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Note

Insights into biological indices of six indigenous fish species from Bihar, India

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Abstract

In this study, we examined the length-weight relationship, relative condition factor and hepatosomatic index of six fish species: *Sperata seenghala*, *Xenentodon cancila*, *Puntius sophore*, *Glossogobius giuris*, *Mastacembelus armatus* and *Eutropiichthys vacha*, which belong to families Bagridae, Belonidae, Cyprinidae, Gobiidae, Mastacembelidae and Schilbeidae, respectively. Fish specimens were collected using a monofilament drift gill net, *Current Jal* (100-200 m long, 2 m depth, and mesh size 10-30 mm) and a trap net locally known as *Khairel jal* (8 m long, 10 m wide mouth, 1 m cod-end length and 5-10 mm cod-end mesh size). The estimated regression coefficient (*b*) of the length-weight relationship for these fish species ranged from 2.748 to 3.952, with an average of 3.188±0.43. (*M. armatus* and *S. seenghala*) Two species exhibited negative allometric growth (*b*<3), two species (*E. vacha* and *G. giuris*) showed isometric growth (*b*=3) and the remaining two species (*P. sophore* and *X. cancila*) exhibited positive allometric growth (*b*>3). The relative condition factor reveals that *P. sophore* is more robust than the other species. The hepatosomatic index value for the studied fish ranged from 0.79 to 3.03, with an average of 1.74±0.83. All the species' liver weight positively correlated with body weight (*r* = 0.545-0.896).

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The Ganga is India's largest freshwater riverine ecosystem and a 480–kilometer length of it flows through Bihar. It has religious value and provides several ecological services such as drinking, irrigation, electricity generation, transportation and fishing. It supports a wide range of fish species and approximately 20% of the fish fauna in the middle stretch of this river is threatened as a result of habitat loss, pollution and other factors (Sarkar *et al.,* 2012). Length-weight relationship is an important tool in fisheries science to evaluate some of the basic biological parameters of fish population by establishing the mathematical relationship between length and weight of fish (Le-Cren, 1951). It can be used to gather information on growth (Sarkar *et al.,* 2013; Prajapati *et al.,* 2022), ontogenetic changes (Froese, 2006; Lopez-Perez *et al.,* 2020) and population dynamics of fish species. It is also used to compare the life history and morphology of fish populations from different regions, rivers, lotic and lentic ecosystems (Sani *et al.,* 2010; Sarkar *et al.,* 2013; Lopez–Perez *et al.,* 2020; Singh *et al.,* 2023; Kumar *et al.,* 2024). Relative condition factor and hepatosomatic index are important tools for measuring an individual's physiological state or well-being, since the environmental conditions of the inhabited ecosystem influence the metabolic activity of fish (Le Cren, 1951; Oni *et al.,* 1983; Lenhardt *et al.,* 2009). Numerous studies on the aspect of length-weight relationship for various fish species in the Ganges have been published (Sarkar *et al.,* 2013; Baitha *et al.,* 2018; Ray *et al.,* 2019; Ahirwal *et al.,* 2022; Ahirwal *et al.,* 2023). In spite of this, there is still a dearth of information on the biological characteristics of several fish species in the middle stretch of the river Ganga, where the fishing operations are carried out by local

fisher folk communities with a traditional plank-build boat, the *Dinghi* (3.3 m in length) and a motorised boat (fitted with diesel engine) to earn their livelihood. Most of the fish caught in this region are juveniles due to the non-selectivity of the gear. Hence, for the conservation of fish diversity and their long-term utilisation, there is a need to have basic knowledge of biological parameters. Therefore, the present study was undertaken to generate baseline information on length-weight relationship, relative condition factor and hepatosomatic index of *Sperata seenghala* (Bagridae), *Xenentodon cancila* (Belonidae), *Puntius sophore* (Cyprinidae), *Glossogobius giuris* (Gobiidae), *Mastacembelus armatus* (Mastacembelidae) and *Eutropiichthys vacha* (Schilbeidae), from the middle stretch the Ganga in Bihar, India.

