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Studies on *Chagunius chagunio*, Hamilton, 1822 (Cypriniformes: Cyprinidae) collected from Mayurakshi River, Siuri, Birbhum, West Bengal, India

Arup Kumar Sinha, Pradip De and Somnath Bhakat

Abstract

The present report of *Chagunius chagunio* confirms its distribution in the rivers of South Bengal. The species is diagnosed by overhanging bilobed snout, fleshy papillose lips, large eyes, horny tubercles around mouth, two pairs of barbels and strong, osseous, recurved dorsal spine.

Sexual dimorphism is distinct in which females are dominant/superior on the basis of caudal fin length, dorsal fin and spine length. Anal fin rays of mature males bear filament that is absent in females.

Overall growth of *C. chagunio* is negatively allometric though males show slight positive allometric growth. The correlations in length-length relationship are highly significant. The difference of mean condition factor in between males and females reflects a picture of dominance of gravid females over the males of same length.

Multiple linear regression equation calculated on various lengths indicates best fit.

Keywords: condition factor, length-length, length-weight, morphometry, sexual dimorphism

Introduction

Chagunius, first described by Hamilton, ^[1] as *Cyprinus chagunio* while Day ^[2] placed it under the genus *Barbus* (Cuvier). Hora ^[3] opined same generic name as Hamilton proposed, but Smith ^[4] proposed the genus *Chagunius* ^[5]. *Chagunius chagunio* Hamilton was reported to be distributed in Orissa, Bengal, Assam, Bihar, Northern Provinces to Punjab, North and East India, Pakistan, Thailand, Bangladesh, Nepal, Burma now known as Myanmar ^[1, 6-9]. The species gets listed LC (least-concerned) as per IUCN status ^[10], while Kumar *et al.* ^[9] was of opinion that the species might face a great threat due to over exploitation and habitat destruction.

The well-defined monotypic genus, *Chagunius*, closely allied to *Puntius*, Hamilton-Buchanan, is distinguished in having divided snout with a median and two lateral lobes and presence of horny tubercles on the snout and cheeks ^[11, 12, 8] and is also sexually dimorphic ^[3, 13, 6, 14].

Though *Chagunius chagunio* was reported to be distributed in three northern districts of West Bengal namely, Darjeeling, Coachbehar and Jalpaiguri during a survey conducted by Basu *et al.* ^[15], though Kumar *et al.* ^[9] recorded its occurrence at Kangsabati reservoir in southern West Bengal. The present workers collected the species at Tilpara Barrage on Mayurakshi river, Birbhum. This work deals with study of morphological characters, length-weight relationship along with relative condition factor and length-length relationship.

Materials and Methods

Chagunius chagunio, nick-named as 'Patharchatta' locally or 'Lalputi' in bengali (Fish base), were collected from Tilpara Barrage on Mayurakshi river at Siuri (87° 32' 00" E, 23° 55' 00" N; Fig. 1.), district Birbhum, West Bengal during rainy season, 2017 by a local fisherman. The present workers collected the fishes from the fisherman in living condition. The colour of the fresh specimens was noted down before fixation. The specimens were preserved in 10 % formalin ^[16]. Morphological details of the specimens were carried out including its dimorphic variations. Measurements were taken within two days of preservation. The morphometric characters except the total length and standard length were measured with dial calipers in the nearest 0.1 mm. The morphometric measurements were expressed as proportion of standard length (SL) and the characters associated with the head were expressed as proportions of head

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length (HL) ^[17]. Lateral lines scale counts was also done followed by Kottelat ^[18].

To find isometric or allometric somatic growth of *C. chagunio*, length-weight relationships along with relative condition factor were determined statistically following LeCren ^[19]. The length-weight ratio of *Chagunius chagunio* was determined from the general formula,

$$W=aL^b,$$

In its logarithmic form, viz,

$$\log W= \log a+ b \log L,$$

Where, W= weight in gram,

L= length in millimeter,

a= coefficient related to body form and b= exponent factor.

The condition factor, K was calculated from the equation of LeCren ^[19]

$$K= W \times 100/ L^3$$

Where, W= weight in gram,

L= length in millimeter.

In the present study, length-length correlations were also estimated in between total length (TL) and standard length (SL), in between total length (TL) and fork length (FL) and in between total length (TL) and head length (HL).

Statistical analyses were conducted to find out the correlation in between different parameters. Bivariate regression analyses were done on length-weight relationship. As different body parameters, namely SL, FL and HL of a fish depend on TL, so SL, FL and HL are the independent variables and predictors whereas, TL is dependent variable or predictant. On this principle, a multivariate regression analysis was designed to know the relationship in between dependent variable and three independent variables. Bivariate regression analyses were also done in between TL and SL, TL and FL and TL and HL.

