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Age and growth profile of Indian major carps *Catla catla* from rivers of Northern India*

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Abstract In the present communication age and growth of *Catla catla*（Hamilton-Buchanan 1822）was studied in order to obtain the information on its age structure and important growth parameters in the wild populations of rivers of the Ganga basin in the Northern India. Scales were collected from commercial and experimental catch. Based on the analysis we found *C. catla* with a maximum age group 8^+ from river Bhagirathi where mean total length（TL）was 521.51 mm and the back calculated length were ranged from 288.9 to 1132.3 mm and from river Satluj，Punjab with a mean total length of 641.6 mm and back calculated length data were ranged from 335.4 to 1096.08 mm. The specific rate of linear growth（C_l）and specific rate of weight increase（C_w）of the entire population exhibited sharp decreasing trend in 2^+ age group. The value of other growth parameter（C_{lt}）showed an abrupt decreasing trend. Analyses of variances（ANOVA）of the back-calculated length data showed significant variation（$P < 0.05$）in length attainment between the different drainages of river Ganga basin for the age groups up to 1^+ to 4^+ only，however，no significant variations was observed for the higher age groups（5^+ to 8^+）. Based on this study strategies can be made for sustainable exploitation of the *Catla catla* from wild population with reference to rivers of Ganga basin in the Northern India［*Acta Zoologica Sinica* 54（1）：136 – 143，2008］.
Key words *Catla catla*，Age and growth，Conservation，India

印度北方河流中主要鲤科鱼类卡拉□的年龄和生长*

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摘　要　为了获得印度北部赣达（Ganga）盆地河流中野生卡特拉□种群的年龄结构和重要生长参数，对该鱼的年龄和生长进行了研究。鳞片取自商业捕捞和实验室饲养的样品。根据研究分析，该鱼最大年龄可达 8 龄；巴吉拉蒂河（Bhagirathi R.）的种群平均体长为 521.51 mm，退算体长为 288.9 – 1132.3 mm；旁遮普邦（Punjab）Satluj 河种群平均体长为 641.6 mm，退算体长为 335.4 – 1096.08 mm。2 龄时，种群线性生长率（C_l）和体重增加率（C_w）表现出迅速下降的趋势。其它生长参数值（C_{lt}）也呈现快速下降。退算体长差异（ANOVA）分析显示，生活在赣达盆地不同流域中的种群，$1^+ – 4^+$ 龄组的长度差异较明显（$P < 0.05$），高龄组（$5^+ – 8^+$）差异不显著。根据本项研究结果，提出了对印度北部赣达盆地相关河流中生活的野生卡特拉□种群资源持续利用的对策［动物学报 54（1）：136 – 143，2008］。
关键词　野生卡特拉□　年龄和生长　保护和持续利　赣达盆地　印度

Catla catla commonly known as "Bhakur or Catla" belongs to the family Cyprinidae and constitutes a highly important commercial species for freshwater aquaculture and capture fisheries in India. The species inhabits freshwater rivers，reservoirs，lakes，jheels and beels（myriads of natural waterbodies）. Its natural distribution is extends upto Godavari River in the Andhra Pradesh of India，down to the river Krishna，and widely distributed in Bangladesh，Burma，Siam to Pakistan（Day，1889）. This is the fastest growing riverine carp of India. It attains at least 6 feet in length（Day，1878）. Recently，due to reduced abundance over the last 10 years，the species has

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been categorized as vulnerable as per IUCN criterion (CAMP, 1998).

Age and growth studies are most important aspects of modern fishery biological research, as information on these are essential for the scientific interpretation of the fluctuations in the fish populations at different spatial and temporal scale. These are also highly significant for the management and conservation of fish population in natural water bodies. Age and growth of fish have been extensively studied using marks on scales, otolith, opercular bones, vertebrae, fin spines and cleithrum. The importance of growth rings on scales and otoliths has been well documented. In many cases these rings have been shown to be annual, probably formed due to seasonal fluctuations in growth. Studies on scales for age and growth determination of fishes are reported by several authors (Kagwade, 1971; Hanumantha Rao, 1974; Pathani, 1981; Tandon and Johal, 1993; Johal and Tandon, 1992b; Tandon et al., 1993; Desai and Srivastava, 1990; Khan, 2000; Madan Mohan, 2006; Licandio et al., 2006; Sarkar et al., 2006). Age composition of each catch has often been used in different fisheries of the world to predict the future available stock (Tandon and Johal, 1996). The information on age profile of a species from different population can be useful to draw inferences on health of the population, mortality and survival rate (Nikolsky, 1976; Bagenal, 1978). The studies conducted so far on age composition of *Catla catla* are fragmentary, and current information on the changing pattern of age and growth profile of most of the freshwater carps are not available. Hoque and Ali (1984) reported the back calculated length of up to 7^+ age group and observed annual average increment as 27.00 cm (1^+ age group). However, Johal and Tandon (1989, 1992a, b) reported few studies on age and growth of Indian Major Carps from lentic and semi lentic waters including lakes and large tanks at limited geographical scale. In the present communication age and growth profile of *C. catla* was studied for the wild samples collected from different drainages/watersheds of the rivers of Northern India Ganges basin at a very wider geographical scale, which may be helpful in conservation and management of fish population for their sustainable utilization.

