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RESEARCH ARTICLE

STUDIES ON SOME ASPECTS OF CARP MINNOW *Gonialosa manmina* (HAM.)FROM THE RIVER YAMUNA AT ALLAHABAD (U.P.) INDIA

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ABSTRACT

Twelve morphometric and six meristic characters, length-weight relationship and condition factor of *Gonialosa manmina* (Ham.) from the river Yamuna at Allahabad, have been studied. The relationships determined by least squares method, by fitting straight line $y = a+bx$, are found to be linear. The ratios of different body parts with total length and those of head region with head length have been replaced by the percentage values. Morphometric and meristic characters analysis showed that present finding were significantly different from the earlier descriptions, specifically in case of morphometric characters. In length-weight relationship the value of the exponent (b) for males, females and pooled data were estimated as 3.0137, 3.0167 and 3.0495, respectively. The values of regression co-efficient was found to be ideal (b=3) followed by cube law hence species is showing isometric growth. The values of relative condition factor (K) were higher for different length group in pooled and in both the sexes. The biology of *G.manmina* is poorly known. Therefore, an attempt has been made to revise the description of *G.manmina* for the purpose of identification. This paper aims to provide data on LWR, condition factor and relative condition factor of this species for the first time.

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INTRODUCTION

Morphometric characters are useful for the identification of fish species and for detecting variations in the fish population. Morphometery reflects the proportionate growth of different body parts and the influence of environmental factors in a particular habitat. A good knowledge of the identity of the stock through such studies has proved useful for management and exploitation of fisheries and as an important step to understand the biology of the species. The present communication thus considered to be essential to see how far the morphometric characters observed by the author differ from those of the previous workers and at the same time to determine the general equations of various relationships of the different body parts measurements of the species. Length-weight relationship (LWR) of fish is important in fishery biology because it allows the estimation of the average weight of the fish of a given length group by establishing a mathematical relationship between them.

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Like any other morphometric character, the LWR can be used as a character for the differentiation of taxonomic units and this relationship is seen to change with various developmental events in life such as metamorphosis, growth and onset of maturity (Le Cren, 1951). Another important use of LWR is what fishery biologists have termed condition factor, coefficient of condition, Ponderal index and 'K' factor (Hile, 1936; Thompson, 1942). The above index is an indicator of general well-being or relative plumpness of fish (Bolger and Conolly, 1989). Often it is employed to measure the effects of environmental factors.

MATERIALS AND METHODS

The fish samples for the present study were collected from Sadiapur fish landing center and by way of experimental fishing in the river Yamuna at Allahabad. Regular random samples were collected for two years, Jan'2007- Dec'2008. Total 426 samples were measured for 12 morphometric characters (Figure 1) up to 0.1 mm in fresh condition and counts were made for six meristic characters. Morphometric measurements were defined on the basis of description provided by Jayaram (1999).

Various mathematical relationships were determined by using the method of least square. A linear regression model *y* = *a*+ *bx* was fitted to the data, where *y* is the value of dependent character, *x* is the value of independent character, *a* is intercept or elevation of the line and *b* is the slope of regression line, the change in y per unit increase in x. For LWR 923 specimens of *G.manmina* in the size range of 4.7 to15.3 cm were studied. Total length (mm) of individual fish was taken from the tip of the snout to the extended tip of the caudal fin using a measuring board. Body weight was taken to the nearest gramusing an electronic balance after blot- drying excess water from the body. The mathematical relation between length and weight was calculated following the formula of Le Cren (1951), after transforming into a straight-line equation where logarithmic values of length and weight are used.

$$\log w = \log a + b \log l$$

Where w is the weight (gm), l is the length (mm), 'a' and 'b' are constants. The values of constant 'a' and the exponent 'b' are calculated following (Lagler, 1956). To see whether the species followed cube law the value of the exponent 'b' was tested against '3' applying 't' test. Fultan's condition factor or ponderal index K was calculated as:

$$K = \frac{W}{L^3}.10^5$$

Where K = co-efficient of condition and the multiplying factor 10^5 was used to bring the value around unity. As in many cases the cube law fails to apply, Le Cren (1951) recommended use of relative condition factor (K_n) and it was calculated by using the formula

$$K_n = \frac{w}{\hat{w}}$$

Where, w is the observed weight and, $\hat{w}$ is the estimated weight for the observed length based on the length-weight relationship. Fluctuation in $K_n$were examined at different months of the year. The data were analyzed using statistical software STATA 10.

