatus*.

5. Distribution on Ichthyological Division.

The fish species of Sikkim have been classified into six ichthyological divisions and an account on the distribution trend of each division is as follows:

5.1 ANGUILLIDS

The group represented by single species (*A. bengalensis*) shows somewhat restricted occurrence (River Rangit) at an elevation from 240 m to 500 m.

5.2 CARPS AND MINNOWS

Seventeen species represented from this group reveal wide range of distribution pattern. Two species of *Labeo* and one species of *Semiplotus* are found at lower elevations 340 m to 525 m. *Labeo pangusia* is confined to river Rangit; *Labeo dero* occurs in Tista, Rangpo khola, Rangit, Roathak and Rangbhang and *Semiplotus semiplotus* in Rangpo khola, Rangit, Roathak and Rangbhang. Likewise, two different species of *Barilius* have been recorded within 240 m to 700 m. *B. bendelisis bendelisis* and *B. vagra* are widely distributed in both the Tista and the Rangit drainages while *B. bendelisis chedra* is confined to Tista, Rani khola and Rangit. *Schizothorax richardsonii* and *Schizopyge progastus* are widely distributed throughout the drainages of Sikkim up to 1340 m and 745 m (msl) respectively.

Although *Danio aequipinnatus* occurs from 240 m to 775 m, it shows restricted distribution and have been recorded only in Rin khola, Rangpo khola, Rangit, Roathak, Rangbhang and confluence of Tista and Rangit. *Danio naganensis* is confined to Dik chhu (500 - 600 m).

Seven species of this group are true hill stream dwellers. Of them, *Balitora brucei* occurs exclusively in Rangit drainage (340 to 645 m). All the six species of *Garra* are most widely distributed in both the drainages. *Garra annandalei*, *G. gotyla gotyla*, *G. lamta* and *G. McClellandi* occurs within 240 m to 750 m. However *G. gotyla stenorhynchus* and *G. mullya* exhibit their distribution up to 1065 m. Another widely distributed species, *C. latius latius* is found in both the Tista & Rangit drainages from 240 m to 700 m.

5.3 MAHSEERS

A single species of golden mahseer (*Tor puitora*) occurs at low elevations (240 m to 525 m) whereas one species of chocolate mahseer (*Acrossocheilus hexagonolepis*) is found to be widely distributed from 240 m to 745 m.

5.4 COBITIDS

Out of the nine species of *Noemacheilus*, two species (*N. carletoni* and *N. Corica*) are confined to Rimbi khola (1065 m) while *N. spilopterus* has been recorded exclusively from Dik chhu (500 m - 600 m). *N. sikmaiensis* also shows restricted distribution to Dik chhu (500 m) and Rimbi khola (1065 m), whereas *N. multifasciatus*, one of the most widely distributed species of cobitids, is found within 380 m to 1065 m. *N. scaturigina* exhibits its distribution from 310 m to 745 m. *N. kangjupkhulensis* is restricted to Dik chhu (500 m) and Rangit (340 m). *N. beavani* and *N. devdevi* are confined up to an elevation of 530 m. A single species of *Acanthopthalmus pangia* has been recorded exclusively from Rani khola (745 m).

5.5 CAT FISHES

Out of 15 species of this group, 12 are specialized hill stream dwellers. *Laguvia ribeiroi ribeiroi* and *L. ribeiroi jorethangensis* are confined to Rangit and Rangbhang at low elevations (340 m). *Glyptothorax sinense sikkimensis* is exclusively restricted to Rangbhang khola (340 m). *G. basnetti*, *G. bhutiai* and *G. trilineatus* occur within 240 m to 525 m. *G. deyi*, *G. gracilis* exhibits distribution within 240 m to 500 m but *G. sinense manipurensis* is confined to Dik chhu and Rangpo khola. *G. conirostrae* is restricted at low elevations (240 m to 340 m) to Rangit and confluence of Tista & Rangit.

Euchiloglanis hodgarti is found in both the drainages within 645 m to 1640 m while *Pseudecheneis sulcatus* is widely distributed in all the rivers from 240 m to 1065 m.

Clupisoma bhandarii and *Bagarius bagarius* occur only at two elevations (240 m to 525 m) while *Pangasius pangasius* is recorded only from the confluence of Tista and Rangit (240 m).

5.6 MURRELS

Channa orientalis, the single representative of the group have been recorded at lower elevations (340 to 380 m) in Rangit, Rangbhang khola and Roathak khola.

Table 103. Distribution of the ichthyospecies in the Tista & Rangit river systems (Abbr. 1, Yumthang chhu; 2, river Tista; 3, Bakcha chhu; 4, Seti khola; 5, Jali khola; 6, Rani khola; 7, Rin khola; 8, Dik chhu; 9, Ghattay khola; 10, Rangpo khola; 11, R. Rangit; 12, Rimbi khola; 13, Kalej khola; 14, Rishi khola; 15, Roathak khola; 16, Rangbhang khola; 17, Confluence of Tista & Rangit rivers; +, present, -, absent).

Ichthyospecies	Tista drainage										Rangit drainage							Confluence of Tista & Rangit
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
<i>Anguilla bengalensis</i>	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	
<i>Salmo trutta fario</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Schizopyge progastus</i>	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	
<i>Schizothorax richardsonii</i>	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
<i>Danio aequipinnatus</i>	-	-	-	-	-	-	+	-	-	+	+	-	-	-	+	+	+	
<i>Danio naganensis</i>	-	-	-	-	-	-	+	-	-	+	+	-	-	-	+	+	-	
<i>Barilius bendelisis bendelisis</i>	-	+	-	-	-	+	-	-	-	+	+	-	-	-	+	+	+	
<i>Barilius bendelisis chedra</i>	-	+	-	-	-	+	-	-	-	+	+	-	-	-	+	+	-	
<i>Barilius vagra</i>	-	+	-	-	-	+	-	+	-	+	+	-	-	+	-	+	+	
<i>Semiplotus semiplotus</i>	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	+	-	
<i>Labeo dero</i>	-	+	-	-	-	-	-	-	-	+	+	-	-	-	+	+	-	
<i>Labeo pangusia</i>	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	
<i>Acrossocheilus hexagonolepis</i>	-	+	-	-	-	+	+	+	+	+	+	-	+	+	+	+	+	
<i>Tor punitora</i>	-	+	-	-	-	-	-	-	-	+	+	-	+	+	+	+	+	
<i>Crossocheilus latius latius</i>	-	+	-	-	-	+	-	+	+	+	+	-	+	+	+	+	+	

Table 104. Distribution of Ichthyospecies in between Tista and Rangit drainages of Sikkim (Abbr. +, present; -, absent).

Ichthyospecies	Twin drainage	Tista	Rangit
<i>Anguilla bengalensis</i>	-	-	+
<i>Schizopyge progastus</i>	+	-	-
<i>Schizothorax richardsonii</i>	+	-	-
<i>Danio aequipinnatus</i>	+	-	-
<i>Danio naganensis</i>	+	-	-
<i>Barilius bendelisis bendelisis</i>	+	-	-
<i>Barilius bendelisis chedra</i>	+	-	-
<i>Barilius vagra</i>	+	-	-
<i>Semiplotus semiplotus</i>	+	-	-
<i>Laheo dero</i>	+	-	-
<i>Labeo pangusia</i>	-	-	+
<i>Acrossocheilus hexagonolepis</i>	+	-	-
<i>Tor putitora</i>	+	-	-
<i>Crossocheilus latius latius</i>	+	-	-
<i>Garra annandalei</i>	+	-	-
<i>Garra gotyla gotyla</i>	+	-	-
<i>Garra gotyla stenorhynchus</i>	+	-	-
<i>Garra lamta</i>	+	-	-
<i>Garra mcClellandi</i>	+	-	-
<i>Garra mullya</i>	+	-	-
<i>Balitora brucei</i>	-	-	+
<i>Noemacheilus beavani</i>	+	-	-
<i>Noemacheilus carletoni</i>	-	-	+
<i>Noemacheilus corica</i>	-	-	+
<i>Noemacheilus devdevi</i>	+	-	-
<i>Noemacheilus kangjupkhulensis</i>	+	-	-
<i>Noemacheilus multifasciatus</i>	+	-	-
<i>Noemacheilus scaturigina</i>	+	-	-
<i>Noemacheilus sikmaiensis</i>	+	-	-
<i>Noemacheilus spilopterus</i>	-	+	-

<i>Acanthopthalmus pangia</i>	-	+	-
<i>Clupisoma bhandarii sp. nov.</i>	+	-	-
<i>Pangasius pangasius</i>	+	-	-
<i>Bagarius bagarius</i>	+	-	-
<i>Laguvia ribeiroi ribeiroi</i>	-	-	+
<i>Laguvia ribeiroi jorethangensis sub. sp. nov.</i>	-	-	+
<i>Glyptothorax basnetti sp. nov.</i>	+	-	-
<i>Glyptothorax bhutiai sp. nov.</i>	+	-	-
<i>Glyptothorax conirostrae</i>	-	-	+
<i>Glyptothorax deyi. sp. nov.</i>	+	-	-
<i>Glyptothorax gracilis</i>	+	-	-
<i>Glyptothorax sinense manipurensis</i>	-	+	-
<i>Glyptothorax sinense sikkimensis sub. sp. nov.</i>	-	-	+
<i>Glyptothorax trilineatus</i>	+	-	-
<i>Euchiloglanis hodgarti</i>	+	-	-
<i>Pseudecheneis sulcatus</i>	+	-	-
<i>Channa orientalis</i>	-	-	+

CHAPTER EIGHT

FISHERIES PROPENSITY AND TREND

CHAPTER 8

FISHERIES PROPENSITY AND TREND

As a measure towards conservation of riverine fisheries, State Fisheries has put some restrictions on fishing in Sikkim rivers. The entire length of both the Tista and the Rangit drainages are constantly under ward and watch of the fisheries personnel. Provision of fishing facilities have been made by the State Fisheries in all the four districts. However, fishing in a particular zone is permissible only after obtaining the license from the concerned Fisheries Development Officer.

Fishing licenses are issued at the following rates according to the type of the gear used: Cast net @ Rs 20.00/month (@ Rs 2.00/day) and rod & line @ Rs 10.00/month (@ Rs 2.00/day).

Fishermen families are localized at various places at Ranipool, Namli, Martam, Singtam, Passingdong, Sangkalang, Dikchu, Rorethang and along the banks of Tista drainages. Likewise along Rangit drainages, fishermen are concentrated notably at Rimbi, Legship, Tatopani, Birdang, Budang, Nayabazar and Jorethang.

Altogether nearly 400 - 500 fishermen families are engaged in fishing in the state. About 20 - 25% of the fishermen population are professionals, who earn their living solely by catch and sale of fish. The average catch of fish with a conventional cast net of mesh size of 15 mm to 30 mm is 1.5 - 2.0 kg per head for four hours. Due to difficult terrain, fishermen can not operate cast net continuously for more than 4 hours a day. The state has so far no fish landing station or regular market for local fish. Since the riverine fish is too little to meet the demand; the fish caught by the individual fisherman gets sold off @ Rs. 40.00 - 50.00 per kg as soon as it is brought to the road side situated close to the fishing site.

8.1 Principal rivers and their fisheries

Principal rivers of Sikkim have been selected mainly on the basis of occurrence of commercially important ichthyospecies alongwith the total species abundance. Together with this, other important parameters such as shoreline, discharge rate, no. of commercial ichthyospecies and capture per person per gear per hour have also been taken into consideration. Parameters justifying the selection of principal rivers of Sikkim are shown in Table 106. Out of the sixteen rivers investigated, ten (five under the Tista drainages and five under the Rangit drainages) have been selected as principal rivers as follows:

1. River Rangit (Plate X) This river with the highest number of commercially important ichthyospecies ranks top amongst the principal rivers of Sikkim. It has a shoreline of ca 73 km, CPGH 27.00 and mean seasonal discharge rate of 101.19 m³s⁻¹ (at Nayabazar). Important commercial fishes are *Anguilla bengalensis*, *Schizopyge progastus*, *Schizothorax richardsonii*, *Barilius bendelisis*, *Semiplotus semiplotus*, *Labeo dero*, *Labeo pangusia*, *Acrossocheilus hexagonolepis*, *Tor putitora*, *Crossocheilus latius latius*, *Clupisoma bhandarii*, *Bagarius bagarius*, *Glyptothorax basnetti*, *Glyptothorax conirostrae*, *Glyptothorax deyi*, *Glyptothorax gracilis*, *Glyptothorax trilineatus*, *Pseudecheneis sulcatus* and *Channa orientalis*.

Table 106. COMPARATIVE STUDIES OF PERTINENT PARAMETERS IN IDENTIFICATION OF PRINCIPAL DRAINAGES (PR) OF SIKKIM.

Sl. No.	Rivers	Shoreline (km)	Discharge (m ³ s ⁻¹)	No. of Commercial Ichthyospecies	Abundance No. m ⁻²	CPGH	Overall Rank	Remark
1.	R. Tista	162	202.38	16	27x10 ⁻³	23	IV	PR
2.	Yumthang chhu	42	23.73	1	12x10 ⁻³	4	XVI	-
3.	Bakcha chhu	18	24.42	1	52x10 ⁻³	35	VII	PR
4.	Seti khola	13	14.86	6	11x10 ⁻³	13	XIV	-
5.	Jali khola	18	26.98	5	12x10 ⁻³	11	XV	-
6.	Rani khola	25	15.49	12	13x10 ⁻³	14	V	PR
7.	Rin khola	8	13.24	5	20x10 ⁻³	12	XII	-
8.	Dik chhu	7	37.47	9	39x10 ⁻³	21	VI	PR
9.	Ghattay khola	7	0.83	12	22x10 ⁻³	13	XIII	-
10.	Rangpo khola	40	55.55	22	35x10 ⁻³	21	II	PR
11.	R. Rangit	73	101.19	25	34x10 ⁻³	27	I	PR
12.	Rimbi khola	21	21.67	4	28x10 ⁻³	24	VIII	PR
13.	Kalej khola	25	26.51	14	14x10 ⁻³	15	X	PR
14.	Rishi khola	14	12.37	11	12x10 ⁻³	12	XI	-
15.	Roathak khola	13	12.58	14	13x10 ⁻³	16	IX	PR
16.	Rangbhang khola	38	48.21	20	37x10 ⁻³	29	III	PR

River Rangit harbours the highest number of plain water fishes e.g. *A. bengalensis*, *S. semiplotus*, *L. dero*, *L. pangusia*, *T. putitora*, *C. bhandarii*, *B. bagarius* & *C. orientalis*. The largest size of *Tor putitora* & *Bagarius bagarius* so far in record are from Rangit which are 13 kg and 62 kg respectively. All of those plain water forms start migrating up from adjoining plains of North Bengal into river Rangit from early March and remain there until October.

The number of commercial ichthyospecies is less in the upper reach (600 - 645 m elevation) of the river. River Rangit is recorded with higher CPGH during Summer at lower elevations within 360 m msl to 450 m msl. Four lakes viz. Lam Pokhari, Nir Pokhari, Samitik lake and Kabortem lake (Departmental survey) are associated with the river Rangit at its upper reaches above 3962 m elevations.

2. Rangpo khola (Plate IX) This is the second principal river flowing north-east of the state with twenty three commercial ichthyospecies, having a shoreline of ca 40 km. It has the mean discharge rate of $55.55 \text{ m}^3\text{s}^{-1}$. The commercial ichthyospecies of the river comprises of *S. progastus*, *S. richardsonii*, *B. bendelisis bendelisis*, *B. vagra*, *S. semiplotus*, *L. dero*, *L. pangusia*, *A. hexagonolepis*, *T. putitora*, *C. latius latius*, *G. annandalei*, *G. goryla*, *G. goryla stenorhynchus*, *G. lamta*, *G. McClellandi*, *G. mullya*, *B. bagarius*, *G. basnetti*, *G. bhutiai*, *G. gracilis*, *G. sinense manipurensis*, *G. trilineatus* and *P. sulcatus*. Of above, only four belong to the plain water forms viz. *Semiplotus semiplotus*, *Labeo dero*, *Labeo pangusia* and *Bagarius bagarius*. The river is rich in commercial fish from its confluence with river Tista at Rangpo up to an elevation of 550 m msl. However, the average CPGH (22.00) and total species abundance (9.00) are recorded to be highest at Rorethang. A total of eleven lakes viz. Bitang chho, Jalep La lake, Andha Pokhari, Bikram lake, Chandra lake, Nathula lake, Khargose lake, Yakla lake, Chhanggu lake, Jore Pokhari (Departmental survey) including Menmoi chho are associated with Rangpo khola at its upper reach above 3780 m.

3. Rangbhang khola (Plate XIII) Rangbhang khola with a shoreline of ca 38 km ranks third as principal rivers of the state. It has a mean discharge rate of $48.21 \text{ m}^3\text{s}^{-1}$. The total number of commercial ichthyospecies is twenty-one which consists of *S. progastus*, *S. richardsonii*, *B. bendelisis bendelisis*, *S. semiplotus*, *L. dero*, *A. hexagonolepis*, *T. putitora*, *C. latius latius*, *G. annandalei*, *G. goryla goryla*, *G. goryla stenorhynchus*, *G. lamta*, *G. McClellandi*, *G. mullya*, *C. bhandarii*, *B. bagarius*, *G. basnetti*, *G. deyi*, *G. sinense sikkimensis*, *P. sulcatus* & *C. orientalis*. The average CPGH recorded is 20.00 and average total species abundance is 6.00.

4. River Tista (Plate IV) The river ranks fourth amongst the principal rivers of Sikkim. It has the longest shore-line of ca 162 km from its origin to its confluence with river Rangit near Tista bazaar and is having the highest mean seasonal discharge rate of $202.38 \text{ m}^3\text{s}^{-1}$ (at Singtam).

The upper reach of the river above 1325 m (Tong) is devoid of any fish. However, as many as eighteen commercial fishes are available in the lower reaches of Tista within 360 m to 500 m gradients. These consist of *S. progastus*, *S. richardsonii*, *B. bendelisis bendelisis*, *L. dero*, *A. hexagonolepis*, *T. putitora*, *C. latius latius*, *G. annandalei*, *G. gotyla stenorhynchus*, *G. lamta*, *G. McClellandi*, *G. mullya*, *C. bhandarii*, *B. bagarius*, *G. bhutiai*, *G. gracilis*, *G. trilineatus*, *P. sulcatus*. The average CPGH of the river is 11.06; however highest CPGH recorded during monsoon at Singtam is 25.01. The average total species abundance is 11.00. Eleven lakes are associated with river Tista above 3962 m gradient. These are Khangchung chho, Gurudongmar, Gayum chhona, La chhu, Sugo chho, Gyapji chho, Thang chho, Kora chhobuk, Green lake, Lampepui chho and Chho Lhamu.

