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Growth Pattern of *Labeo calbasu* (Ham) Affected By Socio-Geographical Condition of the Riverine Habita

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Abstract: This study presents the findings of the study on the growth parameters, length-weight relationship and condition factor of *Lebeo calbasu* at the Guptar Ghat of Ghaghra River in Faizabad district of Uttar Pradesh, India and compares the growth pattern of the species in other areas, to suggest ways and means to improve the status of fish population in a defined socio-geographical condition. During the study 193 specimens were examined including 98 females, 90 males and 5 juveniles. The von Berlanffy growth parameters L_∞ and K for the species were 667 mm and 0.249 per year, respectively. Regression coefficient and correlation coefficient of the fishes were higher in males (3.0561 and 0.9602) than that of females (3.00497 and 0.909). The present study speculated that condition factor value was highly affected by gonadal maturation than feeding.

Key words: Ghaghra River, growth pattern, *Lebeo calbasu*

INTRODUCTION

Age and growth play a very important role in the management of fishery. Age provides a means to understand the composition of fish population, while growth parameters differ from species to species and from stock to stock within the same species depending upon the habitat conditions. Also, successive cohorts may grow differently depending upon the environmental conditions such as extrinsic factors, except for fluctuation associated with daily lunar and seasonal cycle, intrinsic factors such as physiological stress, natural selection and food and predation cause oscillations. Therefore, sustaining power of a fish stock can be ascertained by understanding the age and growth (Gulland, 1983; Nikolskii, 1980).

Knowledge of length-weight relationship and population dynamics of the fish are vital in fishery science (Lizama and Ambrosio, 2001; Ahmad *et al*., 2003). Any deviation from the established length-weight relationship of a species in a particular geographical area may indicate taxonomic differences, stages of life history such as metamorphosis, onset of maturity, spawning stress etc. that may be influenced by habitat conditions e.g., food availability and pollution. Length-weight relationship not only helps to establish the mathematical relationship between these two variables, but also converts one variable into other. It is known that with the increase in the length of fish, the weight also increases, thereby showing that the weight of fish is a function of length (Kulbicki *et al*., 1990).

In fishes, Condition factor (k) reflects through its variations and provides information on the physiological state of the fish in relation to its welfare. From nutritional point of view, there is accumulation of fat in the abdominal parts of the body and the gonads (Le Cren, 1951) and from reproductive point of view, the highest (k) values are reached in some species such as *Amblypharygodon mola*, *Botia lohachata* & *Rhinomugil corsula* (Angelescu *et al*., 1958; Thakur, 1975; Afroz *et al*., 1999; Mortuza and Mokrrama, 2000; Mortuza and Rahman, 2006). Condition factor (k) also gives information about two comparative populations of different feeding zones, density, climate, and other conditions, in determining the period of gonadal maturation and the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley, 1972; Ricker, 1975; Kangur *et al*., 2003). Hile (1936) also provided a useful comparison of the weight of an individual fish relative to its length, strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which the fish lives (Anene, 2005).

Labeo calbasu is an herbivorous fish found in slow-moving rivers and ponds, generally attaining a length of about 90cm and weight of 5.5 kg. It is a commercially important species often cultured in South Western China, India, Pakistan, Bangladesh and Thailand. Fecundity ranged between 193,000 and 238,000 (Jhingran, 1982; Talwar and Jhingran, 1991; Alam *et al*., 2000). Average annual fish catch composition at Guptar Ghat of Ghaghra River is as Indian major carps (45%), catfishes (20%) and miscellaneous group (35%). This species contributes about 4.5% among the total fish catch of this River (Dwivedi, 2006).

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There is a good record of literature on length-weight relationship and condition factor of this species from south India (Jhingran, 1957; Khan and Siddique, 1973; Prakash and Gupta, 1986). Only a few authors have reported the population dynamics of the fish in Ganga, Yamuna, Ken, Paisuni and Tons rivers of India (Gupta and Tyagi, 1992; Dwivedi, 2006). Similar work has also been reported from the Sylhet basin of Bangladesh (Alam *et al*., 2000; Haroon *et al*., 2002). So far, only a few studies have been conducted on these aspects of *L. calbasu* in Ghaghra system (Dwivedi *et al*., 2004, 2006, 2007; Singh *et al*., 1999). This paper presents the findings of the study on the growth parameters, length-weight relationship and condition factor of *L. calbasu* at the Guptar Ghat of Ghaghra River in Faizabad, Uttar Pradesh (India) and compares the growth pattern of the species in other areas, to suggest ways and means to improve the status of fish population in a defined socio-geographical condition.

