# MIGRATION IN CERTAIN FISH SPECIES OF THE KALI RIVER SYSTEM IN KUMAON HIMALAYA

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## ABSTRACT

The present communication unravels the migratory phenomenon in 4 fish species of Himalayan region, for the first time. The study was carried out in the river Kali and its some upstream tributaries. The river system harbours over 30 fish species, in which *Tor putitora, Schizothorax richardsonii, Labeo dero* and *Bagarius bagarius* were found migratory in nature. *Tor putitora* start downward migration for over wintering as ambient water temperature in the upstream segments drops below 16.0$^0$C and *S. richardsonii* start migration as temperature drops below 13.0$^0$C, during September-October. The migrated stock of both the species congregates at the foothill zone up to March-April, where they feed, grow and attain sexual maturity. The immature, juveniles and occasionally few adult fishes take shelter in the deep pools located in the mid stream of the tributaries, for over-wintering. The stock starts upward movement during March-April as the water temperature in the midstream of the Kali gradually rises above 13.0-16.0 $^0$C. *T. putitora* and *S. richardsonii* breeds in the upstream waters. *Labeo dero* and *Bagarius bagarius* were observed to migrate upstream locations during summer months, primarily for feeding.

***Key words***: *Tor putitora, Schizothorax richardsonii, Labeo dero, Bagarius bagarius,* migration, Kali river

## INTRODUCTION

Migration has been a way of life in many of the upland creatures including human beings. The hill-landers used to shift from the severe skin-biting cold hilltops and spend winter months in the comparatively warm valleys along with their cattle herds. Likewise, they moved from harsh summers of the valleys to the salubrious, soothing and pleasant hilltops. Similar phenomenon is also being shown by a few other mammals, birds and fishes. Beside comparatively conducive thermal regime, food availability also played a vital role in the process. In animals, especially in poikilotherms like fishes, seasonal changes in the external environment have striking effects on the body activities, both at structural and functional level. This is more common in species of temperate zone where climatic conditions have greater extremes. As water temperature decreases in autumn, the metabolism of fish decreases, feeding, digestion and growth rates are drastically reduced, swimming ability decreases and there is need to conserve energy (Rimmer *et al*., 1985; Cunjak and Power, 1986, 1987; Cunjak *et al*., 1998). Seasonal variations in the temperature, photoperiod, food or chemicals in the ambient medium may serve as trigger for bringing about changes in the associated physiological regulatory mechanism that in turn is manifested in the fish behaviour. In these circumstances, the organisms react towards their changing environment in a characteristic way, by being able to adjust physiologically within their genetic limits or move to congenial habitats, in rare cases. Such adjustments of the organisms with their environmental cycles are adaptive and imperative for their survival.

There is complete dearth of documented information on migratory fishes of the Himalayan region except a preliminary report on Garhwal Himalayan mahseer (Nautiyal and Lal, 1983). Therefore, an attempt has been made to unravel the migratory phenomenon in upland fishes in the Kali river system. The present communication is the extract of detailed work conducted during 1994-2000 in the Kali river and some of its tributaries.