5. Rani khola (Plate VII) Rani khola has a shore-line of ca 25 km from its origin down to its confluence with river Tista at Singtam. Its seasonal mean discharge rate recorded at Saramsa is $15.49 \text{ m}^3\text{s}^{-1}$. The highest CPGH and total species abundance are 14 and 12.15 respectively during summer at 32 No. Martam. Altogether twelve commercial fishes are found in the river consisting of *S. progastus*, *S. richardsonii*, *B. bendelisis bendelisis*, *A. hexagonolepis*, *C. latius latius*, *G. annandalei*, *G. gotyla goryla*, *G. gotyla stenorhynchus*, *G. lamta*, *G. McClellandi*, *G. mullya* & *P. sulcatus*.

6. Dik chhu (Plate VIII) Though this river has a short shore-line of only ca 7 km, it is considered as one of the principal rivers of the state due to high mean discharge rate of $37.47 \text{ m}^3\text{s}^{-1}$, higher average abundance of total species (0.93) and CPGH 21. Besides, there are a total of nine commercial species available in the river consisting of *S. progastus*, *S. richardsonii*, *A. hexagonolepis*, *C. latius latius*, *G. annandalei*, *G. gotyla stenorhynchus*, *G. mullya*, *G. sinense manipurensis* & *P. sulcatus*. The highest CPGH & total species abundance are recorded during summer which are 29 and 0.04 respectively.

7. Bakcha chhu (Plate VI) This river has a shore-line of ca 18 km and mean discharge rate of $24.42 \text{ m}^3\text{s}^{-1}$. *Schizothorax richardsonii* is the only fish recorded in Bakcha chhu during the entire investigation period. Since the average abundance of the fish is found to be highest (0.051) amongst the entire drainages of the state and average CPGH value is also as high as 14.00; the river is considered as one of the principal rivers of the state especially for *S. richardsonii*.

8. Rimbi khola (Plate XI) It has a shore-line of ca 21 km and mean discharge rate of $21.67 \text{ m}^3\text{s}^{-1}$. However, there are four commercially important fishes occurring in Rimbi khola. These are *S. richardsonii*, *G. gotyla stenorhynchus*, *G. mullya* & *P. sulcatus*. The average CPGH recorded is 24.00 while the average total species abundance is 0.42. Khechiberi lake is associated with

Rimbi khola above 4000 m (msl).

9. Roathak khola (Plate XII) It has a shoreline of ca 13 km and mean discharge rate of $12.58 \text{ m}^3\text{s}^{-1}$. The commercially important ichthyospecies consists of *S. progastus*, *S. richardsonii*, *B. bendelisis bendelisis*, *S. semiplotus*, *A. hexagonolepis*, *T. putitora*, *C. latius latius*, *G. annandalei*, *G. goryla goryla*, *G. lamta*, *G. mcClellandi*, *G. mullya*, *P. sulcatus* & *C. orientalis*. The average CPGH and total species abundance are 1350 and 6000 respectively.

10. Kalej khola (Plate XI) Kalej khola has a shoreline of ca 25 km and seasonal mean discharge rate of $26.51 \text{ m}^3\text{s}^{-1}$. The important commercial fishes are *S. progastus*, *S. richardsonii*, *B. bendelisis bendelisis*, *A. hexagonolepis*, *T. putitora*, *C. latius latius*, *G. annandalei*, *G. goryla goryla*, *G. goryla stenorhynchus*, *G. lamta*, *G. mcClellandi*, *G. mullya*, *G. bhutiai* & *P. sulcatus*. The average CPGH and total species abundance recorded are 1350 and 6000 respectively.

8.2 Trends in fisheries of different species

Of the forty-eight (48) species, *Schizothorax richardsonii*, *Pseudecheneis sulcatus*, *Garra spp.*, *Schizopyge progastus*, *Crossocheilus latius latius* & *Acrossocheilus hexagonolepis* are the dominant species followed by *Barilius spp.*, *Noemacheilus multifasciatus*, *Tor putitora*, *Noemacheilus scaturigina*, *Danio aequipinnatus*, *Euchiloglanis hodgarti*, *Bagarius bagarius*, *Glyptothorax bhutiai*, *Semiplotus semiplotus*, *Labeo dero*, *Balitora brucei*, *Noemacheilus beavani*, *Noemacheilus devdevi*, *Glyptothorax trilineatus*, *Clupisoma bhandarii*, *Glyptothorax basnetti*, *Glyptothorax gracilis*, *Glyptothorax deyi*, *Barilius bendelisis chedra* & *Channa orientalis*. However, *L. pangusia*, *N. Kangjupkhulensis*, *N. sikmaiensis*, *N. spilopterus*, *Laguvia ribeiroi ribeiroi*, *L. ribeiroi jorethangensis*, *G. sinense manipurensis*, *G. conirostrae*, *A. bengalensis*, *S. trutta fario*, *D. naganensis*, *N. carletoni*, *N. corica*, *Acanthopthalmus pangia*, *G. sinense sikkimensis* & *Pangasius pangasius* are the rare species confined to only one or two rivers. The first category of dominant species alongwith *Tor putitora*, *Bagarius bagarius*, *Glyptothorax spp.*, *Semiplotus semiplotus*, *Labeo spp.*, *Clupisoma bhandarii*, *G. basnetti* & *Channa orientalis* contributes as important fisheries of the state. Fish in general are very much in demand irrespective of their size and shape. However, *Tor putitora*, *Schizothorax richardsonii*, *Schizopyge progastus* and *Acrossocheilus hexagonolepis*, *Semiplotus semiplotus*, *Labeo spp.* & *Clupisoma bhandarii* are highly relished by the common folk.

Miscellaneous group consisting of 2 species of *Barilius*, 7 species of *Noemacheilus*, 2 species of *Danio*, *Euchiloglanis hodgarti*, *Balitora brucei*, 2 species of *Laguvia*, *Acanthopthalmus pangia* & *Pangasius pangasius* have not much fishery value.

Schizothorax richardsonii, the snow trout is by far, the most dominant species recorded

throughout the drainages of Sikkim from the lowest elevation 240 m up to 1340 m. However, the present investigation reveals that the species is more abundant at higher stretches from 500 m to 1340 m. It is a cold water fish; attains a length of ≤ 600 mm (Jhingran, 1983). The flesh of this fish is highly relished and contributes as one of the most important commercial fisheries of the state. Snow trout prefers rapids and pools of torrential streams of the temperate range 9.25°C to 27°C.

Bakcha chhu is exclusively established with *S. richardsonii* with highest CPGH of during Summer, 14.5 during Monsoon and 18 in Winter. The corresponding abundance value during the three seasons are 0.072, 0.034 and 0.042 respectively. The species is available in plenty in Rimbi khola together with other species where average CPGH and total species abundance are 0.033 and 0.023 respectively.

Pseudecheneis sulcatus ranks second amongst the most dominant species of the region. Its distribution is extended to all the rivers of both the Tista and the Rangit drainages from 240 m to 1065 m gradients. Being a species of wide distribution, it plays a major role in the fisheries of the state. The species is available round the year and is caught by cast net.

Schizopyge progastus is another representative of the Schizothoracinae known to inhabit all the rivers at the foothills up to 745 m elevation namely Tista, Jali khola, Rani khola, Dik chhu, Ghattay khola, Rangpo khola, Rangit, Kalej khola, Rishi khola, Roathak khola and Rangbhang khola. The species is available in abundance from March till late October in rivers with high discharge rate - Tista, Dik chhu, Rangpo khola, Rangit and Rangbhang. The catch decreases gradually with the onset of winter.

Garra spp.: The distribution of the six different species of *Garra* under report is of the order of *G. mullya* > *G. annandalei* > *G. goryla goryla*, *G. goryla stenorrhynchus* > *G. mcClellandi*, *G. lamta*. Of the 16 rivers surveyed, *G. mullya* & *G. annandalei* are found to be present in 12 rivers up to 1065 m and 750 m respectively. Other 4 species are restricted in their distribution up to 750 m. The small rivulets and streams swell up during monsoon with an increase in turbidity, as a result, the excess stream water alongwith its fish fauna comprising mostly of *G. mullya*, *G. lamta*, *G. annandalei* & *G. mcClellandi* rushes into the adjoining terraces of paddy fields. The villagers harvest the crop without putting any effort or investment. This is a regular feature in the hills at altitudes ranging from 300 m to 1065 m. Thus, the group in general has a significant contribution towards the fishery of the state. The largest member of the group *G. goryla goryla* & *G. goryla stenorrhynchus* as large as 230 mm and 240 mm were collected during the present study from the lower stretches (530 m) of both the drainages. *Garra* spp. are all typical hill stream dwellers and browse on the algal matter covering rocks, stones and pebbles. Like *S. progastus*,

Garra spp. are available in plenty during summer and monsoon. It breeds in small streams and rivulets during May-June.

***Crossocheilus latius latius*:** Though the average size of the fish is 150 mm, it forms an important fishery of the state as it is very common in all the rivers of both the drainages. The species is widely distributed up to 700 m in Tista, Rani khola, Rin khola, Dik chhu, Ghattay khola, Rangpo khola, Kalej khola, Rishi khola, Roathak khola, Rangbhang khola and river Rangit. Though the species is available throughout the year, it becomes more abundant during monsoon. The species looks very close to *Garra*, but its highly indented upper lip distinguishes it from the latter.

***Acrossocheilus hexagonolepis*:** The well known copper mahseer or chocolate mahseer is a true hill stream fish occurring in all the rivers of both the Tista and Rangit drainages up to 700 m elevation. With the first downpour of monsoon, the species is caught in plenty in the lower stretches of the rivers. It attains a length of 900 mm and contributes as an important commercial species. It differs from *Tor putitora* in having thin lip continuous around the angles of the mouth with the labial fold widely interrupted in the middle. It has head more or less equal to body depth. The species derives its name hexagonolepis due to the hexagonal shape of the exposed portion of the scales.

***Barilius bendelisis bendelisis*:** Of the three different species reported from the state, *B. bendelisis bendelisis* is fairly common at the lower reaches of both the drainages within 240 m to 700 m and forms an important fishery of the state. The species occurs in Tista, Rani khola, Rangpo khola, Rangit river, Kalej khola, Rishi khola, Roathak khola, Rangbhang khola and is caught in plenty during late summer gradually declining in winter. Other two species *B. b. chedra* & *B. vagra* are of not much value.

Tor putitora or the golden mahseer is the most common mahseer of the Himalayas. The present study reveals that the species becomes available in the lower gradients (up to 525 m) of the rivers viz. Tista, Rangpo khola, Rangit and Rangbhang from early March till late October. Confluence of Rani khola and Tista at Singtam, Rangpo khola at Rorethang, Confluence of Rangit & Rangbhang at Nayabazar, Rangit river from Jorethang up to Manpur are some of the well known zones/spots where commercial fishermen as well as anglers have been recorded to catch *Tor putitora* as large as 13 kg weight during March to May and September - October. The fish migrates from main rivers in plains to smaller tributaries in hills for spawning. Besides being a good food fish, it affords a lucrative source of sport.

***Glyptothorax* spp.:** Six different species of *Glyptothorax* together constitute one of the most important fishery of the state. They are distributed in the order *G. bhutiai* > *G. trilineatus*, *G.*

basnetti, *G. gracilis* > *G. deyi* > *G. sinense manipurensis*, *G. conirostrae* > *G. sinense sikkimensis*. No sooner the water becomes turbid with the first flush of the monsoon, different species are caught in abundance by cast net. These are commonly available in the lower stretches of the river within 240 m to 525 m elevations during the monsoon. It is seen from the present study that the largest member of the group is *G. basnetti* which grows to 390 mm in length.

Clupisoma bhandarii: It is a rare species inhabiting the lower gradients (240 m to 360 m) of Tista, Rangit and Rangbhang only during monsoon. Though the species is of rare occurrence confined to few rivers at lower stretches, it has a very good taste and is highly relished by the local people.

Bagarius bagarius is the biggest Siluroid recorded from the lower stretches of large rivers namely Tista, Rangpo khola, Rangit and Rangbhang up to 525 m. The species are mostly caught by anglers at the confluence of Rani khola and Tista at Singtam, Rangpo khola at Rorethang, Rangbhang khola, river Rangit from Jorethang to Manpur. The species is available from March till the end of October. The largest catch record of the species is 62 kg.

Anguilla bengalensis: Although it is a rare species available only in river Rangit up to 500 m during monsoon and post - monsoon, it is considered as an important commercial species because of its large size and good taste.

Channa orientalis: The only species of the snake headed murrels is distributed in rivers Rangit, Roathak and Rangbhang within 240 m to 380 m elevation. It is a rare species and is available only during monsoon.

Labeo spp.: *Labeo dero* & *L. pangusia* under report are rare species occurring in the lower altitudes of the drainages (240 m to 525 m). The former is found to be present in rivers Tista, Rangpo khola, Rangit and Rangbhang while the latter species is a casual visitor to Rangpo khola and Rangit river. *Labeo dero* becomes available from late summer till the end of monsoon while *L. pangusia* was collected only during monsoon. *Labeo dero* is very close to *L. pangusia* but differs from it due to the absence of distinct groove across the snout and labial fold is uninterrupted.

Semiplotus semiplotus: It is a rare species found only in rivers Rangpo khola, Rangit, Roathak and Rangbhang. However, it is more concentrated in Rangpo khola at 525 m elevation. The species becomes available from March - April till the end of October. It grows to a length of 193 mm. Some of the fishermen living by the banks of Rangpo khola at Rorethang process the fish by the local method of smoking and preserve it for future use as and when required.

8.3 Fishing Gears & Devices

Various types of fishing gears and devices are found in operation in the drainages of Sikkim to catch the riverine fish which are elucidated hereunder.

I. Fishing without gear

Sometimes, fishes in stream and shallow rivers are captured mainly by the following two methods without applying any gear:

1. Grooping

Shallow pools formed along the course of a stream or rivulet are best habitats of some of the smaller variety of fish. Some children are fond of collecting fish by simple grooping with bare hand. This is a common phenomenon practiced throughout the state mostly during monsoon at elevations ranging from 300 m to 1640 m. Besides *Noemacheilus* spp. and *Euchiloglanis hodgarti*, fry of *Schizothorax richardsonii*, *schizopyge progastus*, *Garra* spp., *Acrossocheilus hexagonolepis*, *Barilius* spp. etc. are captured by this method.

2. Impoundment (Plate XXI-3 & 5)

Smaller rivers of 1.5 m to 5 m breadth are best suited for collecting fish by this method which is locally referred to as '*Duwali*'. The natural course of the stream/river where it bifurcates is selected for the purpose and the water is diverted to flow through only one course by erecting a barricade of stones, silt, mud along with the shrubs in the other channel. As soon as the water flow is stopped completely, the channel gets dried up and the fishes are exposed and are thus collected with bare hand. All the different species of fish and their fry available in the stream collected by this method are - *Schizothorax richardsonii*, *Schizopyge progastus*, *Pseudecheneis sulcatus*, *Garra* spp., *Acrossocheilus hexagonolepis*, *Barilius* spp., *Euchiloglanis hodgarti*, *Noemacheilus* spp. etc. This method is usually practiced from late summer to late monsoon.

II. Fishing with gear

Different fishing gears are used for different types of water bodies. In deep waters, angling with rod & line and cast nets are the major fishing gears operated.

A. Rod and Line

1. Without hook (locally known as '*manew*' Plate XXI-1)

At one end of the nylon string, two loops of desirable diameter 50 mm to 150 mm are made opposite to each other and a lure of bright paper is tied in the middle of the two. A small load is placed just vertically below the lure so that the whole structure when dropped in water does not get carried away. The other end of the string is tied to a bamboo pole. The pole is placed in an inclined position dipping the lure and loop in water where the water flushes from a higher gradient

to lower gradient. As soon as the fish comes to attack on the lure, it gets entangled in the loop and is caught alive without any injury. This practice of fish capture is indigenous to Sikkim and is operated in clear water from December to March in all the rivers. *Schizothorax richardsonii* & *Schizopyge progastus* from 150 g to 2 kg are caught by this method.

2. With hook

Under this category, two types of gear most commonly in use are '*Balchhi*' and '*Dhukuwa*'.

Balchhi: Bamboo rod (length 3.658 m) and nylon lines (length 1.829 m to 2.438 m) with metallic hooks and bait of caddish larvae, earthworm etc. are operated to hook fishes like *Schizothorax richardsonii*, *Schizopyge progastus*, *Acrossocheilus hexagonolepis*, *Tor putitora*, *Glyptothorax spp.* (except *G. basnetti*), *Danio spp.*, *Barilius spp.* etc. The size of the catch ranges from 100 g to 13 kg. '*Balchhi*' is operated in all the rivers irrespective of seasons.

Dhukuwa : The principle of mechanism of '*Dhukuwa*' is similar to that of '*Balchhi*'. Stronger metal is used to make stouter and larger hook which is connected to a parachute thread of 40 cm length tied to a stone of 1 - 1.5 kg. The free end of the parachute thread is again connected to a nylon thread of 30 metres length which is tied around a rock or boulder. Natural baits of caddish larvae, earthworm etc. are placed in the metallic hook. Once the fish attacks the bait, the upper jaw gets entangled in the hook and as it tries to free, the inner sharp hook pierces the palate. Larger fish namely *Tor putitora*, *Acrossocheilus hexagonolepis*, *Bagarius bagarius* of 5 kg to 62 kg are caught by this operation and is practiced mostly in larger rivers - confluence of Tista & Rani khola at Singtam, Rangbhang khola, Kalej khola, Rangit at Nayabazar, Jorethang and Manpur belt.

B. Scooping net

These are usually operated in shallow waters of 10 mm to 40 mm depth with stones and pebbles.

Hand net: Wire mesh or muslin cloth or mosquito nets are tied to a bamboo stick or metallic wire which is then bent to prepare hand nets of desirable shape and size to suit the need. U shaped net (Plate XXI-4) was prepared during the present investigation to collect *Noemacheilus spp.* from the rheophilic rivers of Sikkim.