MATERIALS AND METHODS

Study area: The Ghaghra, an important tributary of River Ganga, originates near lake Manasarovar on Tibetan plateau and cuts through Nepal where it is known as Karnali. It joins Ganga at Bramha Ghat in India. The study was conducted in between 26º9′ and 26º50′ N latitudes, and 81º85′ N longitude span of River Ghaghra (Fig. 1).

Data collection: Random length frequency data of *L. calbasu* were collected monthly from fish market at Guptar Ghat of Ghaghra River in Faizabad from of December, 2003 to March, 2005. During this period, 193 individuals including males, females and juveniles ranging from 154 to 574 mm in length and 50 to 2800 g in total weight were collected. The collection included 98 females (range from 163 to 574 mm in length and 50 to 2700 g in weight) and 90 males (from 160 to 545 mm in length and 55 to 2800 g in weight). The total length of the individual fish was measured (in mm) using measuring scale from the tip of the snout to end of the largest caudal fin. The weight (in g) of the fish was measured on the electronic monopan balance with 0.1 g accuracy.

Age determination: The age of the fish was determined using Carl Zeiss Jena scale Reader. The healthy scales of *L. calbasu* were obtained from the dorsal fin region just above the lateral line of the fish. After proper cleaning of the scales, the counting of growth rings was performed. The annulus counting was determined according to the criterion suggested by Bagenal and Tesch (1978).

Analysis of growth parameters: The fish samples were weighed. The length measurements were distributed in 50 mm size interval. The size frequencies were raised to the catch of the species on the days of observations and subsequently for the monthly catch following calculation were made. The calculation in relation to the growth increment was made manually according to Sparre and Venema (1998) using the Gulland and Holt (1959) formula:

$$\frac{\Delta L}{\Delta t} = K \times L\infty - K \times \overline{L}(t)$$

where,

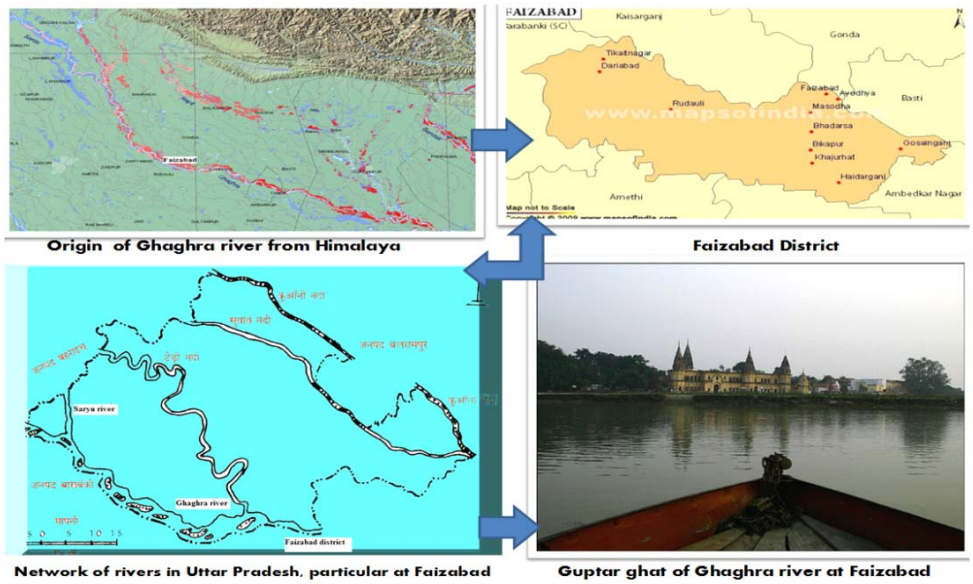

Fig 1: Maps showing origin of Ghaghra River, distribution at Faizabad district and habitat of Guptar ghat of Ghaghra River

$\frac{\Delta L}{\Delta t}$ = Growth increment as dependent variable

$\bar{L}(t)$ = Mean length as independent variable

K = Growth coefficient

L_∞ = Asymptotic length

whereas, t_o (length at age is zero) was calculated by von Bertalanffy (1938) method.

Growth performance in terms of length was compared using the index ϕ = Log10 K + 2 Log 10 L_∞ (Pauly and Manro, 1984).