RESULTS AND DISCUSSION

Meristic characters

The values of various meristic characters are shown in table 1.

Morphometric Characters

Ratio and percentage of various morphometric characters in relation to total length and head length

The maximum total length of the fish was 15.3 cm. The ratio of total length with standard length, head length, pre dorsal length, pre pelvic length, pre anal length, maximum body depth and caudal length rangedfrom1.2 to 1.3, 4.5 to 5.8, 2.6 to 3.0, 2.6 to 3.1, 1.7 to 1.9, 2.6 to 3.7, 4.1 to 6.1 respectively; whereas these parameters made up 76.8 to 84.4 %, 16.9 to 22.4 %, 32.4 to 38.5%, 31.2 to 38.3 %, 51.9 to59.3%, 25.2 to 36.5% and15.5 to 23.2 % of total length in the given order. The ratio of head length with snout length, eye diameter, pre orbital length and post orbital length ranged from 2.7 to 11.5, 2.0 to 3.8, 1.7 to 2.3 and 1.7 to 2.3 respectively; whereas these parameters formed 5.9 to 25.0 %, 23.5 to 46.1 %, 40.9 to 58.3 % and 41.7 to 59.0 % of the head length. The ratio and percentage of different body parts and their mean values in relation to total length and head length has been described in Table 2.

Mathematical relationship of various morphometric characters with total length and head length

The various relationships along with the value of correlation coefficient (r) are given in table-3 The values of 'r' were found to be highly significant at 1% level of significance in all the cases. The regression coefficients for caudal length, and eye diameter were minimum, implying that increase in these parameters is small for per unit increase in independent variable. The maximum total length of *G.manmina* (Ham.) was 153 mm in the present study as against the recorded length of 279 mm (11 inches; Day 1889). In case of regression lines taking total length as independent variable, the coefficient of correlation was of high order but for head length as independent variable the correlation coefficient for snout length and eye diameter was minimum, implying that increase in these parameters is small for per unit increase in independent variable. However in all the cases, the independent variable well explained the dependent variable and the values of correlation coefficient (r) were highly significant at 1% level of significance. It has been observed that most of the characters follow straight line relationship indicating that all the morphometric characters increase in direct proportion. The highest (0.9971) correlation was observed between standard length and total length and minimum (0.8169) was observed between head length and snout length.

Chonder (1974) reported a change in the relative position of dorsal and pelvic fins in *G.chapra*(Ham.). Srivastava and Tyagi (1979) observed that the pelvic fins in *O. cotio* (Ham.) develop posterior to the dorsal fin and consequently occupy position before the dorsal fin. For *G. manmina*, the dorsal and pelvic fins were almost opposite to each other. The regression lines for predorsal and prepelvic lengths almost overlapped each other as their regression coefficients were almost equal (0.3694 and 0.3535, respectively). Information regarding morphometric studies of fishes, especially smaller species is quite insufficient (Hossain, 2010). Morphometric and meristic characters are very important so far as identification of a fish species and these characters have been employed by several authors for such studies. Hubs (1941) pointed out that ecological conditions of a water body have great impact on morphometric characteristics and may ultimately lead to speciation. Pivnica (1970) and Ihssen *et al* (1981) used morphometric characters extensively for the separation of subspecies from different ecological and geographical regions. David (1962) established that the population of *Pangasius pangasius* from the rivers Godavari and Krishna are entirely different and require distinct status of subspecies.

Table 1. Comparison of the different morphometric and meristic characters of *G.manmina* (Ham.)