Rectangular net: Two persons, holding the opposite ends of a rectangular piece of cloth/wire mesh/mosquito net place it under stagnant pool or running water and allows the water to flow over the cloth for sometime. Small fishes and fry of *Schizothorax richardsonii*, *S. progastus*, *A. hexagonolepis*, *Barilius spp.*, *Semiplotus semiplotus* etc. are caught when the cloth is lifted above.

These two methods are applied generally by children of age group 6 - 14 years for

entertainment and are practiced mostly during monsoon.

C. Encircling net

Locally known as '*Jal*' (Plate XXI-2), this circular cast net is made of nylon or parachute thread woven and enlarged from a central knot. The periphery line has metallic sinkers of iron or lead. The fishermen generally operate cast net of two different sizes

- (1) small size locally known as '*Bhure jal*' with 1.5 m diameter, 15 mm to 20 mm mesh size with 3 kg weight; and
- (2) bigger size net locally known as '*Totay jal*' 2 m in diameter, mesh size 30 mm with 4 - 5 kg weight.

But, during the present study cast nets of various sizes (diameter 11 feet to 13 feet) and weight (5 kg to 7 kg) have been found in operation in few locations namely Passingdong, Dikchu and Rorethang. Once the net is thrown over the river, sinkers settle down at the bottom of the river; as a result the net encircles an area. Small to large sized fish inhabiting the surface, column and bottom waters are caught by this method. This is one of the most common method of fishing in all the water bodies of the state round the year. The fisherman usually carries a bamboo stick of 1.5 m to 2 m length mainly to support himself against the water current and also to pull out the entangled net from odd substratum.

D. Maize and barricades

1. Basket trap

Locally known as '*Dharhia*' or '*Bhuk*' is fabricated with bamboo splits (1 mm to 2 mm thickness strips) knitted in a rectangular shape of varying sizes from 2 x 1.5 feet to 6 x 2 feet. The inner mouth of the basket is knitted in a conical form with pointed bamboo splits projecting and forming a trap door. The basket is placed in a stagnant pool by the river bank at night. Fishes coming along the barricade enters through the trap door which obstructs any exit. This is operational in all the rivers throughout the year. All the different species of fish of varying size up to 1 kg are caught by this method.

2. Tharhe Bhuk

One end of larger size of green bamboo is cut longitudinally making a funnel shaped trap (diameter 1.5 feet, length 7 feet) with long tube. Split bamboo and wire are tied around the funnel shaped structure leaving uniform mesh size. This is placed along the water current of the river at the time of down migration. All the different species of the fish like *Schizothorax richardsonii*, *S. progastus*, *Garra spp.*, *Crossocheilus latius latius*, *Barilius spp.*, *Danio aequipinnatus*, *A. hexagonolepis*, *Semiplotus semiplotus*, *Labeo spp.*, *Channa orientalis* etc. are often caught by this

trap.

3. Chip

Bamboo splits are woven to form a small platform keeping uniform interspaces and is placed in an inclined position under a low water fall allowing the entire stream water fall over it. The height of the fall is maintained in such a way that the fish falling on the bamboo platform can not return back. This method is used at the time of down migration in September - October. Medium to large sized fishes especially *Tor putitora*, *Semiplotus semiplotus*, *Channa orientalis*, *Labeo dero* & *Labeo pangusia* are caught with this gear.

III. Miscellaneous Methods

1. Blasting with dynamite

Incalculable loss of fish is done by blasting selected pockets of deep pools along both the drainages. The dead fish in mass are floated and carried away by water. The after effect of dynamite is so severe that the specific length of the river becomes uninhabitable for fish for a couple of months.

2. Poisoning

Several kinds of both organic and inorganic materials are applied for killing fish in both the drainages. In the most indigenous method, villagers use the extract of local plants - *Artemesia vulgaris*, *Raphidophora*, barks of “ Angeri ” and also saw dust in deep pools. Bleaching powder, Lime, gypsum, various insecticides and pesticides have also been recorded to be in use in specialized pockets of the Sikkim drainage to capture fishes.

Explanations of Plate XXI

Fish capturing gears and devices found in operation in the drainages of Sikkim.

1. Angling with " Rod and Line " in Rimbi khola
2. Fishing with " cast net " in Kanaka chhu
3. Fishing through " diversion of stream course "
in Rani khola
4. Scooping with " hand net "
5. Collection of *Garra sp.* (white arrow) and *Noemacheilus sp.*
(black arrow) through diversion of stream course in Rani
khola.
6. Captured fish being carried by fishermen for sale.



8.4 Biology of *Schizothorax richardsonii* (Gray)

Of the 48 ichthyospecies recorded in the twin drainages of Sikkim, *Schizothorax richardsonii* (Gray) is found to be the most dominant and widely distributed fish species exposing potentialities and prospects for its fisheries in this Himalayan state of the country. Some pertinent aspects of its biology, hitherto remain unreported but presently studied even with the limitations of the principal objectives of the treatise under report notwithstanding, are presented below.

(a) Growth trend of different body parts

Head length, head breadth, head depth, gape of mouth, eye diameter, inter orbital distance, inter nasal distance, snout length, maxillary barbel length, rostral barbel length, body depth, body width, dorsal height, anal height, pectoral length, pelvic length, length of caudal fin, length of caudal peduncle, highest depth of caudal peduncle, least depth of caudal peduncle, pre-dorsal distance, pre-pectoral distance, pre-pelvic distance, pre-anal distance, distance between origin of pectoral and origin of pelvic, distance between origin of pelvic and origin of anal and distance between origin of pelvic and anus selected in *Schizothorax richardsonii* (Gray) and regressed against the total body length amongst the population in the species to help assess the relative growth of these body parts. Pre-anal distance has been recorded to be the fastest growth rate zone and the barbel length as the minimum. A detailed account is purported in Table 13.

(b) Weight-length relationship

Considering the specific gravity as constant throughout life this relationship is used to calculate the weight of the fish from a known length and vice versa within a certain range of error. The main object of the work is aimed at fitting this relationship and testing the goodness of fit and is judged from the sample coefficient in all the cases. Length-weight relationship gives a straight line regression and shows that the increase in weight of fish is an exponent function of its length.

The parabolic form of the equation for *Schizothorax richardsonii* (Gray) obtained in respect of both sexes during the periods of investigation from the Sikkim drainages is purported below.

The data on *Schizothorax richardsonii* (Gray) consisted of measurements of 1218 specimens ranging in total length from 17 to 410 mm and in weight from 0.4 to 423 g. The formula correlating both length and weight of the species is given below, while the trend has been depicted in Figures 14 to 21.

For male (n = 6.44)

$$\text{Weight} = 513 \times 10^{-6} L^{3.153}$$

$$\text{or } \log \text{Weight} = - 5.290 + 3.153 \log L$$

The coefficient of correlation between the log Length and log Weight is 0.892. The standard error

of estimate in terms of logarithm is ± 0.008 .

For female ($n = 574$)

$$\text{Weight} = 188 \times 10^{-5} L^{2.890}$$

$$\text{or log Weight} = - 4.726 + 2.890 \log L$$

The coefficient of correlation between the log Length and log Weight is 0.933. The standard error of estimate in terms of log. is ± 0.005 .

Besides, the overall L-W relationship expositions in male and female species, its seasonality trend had also been observed in each case especially because the result would help understand the growth trend of different sexes in different periods of time. The computed data, thus obtained, are presented below in a tabular form.

Sex	N	Season	Log c	n	r + SE
MALE	220	Summer	-3.545	2.287	0.802 \pm 0.024
	265	Monsoon	-5.690	2.422	0.815 \pm 0.021
	159	Winter	-4.561	2.833	0.931 \pm 0.011
FEMALE	221	Summer	-5.234	3.124	0.895 \pm 0.013
	160	Monsoon	-2.969	1.971	0.721 \pm 0.038
	193	Winter	-4.835	2.931	0.986 \pm 0.019

(c) Condition coefficient

The usual mode of expression of the value of the condition is the mathematical equation proposed by Fulton (1902) :

$$Q = \frac{W \times 100}{l^3},$$

where W = weight of fish, l = its length and Q = the condition coefficient. The cube root of the length is taken because the growth in weight is proportional to the growth in volume.

However, this equation becomes untenable where the sizes of the fish varies between a wide amplitude (Rounsefell & Everhart, 1953). In such case, Ricker (1975) relative condition coefficient (K_n) gives dependable result which has therefore been applied in the present study. It is computed after the equation $K_n = w/W$ where w is the observed weight and W is the expected weight calculated through cL^n (Rounsefell & Everhart, 1953).

With condition coefficient it is possible to define the seasonal changes in the condition of fishes in relation to size and sex of the fish (Nikolsky, 1963). It is also an index of the well being

of the fish and reliably used for comparative studies amongst the closely related species as well.

In the present investigation, specimens of *Schizothorax richardsonii* (Gray) above 400 mm total length could not be collected in reasonable number especially at male and female segregation levels through three discernable seasons of the year, which was why, the condition coefficient of the size range 150 - 400 mm TL had been accounted (above 150 mm size group) within the purview of the present study. The average value thus obtained in each size group is presented below.

Sex	Size	Summer	Monsoon	Winter
Un-sexed	Below 150 mm	1.05	0.86	0.91
Male	150 - 400 mm	1.23	1.06	0.94
Female	150 - 400 mm	0.99	1.08	1.06

(d) Gonadosomatic index

Knowledge of the various aspects of breeding in fishes is of great value to help assess how successful a species is in colonizing a body of water against resistance from biotic and abiotic factors. And in such perspectives the gonadosomatic index (GDSI) is considered as an indicator of the spawning frequency. The index is also used to study the maturity of ovaries.

The seasonal trend of the mean GDSI recorded in *Schizothorax richardsonii* (Gray) from the drainages of Sikkim is given below.

SEASON	X GDSI
Summer	3.47
Monsoon	10.73
Winter	3.15

The higher GDSI values of *Schizothorax richardsonii* (Gray) during monsoon exhibits the maturity of the fish culminating its breeding in this period in sharp contrast to very low values during summer and winter.

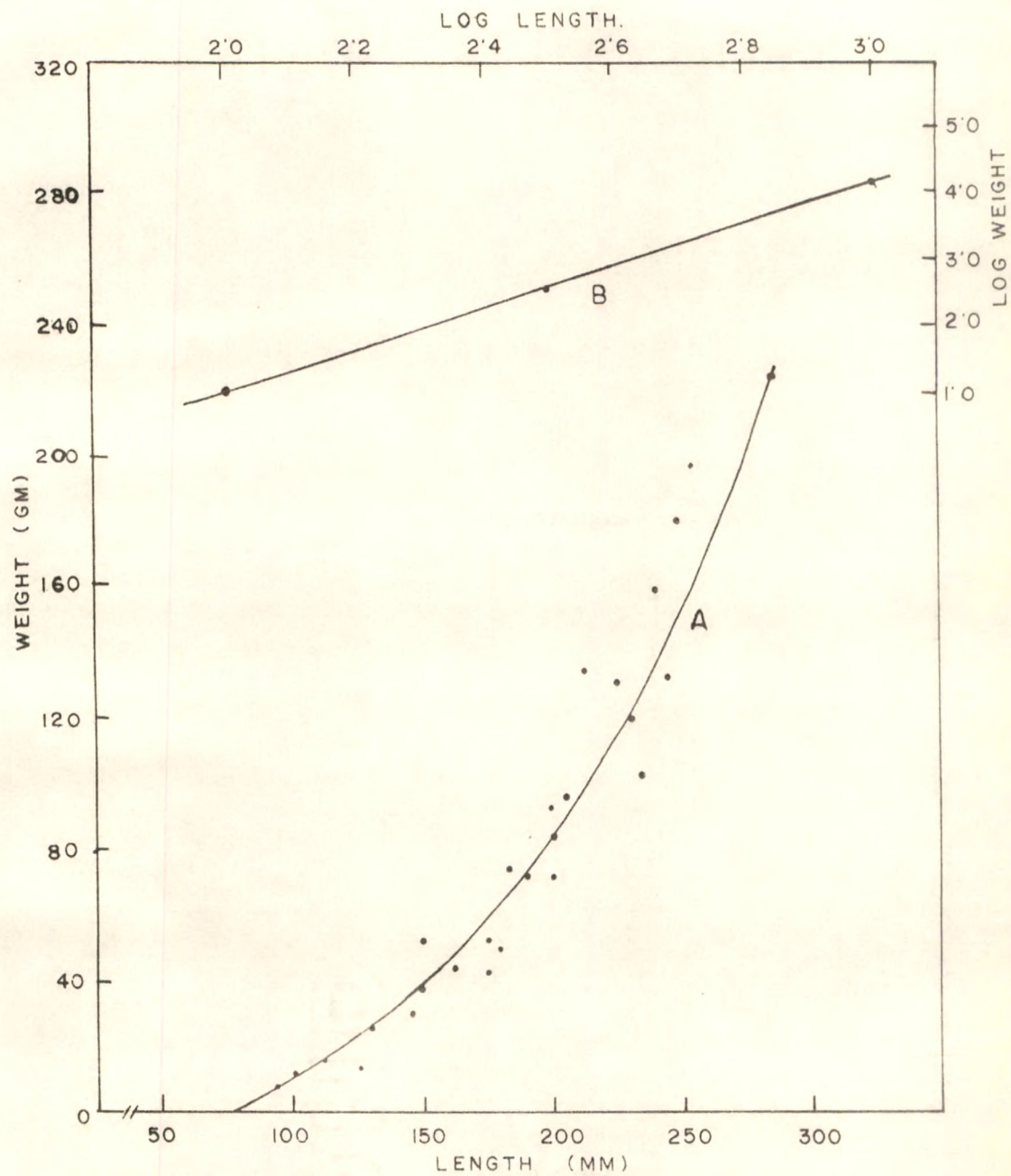


FIGURE.14. GENERAL LENGTH WEIGHT RELATIONS IN MALE SCHIZOTHORAX RICHARDSONII DURING 1987 AND 1988. CURVE - A, ABSOLUTE VALUES; CURVE - B, LOG LOG TRANSFORMATION.

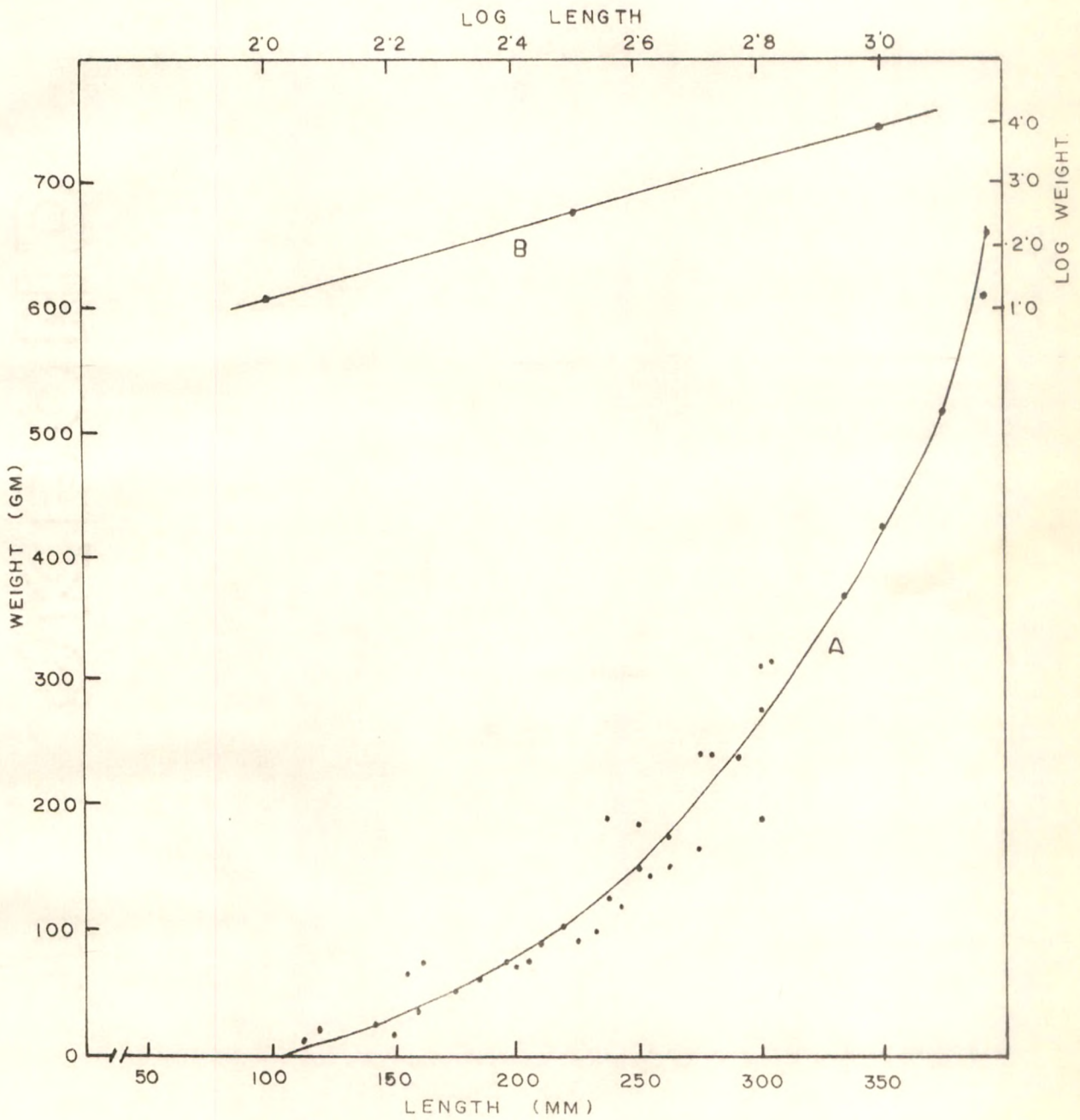


FIGURE 15. GENERAL LENGTH WEIGHT RELATIONS IN FEMALE SCHIZOTHORAX RICHARDSONII DURING 1987 AND 1988. CURVES A, B, AS IN FIGURE 14.