1 Materials and methods

The scale samples of *C. catla* were collected from different drainages/watershed of river Ganga basin (Table 1) with reference to Northern India as shown in Fig.1. Altogether 446 samples were collected from commercial and experimental catch in the natural habitat. Collections were made for the period from June 2000 to December 2005. For age and growth, fish were collected and measured length-weight data. Four to five scales were removed by using scalpel from each fish from each location, just below the dorsal fin and above the lateral line. After collection the scales, washed with 5% KOH and rinsed in distilled water. Finally the cleaned scales were kept in an envelop duly coded (Lagler, 1956) with total length (mm) and weights (g) of the fish and examined detailed in laboratory for further analysis. After collection of scales, the duly coded envelopes were kept in sunlight for about 5 – 6 h in a basket to remove the moisture; otherwise fungus may develop on the scales. Scales were cleaned and mount between two glass sides (4 × 4) for permanent storage and studied under stereo zoom microscope at appropriate magnification and the radius was measured. The scales of *C. catla* were cycloid (Fig.2a, b, c). With the help of ocular micrometer, the complete and bright lines were identified as annuli. The annuli were characterized by light bands in the forms of grooves that extended to all sides of the scales while irregular and complete rings were identified as false. These annuli were counted, as the age of fish in years was determined.

1.1 Back calculation

Growth patterns of *C. catla* were determined using size at age data from counts of inner layer in scales. Since scales have been found very convenient and authentic in use for age and growth, the following formula given by Le Cren (1951) have been used for calculating back calculation based on the scale readings as

$$Ln = L \times Sn/S$$

where L = Total length (mm) of the fish at the time of scale removal.

Ln = Total length (mm) of the fish at the time of annulus "n" formation

Sn = Scale radius (mm) from nucleus to the annulus "n".

S = Total radius (mm) the scale.

1.2 Growth parameters

The following growth parameters were calculated as suggested by Tandon and Johal (1996). Specific rate of linear growth (C_l):

i) Specific rate of linear growth

$$C_l = \frac{ln - ln-1}{ln-1} \times 100$$

ii) Specific rate of weight increase

$$C_w \text{ or } C_g = \frac{Wn - Wn-1}{Wn-1} \times 100$$

iii) Growth constant

$$C_{lt} = \frac{\text{Log}ln - \log ln-1}{0.4343} \times \frac{t_2 + t_1}{2}$$

The analyses of Variance (ANOVA) of the back-calculated length of nine populations have been used for showing the significant variance using statistical software SPSS Base 10.0 user's guide. Differences were considered significant at $P < 0.05$.