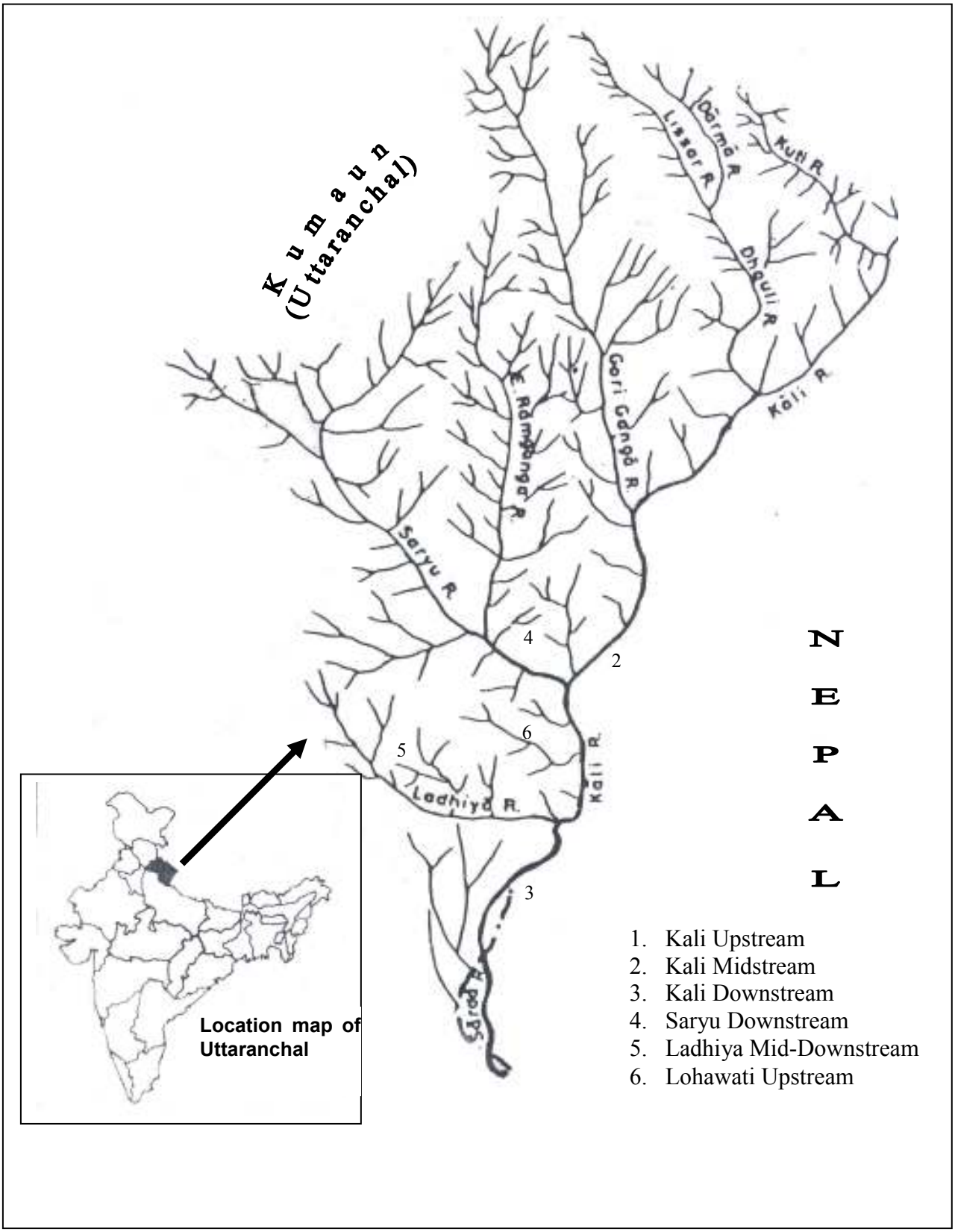


**Fig. 1. Map of Kali River System showing different rivers, referred in the text**
(Not to scale)

## STUDY AREA

The present study was conducted in the river Kali and its tributaries – river Saryu, rivulet Ladhiya and Lohawati in Kumaon region of Uttaranchal state. The river Kali is a glacio-fluvial and largest river system in Kumaon Himalaya, traverses about 220 km distance through varied catchments area, from its origin in the glacial zone to entrance in the plains at Baramdeo (260m asl). Thereafter the river is known as the Sharda. The river Kali originates from Lipulekh Glacier at an altitude of 7,820 m a.s.l. and traverses through vast catchments spread over 12,100 $km^2$. Average annual runoff of the river is estimated as 18,546 m cum. All the above three tributaries- Ladhiya, Lohawati and Saryu debouch into the river Kali in the downstream region at Chuka (23 km upstream from Baramdeo), Bhanar (52 km upstream from Baramdeo) and Pancheswar (68 km upstream from Baramdeo), respectively. The study sites (Table 1, Figure 1) were selected on the basis of accessibility by roads.