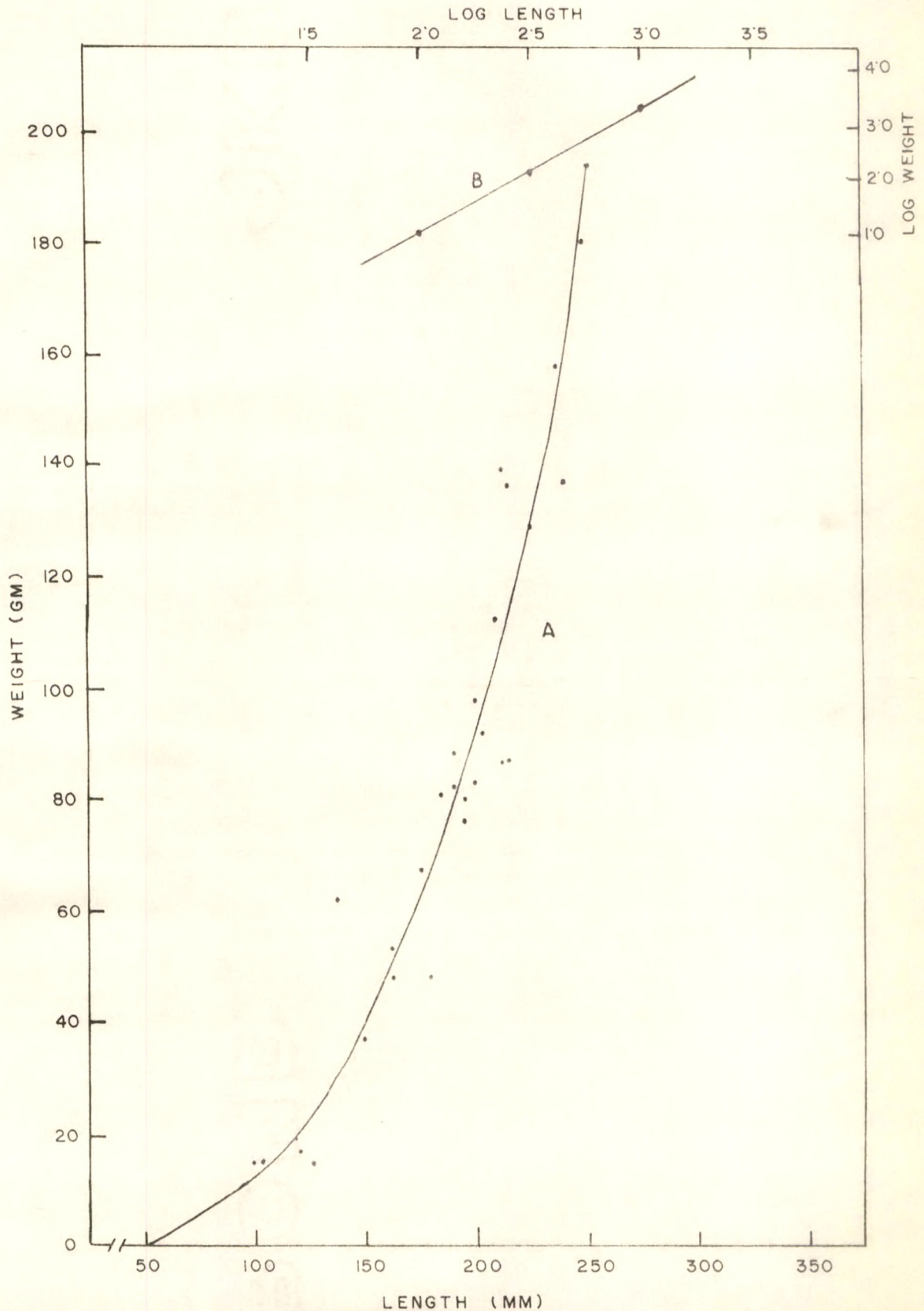


FIGURE.16. GENERAL LENGTH WEIGHT RELATIONS IN MALE SCHIZOTHORAX RICHARDSONII DURING SUMMER OF 1987 AND 1988. CURVE - A, ABSOLUTE VALUES; CURVE - B, LOG LOG TRANS-

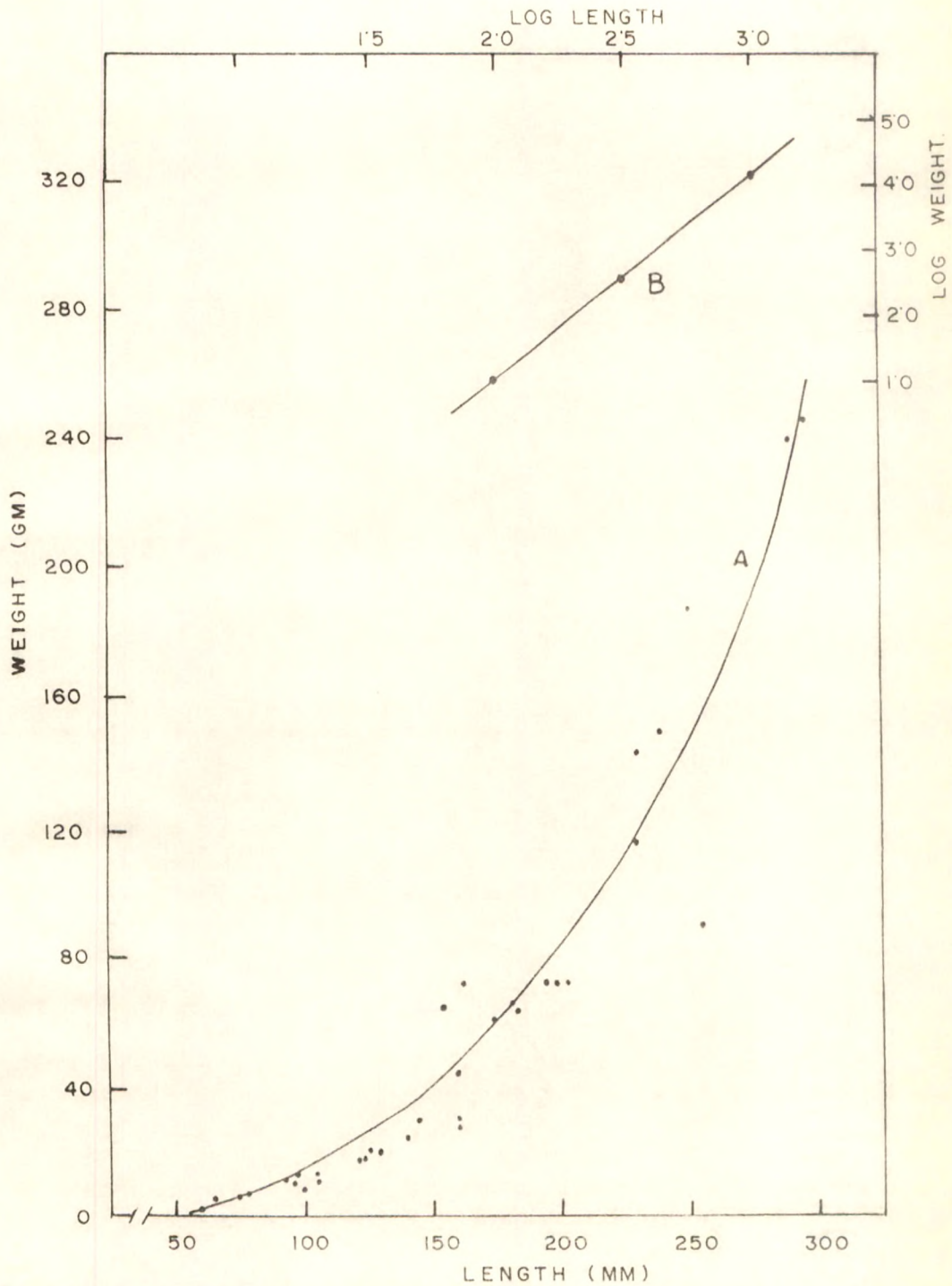


FIGURE 17. GENERAL LENGTH WEIGHT RELATIONS IN FEMALE SCHIZOTHORAX RICHARDSONII DURING SUMMER OF 1987 AND 1988. CURVES A, B, AS IN FIGURE 14.

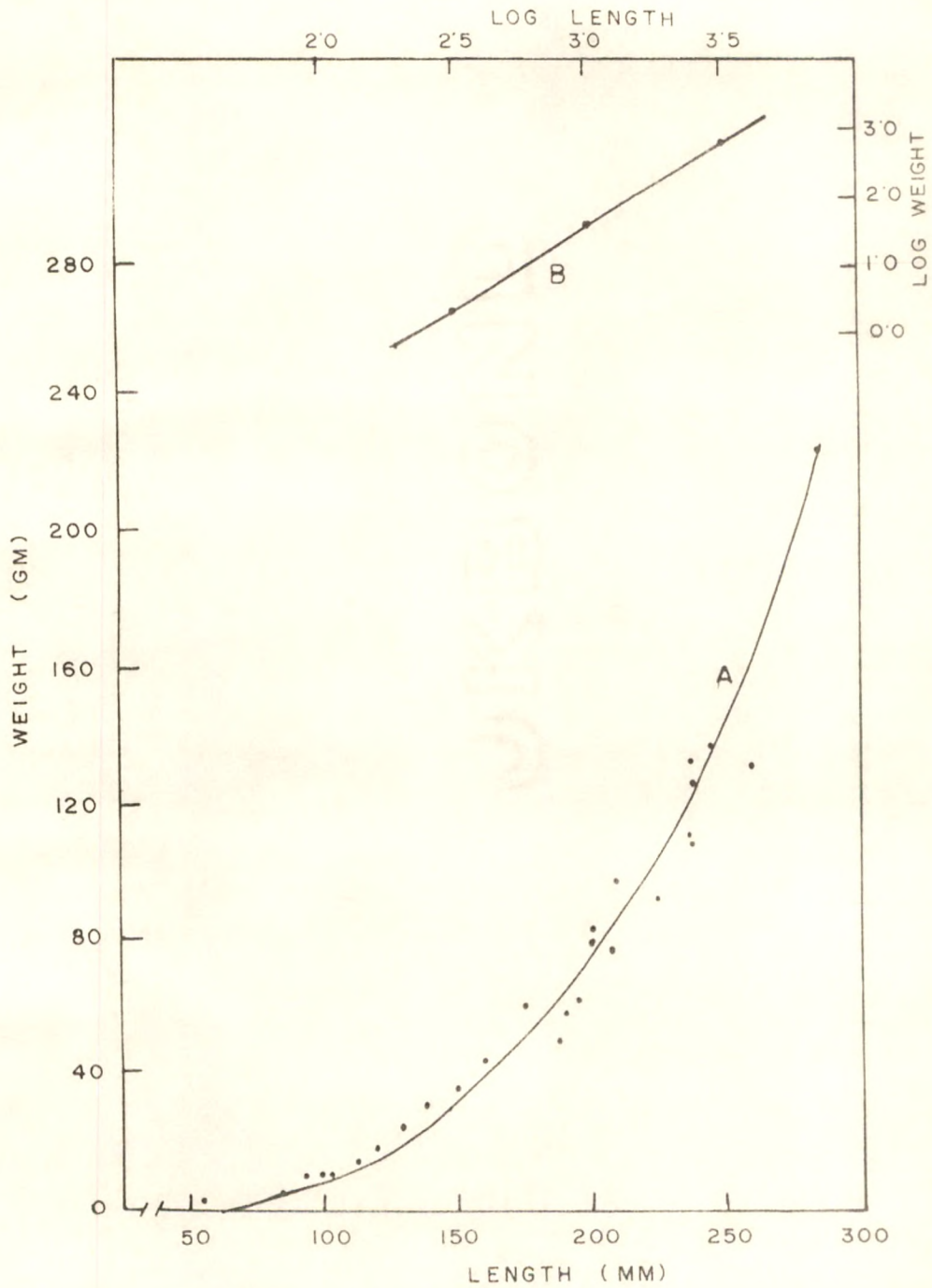


FIGURE 18. GENERAL LENGTH WEIGHT RELATIONS IN MALE SCHIZOTHORAX RICHARDSONII DURING MONSOON OF 1987 AND 1988. CURVES A, B, AS IN FIGURE 14.

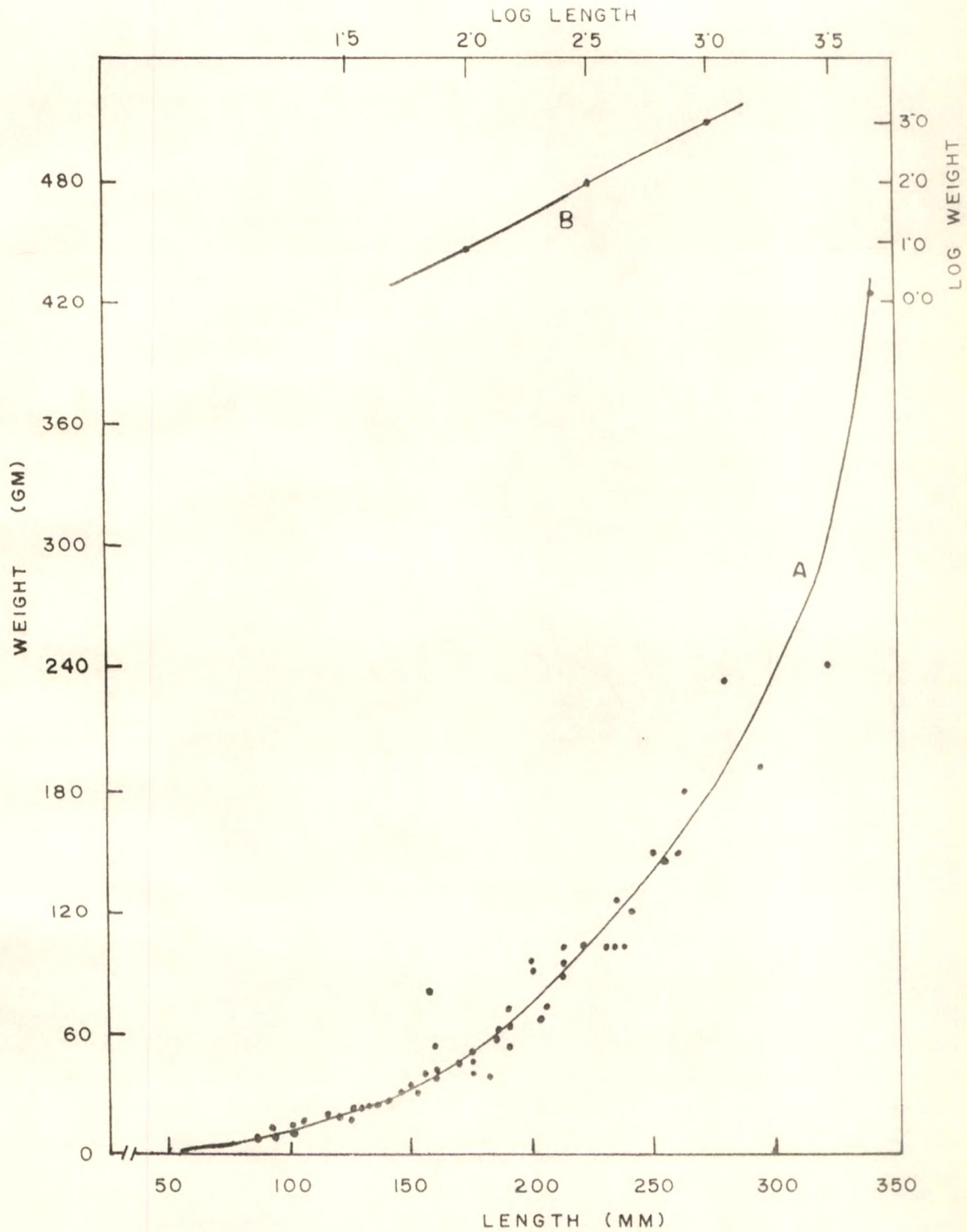
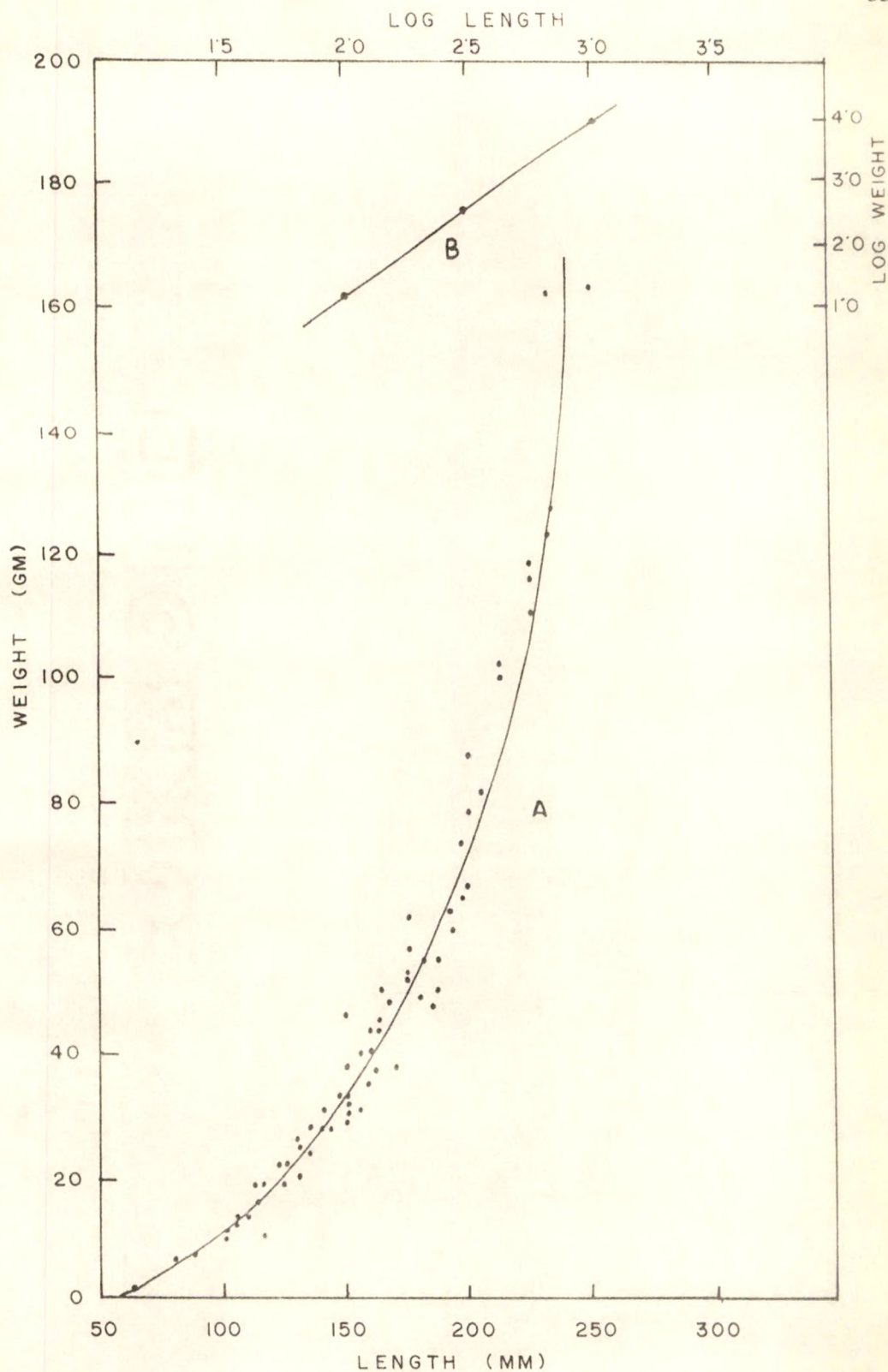


FIGURE. 19. GENERAL LENGTH WEIGHT RELATIONS IN FEMALE SCHIZOTHORAX RICHARDSONII DURING MONSOON OF 1987 AND 1988. CURVES A, B, AS IN FIGURE 14.