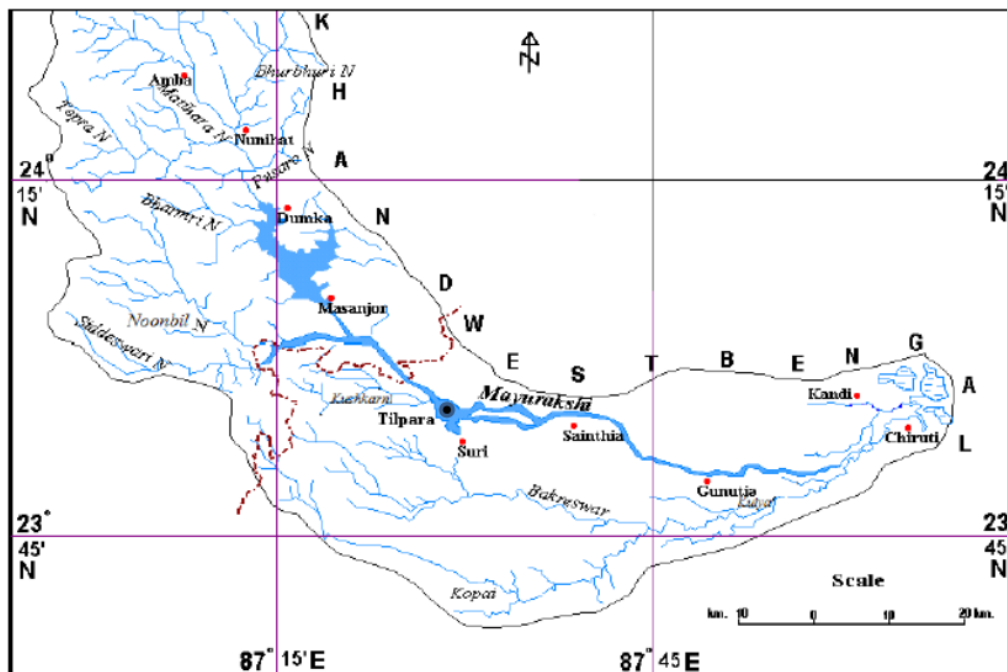


Fig 1: Collection site (•) at Tilpara Barrage on Murrumbidgee River

Results

Diagnosis

Elongated body, compressed head; sub-terminal, blunt mouth with thick, fleshy, papillose lips; eyes large, superior, not visible from below the ventral surface; abdomen broadly rounded; snout over-hanging; upper lip extended more than lower one; lower lip with a groove not extending the median line of chin; numerous tubercles (beads) present ornamentally up to a ventral fissure, anterior to operculum; small tubercles more denser in the region of mouth; distinct external and internal nostrils, separated by flaps; presence of a ridge at the tip of the bi-lobed snout; two pairs of well-developed barbels (rostral and maxillary), slender rostral barbels arose from a thick muscular band present in the lip, while the maxillary barbels arose from the junction of upper and lower lips (Plate 1). The maxillary barbels extended up to eye margin or reached at the end of lip-fold, while rostral barbel is not extended to the eye. Dorsal fin inserted slightly ahead of ventral fins; anal fin short.

Description

Morphometric characters are presented in Table II.

Fleshy papillose lips; presence of tubercles; eye with swollen eye-brow; two pairs of barbels; black spot in operculum behind the vertical furrow; posterior margin of operculum thin; dorsal fin is inserted within a hump and arose ahead of ventral fin and extends beyond the ventral fin, but not reach the anal fin origin; the first three fin rays are strong, osseous, among them the third one being long and re-curved with 14 serrations (dorsal spine); other eight rays of dorsal fin are branched and last of them is divided to the root. Ten ventral fin rays of which first is very small and the second one is undivided. Conical triangular notch like membranous double scales are present on the lateral sides of both the ventral fin. 15 fin rays in the pectoral fin of which the first one is undivided. In the anal fin, the first three rays are closely associated and undivided, others are branched, last of them being divided in the root. Anal fin do not reach the caudal peduncle. Caudal fin is forked with distinct rays. There are

three branchiostegal rays on either side covered by branchiostegal membrane.

Dorsal fin is reddish at the margin. The inner part of the caudal fin is with blackish margin while the outer margin is distinctly orange in colour.

Small scales; six scale rows between the lateral line;

Meristic Counts: D ii8, P iii12, V ii8, A iii6, C 22, L 146.
Circum-peduncular scales 24, Circumferential scales 40.