A total of 271 fish specimens of six indigenous fish species were collected from the Digha Ghat Patipul (25°40'8.4"N; 85°0'18"E) and Fatwah/Fatwa (25°30'50.3"N; 85°18'11.4"E) fish landing sites of the Gangas, during September 2021 to August 2022. Fish were caught through monofilament drift gill net called *Current Jal* (100-200 m long, 2 m depth, and mesh size 10-30 mm), and a trap net locally known as *Khairel Jal* (8 m long, 10 m wide mouth, 1 m cod-end length and 5-10 mm cod-end mesh size). The collected samples were brought to the laboratory, where they were washed thoroughly and identified up to the species level using standard manuals and taxonomic literature (Jayaram, 2010). The total length of each specimen was measured to the nearest 1 mm using a digital Vernier caliper (Insize–0/150 mm) and the weight was recorded to the nearest 1 g using a digital balance (WENSAR TM-MAB 220).

The length-weight relationship was established separately for each species using the equation $W = {}_aL^b$, where W is weight of fish (g), L is total length of fish (mm), a is intercept, and b is slope of the regression line (Le-Cren, 1951). Fish growth considered to be isometric if the estimated regression coefficient value b is close to 3. In contrast, if it deviates from 3, fish growth becomes either negative allometric (b<3) or positive isometric (b>3).

The fish condition was estimated using the relative condition factor equation: $Kn = W / {}_aL^b$. It is the ratio of observed weight (W) of a fish at a given length to the expected weight (${}_aL^b$) of a fish of the same length as calculated from the length weight regression (Le-Cren, 1951). The hepatosomatic index for each fish species were determined as per the formula: $HSI = L_W / F_W \times 100$, where L_W is weight of liver (g) and F_W is weight of fish (g). Linear regression was also performed between the weight of each fish (F_W) and the weight of their liver (L_W). A statistical analysis of all the data was performed using Graph Pad Prism software. The data were presented as mean±SD.

Table 1 presents the statistical analysis of the length-weight relationship for six fish species. The estimated regression coefficient (b) values for *S. seenghala, X. cancila, P. sophore, G. giuris, M. armatus,* and *E. vacha* ranged from 2.675 to 3.185, 3.122 to 4.783, 2.630 to 3.395, 2.866 to 3.141, 2.515 to 2.981 and 2.679 to 3.518, respectively. The coefficients of determinant (r^2) for the fitted equations of the studied fish species varied from 0.927 to 0.968 with an average value of 0.940 ± 0.02. Fig. 1 illustrates the relative condition factor (Kn) values for the studied fish, which ranged from 0.61 to 1.18 for *S. seenghala*, 0.24 to 0.42 for *X. cancila*, 1.68 to 2.08 for *P. sophore*, 0.65 to 1.76 for *G. giuris*, 0.62 to 1.24 for *M. armatus* and 0.74 to 1.46 for *E. vacha*. Fig. 2 depicts the hepatosomatic index values for the studied fish, which ranged from 0.47 to 1.28 for *S. seenghala*, 1.33 to 5.33 for *X. cancila*, 0.57 to 1.81 for *P. sophore*, 0.63 to 5.07 for *G. giuris*, 0.61 to 6.70 for *M. armatus* and 0.56 to 2.24 for *E. vacha*. The linear equation between the weight of fish (F_W) and the weight of liver (L_W) was fitted as follows: $F_W = 10.23 + 90.86\ L_W$ ($r^2 = 0.602$) for *S. seenghala*, $F_W = -0.94 + 93.24\ L_W$ ($r^2 = 0.648$) for *E. vacha*, $F_W = 11.18 + 19.59\ L_W$ ($r^2 = 0.372$) for *M. armatus*, $F_W = 3.52 + 19.59\ L_W$ ($r^2 = 0.802$) for *G. giuris*, $F_W = 3.56 + 22.24\ L_W$ ($r^2 = 0.679$) for *X. cancila* and $F_W = 5.01 + 30.79\ L_W$ ($r^2 = 0.297$) for *P. sophore*. Data analysis showed that *M. armatus* and *S. seenghala* exhibit negative allometric growth, *E. vacha* and *G. giuris* isometric growth and *P. sophore* and *X. cancila* have positive allometric growth.