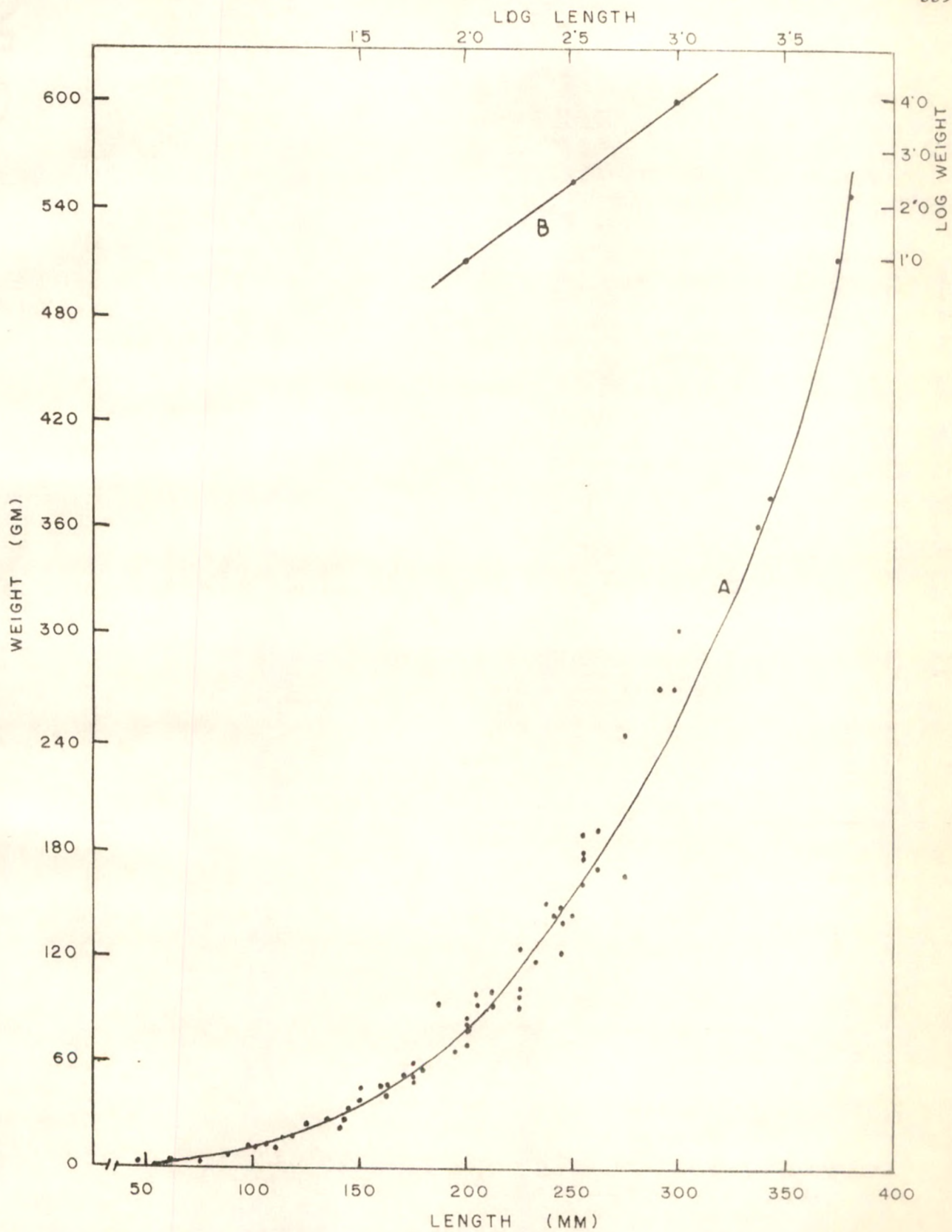


FIGURE.21. GENERAL LENGTH WEIGHT RELATIONS IN FEMALE SCHIZOTHORAX RICHARDSONII DURING WINTER OF 1987 AND 1988. CURVES A, B, AS IN FIGURE 14.

(e) Fecundity

The fecundity of a good may females of *Schizothorax richardsonii* (Gray) with TL ranging from 102 to 453 mm were estimated. The mean fecundity of different size ranges are purported below.

TL (mm) Range		\bar{X} Fecundity
< 200	1445
200 - 250	1810
251 - 300	2534
> 300	2688

In *Schizothorax richardsonii* (Gray) the fecundity ranges from 1167 to 3653, the number of ova per gram weight of ovary was estimated as 101 to 292 with corresponding ova/gm fish weight from 11 to 12.

The relationship between fecundity and relevant parameters, namely, total fish length, total fish weight and total ovary weight was regressed by least square method and the results thus obtained in *Schizothorax richardsonii* (Gray) are given below.

Fecundity and Total length (Figure 22)

A least square regression on the absolute values was used to fit a straight line equation to the relationship between the total length of the fish and its fecundity. It exhibited a high degree of positive but limited correlation ($r = + 0.715 \pm 0.028$) which was tested to be highly significant ($P < 0.01$). The regression equation thus estimated was as follows:

$$F = 38.01 \text{ TL} - 7132$$

where, F was the number of ova and TL was the total length of the fish in mm.

Fecundity and Total body weight (Figure 23)

Linear least square regression was carried out on the absolute values of both total body weight of the fish in gm and the fecundity in number and the result showed a positive but limited correlation, with $r = + 0.468 \pm 0.124$ and the t-test showed the correlation insignificant ($P > 0.05$) even at 5 % probability level. The computed RE was estimated as,

$$F = 5.12 \text{ TW} + 1027$$

where, TW was the total body weight of the fish in gm.

Fecundity and Ovary weight (Figure 24)

The straight line equation to the relationship between ovary weight in gm. and fecundity in number was regressed through least square method. It showed a positive limited correlation, $r = + 0.135 \pm 0.011$, with t-test insignificant at 5 % probability level ($P > 0.05$). The following regression equation was obtained:

$$F = 1.52 OW + 1638$$

where, OW was the ovary weight in gm.

Ratios between observed fecundity (OF) and estimated fecundity after RE (EF) had been analyzed in *Schizothorax richardsonii* (Gray) to evolve the reliability level of EF over OF and the result is given below:

OF : Ef (TL)	OF : EF (BW)	OF : EF (OW)
1 : 0.98	1 : 1.88	1 : 1.50

The result demonstrated that the relationship could reliably be used to determine the fecundity of matured female in *Schizothorax richardsonii* (Gray) from its known length (TL) than the body weight (BW) or ovary weight (OW).

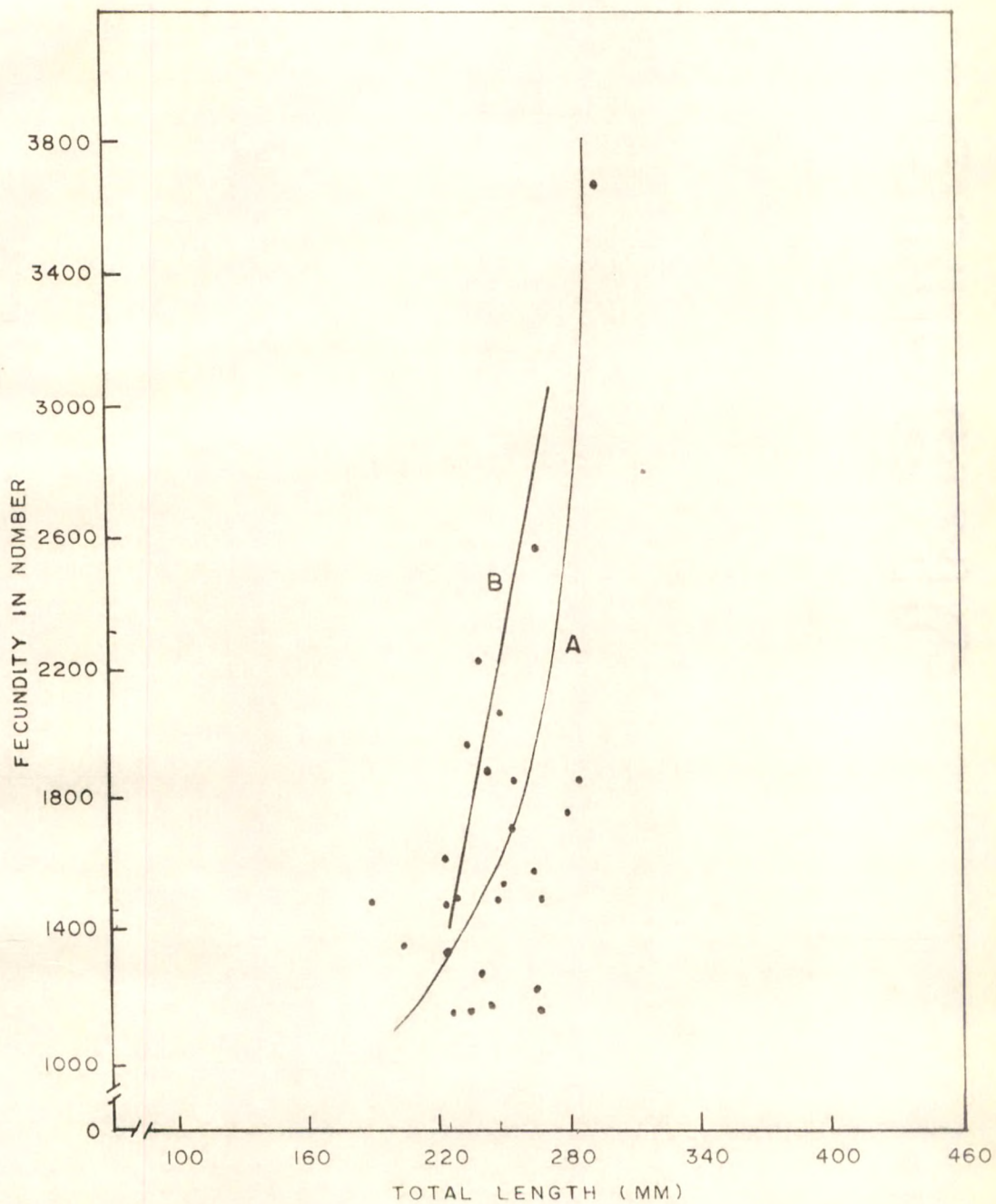


FIGURE.22. TOTAL LENGTH AND FECUNDITY RELATIONS IN SCHIZOTHORAX RICHARDSONII. CURVE - A, OBSERVED VALUES ; CURVE - B, EXPECTED VALUES,

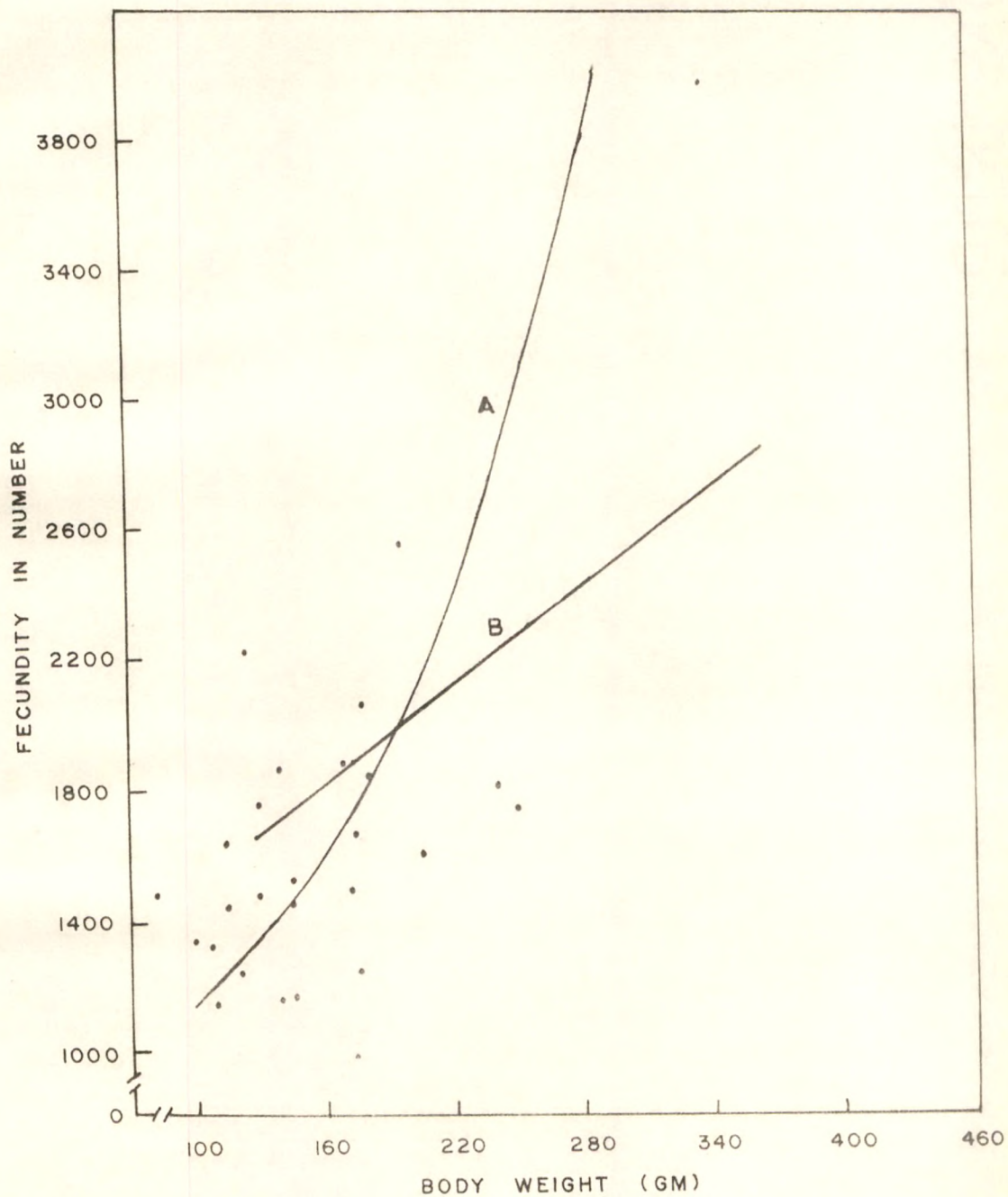


FIGURE. 23. BODY WEIGHT AND FECUNDITY RELATIONS IN SCHIZOTHORAX RICHARDSONII. CURVES A, B, AS IN FIGURE 22.

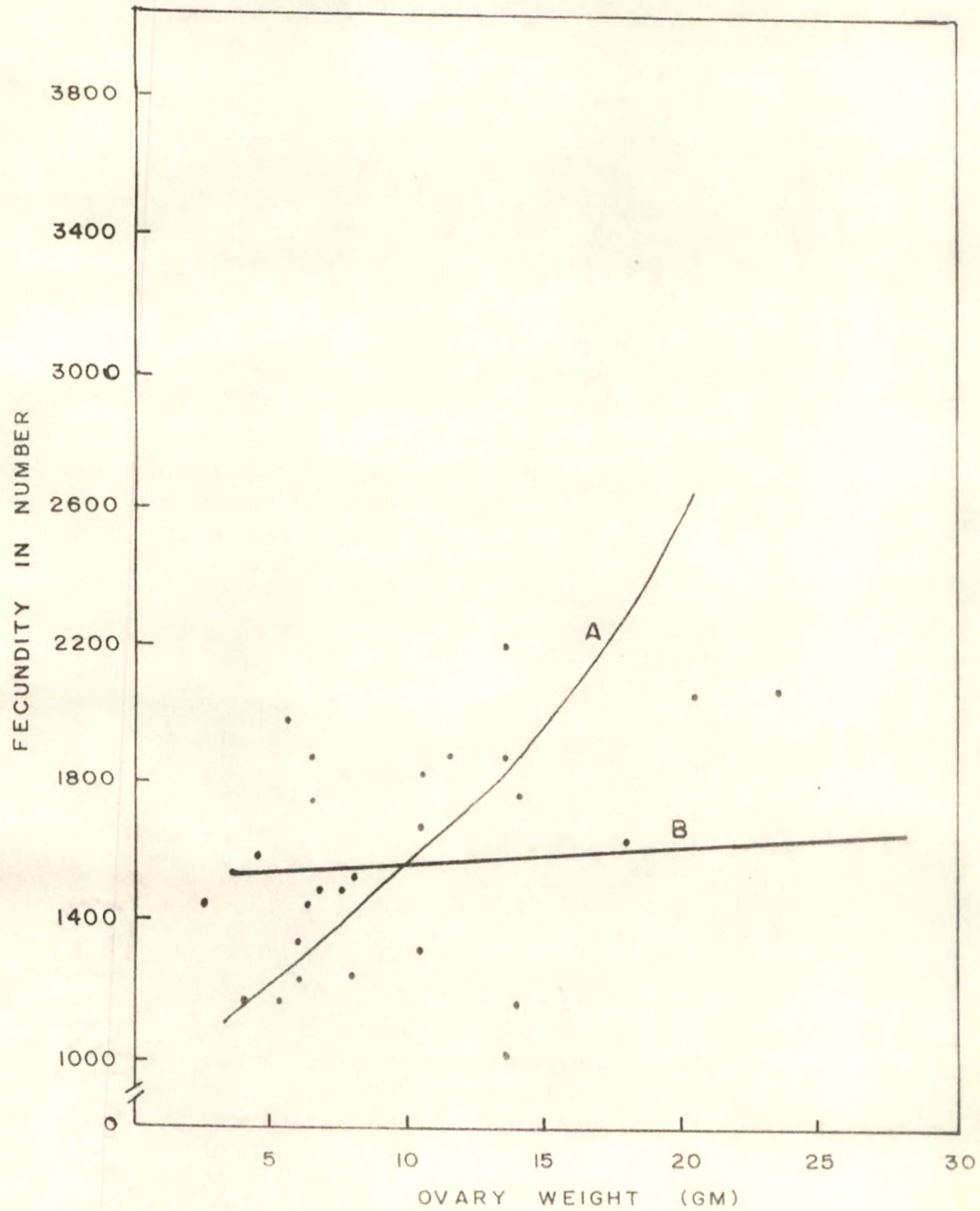


FIGURE 24. OVARY WEIGHT AND FECUNDITY RELATIONS IN *SCHIZOTHORAX RICHARDSONII*. CURVES A, B, AS IN FIGURE 22.