Sexual dimorphism

Morphologically there is a sharp distinction in between the males and females in *C. chagunio*. In males, the tubercles are structurally more stout and prominent than that of females. Though the tubercles in females are small, but they are uncountable in numbers. In males, the bilobed snout forms a ridge like structure, while in females, the snout is bilobed only. (Plate 2)

In respect to fin structure and shape, the fins bear petalous arrangement in males while it is uneven in females (Plate 3). In adult male, the anal fin is with a filament and the fin rays are joined by thick membranes, while in immature male anal fin is without filament and fin rays are covered by thin membrane with branches. At the base of the anal fin three ridges- like scale-structure is found in males while it is two in females. In female, a few blackish horizontal stripes with silvery base are seen in scales above the lateral line, but below the lateral line the scales are pale in colour. In male, a few scales in the lateral side are squarish in shape with a black coloured corner uniformly. The dorsal side is blackish in male rather than the female. Posterior half below the lateral line in male is orange in colour, while it is silvery in female (Plate 4). Considering the morphometric data (Table-I) in *C. chagunio*, it is noticed that the females are dominant / superior to males in respect to following characters like upper lobe of caudal fin length (1.18: 1), body depth at anal region (1.06: 1), dorsal fin length (1.16: 1), and dorsal spine length (1.27: 1) of SL and eye diameter (1.105: 1) and rostral barbel length (1.15: 1).

Comparative study

Different body parameters of *C. chagunio* as reported by different authors are presented in Table-II. The study by Kumar *et al* [9] is exceptional in relation to body depth at dorsal fin length, caudal peduncle length, snout length, head width, lengths of maxillary and rostral barbels compared to the observations of other workers. Body depth at dorsal fin region differs from the study of Rainboth [20] and the reference of Shodhganga [29]. Talwar and Das [5] observed minimum head length in the said species. Caudal peduncle depth is more or less similar as observed by different authors.

Condition factor

Mean condition factor in male and female *C. chagunio* is 0.0012 and 0.0014 respectively. This shows that females are heavier than males in a fixed length of mature fishes.

Length-length relationship

Regression analyses of SL, FL, and HL on TL of male, female and unsexed *C. chagunio* are presented in Figs. 2 – 10. The results of regression analyses in all the cases showed significant variations (Table IV).