## MATERIAL AND METHODS

The information on occurrence, seasonal availability and fishery aspects of migratory fishes were collected in the Kali river system at 6 different river stretches from the fishes caught by local people, experimental fishing conducted and observations made by local people, during the period 1994-2000. The morphological changes in the gonads were observed after Joshi (1989, 2004) and Joshi and Joshi (1993). There is no record of regular fishing and landing activity in the upland lotic systems particularly in Kumaon Himalayan region, so it is very difficult to ascertain about the fish species in the system, their composition and catch spectrum. Therefore, a method based on experimental catch per castings (ECPC) (Joshi, 2003) was followed to quantify the catch. All the fishes collected were identified after Talwar and Jhingran (1991). The study sites were frequently visited and the movement of fishes was keenly observed for their seasonal availability and migratory run.

## RESULTS AND DISCUSSION

Most of the glacio-fluvial river systems of Himalayas traversing from their upland reach to the down plains harbour rich piscine diversity along with certain migratory fishes. The Kali is a similar river system traversing through Kumaon Himalaya. Owing to its glacio-fluvial drainage, diverse physical features, altitudinal variations, vast and varied catchments, diverse substratum, huge volume of water, vast course, anastomosing network of tributaries and wide array of ecological niches the river system offers amiable habitats to a variety of upland fishes. The varied river catchments also offer drastic variations in its physico-thermal regime. As a result of diversity in habitat, the river harbours over 30 fish species of which 4 are of migratory in nature (Joshi 1998 & 1999).

All the river stretches (study sites) of the system, except site 3 (Table 1), are traversing through rhithronic zone, where torrential flow is the main characteristic feature. In this zone the substratum of the rivers consists of bedrock, boulders, coarse gravels and sand whereas at site 3 (Kali-Shards downstream), the river has lesser flow rate and substratum mainly consists boulders, course gravel, sand and silt. The migratory fishes observed in the Kali river system are: *Tor putitora, Schizothorax richardsonii, Labeo dero* and *Bagarius bagarius.* Among these *T. putitora* and *S. richardsonii* spend most of their life span in the upland waters, whereas the latter 2 occasionally visit the region for a short period.

### Thermal Regime in the River System

Seasonal temperature variation in the different river stretches of the Kali river system has been revealed in Table 2. Water temperature was recorded between 5.5-23.2 $^0$C in the Lohawati, 11.3-29.8 °C in Ladhiya, 9.8-30.2 °C in Saryu, and 5.8-29.6 °C in the up, mid and downstream of the river Kali. The water temperature in these tributaries remained at 12.6-30.2 °C during the period between March to October.

**Table 1: Details about the different study sites in the Kali river system**

| S.N. | River stretches | River stretches under observation (length in km) | Altitude (m ) |
|---|---|---|---|
| 1. | Kali: upstream (Jauljibi to Dharchula) | 22 | 670-990 |
| 2. | Kali: midstream (Pancheswar) | 02 | 530-540 |
| 3. | Kali (Sharda):downstream (Baramdeo to Chukha) | 23 | 260-320 |
| 4. | Saryu: down stream (Kakrighat- Ghat) | 15 | 540-566 |
| 5. | Ladhiya: mid-down stream (Chukha- Ritha) | 40 | 320-912 |
| 6. | Lohawati: upstream | 14 | 1340-1600 |