Character	Day (1878, 1889)	Talwar and Jhingran (1991)	Shaw and Shebbeare (1937)	Srivastava (2006)	Misra (2003)	Present finding
Dorsal fin ray	$14-15\left(\frac{2-3}{12-13}\right)$	iii-iv 11-13	14-15	$14-15\left(\frac{3}{11-12}\right)$		13-14
Pectoral fin ray	15	i 14	15	15		14-15
Pelvic fin ray	8	i 8	8	8		8
Anal fin ray	$22-24\left(\frac{3}{19-21}\right)$	ii-iii 20-24	22-24	$22-25\left(\frac{2}{20-23}\right)$		23-26
Caudal fin ray				21		20-21
Lateral line scale	58-63	51-71	58-63	55-58	58-65	54-58
Total length	11 inches	11.5 cm (SL)	11 inches		11 inches	15.3cm
Head length (in total length)	$4\,{}^{2}/_{3}-5$		$4\,{}^{2}/_{3}-5$	4.6-4.75 (4.7)	4.6-5	4.5-5.7 (16.9-22.4)
Caudal length (in total length)	$4\,{}^{2}/_{3}-5\,{}^{1}/_{2}$					4.3-6.8 (15.5-23.2)
Maximum depth (in total length	$3\,{}^{2}/_{3}-3\,{}^{3}/_{4}$		$3\,{}^{2}/_{3}-3\,{}^{3}/_{4}$	3.3-3.6 (3.57)	3.6-3.7	2.8-3.7 (25.2-36.5)
Eye diameter (in head length)	$3-3\,{}^{1}/_{4}$			3.5-3.75 (3.6)	3-3.2	2.3-3.8 (23.5-46.2)

Table 2. Mean, S.D. and range difference of different morphometric characters of. *G.manmina* (Ham.)

Variable	Mean	Std. Dev.	Min	Max	Range difference
Body parts as ratio of total length and head length					
Standard Length	1.24	0.02	1.18	1.30	0.12
Head Length	5.10	0.26	4.46	5.82	1.36
Predorsal Length	2.83	0.09	2.57	3.04	0.47
Prepelvic Length	2.85	0.10	2.57	3.14	0.57
Preanal Length	1.80	0.04	1.68	1.92	0.23
Max. Body Depth	3.24	0.21	2.63	3.86	1.23
Caudal Length	5.17	0.38	4.13	6.15	2.02
Snout Length	6.79	1.51	2.71	11.50	8.79
Eye Diameter	2.91	0.35	2.00	3.83	1.83
Preorbital Length	2.02	0.12	1.71	2.33	0.62
Postorbital Length	1.99	0.12	1.69	2.33	0.64
Body parts as percentage of total length and head length					
Standard Length	80.62	1.45	76.84	84.48	7.64
Head Length	19.65	1.03	16.92	22.41	5.49
Predorsal Length	35.39	1.09	32.39	38.54	6.15
Prepelvic Length	35.08	1.21	31.67	38.33	6.67
Preanal Length	55.68	1.39	51.90	59.35	7.45
Max. Body Depth	30.90	2.04	25.20	36.49	11.28
Caudal Length	19.38	1.45	15.52	23.16	7.64
Snout Length	14.96	3.48	5.88	25.00	19.12
Eye Diameter	34.62	4.06	23.53	46.15	22.62
Preorbital Length	49.67	3.06	40.91	58.33	17.42
Postorbital Length	50.33	3.06	41.67	59.09	17.42

Table 3. Fitted regression lines and coefficient of correlation for *G. manmina*(Ham.)

X	Y	Regression Equation	R
Total Length	Standard Length	$y=-0.0332+0.8102x$	0.9971
	Predorsal Length	$y=-0.1442+0.3694x$	0.9893
	Prepelvic Length	$y=-0.0007+0.3535x$	0.9197
	Preanal Length	$y=-0.0810+0.5650x$	0.9947
	Caudal Length	$y=0.0332+0.1898x$	0.9519
	Head Length	$y=0.1315+0.1816x$	0.9768
	Maximum Body Depth	$y=-0.0461+0.3130x$	0.9690
Head Length	Snout Length	$y=-0.0688+0.1910x$	0.8169
	Eye Diameter	$y=0.1243+0.2739x$	0.8638
	Preorbital Length	$y=0.0415+0.4714x$	0.9664
	Postorbital Length	$y=-0.0415+0.5286x$	0.9730

Vladykov (1934) suggested that morphometric and meristic characters of fishes can be divided into three categories. First category includes those characters with low range or body proportions and is genetically controlled. Second includes those characters having wide range or body proportions and show profound impact of hydro biological conditions. Third is the intermediate category and includes those characters which are partly controlled by the environment. Johal *et al*. (1994) classified various morphometric characters on the basis of range difference into genetically (0-5%), intermediate (5-15%) and environmentally (>15%) controlled characters. On the basis of the present studies all the meristic characters barring lateral line count were put under category one. Among morphometric characters, the head region characters, eye diameter, pre orbital, post orbital and snout length showed much variation and can be categorized as environmentally controlled characters which are in conformity to Vladykov (1934).