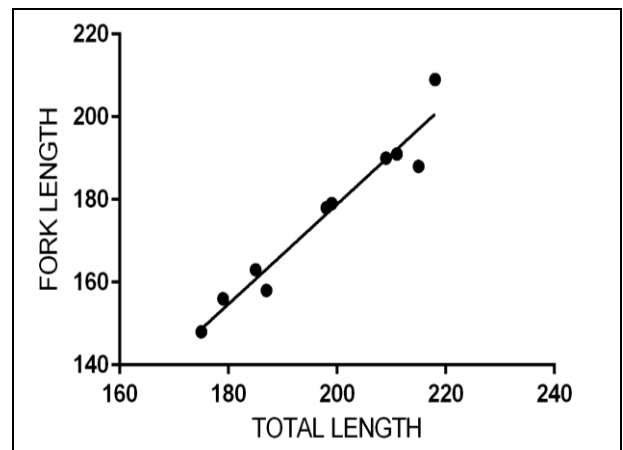


Fig 2: Regression of FL on TL in male *C. chagunio*

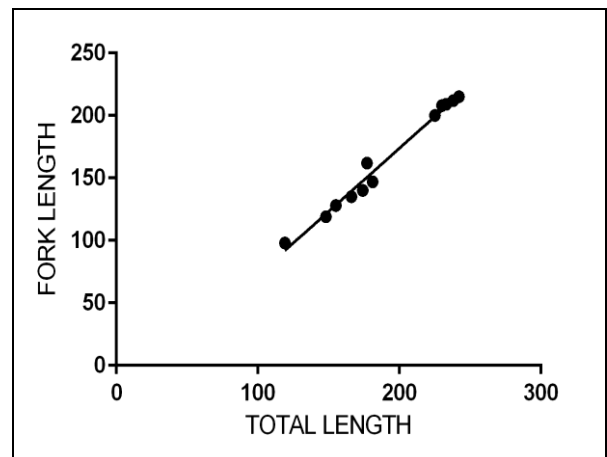


Fig 3: Regression of FL on TL in female *C. chagunio*

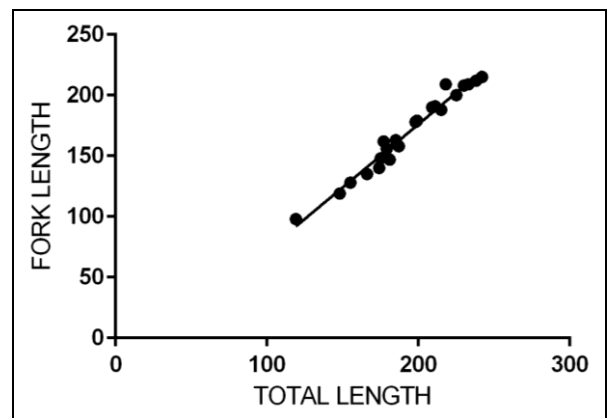


Fig 4: Regression of FL on TL in unsexed *C. chagunio*

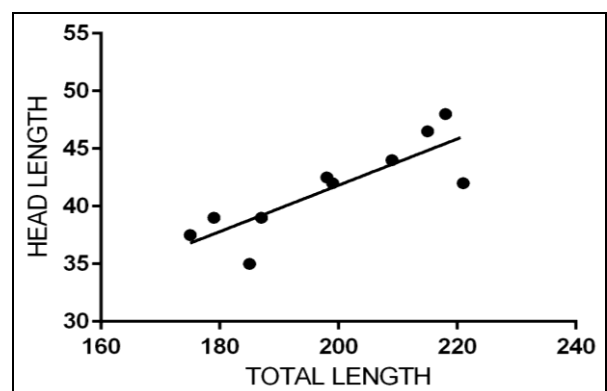


Fig 5: Regression of HL on TL in male *C. chagunio*

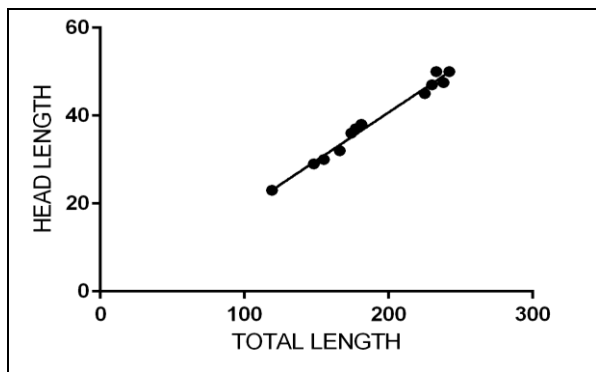


Fig 6: Regression of HL on TL in female *C. chagunio*.

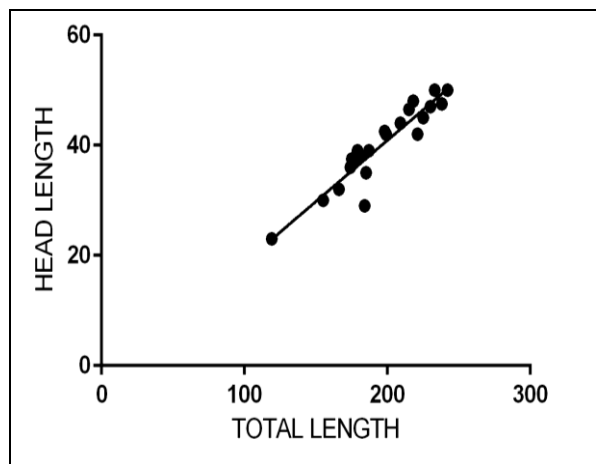


Fig 7: Regression of HL on TL in unsexed *C. chagunio*.

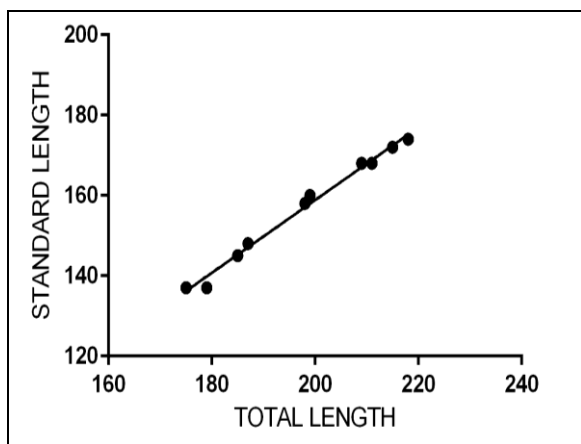


Fig 8: Regression of SL ON TL in male *C. chagunio*.

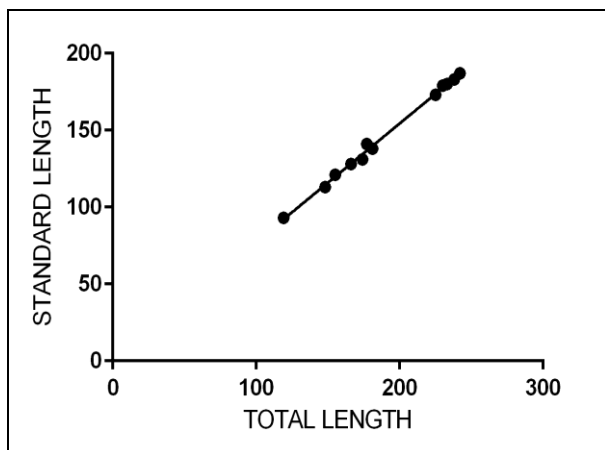


Fig 9: Regression of SL on TL in female *C. chagunio*.