CHAPTER NINE

DISCUSSION

CHAPTER NINE

DISCUSSION

ON FISH SYSTEMATICS

Of the 48 species reported in the present study, 18 species and 6 sub-species form a new record from the drainages of Sikkim. And significantly, 4 species namely *Glyptothorax basnetti*, *G. bhutiai*, *G. deyi*, *Clupisoma bhandarii* and two sub-species namely *Glyptothorax sinense sikkimensis* & *Laguvia ribeiroi jorethangensis* are found new to science.

Variations in certain meristic characters are evident in some ichthyospecies from those reported by earlier workers and are discussed hereunder.

Acrossocheilus hexagonolepis: D.i.9 (versus D.iv.9 by Jayaram, 1981); *Glyptothorax conirostrae*: A.i.9 (versus A.i.i.9 - 10 by Day, 1878 and Jayaram, 1981); *G. gracilis*: A.9 - 12 (versus A.14 by Jayaram, 1979).

Morphometrically some ichthyospecies of Sikkim drainages also differ from those reported earlier from other drainages of the country. In this context the notable species are: *C. latius latius* - DF; *S. semiplotus* - maxillary barbels; *L. dero* - position of eyes; *G. annandalei* - HL, HB, IOD and DL; *G. goryla goryla* - HL, IOD, distance from vent to anal in that between anterior origin of pelvic and anal fin; *G. goryla stenorhynchus* - BD, distance from vent to anal in that between anterior origin of pelvic and anal fin; *G. lamta* - HD, distance from vent to anal in that between anterior origin of pelvic and anal, CPDL; *G. mulya* - BD, distance from vent to anal in that between anterior origins of pelvic and anal fin; *N. beavani* - Snout length, PFL; *N. carletoni* - VF, VFL, CFL; *N. corica* - PF, AF; *N. devdevi* - DF and CF with two black spots; *N. kangjupkhulensis* - Rostral barbel; *N. multifasciatus* - PFL, CFL; *N. scaturigina* - DF, VF, PFL and CFL; *N. sikmaiensis* - DF, VFL, CF; *N. spilopterus* - Barbels; *P. pangasius* - nature of head; *G. conirostrae* - Maxillary barbel, DF height, BD; *E. hodgarti* - CPD and ADFL.

Further the present investigation noteworthy extends the maximum TL of ten species from earlier size limit reported. They are *B. bendelisis chedra*, 160 mm (- 155 mm, Talwar & Jhingran,

1991); *C. latius latius*, 210 mm (- 150 mm, Datta Munshi & Srivastava, 1988; - 124 mm, T & J, 1991); *G. goryla goryla*, 230 mm (- 200 mm, DM & S, 1988; - 140 mm, T & J, 1991); *G. goryla stenorhynchus*, 240 mm (- 150 mm, T & J, 1991); *A. pangia*, 69 mm (- 65 mm, T & J, 1991); *G. sinense manipurensis*, 257 mm (- 94.5 mm, Jayaram, 1979; - 126 mm, T & J, 1991); *G. gracilis*, 164 mm (- 127 mm, T & J, 1991), *G. conirostrae*, 220 mm (- 140 mm, T & J, 1991); *E. hodgarti*, 120 mm (- 57.5 mm, Jayaram, 1979; - 65 mm T & J, 1991); and *P. sulcatus*, 196 mm (- 180 mm, Jayaram, 1979).

Amongst the species reported from Sikkim, it has been observed that some workers used wrong nomenclature while identifying the species. An elucidation to this context along with the valid species has been reported hereunder in tabular form:

Author (year)	Nomenclature used	Valid species
Tilak (1972)	<i>Schizothorax plagiostomus</i>	<i>Schizopyge progastus</i> (McClelland)
Bhutia & Acharya (1987)	<i>Schizothorax progastus</i>	<i>Schizopyge progastus</i> (McClelland)
Tilak (1972)	<i>N. englishi</i>	<i>N. multifasciatus</i> Day

Besides, the presence of *Tor mosal* (Hamilton) in the drainages of Sikkim reported by Tilak (1972) is doubtful. The apprehension gets reasons to avow due to the fact that the species, a South Indian form is not known to occur in any of the drainages of North East India (Dey & Das, 1989) nor it could be found in any of Sikkim drainages by the present investigator. Further, the occurrences of *Glyptothorax striatus*, *Glyptosternum maculatum*, *Puntius spinulosus*, *P. clavatus*, *Labeo dyocheilus*, *Barilius barna* by Tilak (1972) and of *Glyptothorax pectinopterus*, *Barilius barna* by Bhutia & Acharya (1987) could not be confirmed in the present extensive investigations raising scope of incredulity about the validity of such occurrences of ichthyospecies in Sikkim drainages. Further, *N. de Terrai* described by Tilak (1972) and Bhutia & Acharya (1987) has not been included in the list of species belonging to the genus *Noemacheilus* van Hasselt by Menon (1987) in his monographic work on cobitoidea.

On the species of the genus *Clupisoma* Swainson:

Bhulia & Acharya (1987) have wrongly identified the single species of genus *Clupisoma* Swainson as *C. montana* Hora. The present species is identified to be new to science and has been named as *C. bhandarii* (Plate XVIII-5 & XIX-3). The species can be readily distinguished from allied species on various characters especially on the keel, maxillary barbel, pelvic fin and anal fin rays characters. Accordingly, a key to identification prepared on these characteristics is purported hereunder among the species of the genus *Clupisoma* Swainson known so far.

Key to the identification of the genus *Clupisoma* Swainson

- | | | |
|----|---|-------------------------------------|
| 1. | Abdominal edge rounded | 2 |
| | Abdominal edge keeled throughout or partly | 3 |
| 2. | Maxillary barbels not reaching beyond base of pectoral fin. Pectorals reaching pelvic fins. Anal fin with 41 - 43 rays | <i>C. montana</i> Hora |
| | Maxillary barbels extending up to or behind base of pelvic fin. Pectorals may or may not reach pelvics. Anal fin with 40 - 47 rays. | <i>C. naziri</i> Mirza & Iqbal Awan |
| 3. | Abdominal edge keeled throughout. Maxillary barbels not reaching pelvics. Anal fin with 40 - 44 rays. | <i>C. prateri</i> Hora |
| | Abdominal edge keeled partly | 4 |
| 4. | Abdominal edge keeled from vent to thorax. Pectorals not reaching pelvics. Maxillary barbels reaching anal fin base. Anal fin with 52 - 54 rays. | <i>C. bastari</i> Datta & Karmakar |
| | Abdominal edge keeled between pelvic and vent. Pectorals not reaching pelvics. | 5 |
| 5. | Maxillary barbels reaching pelvic fin. Anal fin with 29 - 36 rays. | <i>C. garua</i> (Hamilton) |
| | Maxillary barbels crossing pectoral base but not reaching pelvic fin. Anal fin with 39 - 41 rays. | <i>C. bhandarii</i> sp.nov. |

On the species of the genus *Laguvia* Hora:

There exists no report of genus *Laguvia* Hora by previous workers from Sikkim waters. Two sub-species of *L. ribeiroi* have been reported from Sikkim drainages for the first time by the present investigator namely *L. ribeiroi ribeiroi* Hora (Plate XVI-12) & *L. ribeiroi jorethangensis sub. sp. nov.* (Plate XVI-15 & XIX-5). Of the two, *L. ribeiroi jorethangensis* is new to science. These two sub-species can be readily distinguished from each other and allied species mainly on the dorsal spine and position of pelvic fin. A key to identification prepared on these characteristics is purported hereunder:

Key to the identification of the genus *Laguvia* Hora

1. Dorsal spine smooth. Origin of pelvic fin distinctly nearer base of caudal than tip of snout 2
 Dorsal spine finely serrated along whole of anterior margin and also along upper one third of posterior margin. 4
2. Body depth 4.5 - 5.0 in standard length.
 Inter - orbital width 3.2 t 3.5, snout length 2.0 to 2.2 in head length.
 Body with two bands, posterior band below entire width of adipose dorsal *L. shawi* (Hora)
 Body depth 3.3 to 3.4 in standard length.
 Inter - orbital width 2.5 to 2.85, snout length 1.66 to 1.82 in head length.
 Body with two bands, posterior band base of adipose fin. *L. asperus* (McClelland)
3. Origin of pelvic fin equidistant from tip of snout and caudal base or nearer tip of snout. *L. ribeiroi ribeiroi* Hora
 Origin of pelvic fin distinctly nearer caudal base than tip of snout. *L. ribeiroi jorethangensis sub.sp.nov.*

On the species of the genus *Glyptothorax* Blyth:

The previous workers reported three species of the genus *Glyptothorax* Blyth namely *G. striatus* (Tilak, 1972), *G. gracilis* (Tilak, 1972) and *G. pectinopterus* (Bhutia & Acharya, 1987). In the present study, altogether seven species have significantly been reported from the drainages of Sikkim namely *G. basnetti* sp. nov. (Plate XVII-4 & XIX-4), *G. bhutiai* sp. nov. (Plate XVII-8 & XIX-6), *G. conirostrae* (Plate XVII-6), *G. deyi* sp. nov. (Plate XVII-7 & XIX-2), *G. gracilis* (Plate XVII-3), *G. sinense manipurensis* (Plate XVII-1), *G. sinense sikkimensis* sub. sp. nov. (Plate XVII-5 & XIX-1) and *G. trilineatus* (Plate XVII-2). All the seven species with two sub-species can reasonably be distinguished from each other and allied species on various characters especially on adhesive apparatus, dorsal fin, body depth, pectoral fin and on barbel characteristics. Accordingly, a key to the identification prepared on these characters is purported hereunder:

Key to the identification of the genus *Glyptothorax* Blyth

- | | | |
|----|---|---|
| 1. | Skin smooth, devoid of granulations or tuberculations.... | 2 |
| | Skin rough with granulations or tuberculations..... | 10 |
| 2. | Adhesive apparatus on thorax distinctly | |
| | longer than broad | 3 |
| 3. | Occipital process not reaching basal bone of dorsal fin... | 4 |
| 4. | Dorsal spine strong | 5 |
| | Dorsal spine weak | 6 |
| 5. | Adhesive apparatus on thorax without a central pit. | |
| | Paired fins plaited | <i>G. sinense manipurensis</i> Menon |
| | Adhesive apparatus without a central pit. | |
| | Paired fins not plaited. | 7 |
| | Adhesive apparatus on thorax complete posteriorly enclosing a central pit. | 11 |
| 6. | Dorsal spine serrated along inner margin. | |
| | Paired fins not plaited. | <i>G. sinense sinense</i> (Regan) |
| | Dorsal spine smooth. Paired fins plaited | <i>G. sinense sikkimensis</i> sub. sp. nov. |
| 7. | Dorsal fin higher than body depth below it | 8 |
| | Dorsal fin shorter than or equal to body depth below it.. | 9 |
| 8. | Body depth 5.0 - 5.5 in standard length. | |
| | Pectoral fins longer than head | <i>G. gracilis</i> (Gunther) |
| | Body depth above 5.8 in standard length | <i>G. bhutiai</i> sp. nov. |

9. Anal fin inserted opposite or before adipose origin.
 Nasal barbels reaching anterior border of eye..... *G. trilineatus* Blyth
 Nasal barbels not reaching anterior of eye 10
10. Body with one or two bands. *G. deyi* sp.nov.
 Head, sides and fins mottled with dark spots..... *G. telchitta* (Hamilton)
11. Body depth 5.9 - 6.6 in standard length.
 Least height of caudal peduncle 2.5 times in its length... *G.cavia* (Hamilton)
 Body depth 4.5 - 5.6 in standard length. Least height
 of caudal peduncle 1.9 - 2.2 times in its length..... *G.basnetti* sp. nov.

ON ECOLOGY AND FLUVIAL DYNAMICS

The Tista and the Rangit drainages of Sikkim are situated in the North of Tropic of Cancer between 28°07'48'' and 27°04'46''N and 88° and 89° E and the region has a mixture of sub-tropical, temperate and alpine climatic conditions (mean air temperature minimum - 4°C to maximum 34°C).

The two major drainages in the higher gradients have a meandering course with feeble and crystal clear water; the middle reach with very deep and narrow gorges with turbulent water flowing through rocky to gravelly bottom; and in the lower gradients the rivers with relatively low velocity pass through broader valleys demarcating the two adjacent hills before confluencing with each other near Tista bazaar in Darjeeling Gorkha Hill Council region of West Bengal.

Although all the rivers under study are perennial, Ghattay khola, Roathak khola and Rishi khola exhibit a dying state with feeble discharge (Figures 2 & 6) during the lean seasons (winter-summer). The discharge rate of the Tista drainages at upper gradients is found to be influenced by the water sources in the upper catchment. Since some of the rivers originating from high elevations (3960 to 5300 m) are snow fed, the discharge rate of such rivers (e.g. Yumthang chhu) have been recorded to be comparatively high during summer. But the common phenomenon exhibited by the river systems is the highest discharge during the monsoon (2.01 to 404.64 m³s⁻¹) and lowest during lean seasons (0.08 to 67.44 m³s⁻¹). Sharma (1983) has described Tista as a wild river and reported that the flow of Tista was around 16,990 m³s⁻¹ in 1950's and it washed away Assam railway link bridge at Sevoke during 1968 flood.

The rate of discharge at the confluence of river Rangit and Rangbhang khola reported by Bhutia & Acharya (1987) as 170.034 - 282.21 m³s⁻¹ is untenable as in the present study it has been recorded empirically to be 44.35 - 278.37 m³s⁻¹ at Nayabazar. Similarly, large variations have been observed in discharge rate reported by Venu *et al* (1990) for river Tista near Rangpo as 96.34 - 1400.37 m³s⁻¹ (*vs.* 67.44 - 404.64 m³s⁻¹ in the present study), Rani khola, 360 - 549 m³s⁻¹ (*vs.* 2.97 - 39.68 m³s⁻¹) and Rangpo khola, 17.65 - 70.6 m³s⁻¹ (*vs.* 15.24 - 106.68 m³s⁻¹).

In general, it is found that discharge rate of the river at a location is greatly influenced by the water velocity, the shape of river profile and its catchment area upstream.

The water velocity is highly influenced by the gradient of the river and the river's volume of discharge. It is observed to be higher during heavy flood in monsoon and lower during winter as a norm. River Tista at Tong exhibits the highest velocity (1.84 ms⁻¹) during monsoon and the lowest velocity of (0.2 ms⁻¹) by Ghattay khola during summer at Sirwani.

Basin patterns are found variable in the course of the river. It exhibits different types of bed made up of boulders, stones, pebbles, sand or even mud. Basin characteristics also vary considerably with altitude and fluvial trend.

Balaraman (1987) has wrongly mentioned the altitude of Thanggu as 4350 m (msl) which in fact is 3812 m (msl). Venu *et al* (1990) state the altitude of Sikkim Himalayas varying from 800 m to 5000 m. In fact, these ranges lie in between 310 m and 5300 m (up to Chho Lhamu) as critically studied in the present investigation. Further they have mentioned the origin of river Tista as Talung Kangshe Glacier which in fact, should be mentioned as Tista Khangse Glacier. Concomitantly, the origin of Rangpo khola is wrongly stated by them as Latui reserve forest instead of Menmoi chho, its actual source.

Some of the descriptions on the drainages of Sikkim put forward by Venu *et al* (1990) are also found erroneous. The depth of Menmoi chho varied from 21.3 m to 27.33 m as recorded in the present study (*versus* 7.5 m by Venu *et al*, 1990). The total length of rivers Tista and Rangit purported by Anon (1981) as 500 km has been corrected as 750 km in the study.

Tilak (1972) while reporting the small list of fishes from Sikkim does spell river / place name erroneously like Rangit as Ranjeet and Tadong as Tardhong. More curiously, chatra the collection place for *Garra lamta* and khola / Khoila river for *G. gotyla gotyla* & *L. ribeiroi* as reported by him has no existence in Sikkim.

Complexity of stream habitat is correlated with the diversity of fish species. Stream depth, bottom type, water current are important factors responsible for the habitat diversity to a wide range of fish groups. From the present study, it is apparent that some fish groups are restricted to swift flowing water (true hill stream forms) while others to slow flowing ones. The correlation between habitat characteristics and presence or absence of fish species suggests that most fishes of small streams are habitat specialists which otherwise concurs the view of Garman and Karr (1978).

Based on fluvial dynamics and ecological conditions the river systems of Sikkim may reasonably be divided into (1) crystal clear zone through meandering course from 4200 to 5500 m (2) the middle aggressive zone from 500 to 3960 m characterized by turbulent water current throughout the year and (3) comparatively sluggish zone from 240 to 500 m.

The present investigation further reveals that some of the rivers remain more or less clear throughout the year with very high transparency of 62 cm and 85.17 cm as in river Rangit at Sikhrip; Yumthang chhu, Bakcha chhu, Rin khola, Rangpo khola, and Rimbi khola. The remaining rivers are turbid during monsoon but clear during rest of the year. Of these rivers, Tista, Rani khola and Kalej khola are excessively turbid with silt and mud load during monsoon. This may be attributed to high rate of soil erosion along their banks (course) in upper reaches resulted due to excessive denudation of forests cover.

The present study reveals the air temperature of Rangit drainages ranging from 18.5°C - 34°C in Sikkim against 10°C to 25°C reported by Bhutia and Acharya (1987). Concomitantly, the air temperature of Sikkim is reported to vary from 0°C to 29°C (Dhiman *et al* . 1988 and - 4°C to 31.1°C (Basnet, 1989). But the present observation portrays the range from -4°C to 34°C.