2 Results

2.1 Back-calculated length

Table 1 Back calculated length of *Catla catla* from rivers of Northern India

Locations	Back calculated length (mm)								
	L1	*L2*	*L3*	*L4*	*L5*	*L6*	*L7*	*L8*	Φ
Yamuna	166.27 ± 12.37^{a} (152 – 172.94)	292.7 ± 292.7^{a} (292 – 292.7)	401.75 ± 401.75^{a} (335 – 423)						133.91
Bagirathi	288.94 ± 83.43 (57.33 – 525.12)	419.83 ± 107.61^{a} (386.66 – 644.18)	539.81 ± 134.31^{b} (513 – 719.24)	659.35 ± 134.52^{a} (633 – 848.03)	790.00 ± 97.06 (634.28 – 964.81)	895.05 ± 114.20 (723.59 – 1043.4)	1002.12 ± 131.05 (884.16 – 1129.18)	1132.31 ± 228.14 (961.83 – 1423.33)	141.53
Sarya	361.15 ± 62.35^{a} (317.08 – 405.23)	502.08 ± 67.76 (385 – 598)	634.34 ± 109.43 (556.96 – 711.72)	711.50 ± 10.59^{b} (704.01 – 719)	793.2 ± 79.2 (790 – 793.2)	896.3 ± 125.3 (890 – 896.3)			149.38
Ganga(Farakka)	339.61 ± 114.43^{b} (187.8 – 515.15)	490.90 ± 118.29^{b} (380.21 – 636.31)	632.60 ± 96.28^{b} (523.29 – 704.84)	701.0 ± 69.9 (623.22 – 758.68)	812.5 ± 81.5 (810 – 812.5)	881.05 ± 881.05 (880 – 881.05)			146.84
Gomti	218.29 ± 84.31^{b,c} (140.75 – 297.12)	308.99 ± 151.28^{a,c} (287.5 – 413.06)	487.52 ± 487.52^{a} (480 – 487.52)						162.50
Ganga(Kanpur)	309.41 ± 63.39^{c,d} (204 – 413.98)	456.12 ± 91.62^{b,c} (277.87 – 576.94)	589.34 ± 101.48^{a,c} (347.98 – 616.66)	621.67 ± 136.16^{a} (466.1 – 679.25)	794.8 ± 28.3 (774.8 – 814.8)				158.96
Sutluj	335.40 ± 141.13 (196.21 – 591.85)	551.58 ± 139.46^{b,d} (326.66 – 766.83)	671.96 ± 107.27 (552.17 – 826.23)	747.15 ± 118.61 (615.26 – 876.59)	827.28 ± 158.51 (647.49 – 946.87)	967.33 ± 29.42 (946.52 – 988.14)	1027.00 ± 44.45 (995.57 – 1058.44)	1096.08 ± 1096.08 (1090 – 1096.08)	137.01
River Geral(KWS)	237.19 ± 16.23^{d} (225.71 – 248.64)								
SBS	282.48 ± 29.80 (236.9 – 318.22)	388.76 ± 23.13^{c,d} (363.4 – 415.05)	454.9 ± 44.63^{a,c} (423.34 – 486.46)	475.6 ± 475.6^{b} (470 – 475.6)					118.9

Values in parenthesis indicate range. Superscripts within same column having same superscript are significantly ($P < 0.05$) different.

Φ: index of species average size.