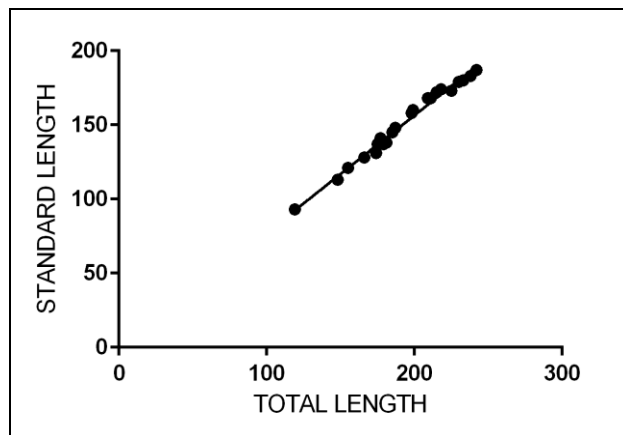


Fig 10: Regression of SL on TL in unsexed *C. chagunio*

Results of multiple linear regression analyses of SL, FL and HL on TL of male female and unsexed *C. chagunio* shows the estimated equations in all three cases are good fit and the F-statistics are also significant in all the cases (Table III).

Length-weight relationship

Regression analyses of log weight on log length of male, female and of pooled data of *C. chagunio* are presented in Fig. 11, 12 and 13 respectively. The results showed significant variation in all three cases.

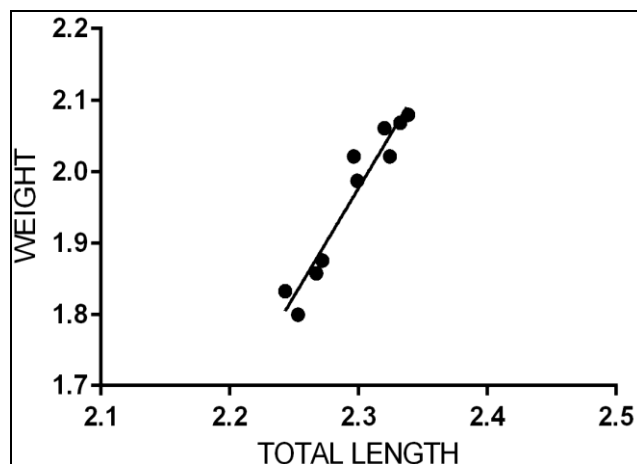


Fig 11: Regression of log weight on log length in male *C. chagunio*. ($Y = 3.02X - 4.97, r^2 = 0.927, P < 0.0001$)

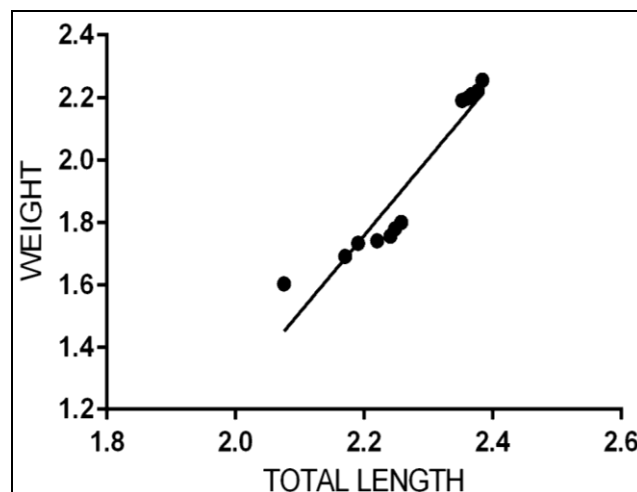


Fig 12: Regression of log weight on log length in female *C. chagunio*. ($Y = 2.47X - 3.67, r^2 = 0.907, P < 0.0001$)

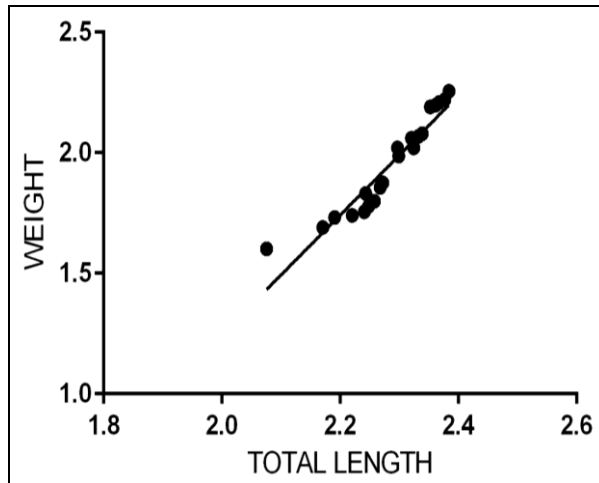


Fig 13: Regression of log weight on log length in unsexed *C. chagunio*. ($Y = 2.48X - 3.72$, $r^2 = 0.900$, $P < 0.0001$)

Table III: Results of multiple linear regressions analysis on length-length relationships of *C. chagunio*.