The scattered plot of length-weight data for *G. manmina* indicated about a parabolic relationship and the data was subjected to log-log transformation to linearize the relationship. The results of regression analysis of transformed data were described by the following regression equations:

Male: Log w = -1.9938 + 3.0137 log l (r =0.9712) or log w = 0.0101 $l^{3.0137}$
Female: Log w = -1.9992 + 3.0167 log l (r =0.9866) or log w = 0.0100 $l^{3.0167}$
Pooled: Log w = -2.0265 + 3.0495 log l (r = 0.9864) or log w = 0.0094 $l^{3.0495}$

In the present study the length-weight relationship of *G. manmina* showed that the weight of the fish increased almost at the cube of length as the value of exponent was found to be very close to 3. In the present study correlation coefficients (r) were highly significant (1% level of significance) (Table 5).

Table 4. Regression analysis of data on log length and log weight for *G. manmina*

reg logw logl (Pooled data)					
logw	Coef.	Std. Err.	95% Confidence interval		R^2
logl	3.0495	0.0231	3.0042	3.0949	0.9725
constant	-2.0265	0.0223	-2.0704	-1.9827	
reg logw logl if sex=male					
logl	3.0137	0.0755	2.8638	3.1636	0.9432
constant	-1.9938	0.0749	-2.1425	-1.8452	
reg logw logl if sex=female					
logl	3.0167	0.0602	2.8966	3.1368	0.9733
constant	-1.9992	0.0622	-2.1232	-1.8751	

The fitted regression lines taking total length as independent character are presented in Figure 2. A detailed re-description of the fish replacing ratios with percentage values is given below:

D. 13-14, P. 14-15, V. 8, A. 23-26, C. 20-21, L.I.54-58. Head length (16.9-22.4%); depth (25.0-36.5%); caudal length (15.5-23.2%); predorsal length (32.4-38.5%); prepelvic length (31.2-38.3%); preanal length (51.9-59.4%) and standard length (76.8-84.5%) in total length. Eye diameter (23.5-46.2.0%); snout length (5.9-25.0%); preorbital length (40.9-58.3%) and post orbital length (41.7-59.1%) in head length. Body oblong, compressed, abdomen serrated. Snout conical, mouth transverse, small, sub inferior. Eyes large, Lips thin, upper jaw projecting over lower. Dorsal fin inserted above half of pectoral fins, pectoral reaches the ventral, caudal deeply forked, lower lobe the longer. Colour silvery glossed with gold, back with a bluish green tint, and usually spot on the shoulder dorsum, dorsum of the body has fine black spots. Fins yellowish, the dorsal and caudal with dark outer edges; total length 153mm. The length- weight relationship of *G. manmina* (Ham.) was explained by fitting a regression line through plots of log length against log weight in the form of scatter diagram for males, females and for combined sexesfigure 3.

Beaverton and Holt (1957) stated that the values of a and b may vary within the wide limits for very similar data and instance of important deviations from isometric growth in adult fishes are rare.

From the above equations the value of b obtained in the present study was statistically significant from 3 but values in all the cases were very close to 3.

Table 5. Monthly $K_n$values of *G.manmina* species

Month	*G. manmina*
Jan	1.04
Feb	0.97
Mar	0.97
Apr	1.06
May	1.00
Jun	1.03
Jul	0.97
Aug	1.03
Sep	0.89
Oct	0.95
Nov	0.96
Dec	1.02