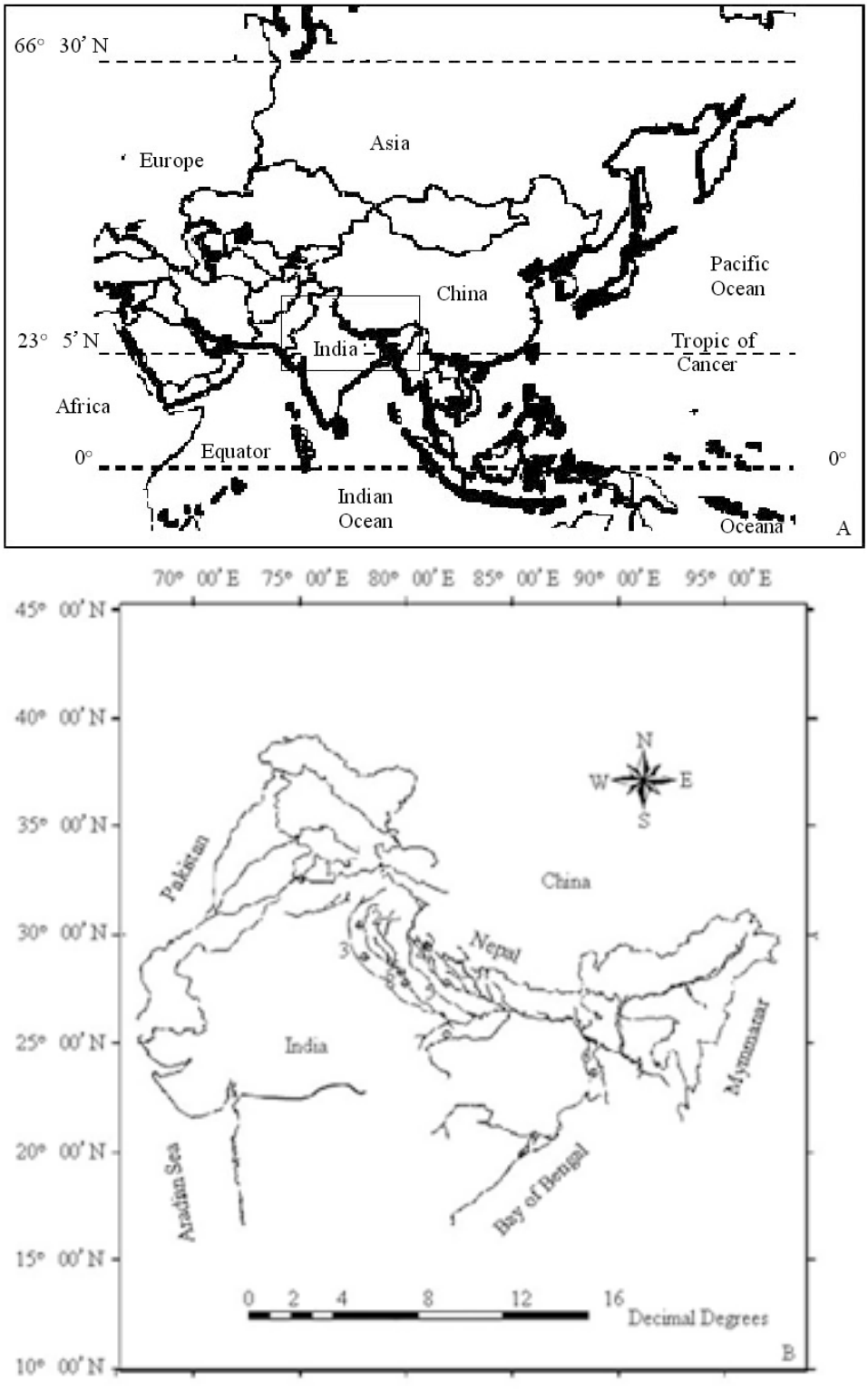

Fig.1 General map of the region (A) and locations of sampling sites of *C. catla* across different rivers basins with multiple locations of Northern India (B)

1: Satluj, 2: Ganga, 3: Yamuna, 4: Gerua, 5: SBS, 6: Bhagirathi, 7: Koshi, 8: Gomti, 9: Saryu.

Catla catla is well known as the fastest growing Indian major carp and attains up to 5.0 – 6.5 kg in a season under different agro climatic and stocking density. Samples collected showed great variations of length attainment over successive year groups up to 1 to 4^+ age group. Maximum samples (n = 93) were collected from river Bhagirathi, while the maximum age groups were recorded from rivers Bhagirathi and Satluj. Lower age