Sex	Equation	r ²	F-statistic	Variance	Durbin-Watson statistic
Male	$Y = 30.33 + (0.86)SL + (0.14)FL + (0.16)HL$	0.99	287.93	1.50	1.89, positive auto-correlated
Female	$Y = -12.45 + (1.78)SL - (0.47)FL + (0.48)HL$	0.99	1554.82	3.53	2.10, negative auto-correlated
Unsexed	$Y = 1.232 + (1.16)SL - (0.02)FL + (0.49)HL$	0.97	116.59	17.45	0.62, positive auto-correlated

Table IV: Results of Bivariate regression analysis on length-length relationship of *C. chagunio*.

Parameter	Sex	Regression equation	r ²	p	Inference
TL/SL	Male	$Y = 0.9061X - 22.35$	0.9900	<0.0001	Highly significant
	Female	$Y = 0.7695X + 0.5308$	0.9964	<0.0001	Highly significant
	Unsexed	$Y = 0.7907X - 1.716$	0.9865	<0.0001	Highly significant
TL/FL	Male	$Y = 1.208X - 62.67$	0.9416	<0.0001	Highly significant
	Female	$Y = 1.011X - 28.42$	0.9832	<0.0001	Highly significant.
	Unsexed	$Y = 1.040X - 31.80$	0.9702	<0.0001	Highly significant
TL/HL	Male	$Y = 0.2010X + 1.639$	0.6974	<0.0026	Significant
	Female	$Y = 0.2186X - 2.973$	0.9832	<0.0001	Highly significant
	Unsexed	$Y = 0.2220X - 3.482$	0.8733	<0.0001	Highly significant



Plate 1: Position of Rostral (A) and Maxillary (B) Barbels of *C. chagunio*.

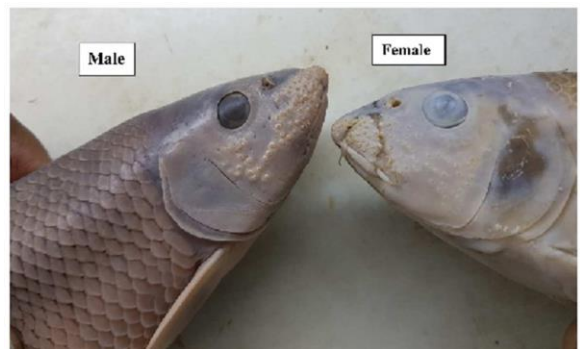


Plate 2: Structure of tubercles and form of snout of *C. chagunio*.



Plate 3: Shape of pectoral fin in *C. chagunio*.

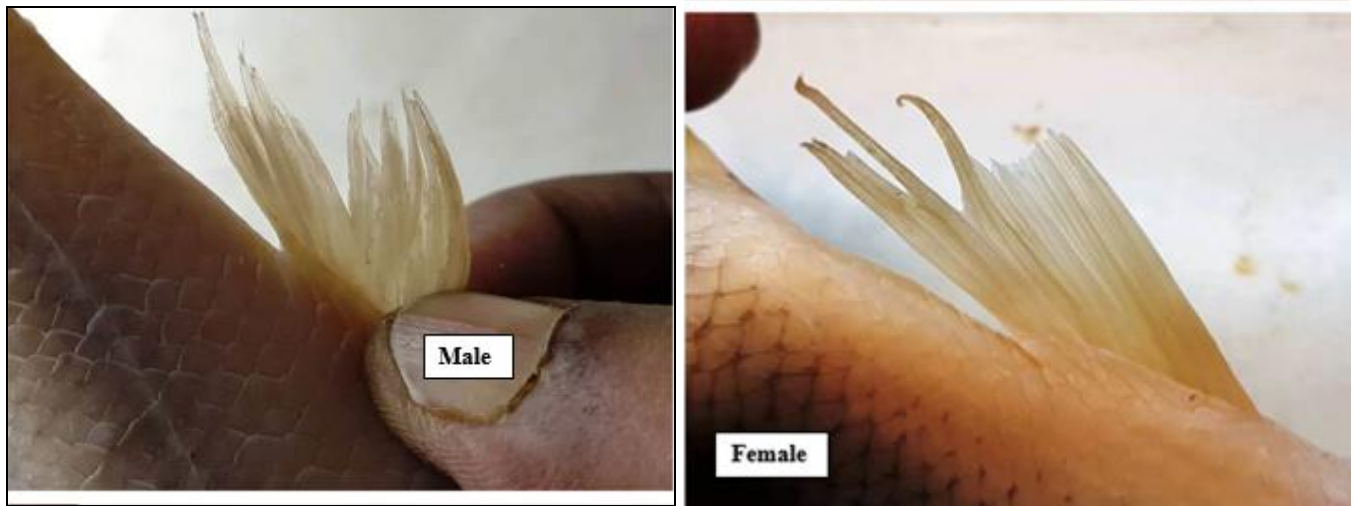


Plate 4: Scale structure and anal fin shape at anal fin region in *C. chagunio*.