**Table 2: Seasonal variation in the water temperature (°C) of the different river stretches**

| S. N. | Season | River stretches | | | | | |
|---|---|---|---|---|---|---|---|
| | | Kali: upstream | Kali: midstream | Kali: downstream | Saryu: downstream | Ladhiya:mid &downstream | Lohawati |
| 1. | Pre-monsoon (March-June) | 12.6-16.4 | 14.8-18.0 | 19.1-29.6 | 26.0-30.2 | 21.0-29.8 | 15.3-23.2 |
| 2. | Monsoon (July-August) | 13.7-16.5 | 16.0-20.4 | 26.3-28.9 | 24.2-27.0 | 25.0-28.4 | 17.0-23.2 |
| 3. | Post-monsoon (Sept.-Oct.) | 13.2-15.8 | 14.5-17.1 | 22.3-26.7 | 21.0-25.3 | 21.4-24.6 | 14.5-20.5 |
| 4. | Winter (Nov. – Feb.) | 5.8-9.6 | 7.0-13.8 | 13.5-21.1 | 9.8-15.6 | 11.3-19.8 | 5.5-13.0 |

The temperature in the down stream of the Kali River remains 13.5-21.$^0$C during winters, which is comparatively higher than the rest of the larger tributaries. Though the temperature in the downstream of the river Ladhiya also recorded a similar range for most of the period, but due to lesser volume of water the temperature is conspicuously influenced by climatic conditions of the riparian catchments in comparison to the rest of the rivers, so the fish rarely occupies the stretch during winters.

## Migratory Movement of Fishes in the River System

### 1. *Tor putitora* (Ham. Buch.)

Golden mahseer (*T. putitora*) has wide distribution and sizeable population in the region. The fish constitute 1.02 – 57.14 % of

the total catches in different lotic systems of the Kumaon region (Joshi 2000a). The golden mahseer is migratory in nature and moves up or downwards in the lotic systems in search of suitable breeding grounds, preferred food and congenial thermal regime.

**(i) Migration for over-wintering**

Most of the upland streams, rivulets and rivers are inhabited by all size groups of golden mahseer (*T. putitora*) during the month of April-May to October. Thereafter, the majority of the mahseer from the above tributaries (sites – 1, 2, 4-6) moves towards down river foothill region of the Kali (site-3) (Table 1). The downward migration starts as ambient water temperature in these tributaries drops below 16.0 $^0$C during September-October. The downward movement among the stock commences earlier from the higher altitudinal region (sites-1 & 6) and followed by the stock of lower altitudes. The stock congregates at the down stream foothill region (site-3) up to March-April. The water temperature in the foothill river stretch remained comparatively congenial (13.5-21.1 $^0$C) for the mahseer during winter season (Table 2). The parent population along with a few immature fishes inhabits the down stream segment, where they feed, grow and attain sexual maturity in the comparatively warmer and physiologically congenial water. Owing to congregation of the adult stock in the foothill section of the river Kali, the percentage catch of the bigger mahseer (180-680 mm) from the river segment increased considerably during winters. However, there was no record of mahseer catch from the rivulet Ladhiya (Table 3) and Lohawati during winters. The small population left in comparatively warmer water of the river Saryu, constitute immature and smaller (< 240 mm in size) mahseers. Immature, juveniles and occasionally a few adult mahseer also take shelter in the deep pools located in the mid-stream of the tributaries, for over wintering. These were observed from the pools after incidences of illegal fishing by use of toxicants.

**(ii) Migration for breeding**

The adult and maturing stock starts upstream migration during March-April as the water temperature in the midstream of the Kali gradually rises up to congenial limit (up to 18.0 $^0$C). Initially the fish occupies the river segments with large water volume and congenial thermal regime *viz*. Kali -midstream, downstream of the Saryu and further moves upwards as the temperature gradually rises in the upstream stretches. The rivulet Ladhiya, Lohawati and other similar spring fed rivulets and streams have less water volume during summer, hence the fish re-appears in these water bodies only after swallowing with pre monsoon or monsoon flood waters (Joshi *et. al*., 2002).