Water temperature is an important parameter, because it affects the rates of chemical and biological reactions, solubility of gases in water (particularly oxygen) and may induce stratified conditions (Rau, 1980). Temperature is a kind of seasonal yardstick and fish depends upon water

temperature as a signal for migration and spawning (Healy, 1976). The degree of insolation, substrate composition, transparency, rain water inflows and wind action have influence on the water temperature in the rivers. Admittedly, a direct relationship between the temperature of air and water as a general norm (Dey, 1981) is discernible in the drainages when water temperature follows air temperature fairly closely. The maximum water temperature is recorded to be 27°C in Rani khola during monsoon and minimum of -2°C in Yumthang chhu during winter. Comparatively higher water temperature (17 - 27°C) has been recorded at Rani khola, Jali khola and Seti khola. This exhibits the direct influence of transparency, gradient of the river basin, low water level and velocity and higher depth of sunlight penetration and influence of ambient temperature.

The range of water temperature of Rangit drainage reported by Bhutia & Acharya (1987) as 7 - 14 °C is significantly found to be 12 - 24 °C during present investigation. Great variations also found to exist in the present study from the range of water temperature reported by Venu *et al* (1990). River Tista near Singtam was reported as 16 - 21.5°C (*vs.* 15.5 - 25°C in the present study), Rani khola 17 - 22°C (*vs.* 18.5 - 27°C), Jali khola 16.5 - 22°C (*vs.* 17.75 - 26°C), Seti khola 16.5 - 22.5°C (*vs.* 17 - 25°C), Rangpo khola 16 - 24.5°C (*vs.* 15 - 21°C), river Rangit 17 - 25.5°C (*vs.* 14.7 - 21.5°C), Lachen chhu 15 - 16.5°C (*vs.* 9.3 - 13°C) and Lachung chhu 18 - 18.5°C (*vs.* 8.5 - 13.5°C).

The distribution of DO within the aquatic ecosystem is one of the main factors influencing the distribution of fish. Maximum fish species have been observed in rivers with DO ranging from 8.45 - 9.47 mg l⁻¹ while the highest fish density in between 7.52 and 11.47 mg l⁻¹. The present study reveals that the rivers Tista and Yumthang have the highest mean DO values thereby exhibiting the direct correlation between the altitude and DO.

The data reported by Venu *et al* (1990) on DO level of the rivers significantly differ from the present investigation, viz, river Tista near Singtam 4 to 10.4 mg l⁻¹ (*vs.* 4.14 to 14.88 mg l⁻¹ in the present study), Lachen chhu 7.1 to 7.3 mg l⁻¹ (*vs.* 8.82 to 13.16 mg l⁻¹) and Lachung chhu 8.4 to 9.1 mg l⁻¹ (*vs.* 6.83 to 13.5 mg l⁻¹).

FCO₂ exhibits a different trend in the present study. River Rangit at lower Tashiding, Rimbi khola and Kalej khola of Rangit drainage are found to contain the highest FCO₂ during summer (30.2 to 60.6 mg l⁻¹); while majority of rivers of Tista drainage are found purporting

comparatively higher FCO_2 during the monsoon season (3.05 to 10.6 mg l^{-1}). And admittedly, FCO_2 is recorded in very small proportion during winter in most of the rivers of Sikkim.

The reports of Venu *et al* (1990) differ from that of present investigation on FCO_2 levels with river Tista near Singtam 1.5 -4.95 mg l^{-1} (*vs.* 1.5 - 7.0 mg l^{-1} in the present study), Rani khola 1.8 - 6.98 mg l^{-1} (*vs.* 2.6 - 10.5 mg l^{-1}), Jali khola 5.8 - 6 mg l^{-1} (*vs.* 2.1 - 9.6 mg l^{-1}), Seti khola 2.1 - 5.4 mg l^{-1} (*vs.* 2.1 - 10.6 mg l^{-1}), river Rangit 1.2 - 4.5 mg l^{-1} (*vs.* 1.5 - 15.9 mg l^{-1}), Lachen chhu 0.86 mg l^{-1} (*vs.* 1.25 - 2.3 mg l^{-1}) and Lachung chhu 1.36 mg l^{-1} (*vs.* 1.9 - 3.05 mg l^{-1}).

pH portrays a moderate range of seasonal variation 6.0 - 7.4 in all the drainages. The increase in rate of influx of FCO_2 in the rivers during monsoon (Chakravorty *et al*, 1959 ; Subba Rao & Govind, 1964 ; Mathew, 1972 ; Laal, 1981) perhaps ensues low pH during that period. Consequently, an inverse relationship between pH and FCO_2 (Dey, 1981; Kumar, 1985) is avowed in the rivers studied.

TA considered as an indicator of productivity (Wallen, 1955) exhibits considerable seasonal fluctuation ranging from 1.9 (M) to 225 (S) indicating direct relationship amongst TA, DO and phytoplankton abundance. Alkalinity is mainly due to bicarbonate present in water (Reid, 1961). The fluctuation in alkalinity is mainly due to rainfall as observed by Michael (1969) and Jana (1973). The sudden influx of FCO_2 in high concentrations leached down to the soil alongwith rainfall lowers down TA to its minimal value during monsoon. Thus the concentrations of FCO_2 in water bears an inverse relationship with TA. Minimal TA level (absent in few rivers) during high flood reported by other fresh water bodies of India (Mookherjee & Bhattacharjee, 1949; Dutta *et al*, 1954; Chakraborty, *et al*, 1959; Subba Rao & Govind, 1964; Mathew, 1978) also happens to be normal phenomenon in the present drainages investigated.

The reports of Venu *et al* (1990) on the TA of Sikkim rivers are contradictory to the present findings - for example river Tista near Singtam is reported as 16.5 to 36.1 mg l^{-1} (*vs.* 17 to 52 mg l^{-1} in the present study), Rani khola 25 - 28.5 mg l^{-1} (*vs.* 1.9 - 102.5 mg l^{-1}), Jali khola 23.1 - 25.6 mg l^{-1} (*vs.* 16.7 - 88.5 mg l^{-1}), Seti khola 28 - 33.1 mg l^{-1} (*vs.* 4.5 - 62.5 mg l^{-1}), river Rangit 28.1 - 44.9 mg l^{-1} (*vs.* 25 - 81 mg l^{-1}), Lachen chhu 47.6 mg l^{-1} (*vs.* 25.5 - 100 mg l^{-1}) and Lachung chhu 40.8 mg l^{-1} (*vs.* 23 - 27 mg l^{-1}).

ON POTAMOPLANKTON

Plankton population, on which the whole aquatic life depends directly or indirectly, is governed by the interaction of a number of physical, chemical and biological conditions and tolerance of the organism to variation in one or more of these conditions (Reid, 1961). Concomitant to physical and chemical elements, the spatial and temporal distribution of plankton in Sikkim drainages is characterized by relatively poor concentration. Indeed, 43 genera of phytoplankton (out of 63 genera) and 17 genera of zooplankton which constitute the potamoplankton communities of the two river systems incidently form record from the present drainages. Besides, correlation between phytoplankton abundance and fluvial dynamics in the present drainages is recorded with relatively more polarization of phytoplankton during winter. That the rate of flow is dominant physical factor affecting planktonic life in a river (Dey, 1973) is discernable in the present study.

The phytoplankton domination, a familiar feature in N.E. freshwater bodies (Dey & Nath, 1982; Dey & Das, 1989) is found to play the key role in the net plankton yield of both the Tista (96.58 %) and the Rangit (95.90 %) drainages (Table 1). The net phytoplankton density of the drainages under study attain maximum level (12906 ul^{-1}) during winter followed by monsoon (12747 ul^{-1}) and summer (8400 ul^{-1}). The sparse phytoplankton flora of the present drainage is mostly composed of *Binuclearia*, *Chlorella*, *Cladophora*, *Geminella*, *Sphaeroplea*, *Spirogyra*, *Ulothrix*, *Anabaena*, *Nostoc*, *Melosira*, *Pinnularia*, *Navicula* and *Tabellaria*. The overall structure of phytoplankton groups in order of dominance is Chlorophyceae (34 genera) > Bacillariophyceae (19 genera) > Myxophyceae (4 genera) > Chrysophyceae (4 genera) > Xanthophyceae (1 genus) and Rhodophyceae (1 genus).

It is interesting to note that the diversity of phytoplankton genera was recorded to be maximum at higher gradients namely river Tista at Tong (33 genera), Yumthang chhu (29 genera) during winter months exhibiting habitat specificity. This is an indicative of relationship between the water velocity, DO, transparency and temperature. Some of the genera found to be restricted to the Tista drainages during the present study are *Bulbochaete*, *Closterium*, *Coleochaete*, *Cosmarium*, *Crenocladus*, *Gongrosira*, *Hydrodictyon*, *Oocardium*, *Palmodictyon*, *Pearsoniella*, *Pediastrum*, *Pithophora*, *Protoderma*, *Rhizoclonium*, *Tetraspora* (Chlorophyceae); *Monocilia* (Xanthophyceae); *Celloniella* (Chrysophyceae), *Fragilaria*, *Gomphonema* (Bacillariophyceae). The single genus of Chrysophyceae found to be confined to Rangit drainage is *Hydrurus*.

Chlorophyceae represented by 34 genera occur all along the twin drainages throughout the year displaying highest abundance (7054 ul⁻¹) from monsoon to winter (6347 ul⁻¹) and the least in summer (3737 ul⁻¹). The genera which are responsible for the peak of Chlorophyceae are *Binuclearia*, *Chara*, *Chlorella*, *Cladophora*, *Dermatophyton*, *Geminella*, *Oedogonium*, *Pearsoniella*, *Sphaeroplea*, *Spirogyra*, *Ulothrix* and *Zygnema*. Of the 16 rivers studied during present investigation, Ghattay khola & Bakcha chhu exhibit the highest density.

Bacillariophyceae which constitute the second dominant group is represented by 19 genera of which *Cymbella*, *Fragilaria*, *Frustulia*, *Gomphonema*, *Melosira*, *Pinnularia*, *Rhabdonema* and *Navicula* are the prime compositions.

Myxophyceae represented by 4 genera in the present drainages exhibits highest abundance during winter, followed by monsoon and summer.

Of the four Chrysophycean genera, *Celloniella*, *Phaeoplaca* and *Synura* are mostly confined to higher gradients of the Tista drainage while *Hydrurus* to the Rangit drainage. The contribution towards total phytoplankton production of the overall drainages made by Xanthophyceae and Rhodophyceae each consisting of only one genus is comparatively low.

Information on zooplankton in running water is sparse because flowing water is unfavourable for zooplankton. Zooplankton populations are, on the whole, very poor in the main channels of a river (Dey, 1973) as evident in the present studies, although numbers can build up in the reduced flow during the dry season. However, the predominance of rotifera, a common feature of Assam waters (Dey, 1973, 1981) is also apparent in the Sikkim drainages in respect of generic composition in the order, Rotifera (7 genera) > Protozoa (4 genera) > Copepoda (3 genera) > Cladocera (2 genera) > and Ostracoda (1 genus).

The total zooplankton population of the two drainages under the present study during 1987 and 1988 is observed to be 1304 ul⁻¹ contributing to only 3.42 % and 4.10 % of the total plankton yield in the Tista and the Rangit drainages respectively. Unlike phytoplankton, zooplankton abundance is recorded to be highest during monsoon (513 ul⁻¹), followed by summer (435 ul⁻¹) and then by winter (356 ul⁻¹) indicating their preference for warmer water showing positive correlation with temperature. A similar trend is also reported by Das and Srivastava (1956), Moitra and

Bhattacharya (1965) and Das (1989).

Protozoa comprising of 4 genera is recorded to be the most dominant group amongst the zooplankton community with highest abundance (558 ul^{-1}) in the two river systems of Sikkim. *Centropyxis sp.* and *Astramoeba sp.* are the dominant genera recorded.

Rotifera represented by 7 genera is the second dominant group (467 ul^{-1}) with *Asplanchna sp.* followed by *Brachionus sp.* as the dominant genera. Ostracoda closely follow rotifera with abundance of 222 ul^{-1} in the present drainages under study. Cladocera and Copepoda each with 2 and 3 genera contributes least with 26 ul^{-1} and 31 ul^{-1} respectively to the zooplankton yield.

Interaction between phytoplankton and zooplankton have been the subject of several workers cited by Seenayya et al., (1971). Higher density of zooplankton during the phytoplankton minima exhibiting an indirect correlation (Das & Srivastava, 1956) is not observed during the present investigation. On the contrary, a positive correlation (Pahwa & Mehrotra, 1966) between them is observed in all the rivers investigated.

ON FISH GEOGRAPHY

The fish fauna of the drainages of Sikkim accounted in the records of the present investigation are apt to focus new lights on the general distribution pattern as well as on the regional distribution too. Primary freshwater forms constitute 97.87 % of the fish population of Sikkim with the remaining 2.12 % contributed by the peripheral groups. Incidentally, similar trend of fish geography have been reported from Barak drainages of Assam (Nath & Dey, 1986) and North East State of Meghalaya (Sen & Dey, 1984).

For brevity and better understanding the distribution trend of the drainages of Sikkim may be divided into Zone I (ZI) consisting of river Tista, Yumthang chhu, Bakcha chhu and Rimbi khola above 1000 m msl; Zone II (ZII) comprising of river Tista, Seti khola, Jali khola, Rani khola, Rin khola, Dik chhu, Rangpo khola, river Rangit and Kalej khola above 500 m to 1000 m msl and Zone III (ZIII) consisting of river Tista, Ghattay khola, Rangpo khola, Rishi khola, Roathak khola, river Rangit and Rangbhang khola 500 m and below. The region-wise pattern of distribution (Table 103) of 47 ichthyospecies (excluding *Salmo trutta fario*, the exotic form) collected indicates that Zone III

is richest in its ichthyofauna composition with 40 spp. (85.10 %) followed by Zone II with 35 spp. (74.46 %) and Zone III with only 9 spp. (19.14 %) while there are more overlapping species of 61.70 % (29 spp.) between ZII and ZIII and only 12.76 % (6 spp.) amongst the three zones. Concomitantly, only 10.63 % (5 spp.) are restricted to ZII and 19.14 % (9 spp.) to ZIII. And significantly only one river in ZI, three in ZII and two in ZIII do contain these restricted species with the endemicity structure in the order, Rimbi khola (2 spp.) in ZI, river Tista (1 sp.), Rani khola (1 sp.) in ZII and river Rangit (1 sp.) and Rangbhang khola (1 sp.) in ZIII.

Schizopyge progastus are confined to ZII and ZIII while *Schizothorax richardsonii* has established its distribution to all the three zones up to 1340 m msl.

Present investigation also exhibits that out of the total ichthyospecies of the Sikkim drainages, their extra-Indian distribution structure (Table 105) is in the order, Nepal (48.93 %) > Burma (31.91 %) > Bangladesh (27.63 %) > Pakistan (25.53 %) > Sri Lanka (10.63 %) and Malaysia (8.51 %). Furthermore, the fish composition of the drainages contain more of north Indian element (25 spp.) with decrease in distribution to southern India (14 spp.).

Endemic species, as evident from the analysis, are found more localized in the Eastern Himalayas as compared to Western one. As many as 13 spp. are endemic to Eastern Himalayas.

Garra mcClellandi & *G. mullya* of southern India have been recorded from this region which infers that Sikkim Himalaya is a part of peninsular shield.

The ichthyofauna of the present drainages may be broadly divided into four categories based on their structural body modification (Dey, 1973) to adjust variable ecological conditions. These are :

Category I. True hill stream forms: The group includes fishes having specialized body modification to withstand the adverse environmental nature of the rheophilic abode. Species of the genera *Garra*, *Balitora*, *Glyptothorax*, *Euchiloglanis* & *Pseudecheneis* belong to this category.

Category II. Semi-torrential form: Fishes with weak body form and minimal body modification belong to this group and include the species of the genera *Crossocheilus*, *Noemacheilus*, *Acanthopthalmus* & *Barilius*.

Category III. Migratory forms: Well built body formed fishes and having capabilities to overcome

unfavourable ecological conditions of the torrents are grouped under this category. This group includes species of the genera *Anguilla*, *Schizopyge*, *Schizothorax*, *Semiplotus*, *Acrossocheilus* and *Tor*.

Category IV. Plain water forms: The fishes without any significant migratory habit or with low degree of body modification to prefer plain water habitat are included in this group. All but the species of the genera mentioned above, recorded belong to this category.

From the general trend of the fish species of Sikkim, it is interesting to note that major percentage (74.46 %) of fishes are having overlapping distribution (Table 104). Occurrence of endemic species are more (19.14 %) in Rangit drainage than in Tista drainage (6.38 %). In Rangit drainage, endemic forms like *Balitora brucei*, *N. beavani*, *N. carletoni*, *L. ribeiroi ribeiroi*, *L. ribeiroi jorethangensis*, *G. conirostrae*, *G. sinense sikkimensis* and *Channa orientalis* are present. Curiously enough these species are absent in the Tista drainages which shelters only two endemic species namely *N. spilopterus* & *Acanthopthalmus pangia*.

Of 35 overlapping species, only 14 of them are widely distributed between the twin drainages whereas 21 are having restricted occurrence. Of 14 widely distributed species, 13 are restricted to Eastern Himalayas (Table 105) only confirming the rimfire type of distribution (Dey, 1973) of the rheophilic fishes along the Himalayan belt.

ON FISHERIES PROPENSITY AND TREND

The present investigation reveals that altogether there are twenty eight fish species of commercial importance distributed in the drainages of Sikkim. Accordingly, these rivers in respect of presence of their commercial ichthyospecies are found in the order, river Rangit (25 spp.) > Rangpo khola (22 spp.) > Rangbhang khola (20 spp.) > river Tista (16 spp.) > Kalej khola & Roathak khola (14 spp.) > Rani khola & Ghattay khola (12 spp.) > Rishi khola (11 spp.), Dik chhu (9 spp.) > Seti khola (6 spp.) > Jali khola and Rin khola (5 spp.) > Rimbi khola (4 spp.) > Yumthang chhu and Bakcha chhu (1 sp.). Such qualitative differences may be attributed largely due to the fluvial dynamics, physico-chemical conditions, potamoplankton populations and elevations of the rivers (Dey, 1973).