Table 1: Morphometric characters of *Chagunius chagunio*.

Morphometric data	Male (n=10)		Female (n=12)	
	Range	Mean	Range	Mean
Total length (TL) (mm)	175-218	197.60	119-242	190.67
Standard length (SL) (mm)	137-174	156.70	93-187	147.25
% of SL				
Fork length	106.76-120.11	112.18	105.31-116.20	110.75
Body depth at anal origin	20.69-21.17	20.93	20.57-23.33	22.21
Body depth at dorsal region	30.17-34.31	31.99	28.10-33.33	30.75
Caudal peduncle length	14.49-15.52	14.99	12.77-18.58	15.79
Caudal peduncle depth	11.38-12.41	11.92	10.91-12.60	11.79
Caudal fin length (Upper lobe)	23.56-26.28	25.13	27.78-31.30	29.54
Caudal fin length (Lower lobe)	23.56-26.28	25.13	22.22-31.30	26.76
Dorsal fin base length	14.94-17.52	16.42	17.02-18.70	17.58
Pre-dorsal length	45.98-48.91	47.45	39.31-52.90	47.60
Dorsal fin height	17.53-22.63	20.44	21.74-25.95	23.70
Dorsal spine length		16.95	19.57-22.90	21.49
Pectoral fin length	21.17-22.27	21.76	20.65-22.90	21.49
Pre-pectoral length	23.36-24.82	23.91	20.99-26.09	23.84
Pectoral fin base length	4.38-5.75	5.08	4.96-6.11	5.55
Ventral fin length	17.15-18.39	17.69	16.67-18.84	17.90
Pre-ventral length	51.17-55.17	53.42	50.35-55.07	52.48
Ventral fin base length	6.32-6.57	6.49	4.35-6.49	5.34
Anal fin length	16.09-18.25	17.29	16.67-19.20	17.61
Pre-anal length	76.64-79.02	77.68	73.05-79.44	76.40
Anal fin base length	8.76-11.21	10.18	9.22-10.28	9.80
Head length(HL)	24.14-28.47	26.89	24.73-27.78	26.15
% of HL				
Snout length	37.33-47.14	40.83	36.32-43.48	39.37
Eye diameter	20.51-25.71	22.76	19.00-27.63	25.15
Head depth at eye	64.10-70.67	66.45	66.00-66.67	66.34
Head width (max.)	51.28-54.67	53.37	49.00-57.89	53.08
Head width (eye region)	38.46-45.83	42.76	41.67-44.00	42.84
Length of maxillary barbel	25.00-31.42	27.17	19.00-34.78	28.19
Length of rostral barbel	18.13-23.08	21.38	17.00-30.43	24.58
Inter-orbital width	33.33-35.42	34.47	33.33-36.11	34.21
Inter-narial width	22.92-26.67	24.22	21.88-25.00	23.99

Table II: Comparative report of different parameters of *C. chagunio*.

Parameters	Talwar & Das ^[5] (n=3)	Rainboth ^[20] (n=6)	Shodganga ^[29] (n=9)	Brahma ^[14]		Kumar <i>et al</i> ^[9] (n=3)	Present study, 2018	
				Male (n=15)	Female (n=15)		Male (n=10)	Female (n=12)
TL (mm)	-	-	-	180-355	181-295	162.1-168.3	175-218	119-242
SL (mm)	117-200	89-169.1	99-267	143-297	141-248	127.9-132.7	137-174	93-187
% SL								
Body depth	31.15	27.7	29.0	30.89	31.49	27.59	31.99	30.75
HL	24.44	26.70	26.30	26.70	27.07	25.91	26.89	26.15
CPL	-	16.0	18.40	17.28	16.57	18.95	14.99	15.79