The length-weight relationship was calculated by the least square method for male and female separately, using the parabolic equation $W = a L^b$ or its logarithmic form:

$$\text{Log } W = \log a + b \log L$$

Where W = weight in grams; L = length of fish in mm; a = intercept; b = slope.

Analysis of Covariance (ANCOVA) was carried out to determine statistical difference in the length- weight relationship of male and female of the species (Snedecor and Cochran, 1967).

A length-wise condition factor of the individual sex of *L. calbasu* was determined by using the expression:

$$k = 100000 \times W/L^b$$

where, 'W' is weight in grams, 'L' is length in mm. and 'b' is exponent of the length-weight relationship.

RESULTS

Growth of the species was studied by following the von Bertalanffy growth model in which asymptotic length (L_∞) and growth coefficient (K) parameters were estimated as 667 mm and 0.249 per year, respectively (Fig. 2), while t_o was calculated 0.982 per year for *L. calbasu* from Ghaghra River at Guptar Ghat.

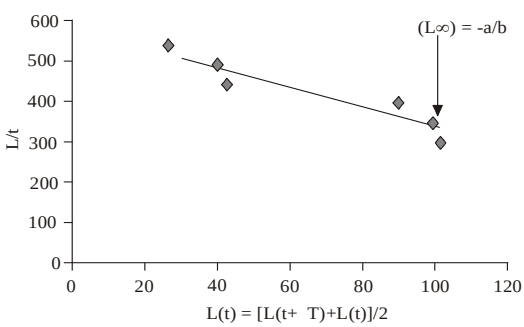

Fig. 2: Estimation of growth parameter L∞ and K of *L. calbasu* by Gulland & Holt. (The intersection point between the regression line and the x axis gives L_∞)

Table 1: Mean length and age of different size groups of *L. calbasu*

Size groups	Mean length (mm)	Mean age (yr)
151-200	177.54	0.5
201-250	225.15	1.2
251-300	275.59	1.5
301-350	326.33	2.2
351-400	376.25	2.5
401-450	421.21	3.1
451-500	470.37	4.3
501-550	522.17	5.8
551-600	574.00	7.5

Age of 0^+ to 7.5^+ years was determined from the scales of *L. calbasu* population. The largest specimen of this species was measured 574 mm; the calculated age for the length at age frequency data being 7.5 years and age of the other size group is given in Table 1. The von Bertalanffy (1938) equation for growth in length for this species could thus be written as:

$$Lt = 667\,(1 - e^{-0.249\,(t-0.982)})$$

The value of growth performance index (ϕ) of *L. calbasu* was estimated 5.0441.

The length-weight relationship and correlation coefficient (r) obtained for the two sexes separately and combined relationship for the two sexes together was logarithmic transformation as depicted in Fig. 3-5.

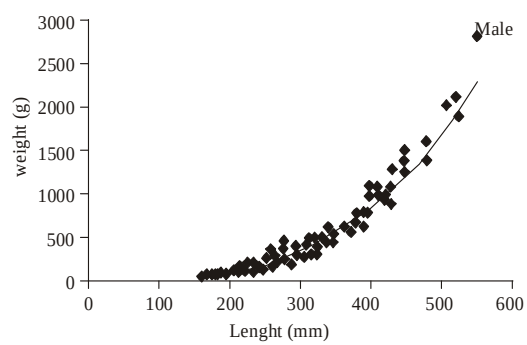

Fig. 3: Length-weight relationship of *L. calbasu* (male)

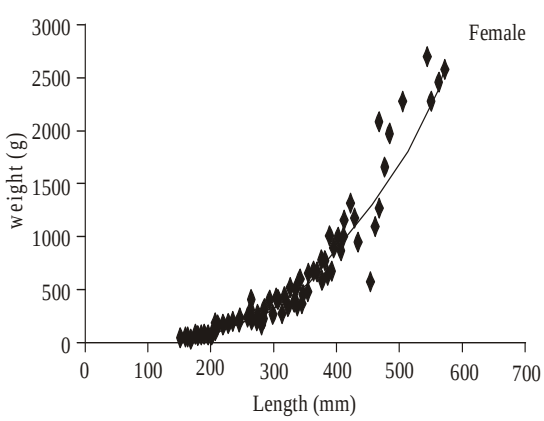

Fig. 4: Length-weight relationship of *L. calbasu* (female)