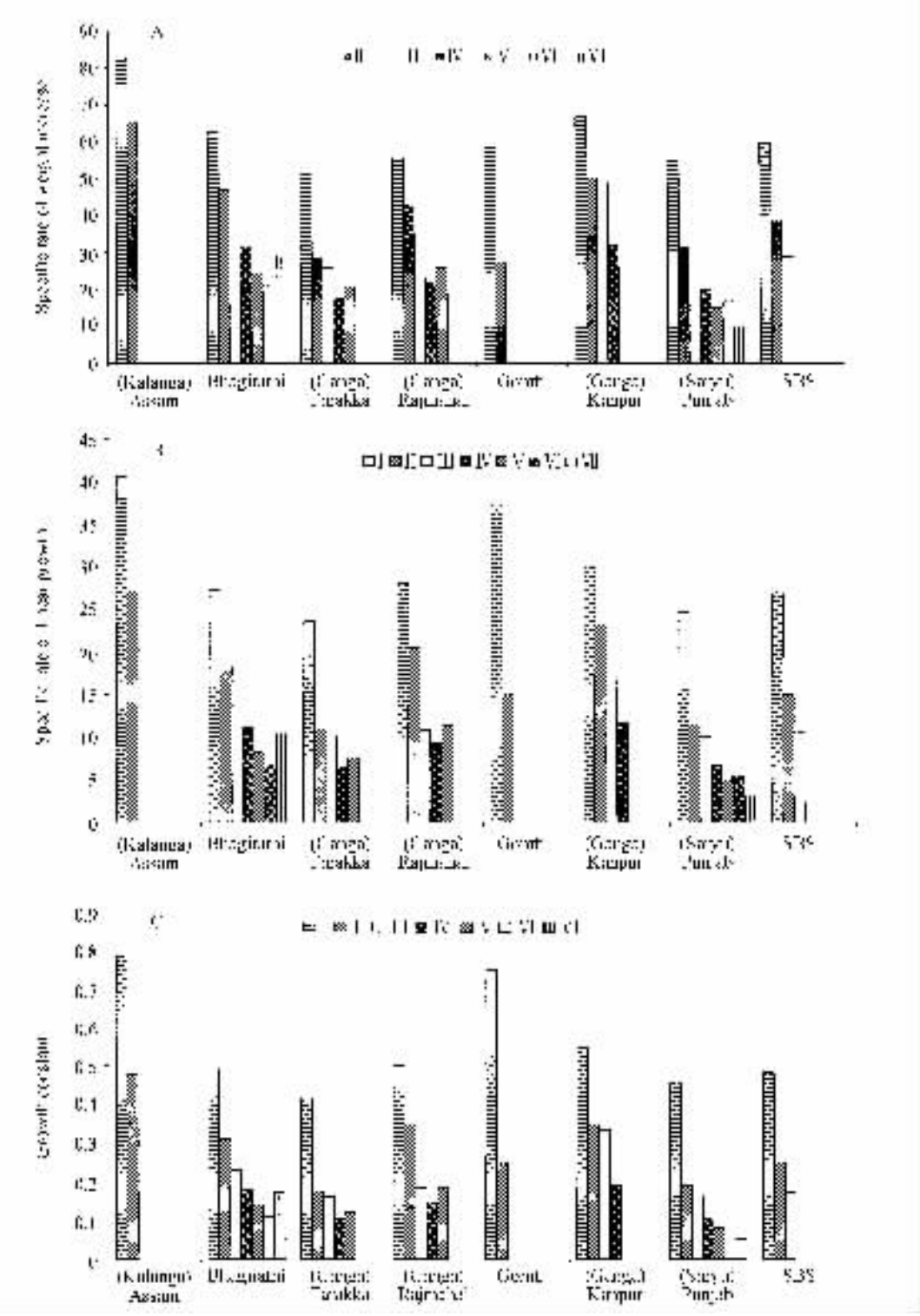

Fig.2 Different growth parameters of *Catla catla* from rivers of Northern India

groups were recorded from river Gerua flowing through Katerniaghat wildlife sanctuary (KWS). The model length was ranged from 152.00 – 591.85 mm (1^+ age groups), 277.87 – 766.83 mm (2^+ age groups), 347.98 – 719.24 mm (3^+ age groups), 615.26 – 876.59 mm (4^+ age groups), 634.81 – 946.87 mm (5^+ age groups), 723.59 – 1043.48 mm (6^+ age group), 884.16 – 1058.44 mm (7^+ age groups) and 961.83 – 1423.33 mm (8^+ age groups) respectively (Table 1). Scales of *C. catla* collected from different wild populations has been shown in Fig.3 (A – B).

The analysis of age composition data of the various populations reveals that maximum age group as 8^+ were observed from river Bhagirathi with back calculated length