CPD	-	-	-	12.04	12.15	12.08	11.92	11.79
Caudal fin length (upper/lower)	-	-	-	26.18	25.41	26.78/26.05	25.13/ 25.13	29.54 / 26.76
DF spine length	17.72	-	-	-	-	22.06	16.95	21.49
DF base length	-	22.3	15.6	-	-	19.07	16.42	17.58
Pre-dorsal	-	51.4	49.9	50.79	50.28	46.59	47.45	47.60
DF length	-	23.90	26.10	20.94	20.99	22.98	20.44	23.70
PF length	18.46	21.50	20.30	19.90	18.78	20.30	21.76	21.49
Pre-pectoral	-	-	-	-	-	25.21	23.91	23.84
VF length	16.00	-	-	16.75	16.57	19.18	17.69	17.90
Pre-ventral	-	-	-	-	-	50.30	53.42	52.48
AF length	-	-	-	16.23	16.57	20.64	17.29	17.61
Pre-anal	-	-	-	-	-	74.86	77.68	76.40
% HL								
Snout length	39.60	40.07	45.25	49.02	51.02	37.32	40.83	39.37
Eye diameter	24.10	26.22	25.48	27.45	30.61	24.29	22.76	25.15
Head depth	-	-	81.37	76.47	73.47	67.38	66.45	66.34
Head width	-	51.69	52.47	-	-	60.42	53.37	53.08
Max. barbel	-	28.09	28.52	-	-	23.70	27.17	28.19
Ros. barbel	-	24.72	27.38	-	-	18.51	1.38	24.58
IOD	36.20	31.09	30.04	-	-	-	34.47	34.21

Discussion

Chagunius chagunio was first described by Hamilton, ^[1] from the river Jamuna and the northern rivers of Bihar and Bengal. Day ^[2] and Shaw and Shebbere ^[21] found the species in Orissa, throughout Bengal, Assam, Bihar and North western provinces to Punjab. Tilak and Sarma ^[6] observed the species in the rivers of north east India. Sen ^[7] recorded the species in India, only in Assam and all along the Himalayas. Talwar and Jhingran ^[22] mentioned the distribution of species in India specially in Brahmaputra and Ganga drainages along the Himalayan foot hills. Jayaram ^[8] in his book 'The freshwater fishes of Indian region' mentioned the distribution of fish in North India along the base of the Himalaya, while Brahma ^[19] collected the specimens from Garuffela and Sankosh two tributaries originating from the southern slope of eastern Himalaya. Basu *et al* ^[23] reported *C. chagunio* in three districts of northern Bengal namely Darjeeling, Coachbehar and Jalpaiguri, though Kumar *et al* ^[9] reported its occurrence at Kangsabati Reservoir in southern part of West Bengal. The present workers found *C. chagunio* at Tilpara Barrage on Mayurakshi river, also in the southern part of West Bengal. So the distribution of the fish is obviously at par with the observation of Day ^[2] and Shaw and Shebbere ^[21].

Present observations on the meristic character have revealed that the number of pectoral fin rays is same as observed by previous workers. The number of ventral fin rays as studied by the present workers is similar to the observation of Hamilton ^[1]. But there is slight deviation in the number of dorsal, anal and caudal fin rays in comparison to other workers.

In regard to sexual dimorphism, stout-denser tubercles, diagnosed by Talwar and Jhingran ^[22] as nuptial tubercles, is also noticed by the present workers. The filament like last anal fin rays which reach the base of the caudal fin, is also reported by Talwar and Jhingran ^[22] as one of the sexual dimorphic character in male. Differences in snout structure, fin shape, ridge like scale structure in the anal fin base, scale shape in lateral line and colouration in between male and female are reported here for the first time.

Talwar and Das ^[5] and Kumar *et al* ^[9] documented morphometric data on unsexed specimens while, Brahma ^[14] reported data separately on the basis of sex biasness. Brahma ^[14] considered only 15 morphometric parameters, whereas, present workers reported more detailed study which include

32 parameters. The mean values of six morphometric characters show distinct differences in between male and female. In the study of Brahma ^[14], no such sharp morphometric differences is observed in between male and female though in the present study, there is a strong observation on female dominance over the male morphometric characteristics.

In the present study, the 'b' value of the length-weight relationship of total 22 specimens is 2.482 which indicate the overall growth of *C. chagunio* is negatively allometric. The negative allometric growth in fishes was also reported by different authors like Torres ^[23] in *Labeo altivelis* ($b = 2.976$) and Ranval *et al* ^[24] in *L. dero*. In the present study, the 'b' values of male and female are 3.020 and 2.467 respectively. It shows positive allometric growth in male and negative allometric growth in female. Pauer and Supugade ^[25] reported negative allometric growth in both sexes of *L. rohita* ($b = 2.664$ in male and 2.695 in female). The negative allometric growth in female is due to liberation of eggs during spawning, when the weight diminishes but the length remains unchanged.

As reported by various authors the 'b' value of fish depends on various factors like feeding ^[19], state of maturity ^[26], sex ^[27] and for different population of a particular species ^[25, 28]. So *C. chagunio* is not an exception.

The mean 'K' is greater in females than males due to state of maturity and sex ^[26, 27].

The multiple linear regression equation is a unique approach in fishery. It is not only species specific but also indicates normal growth of fish. In any species of fish, total length (TL) can easily be estimated by putting the actual value of independent variables like SL, FL and HL and vice versa. Major deviation of calculated value indicates abnormality in size and growth.

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