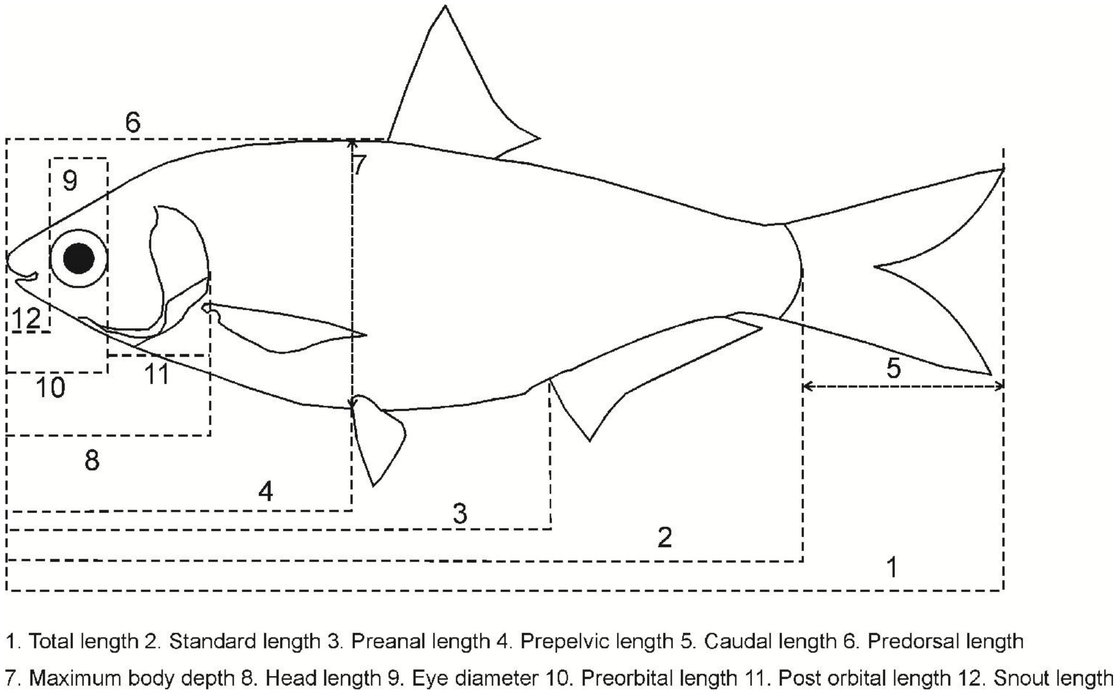
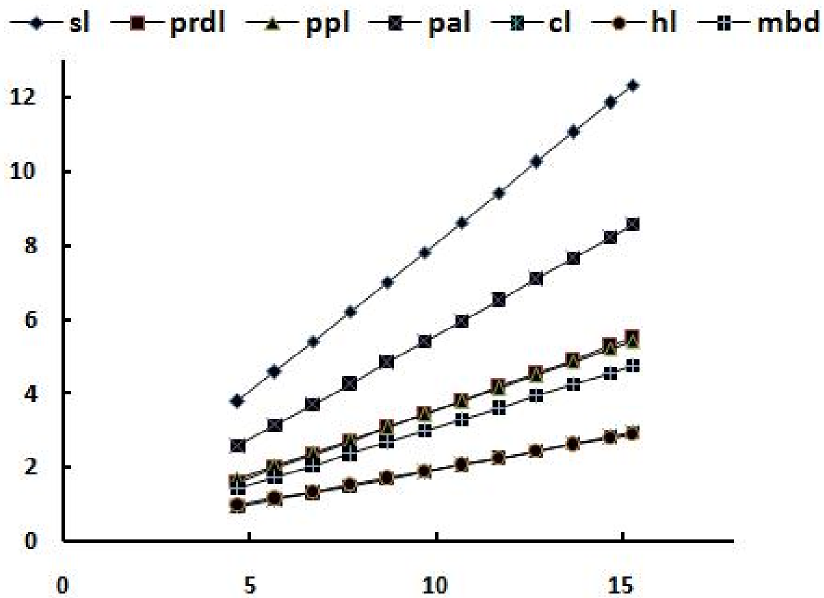


Figure 1. Showing various morphometric characters of *G. manmina* (Ham.)



sl: standard length; prdl: predorsal length; ppl: prepelvic length; pal: preanal length; cl: caudal length; hl: head length; mbd: maximum body depth.

Figure 2. Fitted Regression Lines for *G. manmina* (Ham.)