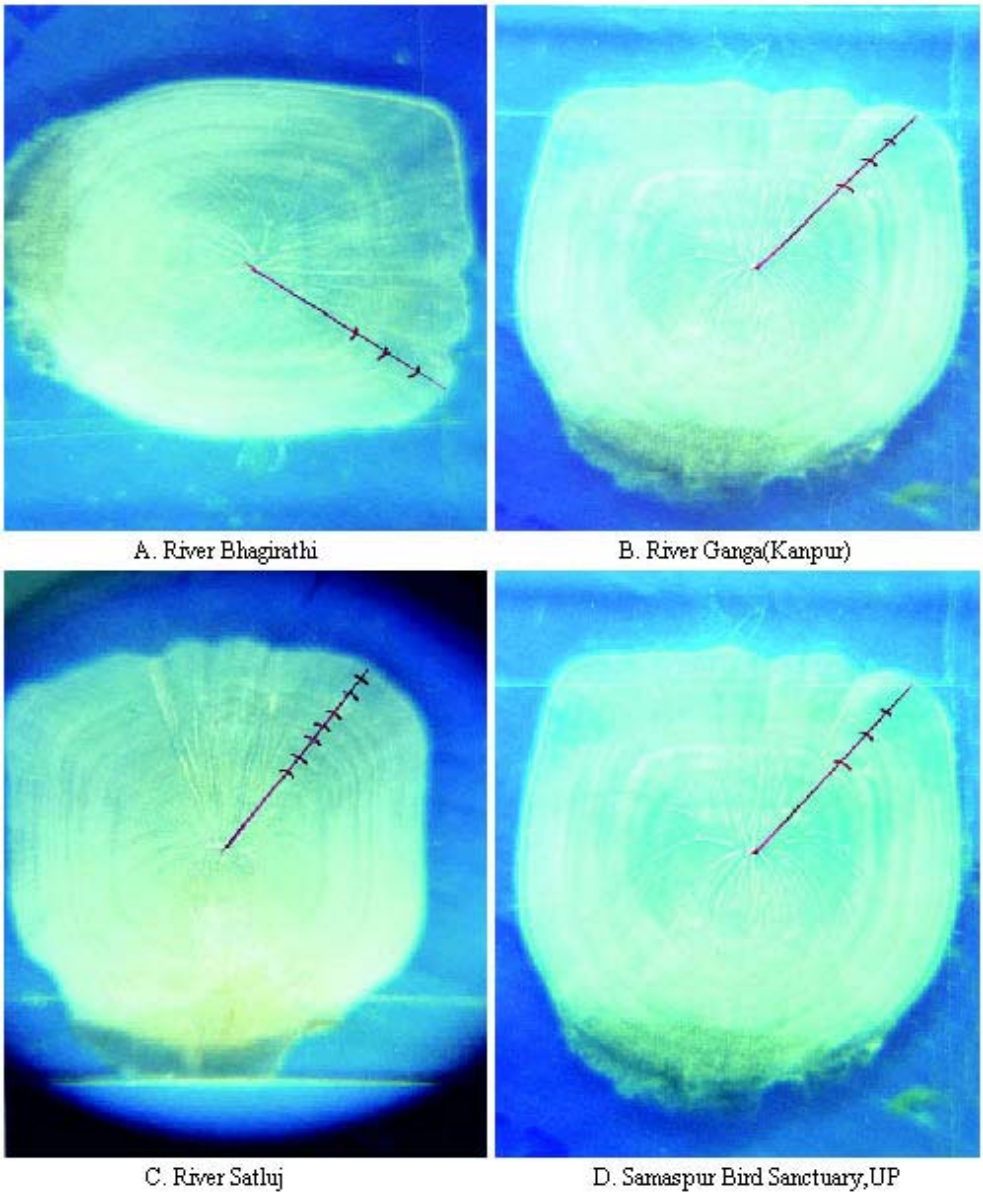

Fig.3 Scales of *Catla catla* collected from river Ganga basin

ranged from 288.94 mm ± 83.43 mm to 1132.3 mm ± 228.14 mm and from Satluj (Punjab), 8^+ were observed with back calculated length data ranged from 361.15 mm ± 62.33 mm to 896.3 mm ± 125 mm followed by 6^+ age group from Saryu and Ganga at Farrakka, 5^+ age group from Ganga at Kanpur and 4^+ age group from Samaspur bird sanctuary (SBS). The results also indicated that annual growth increment (h) rate over the years from different locations were showed decreasing trend with increasing age group for all population. In the present study it was observed that trend of length attainment of fish in the successive years were better for populations of river Ganga (Farakka), Satluj, Bhagirathi, Samaspur Sanctuary, river Gerua (KWS), Gomti and Saryu. The pooled data of the fish growth was analyzed for 246 specimens represented the presence of 8^+ age groups. However, maximum specimens of *C. catla* were recorded in the age groups 1^+ followed by age groups 2^+, 3^+, 4^+, 5^+, 6^+, 7^+ and 8^+ respectively as shown in Fig.1. Interestingly, lower growth increment was recorded for the samples of river Kalanga at Assam. In the present study the back calculated length data of *C. catla* showed variations in lenth attainment across the drainages and rivers studied as presented in Table 1. Analysis of variances (ANOVA) indicated a significant variation ($P < 0.05$) in length attainment between the locations for the age group 1^+ to 4^+ whereas no significant variations were observed for the age group 5^+ to 8^+. Out of nine populations, five populations were significantly varied ($P < 0.05$) in 1^+ age group, four populations at 2^+ and 3^+

age group and two locations with 4^+ age group indicating uniform trend after later life stages of *C. catla*.

2.2 Specific rate of linear growth (C_l)

Specific rate of linear growth shows downward trend with increase in age group except in few cases as from river Bhagirathi and Saryu at 8^+ age group. It has been also observed that there is annual increase in weight with increasing age group. Based on the analysis higher C_l value was recorded from the wild population of river Yamuna (40.59) followed by river Gomti (38.36) and Ganga, Kanpur (30.39), and minimum C_l was recorded for river Satluj (24.98) followed by fishes of river Ganga, Farakka (23.65) at 1^+ age group. However, value of C_l was same (27.3) from populations of both SBS and river Bhagirathi. Similarly at 2^+ age group, the value was maximum from the wild samples of river Yamuna (27.14) and minimum from river Ganga at Farakka (11.02). The value showed much differences in 7^+ age group as maximum as 10.54 from the samples of river Bhagirathi and minimum 3.43 from Satluj. The study showed that the level of C_l was in declining trend with increase in age groups (Fig.3B).

2.2.1 Specific rate of weight increase

The value of specific rate of weight increase (C_w) observed downward trend with the increase in age except in the samples of river Ganga at Farakka (Fig.3A). The value of specific rate of weight (C_w) increased after the age group 4^+ in river Ganga at Farakka. The value of specific rate of weight was maximum from the population of river Yamuna (82.45) followed by Ganga at Kanpur (67.41), Bhagirathi (62.47) and minimum for Ganga at Farakka (52.05) in 1^+ age group. Interestingly the value of C_w was same in the samples of Saryu (55.57). Similarly at 2^+ age group the value was maximum from river Yamuna (65.3) and minimum for river Gomti (27.3). The value showed much differences in 7^+ age group as maximum as 29.2 from the samples of river Bhagirathi and minimum as 10.1 from Satluj.