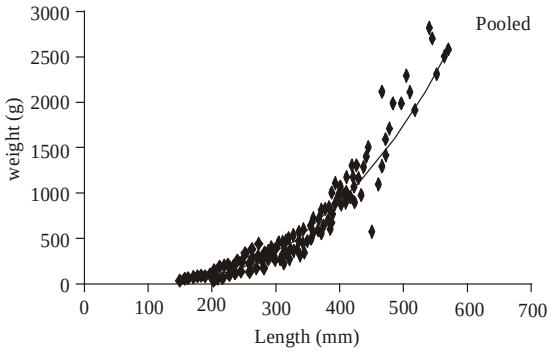

Fig. 5: Length-weight relationship of *L. calbasu* (pooled)

Table 2: Estimation of intercept (a), slope (b) and correlation coefficient (r) for males, females and pooled of *L. calbasu*

Sex	Intercept	Correlation slope	Co-efficient
Male	- 4.99924	3.05316	0.981177
Female	- 4.88324	3.00498	0.982938
Pooled	- 4.933	3.0256	0.982333

Table 3: Analysis of covariance for male and female of *L. calbasu*

ΣSx2	Σy2	Σxy2	df	Σy = (∑xy)2/∑x
1077505	36562229	3656223	99	6766043.2
848681.9	25894268	2589427	90	3839505.9
		Total	189	10605549.1
99931054	62672969	10036453	191	61664970.1
		Difference	2	5105942
Sources of variation		**df**	**ss**	**ms**	**f**
Between sexes		2	5105 9421	2552 9711	454.96
Within sexes		189	10605 549.15	56114.02	

F-value: non-significant at 1% level and 5% level

Male : Log W = - 4.992124 + 3.0561 log L (Fig. 3)
r = 0.9602

Female: Log W = - 4.8832 + 3.00497 log L (Fig. 4)
r = 0.909

Combined: Log W= - 4.933 + 3.0256 log L (Fig. 5)
r = 0.9243

Slope (b) indicates that weight of the fish increased more or less in proportion to the cube to its length but the male grow faster by weight than female as their exponential value was more (Table 2). However, ANCOVA showed that there was no significant difference between 'b' among the sexes of fish species (Table 3).

The condition factor (k) values obtained for different size groups of males and females of *L. calbasu* are shown in Fig. 6 and 7, respectively. The (k) values were maximum in the size groups of 150-190 mm and again in 431-470 mm; the values were minimum in 311-350 to 351-390 mm groups. For the females of *L. calbasu*, the sharp increase in (k) value was noticed in

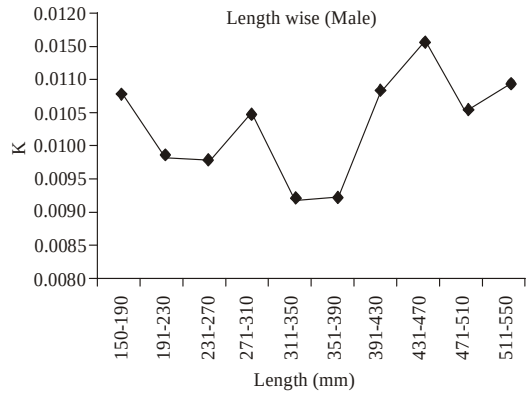

Fig. 6: Length wise condition factor of *L. calbasu* (male)

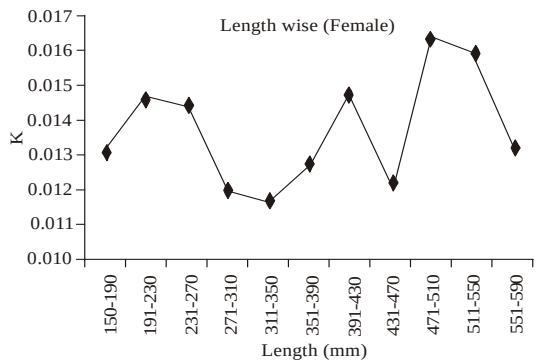

Fig. 7: Length wise condition factor of *L. calbasu* (female)