Thus it could be concluded that the fish follows the isometric growth. The b values obtained for males and females are 3.0137 and 3.0167 respectively. The b value for females was slightly higher than males because of their faster growth rate. Departure from the cubic relation has been recorded by Le Cren (1951). Beaverton and Holt (1957) recorded that the cubic relationship between length and weight existed and suggested the value of 'b' is almost always near to 3.0. Ricker (1958) observed that a fair number of species seem to approach this ideal.

Hile (1936) proposed that the b value for an ideal fish might range between 2.5 to 4.0. Qasim (1973a) and Bal and Rao (1984) indicated that the values of a and b differed not only between different species but also within the same species depending on sex, stage of maturity and food habits.

Condition factor

Condition factor is used to compare the 'condition', 'fatness' or 'well-being' of fish and are based on the hypothesis that the

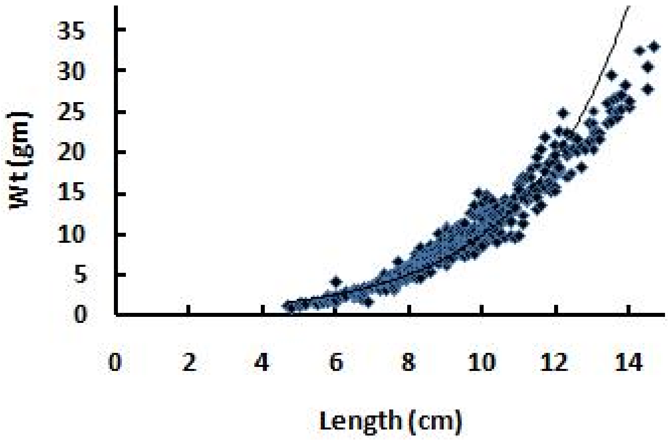


Figure 3. Scatter plot for length and weight data for *G. manmina*

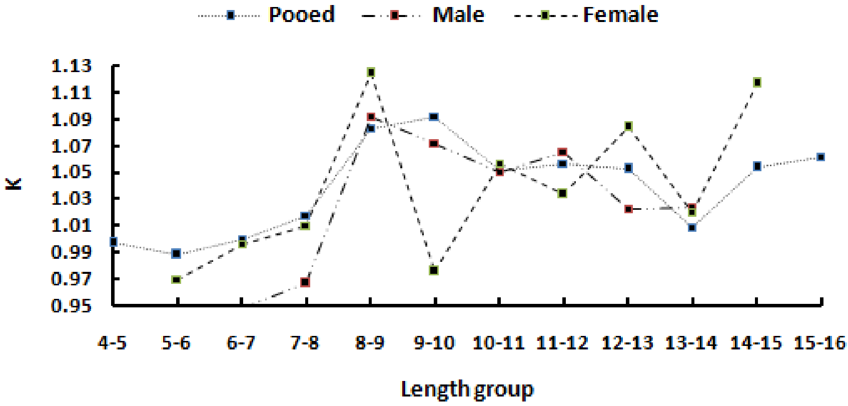


Figure 4. Length-group wise fluctuations in K for *G. manmina*

heavier fish of a given length are in better condition (Bolger and Connolly 1989). The fluctuation in K values of *G.manmina* with the length are depicted in Figure 4. Values fluctuated between 0.95 to 1.09 for males, 0.97 to 1.12 for females and 0.99 to 1.09 for pooled samples. For some length groups K values could not be obtained. This may be due to failure in sex determination, either due to smaller length or due to spent specimens for higher groups. The higher K values were recorded in 8 cm to 14 cm length range for males and for females the maximum values were observed for 8-9 and 14-15 cm length groups. The K values for *G.manmina* in different length groups in pooled and in both the sexes showed higher values, showing that the species was always in good physiological condition except in few length groups when the values were less than unity this may be attributed to immature stage of the fish. In female the K values increased up to length group 8-9 cm it might be the length when fish get maturity with high feeding intensity and gonadal development. Values declined in length groups 9-10 cm which may be attributed to the first spawning of the fish. Afterward, the values showed a regular fluctuation this might be associated with the subsequent maturation and spawning cycle. The higher value in length group 14-15 cm might be due to the fish getting ready for the subsequent spawning. Male and pooled samples were always in better condition the value was low only in smaller length groups.