2.2.2 Index of population weight growth of intensity (ΦC_w)

The index of population size have been shown in Fig.3c. The maximum value of index of population weight growth intensity (ΦC_w) in *C. catla* has been observed from river Kalanga at Assam (73.8) followed by river Ganga at Kanpur (49.8), Gomti (43.4), SBS (42.7), Bhagirathi (36.2), Saryu 33.7 and Satluj (25.1).

2.2.3 Index of species average size (Φh) and growth constant

The maximum value of Φh was obtained from the fishes of river Gomti (162.5) followed by river Ganga at Kanpur (158.9), river Ganga at Farakka (146.8), river Bhagirathi (141.5), Saryu (137.01) and Kalanga (133.9) as shown in Table 1. Thus it appeared that the average value of Index of population weight growth of intensity (ΦC_w) and Index of Species average size (Φh) were more when there was less competition with increase in respective age groups. The value of growth constant was analyzed to understand the periods of life in the life span of the fish. The analysis of growth constant of *C. catla* indicated maximum 3 life phase from river Bhagirathi and Satluj.

3 Discussion

The present study indicated diversity in growth pattern of *C. catla* from the different drainages of river Ganga basin in the Northern India. The results also showed that the length attainment in the successive years varied in different rivers. The variations in growth pattern within different drainages and watersheds of the River Ganga basin might be due to different ecological factors and probably a reflection of changes in different life history traits which was phenotypically different in the respective wild stocks. In this study the average back calculated lengths of *C. catla* indicated maximum growth during first year of life span. The annual average increment in the age group 2^+ is 25.89 cm followed by 15.42 cm (3^+ age group), 17.24 cm (4^+ age group), 12.50 cm (5^+ age group), 5.66 cm (6^+ age group) and 3.16 cm (7^+ age group) respectively. The phenomenon of growth compensation of *C. catla* is exhibited at the 4^+ age group. The annual average increment in the age group 2^+ was 19.44 cm followed by 15.42 cm (3^+ age group), 17.24 cm (4^+ age group), 12.50 cm (5^+ age group), 5.66 cm (6^+ age group), and 3.16 cm (7^+ age group).

Natarajan and Jhingran (1963) have computed the average length and back calculated length for different age groups and the annual and reported instantaneous rates of growth of *C. catla* from the river Yamuna. They described back calculated data upto 5^+ age group as 29.50 cm (1^+ age group), 21.9 cm (2^+ age groups), 20.2 cm (3^+ age groups), 10.7 cm (4^+ age groups) and 9.4 cm (5^+ age groups). Menon et al. (1959) observed higher growth rate from reservoir rather than tanks at 3^+ age group. From reservoirs, they observed model length as 60.00 cm (1^+ age group) followed by 35.00 cm (2^+ age groups) and 16.2 cm (3^+ age groups) rather than 32.00 cm (1^+ age group), 21.00 cm (2^+ age groups) and 17.00 cm (3^+ age groups) from the tank of Madras indicating great variation of length attainment at different age class within riverine, reservoir and tank population.

In this study, it is interesting to note that higher value of specific rate of linear growth (C_l) and specific rate of weight increase (C_w) in the age group 5^+ from river Saryu correspond the occurrence of the phenomenon of growth compensation with respective age groups. Johal (1992b) also reported the above trend of growth for the fish population of Govindsagar lake in India. According to Yablokov (1986) the average value of growth

characteristics can be used to separate populations of the same species or conspecific population. Balon (1974) observed the high value of index of species average size in *Cyprinus carpio* from pond population and of index of population weight growth intensity from the river population.

The value of growth constant was analyzed to understand the periods of life in the life span of the fish. In the present study the analysis of growth constant of *C. catla* indicated a maximum 3 life phase from rivers Bhagirathi and Satluj. The analysis indicated different phases of life and corroborates with Khan (1972) and Singh (1990) who reported three phases of life from some riverine populations of Aligarh and Jaisamand Lake.

The present observation shows a well defined growth pattern of *Catla catla* in different drainages of river Ganga basin at a larger scale and information have been generated on pattern of location/habitat specific growth characteristics for the first time which is new to basic science. The different growth characteristics of the wild population can be used to characterize population of the same or conspecific population. Evidently, fisheries strategy could be made for conservation and sustainable utilization of the wild stocks of *Catla catla* in river Ganga basin.

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References

Bagenal T, 1978. Methods for Assessment of Fish Production in Freshwater. Oxford: Blackwell Scientific Publication, 1 – 356.

Balon EK, 1974. Domestication of the carp, *Cyprinus carpio* L. Roy: Ontario Museum Life Sciences and Miscellaneous Publication, 37.