It is to be noted that maximum number of fish species (25) has been reported from river Rangit at lower gradients having discharge rate 34.43 - 180.72 m³s⁻¹, velocity 0.53 - 1.17 ms⁻¹, DO 8.45 - 9.47 mg l⁻¹, FCO₂ 1.5 - 15.9 mg l⁻¹, TA 25 - 81 mg l⁻¹, pH 6.7 - 7.3, Transparency 39 - 89.28 cm, water temperature 14.7 - 21.5°C and potamoplankton 2076 ul⁻¹ whereas minimum fish species have been recorded from Yumthang chhu and Bakcha chhu.

On the basis of the presence of commercial ichthyospecies, their abundance, discharge rate and shore-line; altogether ten principal rivers (PR) have been identified which are arranged in order of their importance as river Rangit > Rangpo khola > Rangbhang khola > River Tista > Rani khola > Dik chhu > Bakcha chhu > Rimbi khola > Roathak khola > Kalej khola.

Schizothorax richardsonii (Gray), the snow trout is the single most dominant species present throughout the drainages of Sikkim up to an elevation of 1340 m msl. The species thus exhibits its wide range of temperature tolerance from 9.25 - 27°C. The highest density of *Schizothorax richardsonii* (Gray) has been recorded in Bakcha chhu, Rimbi khola and Dik chhu. The mean values of fluvial dynamics and physico- chemical parameters of Bakcha chhu where *Schizothorax richardsonii* has been exclusively established are: discharge rate 24.24 m³s⁻¹, velocity 1.24 ms⁻¹, DO 9.69 mg l⁻¹, FCO₂ 1.3 mg l⁻¹, TA 41.3 mg l⁻¹, pH 6.85, Transparency 47.60 cm and water temperature 14.46°C.

The overall catch composition of ten principal rivers display majority of Carps over Catfishes. The trend analysis is, river Rangit: Carps (14 spp.) > Catfish (11 spp.); Rangpo khola: Carps (13 spp.) > Catfish (7 spp.); Rangbhang khola: Carps (12 spp.) > Catfish (8 spp.); river Tista: Carps (11 spp.) > Catfish (4 spp.); Dik chhu: Carps (5 spp.) > Catfish (2 spp.) > Kalej khola: Carps (8 spp.) > Catfish (2 spp.); Rani khola: Carps (10 spp.) Catfish (2 spp.) > Roathak khola: Carps (9 spp.) > Catfish (1 sp.) > Rimbi khola: Carps (2 spp.) & Catfish (2 spp.) > Bakcha chhu: carps (1 sp.).

It is also significant to note that amongst the Carps the species of the genus *Garra* (Hamilton) top the list in abundance next to *Schizothorax richardsonii* followed by the other genera in the order *Schizothorax* > *Garra* > *Schizopyge* > *Crossocheilus* > *Acrossocheilus* > *Barilius* > *Glyptothorax* > *Tor* > *Bagarius* > *Semiplotus* > & *Labeo*.

The migratory propensity of *Anguilla bengalensis* (Gray) reveals that this interesting catadromous species is found to migrate along the bank of river Rangit up to 500 m msl, 35 km away from the confluence of Tista and Rangit. The species generally prefers deep pools in larger rivers and as such are rarely caught. *Acrossocheilus hexagonolepis* (McClelland) is commonly available fish with wide distribution range from 240 to 745 m (msl) occurring in both the drainages. *Tor putitora* (Hamilton) or the golden mahseer has been observed to migrate up and enter the drainages within 240 to 525 m msl. Alongwith *Tor putitora* (Hamilton) other plainwater forms like *Bagarius bagarius* (Hamilton), *Labeo dero* (Hamilton), *L. pangusia* (Hamilton), *Semiplotus semiplotus* (McClelland) and *Clupisoma bhandarii* sp. nov. exhibit similar trend of migration propensity into Sikkim drainages with the onset of summer and migrate down to warmer water in plains during winter.

The relative growth of different body parts in *Schizothorax richardsonii* (Gray) studied from the twin drainages of Sikkim exhibits allometric growth. Correlation coefficients show corresponding growth of one part of the body with the growth of the other. Pre-anal distance shows fastest relative growth followed by pre-pelvic distance > pre-dorsal distance in accordance with the particulars purported in Table 13 having the length of both barbels showing minimum relative growth trend. The analysis of change in ratio index of each measurable characters (Table 13) as the fish grows in length reveals a steady increase in the present species. And the result happens to be in good agreement with the findings of Misra (1967), Iftekhar and Dwivedi (1977) and Das (1989). The differences between the extreme values of the ratio indices are not statistically significant ($P > 0.05$). The calculated length of the older fish in the earlier years of life are systematically lower than those of younger fish at same age (Carlander, 1977) as revealed in the present investigation.

The weight of the fish considered as the function of its growth (Gulland, 1977) is well established in the species under study through length-weight relationship amongst the populations. And in the present analysis $W = cL^n$ is a better fit (Ricker, 1975) to express relationship between L & N than the hypothetical cube law. The value of exponent ‘n’ in the parabolic equation has been found to lie between 1.97 and 31.5 (Hile, 1936; Martin, 1949). The change in the body form with increasing age often cause the coefficient of regression of logarithm of W on log of L to deviate substantially from the slope value of 3.0 (cube law) which is the characteristic of isometric growth (Allen, 1938) in fishes.

In *Schizothorax richardsonii* (Gray), the L-W relationship shows the slope value deviating marginally from the cube law in both male and female population (Figures 14 to 19), a trend also recorded in other Indian teleosts (Jhingran, 1959b; Rao & Rao, 1972; Pandey *et al.*, 1974; Thakur & Das, 1974; Pathak, 1975; Sen, 1982; Roy, 1986, 1987 & Das, 1989).

The goodness of fit of the equation derived in the present investigation has been analyzed from the sample coefficient of correlation, and the significance is tested through t-test. The result shows that a strong correlation ($P < 0.001$) does exist between $\log W$ and $\log L$ in the species investigated.

The L-W relationship of the present species exhibits seasonal variation (Ricker, 1975) as they do not retain the same shape or body contour throughout the year. Marginal allometry (Tesch, 1968) with the value of "n" nearer to 3.0 has been recorded during winter in males (2.833) and during summer in females (3.124) of *Schizothorax richardsonii* (Gray). Distinct deviation of the slope value from the cube law has been recorded in the males and females of this species during the other seasons of the year investigated. The present observation is in good agreement with the marginal allometry recorded in *Crossocheilus latius latius* (Dey, 1984) and *Acrossocheilus hexagonolepis* (Dey, 1987) from the rheophilic drainages of N.E. India. Natural tangent value of the angle formed by regression line is very much nearer to the slope value (Dutta, 1974), justifying the use of angles to express the relationship between the two variables (Length and Weight) in fishes in general.

The coefficient of condition, an index of well being of fish, exhibits independent trend in the present species. Low value of coefficient of condition has been attributed to poor feeding activity (Varghese, 1973) or cessation of feeding (Carlander, 1977) or onset of spawning (Karamchandani *et al.*, 1967; Desai, 1970) in the fishes appears plausible in *Schizothorax richardsonii* (Gray). Indeed, estimation of coefficient of condition in fishes from total body weight but excluding the internal organs (Clark, 1928) as also advocated by Das (1989) in *Tor putitora* (Hamilton) and *Tor tor* (Hamilton) from the Brahmaputra drainages of Assam deserves serious consideration.

Schizothorax richardsonii (Gray) has been established as sexually dimorphic. The breeding habits and limitation of food space along with other abiotic factors of the water bodies in which the present species maintains itself perhaps necessitate the maintenance of an economic ratio of the

number of males to the females. Sex ratio in the population of *Schizothorax richardsonii* (Gray) dwelling in the river systems of Sikkim has been studied and Chi-square is used to evaluate the abundance of sexes. The dominance of female over male, a common trend in fishes (Corington, 1946; MacDonald, 1948; Das, 1989) however is not discernable in the present species, where male marginally dominates over female with the ratio of 1.12 : 1.0. The relatively higher incidence of male over female may be attributed to more agility of female over male to evade capture (Alm, 1959). Besides other probable factors, the larger number of male than female in the sexed fishes may perhaps also be attributed to the overlapping number of the unsexed individuals accounted.

Fecundity defined as the potential number of matured eggs (yolked ova) that could be spawned during a breeding season (Lowe, 1955; McFadden *et al*, 1965; Bagenal, 1968; Marichamy, 1971; Baglin, 1982; Das, 1989) is a basic determinant of productivity in fishes. In *Schizothorax richardsonii* (Gray) the fecundity is found to vary from 1167 to 3653 in females having TL of 232 to 297 mm. The number of ova per gram ovary weight and fish weight is found between 101 to 292 and 11 and 12 respectively. Admittedly, the fecundity of *S. richardsonii* (Gray) is quite low in comparison to *Schizothorax plagiostomus* Heckel reported by Raizada (1982) from the river Beas in the Kulu district of Himachal Pradesh.

Regression analysis depicts a positive correlation between F and TL, F and BW and F and OW in the species. Although *r*-values depict differential correlation of F with the variables studied in the order, TL ($r = + 0.715 \pm 0.028$) > BW ($r = + 0.468 \pm 0.124$) and OW ($r = + 0.135 \pm 0.011$), *t*-test reveals the correlation highly significant only in respect of TL ($P < 0.01$) purporting the reliability of TL as a parameter in estimating the fecundity of the females of *Schizothorax richardsonii* (Gray).

GDSI is a good indicator of spawning frequency in fishes. Wide fluctuation of GDSI in a year (Qassim *et al* 1961; Joseph, 1980; Das, 1989) as discerned in *S. richardsonii* (Gray) may be attributed to maturity factor. Two spawning periods have been reported in *S. plagiostomus* Heckel by Raizada (1982). The first is from mid April to mid June with peak in May and the second from mid July to mid September with peak in early August. In the context of such observation, the spawning period of *S. richardsonii* (Gray) in the drainages of Sikkim is found to be confined to the monsoon periods extending from June to October.

ON FISHERY STATUS OF SIKKIM

There has been a gradual decline of the fish population in the twin drainages of Sikkim. As opined by some experienced and professional fishermen of the state, the size, weight and the abundance of the fish as they used to catch in earlier days have now become a matter of remembrance. The highest growth of some of the important fishes observed during the present investigation are of meagre proportion namely *Schizothorax richardsonii* 1 kg, *A. hexagonolepis* 1.5 kg, *Tor putitora* 13 kg, *Glyptothorax basneti* 0.75 kg and *L. dero* 0.75 kg. The present investigation further reveals that *Tor putitora*, *Semiplotus semiplotus*, *Anguilla bengalensis*, *Clupisoma bhandarii*, *Balitora brucei* and *Acanthopthalmus pangia* among others are now threatened. Some of the species like *Glyptosternum maculatum*, *Glyptothorax striatus*, *Glyptothorax pectinopterus*, *Puntius clavatus*, *P. spinolosis*, *Tor mosal*, *Labeo dyocheilus*, *Barilius barna*, *Brachydanio rerio* & *Ctenops nobilis* reported by earlier workers could not be collected during the present extensive survey program. This indicates that either these valuable species are wrongly reported or have already started becoming extinct from the Sikkim drainages. The conservation of the existing fisheries, therefore, is of prime importance in order to maintain the sustained population of the natural stocks in the drainages. This decline of the population can be attributed to the impact of various factors, notably, (a) soil erosion induced deforestation, (b) hydroelectric project activities along the banks of rivers Tista and Rangit leading to soil erosion/siltation as well as to restriction in the migration of fish, (c) illegal fishing through dynamiting and poisoning, (d) water pollution by both small and large scale industries especially, distillery, tannery, paper factory, cosmetic factory and mining, (e) sewage and pesticide run-off from agricultural fields and (f) over-exploitation of fishing due to increased human pressure. All these impediments made the fishes exposed to difficulties in sustenance.

In order that a population of fish can exist, it is necessary that they are supported with the law of minimum. And in such manoeuvre the ecological requisites for a species also must be congenial. Otherwise even a change in an ecological parameter may jeopardize the entire network making the habitat unsuitable for successful maintenance of a particular ichthyospecies. It is, therefore, imperative that all conditions necessary for the habitat management of the species are made available. The following measures are, therefore considered pertinent in the effective conservation and management of the riverine ecosystem especially to develop and enhance fisheries productivity of the state.

1. Stream shore improvement by planting suitable trees/shrubs to provide enough vegetation cover/tree canopy. Abundant riverside vegetation will help contribute food supply to fishes in the form of insect falling and also supply of leaf litter will convert detritus in the streams and provide food source for aquatic invertebrates. Concomitantly, soil erosion can also be controlled by this measure and mass mortality of the fish population experienced during monsoon flood will be checked at reasonable proportion.
2. Diversion of stream course by construction of hydroelectric dams and weirs for irrigation purpose, results loss in volume of water in the natural course, changes the natural habitat, spawning and breeding grounds and cause obstruction to fish migration. Hydropower development and irrigation project schemes should address all these environmental adversities through judicious planning and properly designed structures like fish-ladders should be incorporated to provide free passage of migratory fishes.
3. Pollution control measures should be taken up and the affluent should be pre-treated and made to safe tolerance level before they are discharged into the river system.
4. Wanton killing of fishes by illegal and mass destructive methods like dynamiting and poisoning should be strictly prohibited by enforcing proper legislation, conservation policies and implementation of Fisheries Acts. It is of particular concern in the preparation and passage of such legislation relative to wildlife and fish resources to prevent the elimination of the species due to human activities, to ensure that their populations do not decline below self-perpetuating levels, and to preserve representations of all such natural species population for future generations. Water resource sharing policies with adjoining states especially to fisheries development may perhaps be another pragmatic proposition.
5. The water resources of the rivers Tista and Rangit should be harnessed at optimum limit for fishery development.

Artificial propagation techniques of some of the commercially important species like *Schizothorax richardsonii*, *S. progastus*, *A. hexagonolepis*, *Tor putitora*, *L. dero*, *Clupisoma bhandarii*, *Semiplotus semiplotus* and *Anguilla bengalensis* should be taken up to replenish declining population. And in this endeavour, certain rivers have been identified suitable for the breeding of respective fish species notably, (a) Bakcha chhu, Dik chhu and Rimbi khola for *S. richardsonii*, (b) River Tista at Singtam, Rani khola, Rangpo khola, Kanaka chhu, Dik chhu, river Rangit and Rangbhang khola for *S. progastus*, (c) River Tista, Rani khola, Rangpo khola, river Rangit, Rangbhang khola, Roathak khola and Kalej khola for *A. hexagonolepis*, (d) River Tista, Rangpo

khola, river Rangit, Rangbhang khola and Kalej khola for *T. putitora*, (e) River Tista, Rangpo khola, river Rangit and Rangbhang khola for *C. bhandarii* and (f) Rangpo khola, river Rangit and Rangbhang khola for *S. semiplotus*.

The twin drainages of Sikkim harbour one of the most popular game fish, *Tor putitora*. Besides, *S. richardsonii*, *S. progastus*, *A. hexagonolepis*, *Glyptothorax spp.*, *B. bagarius*, and *C. bhandarii* are the common sport fish of the state. This small picturesque mountainous state has already started attracting tourists, both domestic and foreign. Once the identified fishes are allowed to flourish well in Sikkim rivers, it will bring the state on anglers' map of the country and will soon draw the attention of sizeable concentration of tourists. This proposition in turn will help increase revenue earning prospect of the state and formation of a state anglers' association will contribute a great deal in encouraging and organizing such activities.

In fine, it may be inferred that the empirical treatise purported in the present communications will help achieve a blue revolution in this Himalayan state of the country in no time if the results and recommendations are judiciously explored and executed with rigour and subtlety.

SUMMARY

SUMMARY

The distribution of the fishes of the Sikkim drainages lying between $88^{\circ}26'31''$ and $88^{\circ}39'35''$ E and $27^{\circ}15'0''$ and $27^{\circ}19'09''$ N in the Eastern Himalayas along with the fluvial dynamics and ecology including the physico - chemical conditions and potamoplankton communities have been studied for the first time in the present investigation. In addition, fisheries of ten principal rivers identified on the basis of maximum shore line, higher abundance of commercial fish species and higher discharge rate have also been purported in the communication.

Altogether 16 rivers under the Tista and the Rangit drainages are surveyed at intervals and the collection of the fishes made over years of intensive endeavour are incorporated in the present thesis.

The present collection comprises of 48 good species of the fish belonging to 23 genera under 9 families and 5 orders. Amongst these, 4 species and 2 sub. species seem to be new to science; 21 species are reported for the first time from the drainages of Sikkim while the rest are revised.

Separate keys for the identification of new species belonging to the genera *Chupisoma* Swainson, *Laguvia* Hora and *Glyptothorax* Blyth dealt in the present work have been given.

Certain meristic and morphometric variations recorded in 3 and 20 fish species respectively of the present drainages from those described earlier have been purported. In addition, the maximum size of 10 species has been newly reported.

It is interesting to note that the fish fauna of Sikkim drainages includes higher percentage of Burmese than Malaysian elements. Besides, the fishes of Sikkim drainages, which zoogeographically contain more primary freshwater forms than the peripheral group, have reasonably been classified into true hill stream, semi-torrential, migratory and plainwater forms.

Region-wise pattern of distribution portrays that there are more overlapping species of fish between the Tista and the Rangit river systems than exclusively to any one of them. Indeed, while a few species have established endemicity to certain territory some have portrayed definite course of distribution than exclusively to any one of them. However, contribution from the rivers of the

northern region supersedes the southern one.

Besides fishes, the potamoplankton communities of each river have also been investigated along with other related ecological factors. 43 genera of phytoplankton and 17 genera of zooplankton are reported for the first time from the drainages. Chlorophyceae amongst the former and protozoa of the latter are found to dominate the potamoplankton communities of the river systems.

The seasonal trend of each river in respect of fish catch statistics at respective survey station has been focused in the fisheries of the rivers investigated. Besides detailing all the commercial ichthyospecific, contributing to the fishery of the state thirteen principal fish capturing devices under seven categories along with the associated crafts and gears those are found in operation in the drainages are meticulously studied and presented in the communication. The biology of the most dominant species of the state, *Schizothorax richardsonii* (Gray) has also been purported.

The present study gives a coherent picture on the fish and fisheries of the Sikkim drainages for the first time and the findings, it is humbly believed, will help thrash out tangible approaches for the ichthyological development of the state in particular and the nation in general.

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