Brood fish (>3 in age) moves 40 – 110 km distance from foothill locations of the river Kali-Sharda to upstream of flooded Ladhiya, Lohawati, Saryu and other rivers, streams and their tributaries after onset of southwest monsoon. The migration up to these segments is evidenced by occasional catch of bigger specimens from these waters. The fish lays eggs during the low phase of floods in shallow area on the gravel, shingles, sand and debris (Raina *et.al*. 1999). The mahseer is recovered from 110 km upstream of the river Kali at Jauljibi-Dharchula segment during monsoon season, while the population completely disappears during rest of the season According to Cordington (1939), in the Himalayas, elevation of 2000 m a.s.l. is the upper limit for migration of fish during south-west monsoon months (July-September).

**Table 3: Details of the mahseer catch (experimental catch per castings) in the rivulet Ladhiya in different season**

| Sampling season | ECPC (g) | Length ranges (mm) | Body weight (g) |
|---|---|---|---|
| Monsoon (July-August) | 1.0- 14.4 | 120-265 | 13.5-210.0 |
| Post-monsoon (September-October) | 0.2-6.12 | 116-195 | 12.0-156.0 |
| Winter (November-March) | 0.0 | - | 0.0 |
| Pre- monsoon (May-June) | 2.8-9.3 | 104-248 | 11.5- 195.0 |

Observation on the seasonal morpho-histological changes in the gonads depicts that the ovarian maturation in golden mahseer starts in March, progresses in later months and spawning occurs in the confluence zones of the tributaries- Ladhiya, Lohawati and Saryu - during April-June and in the upstream of the tributaries during September-October. The long breeding duration from April- October is in agreement with the findings of Pathani (1983) and Raina *et.al*. (1999). The adult or bigger sized fishes migrate to downstream of the Kali – Sharda system after receding of monsoon, whereas the juveniles and young fishes moves to deep pools within the river for over wintering.

**2. *Schizothorax richardsonii* (Gray)**

*S. richardsonii* inhabits the entire network of snow and spring fed rivers, rivulets, streams and lakes in the region between 270 – 2000 m. a.s.l. The composition of the fish in experimental catches from a few tributaries of the Kali river system in Kumoun Himalaya varied between 23.81 – 98.08 % (Joshi, 2000 b).

**(i) Migration for over-wintering**

The ambient water temperature in Lesser Himalayan region remains conducive for asela during April-May to October (Joshi *et al*., 2005). Thereafter, as the water temperature drops below 13.0 $^0$C, on the onset of winter season, most of the adult or spent brooders of asela snow-trout from all upstream and mid stream tributaries moves towards foothill segment of the river Kali to cope with the steep fall in temperature in the winters. Most of the parental stock take refuge in the comparatively warmer waters from October- November to February- March and feed, grow and attain gonadal maturity. The pattern of migration is similar to golden mahseer, but the mahseer starts downward migration little earlier than snow-trout, because the snow-trout withstand comparatively colder waters. As a result the snow-trout availability in the upstream tributaries is recorded nil (Table 4) during winters.

**Table 4: The details of the snow-trout catch (experimental fish catch per castings) in the Gandaki stream (tributary of the Lohawati stream) in different seasons**

| Sampling season | ECPC (g) | Length ranges (mm) | Body weight (g) |
|---|---|---|---|
| Monsoon (July-August) | 13.6- 28.0 | 110-160 | 8.0-60.0 |
| Post-monsoon (September-October) | 26.8-51.0 | 115-325 | 12.0-340.0 |
| Winter (November-March) | 0.00 | - | 0.00 |
| Pre-monsoon (May-June) | 0.00-4.8 | 105-155 | 6.0-35.0 |

**(ii) Migration for breeding**

As the water temperature in the upstream tributaries gradually rises above 13.0 $^0$C (March onwards), the maturing spawners of *S. richardsonii* start upward migration from their winter sheltering grounds located at the down stream of the river Kali. The putative brooder occupies the Kali midstream and subsequently the river Saryu, rivulet Ladhiya, Lohawati and other tributaries up to monsoon-post monsoon season. The migrating snow-trout feeds on the under-exploited feeding grounds of the upstream, before attaining full maturity stage during early migratory runs in March-April. The spawning in the down stream of the rivulet Ladhiya and also in the down stream of the Saryu (located < 800 m a.s.l.) commences during April-May in shallow pools having gravel-sandy substratum and gentle flow of silt free water. The spawning generally occurs after settling of the silt laden stream water of pre-monsoon heavy showers, when water temperature comes down in the range of 18.0 - 22.5 °C.