CAMP, 1998. Report of the workshop on Freshwater Fishes of India, Conservation Assessment and Management Plan (CAMP), Zoo Outreach Organization/ CBSG, Coimbatore and National Bureau of Fish Genetic Resources, Lucknow, India, 164.

Day F, 1878. Fishes of India. London: William and Norgate, 553.

Day F, 1889. The fauna of British India including Ceylon and Burma Fishes. London: Taylor and Frances, 287.

Desai VR, Srivastava NP, 1990. Studies on age, growth and gear selectivity of *Cirrhinus mrigala* (Hamilton) from Rihand reservoir, Uttar Pradesh. Indian J. Fish 37 (4): 305 – 311.

Hanumantha Rao L, 1974. Studies on biology of *Cirrhinus mrigal* (Ham.) of the river Godavari. Indian J. Fish 21: 303 – 332.

Hoque B, Ali TS, 1984. Determination of age and growth of *Catla catla* (Ham.) from opercular bone. J. Asiatic Soc. Bangladesh (Sc.) 10 (2): 87 – 91.

Johal MS, Tandon KK, 1989. Age and growth of *Catla catla* (Hamilton, 1982) from Rang Mahal, Rajasthan, India. Bangladesh J. Agri 14: 135 – 150.

Johal MS, Tandon KK, 1992a. Age, growth and length-weight relationship of *Catla catla* and *Cirrhina mrigala* (Pisces) from Sukhna Lake, Chandigarh (India). Vest. Cs. Spolec. Zool. 47: 87 – 98.

Johal MS, Tandon KK, 1992b. Age and growth of the carp *Catla catla* (Hamilton 1822) from Northern India. Fish Res. 14: 83 – 90.

Kagwade PV, 1971. Age and growth of *Polydactylus indicus* (Shaw). Indian Journal of Fisheries 18 (1 – 2): 165 – 169.

Khan RA, 1972. Studies on the biology of some important major carps. Ph. D. Thesis submitted to Aligarh Muslim University, Aligarh, India.

Khan MA, 2000. On age and growth determination of certain catfishs from Rihand Reservoir. Rec. Zool. Surv. India 98 (Part Ⅰ): 123 – 130.

Lagle KF, 1956. Freshwater Fishery Biology. USA: Published by W. M. C. Brown Company Dubuque, 545.

Le Cren ED, 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in perch *Perca fluviatilis*. J. Anim. Ecol. 20: 201 – 219.

Licandeo RR, Barrientos CA, Maria Teresa Gonzalez, 2006. Age, growth rates, sex change and feeding habits of notothenioid fish *Eleginops maclovinus* from the central-southern Chilean coast. Environ. Biol. Fish 77: 51 – 61.

Madan Mohan, 2006. Age and growth of snow trout *Schizothorax richardsonii* from Kumao Hills. J. Zool. 26 (2): 163 – 168.

Menon MD, Srinivas S, Krishnamurthy B, 1959. Report to the Indian Council of Agriculture Research on the Madras Rural Pisciculture Scheme Worked from July 1942 – 31st March 1952. Madras: Govt. Press, 171.

Natrajan AV, Jhingran AG, 1963. On the Biology of *Catla catla* (Ham.) from the river Yamuna. Proc. Natl. Inst. Sci. India 29 B (3): 326 – 355.

Nikolsky GA, 1976. The ecology of fishes. London Inc.: Academic Press, 559 – 623.

Pathani SS, 1981. Age and growth of mahseer *Tor putitora* (Ham.) by scale and operculum. Matsya 7: 41 – 56.

Sarkar UK, Deepak PK, Negi RS, 2006. Age structure of Indian carp *Labeo rohita* (Hamilton Buchanan) from different wild population. Environment and Ecology 24 (4): 803 – 808.

Singh J, 1990. Age and growth studies of some commercial freshwater fishes using hard parts. Ph.D. Thesis. Punjab University, Chandigarh, India.

Tandon KK, Johal MS, 1996. Age and growth in Indian freshwater fishes. New Delhi, India: Narendra Publishing House.

Tandon KK, Johal MS, 1993. Characteristics of larval marks and origin of radii. Curr. Sci 64 (7): 524 – 526.

Tondon KK, Johal MS, Kaur J, 1993. Growth parameters of an endangered fish species—golden mahseer *Tor putitora* (Hamilton) from Gobindsagar, 207 – 220. In: Singh HR ed. Advances in Limnology. Delhi: Narendra Publication.

Yablokov AV, 1986. Population Biology: Progress and Problems of Studies on Natural Populations. Moscow: Mir. Publishers, 322.