In the present study, the point of inflection for both the sexes was at 8 to 9 cm length groups, which showed fish attaining maturity at this length. Condition factor or ponderal index is believed to be an indicator of the physiological state involving maturity, spawning, environmental conditions and availability of food (Le Cren, 1951). It has been established that noticeable variation can occur in the K values during the life span of the fish. Suryawanshi and Wagh (2001) reported that the Ponderal index in *P. kolus* influenced by the maturation cycle and feeding activity of the fish. Similar trend was also observed by many workers (Bhatnagar, 1963; Woodland and Jones, 1975; Choudhari *et al*., 1982; Siva Reddy and Baburao, 1992; Masud and Singh, 2011).

Relative condition factor

The monthly fluctuation in relative condition factor of *G.manmina* did not show much variation (table 5) excepting in the month of September when it attained its minimum (0.89).
The relative condition factor K_n are known to be influenced by three main factors; 1. maturity of gonads, 2. supply of food, and 3. changes in the amount of fat stored in the body tissues (Jhingran, 1968). The variations from the general length/weight relationship (i.e. fluctuations in relative condition and condition factor/ ponderal index) are indicative of the well-being of the fishes and have been correlated to cyclic changes in gonad weight and variation in feeding

intensity (Le Cren, 1951; Brown, 1957; Ricker, 1975; Parameswaran *et al*., 1974), which in turn are influenced by seasonal changes in ambient temperature and photoperiod (Qasim and Qayyum, 1961; Parameswaran and Jehangeer, 1981). The relative condition in fishes increases with the commencement of maturation of gonads, becoming maximum when they attain peak maturity, and declining rapidly with the onset of spawning and becoming least when they are spent. Variations in feeding intensity also cause fluctuations in K_n, although to a lesser extent than that due to changes in gonad weight (Jehangeer and Parameswaran, 1982).

The rise and fall in $K_n$values of *G.manmina* might have resulted from the repeated recovery from spawning stress and spawning, respectively, during the life of the fish. The higher value of K_n during December, January, April to June and in August may be due to the presence of mature and maturing fishes. In ripe fishes, the value of K_n were higher, whereas, in spent fishes K_n values were low. During spawning period the weight of the gonad increased considerably resulting in an increase in K_n value. As soon as the fish discharged their gonad products the weight of the fish decreased resulting in a simultaneous decrease in K_n value. The lower K_n value in other months may be attributed to availability of food, stress, environmental conditions, sex, seasons etc. Similar observations have been made in majority of the fish species which are seasonal breeders (Le Cren, 1951; Pillay, 1953). Anibeze (2000) and Gomiero and Braga (2005) reported that fish showed better condition due to the availability of food and development of gonads. Relatively lower $K_n$values are usually due to the fact that a larger part of the energy is allocated for certain activities such as growth and emptying of ovaries (Da Costa and Araujo 2003).

Stewart (1988) observed stress as result of the reduction in breeding and nursery grounds of *O. niloticus* in Lake Turkana, Kenya, as contributing to dramatically lower condition factors. Pollution was also seen to affect the condition factors of *O. niloticus* in lake Mariut, Egypt (Bakhoum, 1994). Variations in condition factor with seasons and pollution has also been documented by Khallaf *et al*. (2003) in Shanawan drainage canal in Egypt.

However, these factors seems to be least responsible in declining K_n values as the studied species do not require any specific breeding or nursery grounds (Hossain *et al*., 2003).
Morphometric and meristic characters analysis showed that present finding were significantly different from the earlier descriptions, specifically in case of morphometric characters. This may be due to difference in ecological conditions which affect the proportionate growth of the different body parts of the fishes. The values of regression co- efficient (b) was found to be ideal (b=3) followed by cube law in all cases hence species showing the isometric growth. In the present study the K values for *G.manmina* in different length groups in pooled and in both the sexes showed higher values, showing that the species was always in good physiological condition. The result of, our study has provided the basic information on the length–weight relationships of *G. mamina* fish species from the Yamuna Rivers that would be beneficial for fishery researcher and conservationists to improve regulations for sustainable fishery management in River Yamuna (U.P.) India , new description has also been suggested

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