Fully mature spawners of *S. richardsonii* migrate upstream segments (altitude, 1400-2000 m a.s.l.) of the River Kali, Saryu, the rivulet Ladhiya, Lohawati and their numerous tributaries and spawn in the upstream shallow, clear and oxygenated waters during September-October. The fish was observed to traverse a maximum distance of about 130 km as it was collected from Chhirkila in the remote up stream zone of the River Kali. The seasonal migration of *S. richardsonii* is also well discernible from the experimental catch per castings (E.C.P.C.) and the size range. In the rivulet Lohawati (Gandaki), the maximum catch with largest specimen was registered during post monsoon season, whereas minimum during the month of May-June (Table 4). The stream is observed well populated with migratory snow-trout population during monsoon and post-monsoon period and breeding of *S. richardsonii* was also reported in the stream during post-monsoon (Joshi, 2004). Breeding of *S. richardsonii* during pre-monsoon and again in post-monsoon season is in agreement with the observations made by Bhatnagar (1964).

Spawning of asela snow-trout in the upstream tributaries takes place during August to October (water temperature 18.0-22.4 $^0$C) and thereafter the water temperature in the shallow channels and rapids turns colder, which is unsuitable for normal metabolic activity of the juveniles as well as that of the fish. Therefore, the spent brooders along with a few immature fishes move to downstream of the Kali – Sharda system, while all the immature, juveniles and occasionally a few adult fishes take shelter in the deep pools located within the river for over wintering. Hence, now the resident snow-trout population of the upstream tributaries mostly consist fry and fingerlings and a few adult fishes.

### 3. *Labeo dero* (Ham. Buch.)

*L. dero* is an inhabitant of the Himalayan foothill rivers, a transitional habitat between hill streams and the rivers of the plains. As most of the fish stock consisting migratory as well as the resident fishes congregate in the down stream zone of the river Kali during winters and many of them subsist on similar food. Later, the water temperature in the midstream and adjoining waters starts rising up to the congenial limit. So, kalabans population ascends upstream in search of under-exploited feeding grounds in the snow-fed rivers during summer months and inhabits in the sides of torrential upland rivers. *L. dero* is observed to ascend 90-110 km up to the midstream of the river Kali and also in the river Saryu up to Ghat-Kakrighat. The upward moving shoal of kalabans is locally known as "Maggar" in some places. The fish returns back to the downstream habitats before onset of monsoon.

### 4. *Bagarius bagarius* (Ham. Buch.)

*B. bagarius* locally known as Gangetic goonch is inhabitant of the river Ganga and its tributaries. The fish lies mostly at the bottom of the rivers and can withstand forceful currents amongst rocks. The fish ascends the midstream of the river Kali and traverses about 60-110 km distance as it was observed from Pancheswar in the Kali and also from Bageswar in the river Saryu during summer months. The fish feeds on under-exploited feeding grounds of the river system when the water temperature remains congenial. The fish ascends the river during May-June and returns back to the foothills before onset of monsoon flood.

## CONCLUSIONS

Out of the 4 migratory fishes observed in the system, *T. putitora* and *S. richardsonii* spent their most of the life span in the upland waters in feeding and breeding and migrate down stream only for over-wintering, while *L. dero* and *B. bagarius* enter the up and mid stream of the river Kali for a brief span of 2-3 months during summer season for the purpose of feeding. Similar migratory phenomenon occurs in all the Himalayan river systems of similar topographical and physico-chemical attributes. Though the present communication throws some light on the behaviour and related attributes of migratory fishes in the Kali river system, there is need to study the river system, the biota and the migratory pattern thoroughly with the help of modern electronic tagging gadgets.

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