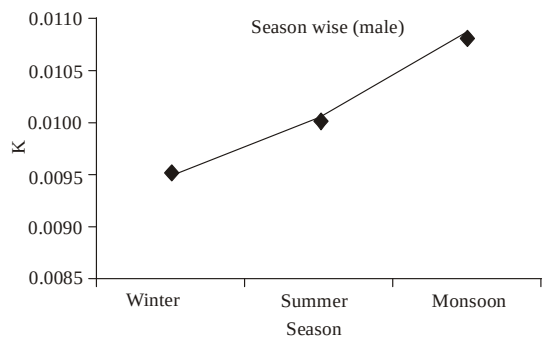

Fig. 8: Season wise condition factor of *L. calbasu* (male)

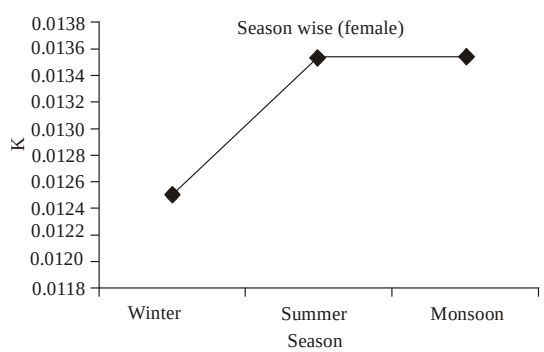

Fig. 9: Season wise condition factor of *L. calbasu* (female)

190-230 to 231-290 and 471-510 to 511-550 mm size groups. Season wise condition factor of *L. calbasu a*re shown in Fig. 8 and 9, respectively. Minimum (k) value observed in winter season whereas maximum in monsoon both in male and female.

DISCUSSION

Beverton and Holt (1957) pointed out that the two parameters of growth such as asymptotic length ($L_{¥}$) and growth coefficient (K) are inversely proportional to each other. It implies that fishes with high $L_{¥}$ should have lower K values and vis-a- vis Consequently, those with longer life span had lower K and *vice versa. L. calbasu* with maximum observed sizes (L_{max}) of 574 mm had $L_{¥}$ = 667mm and K = 0.249 per year in the present study. Alam *et al.* (2000) observed $L_{¥}$ as 493.0 mm and K as 0.63 year^{-1} for *L. calbasu* in Bangladesh water, showing that *L. calbasu* from Ghaghra River had relatively higher $L_{¥}$ and slightly lower K. Thus, the present estimates of asymptotic length and growth coefficient for *L. calbasu* are justified. The growth rate, however, is quite low due to longer life span (7.5 years age) in the Ghaghra River and is also acceptable. The maximum attainable size (2720 mm) was computed for the Himalayan mahseer (*T. putitora* from the Gangetic stock) which has a long life span (17+ years) and had very low K value ie. 0.055 per year (Nautiyal *et al*., 2008). The *Oncorhynchus keta* is known to attain a size of 900 mm and age of 16 years Nikolskii, (1980), Ahmad *et al.* (2004) and Haroon *et al.* (2002) reported the L_{∞} and K values for other Gangetic carps such as *Cirrhinus mrigala* (L_{∞}=850 mm and K= 0.43 year^{-1}), *Catla catla* (L_{∞} = 700 mm & K = 0.73 per year, *Labeo rohita* (L_{∞} = 510 mm & K= 0.80 per year and *Labeo calbasu* (L_{∞} = 525 mm & K= 0.76 per year. The K values were higher in these species than *T. putitora.* Similarly Amin *et al.* (2000) obtained $L_{¥}$ and K values for Jatka (Juvenile Hilsa) as 186 mm and 0.733 per year, respectively in the Meghna River of Bangladesh. Therefore, estimated K value (0.249 per year) of *Labeo calbasu* was higher than Himalayan mahseer and lower than Jatka. Growth rate of *L. calbasu* obtained by Haroon *et al.* (2002) at Sylhet basin in Bangladesh was higher than found in present study. Rao (1974) estimated that L_{∞} and K for *Labeo fimbriatus* at Godavari River were 1090 mm and 0.1422 per year, respectively. Due to higher value of L_{∞}, K value of *L. fimbriatus* (at Godavari River) was found lower than *L. calbasu* (at Guptar Ghat). Age and growth rate coefficient of *L. calbasu* vary in different habitats. *L. calbasu* from the River Yamuna at Allahabad had mean length of 188.5, 291.0, 381.0, 468.5, 543.5, 618.5, 681.0 and 731.0mm for 1to 8 age groups, respectively (Gupta and Jhingran, 1973), from Godavari River had mean length of 202.2, 301.8, 382.1, 451.5, 509.4 547.3 and 616.2 mm for age groups of 1 to 7 (Rao and Rao, 1972), while that from the Ghaggar River 218.9, 339.6, 432.6, 480.0, 521.0 mm for 1 to 5 age groups (Tandon *et al*., 1989). It also showed that long life span fishes have low growth rate.

Length and weight of a particular species of fish are closely related to each other (Le Cren, 1951). Therefore, mathematical representation of length-weight relationship from a study of number of specimens of different sizes can be derived. Since length is a linear measure and weight is a measure of volume, it takes a cube form. Hence, a cube law generally expresses length-weight relationship. The length-weight relationship of a stock from a particular area of a fish is a very useful tool for the study of population dynamics. In addition, it also gives an idea about the general condition of the population.

The value of slope (b) is generally 3 and may vary between 2.5 and 4.0. The value of 'b' closed to 3 indicates that the fish grow systematically or isometrically, provided their specific gravity remains constant. However, in many cases the cube law is apparently not obeyed as the fishes change slope during growth. Under these circumstances, values other than 3 indicate allometric growth.

Soni and Kathal (1979) studied the length-weight relationship of *C. mrigala* and *Cyprinus carpio* and found the value of 'b' 4.36 and 3.75, respectively and stated that variations in 'b' value were due to feeding habit of fish. Pathak (1975) observed the value of 'b' 3.0 of *L. calbasu* from Loni reservoir. Value less than 3 (2.797) has been worked out by Khan (1988) from Tilaiya reservoir and exceeding value of 3.0 has been reported by Singh (2006) from Ganga River at Allahabad.

The length-weight relationships of *L. calbasu* in Bangladesh water for the two sexes together, have been reported by several researchers. Alam *et al.* (2000) reported as Log W = - 2.0330 + 3.109 log L (r = 0.992) and Haroon *et al*. (2002) observed exponent 'b' value for *L. calbasu* >3.0. Both authors found the exponential 'b' to be more than 3, indicating allometric growth of this species. In the present study the value of 'b' calculated as 3.0531 (for male), 3.00497 (for female) and 3.0256 (pooled) respectively show allometric growth of the fish at Guptar Ghat of Ghaghra River.

In males, the condition factor showed an inverse relationship with length. Large sized fishes had low condition values while small fishes exhibited higher values, which may be due to higher rate of metabolism. Similar result was shown by the *Brycinus nurse* species from Asa Reservoir, Nigeria (Saliu, 2001).

The sharp rise in (k), 431-470 mm size group in male and 471-510 to 511-550 mm size groups particularly in the case of females appear to be due to gonadal maturation, as the ovaries attain larger size and weight. The high (k) of 150-190 mm in male and 190-230 to 231-290 mm in the female was attributed due to feeding intensity.

The value of 'b' for males (3.0561) was higher than those of females (3.0049) which means that the increase in per unit weight for unit increase in length is greater in male. Due to this reason the male (470 mm) begins to mature earlier than female (530 mm). Higher rate of increase in weight is related to higher level of nutrition which would be evident from size related analysis of condition factor. This parameter would indicate that at various stages of life, increase in weight may takes place either due to food or growth of gonads. A well fed fish will thus race to sexual maturity. The condition of young is stated to be influenced by the diet or feeding intensity and that of adult by gonads (Gupta, 1967). The linear growth by length is most rapid in immature fish while maximum weight gain occurs in mature fish due to maturity and feeding intensity (Nikolskii, 1980).

The (k) value higher in monsoon season of both the sexes of *L. calbasu* may be due to breeding periodicity whereas low in winter season due to low metabolism of the fishes. The study of length-weight relationship indicates that male was a fast growing fish as compared to female. Correlation coefficient was also relatively higher in male than female.

CONCLUSION AND RECOMMENDATIONS

The present study concludes that growth pattern of *L. calbasu* at Guptar Ghat of Ghaghra River is lower than other geographical regions of Gangetic and Godawari revirine system. Length weight relationship and condition factor of the fish at selected site of the study was also found similar. It is very difficult to find out the possible reasons for lower growth pattern at Guptar Ghat in comparison to Yamuna and Godawari River but it is speculated that anthropogenic activity and natural mortality rate at Guptar Ghat may be one of the reason. Further, long term multicentre studies are required at least in different tributaries of Gangetic River system to know the ecological condition of the running water by estimation of growth pattern of other commercially important fishes including *L. calbasu*.

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