In the present study, estimated regression coefficient b values for the fishes (2.75-3.95) were consistent with the expected range of 2.0 to 4.0 (Tesch, 1971). Negative allometric growth was observed in *M. armatus* and *S. seenghala*; isometric growth in *E. vacha* and *G. giuris* and positive allometric growth in *P. sophore* and *X. cancila*. These species-specific differences in the growth pattern (from negative allometric to positive allometric growth) can be attributed to ontogenetic development and physiological shape. Seasons, localities, the nutritional condition of the specimens at

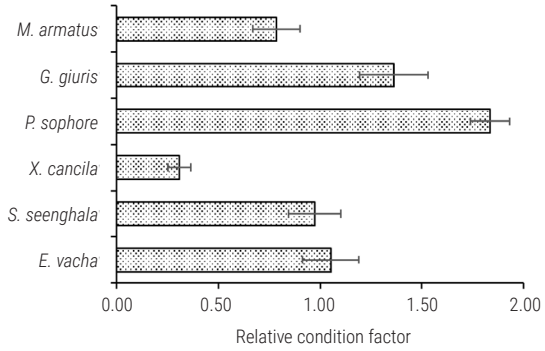

Fig. 1. Relative condition factor of the six indigenous fish species from the Ganga

Table 1. Descriptive statistics and estimated length–weight relationship parameters of six fish species from the Ganga in Bihar, India

Family	Species name	TL (mm)			Fish base	TW (g)		Regression parameters				
		N	Min	Max	Length (mm)	Min	Max	95% CI *a*	95% CL *b*	*a*	*b*	r^2
Bagridae	*Sperata seenghala*	44	143.1	268.3	1500.0	12.24	89.00	0.003-0.010	2.675-3.185	0.005	2.930	0.927
Belonidae	*Xenentodon cancila*	10	138.9	269.5	400.0	04.19	45.12	0.0001-0.002	3.122-4.783	0.0004	3.952	0.948
Cyprinidae	*Puntius sophore*	23	73.2	94.9	200.0	05.59	12.53	0.004-0.018	2.630-3.395	0.008	3.013	0.931
Gobiidae	*Glossogobius giuris*	66	58.4	168.5	500.0	01.68	40.31	0.005-0.008	2.866-3.141	0.006	3.003	0.968
Mastacembelidae	*Mastacembelus armatus*	40	101.4	242.3	900.0	02.52	34.50	0.004-0.011	2.515-2.981	0.006	2.748	0.937
Schilbeidae	*Eutropiichthys vacha*	99	80.3	183.4	382.0	05.28	44.91	0.004-0.008	2.679-3.518	0.004	3.098	0.929

TL: Total length; TW: Total weight; N: Number of samples; Min: minimum; Max: maximum; CI: Confidence of interval; a: Intercept; b: Regression coefficient; CL: Confidence of limit; *r*: Coefficient of determinant

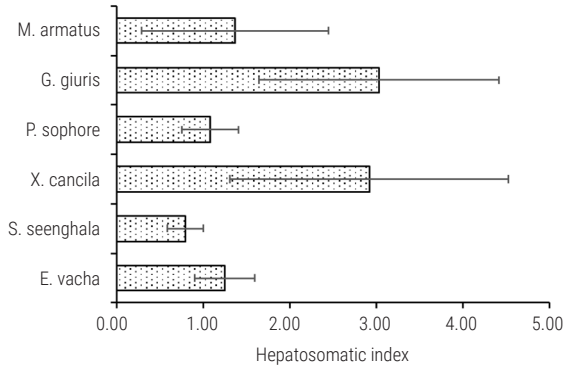

Fig. 2. Hepatosomatic index of the six indigenous fish species from the Ganga

the time of sampling and the stage of maturity all have an impact on the assessment of growth pattern of fish (Tesch, 1971; Froese, 2006; Sarkar *et al.,* 2013; Baitha *et al.,* 2018; Sarma *et al.,* 2022; Ahirwal *et al.,* 2023). The relative condition factor is an important tool to explain the relative robustness of fish. It reveals that *P. sophore* is more robust, followed by *G. giuris*, whereas least value was observed for *X. cancila*. In the entire population of *P. sophore*, more than 50% of the specimens are fully mature; their mean total length, gonad length, and gonad weight are 80.93±4.80, 27.71±4.04, and 0.46±0.26, respectively. In the entire population of *G. giuris*, 25.76% specimens are fully mature; their mean total length, gonad length, and gonad weight are 104.24±31.38 mm, 20.06±3.93 mm and 0.38±0.43 g, respectively. However, all the specimens were immature in *X. cancila*. These species-specific differences in the body plumpness can be attributed to their maturity stage. Moreover, a multitude of factors, including sampling season, seasonality of natural diet, gonadal ripeness, age of the fish, and different physical forms in the juvenile and adult life stages, influence the species' robustness (Le-Cren, 1951; Froese, 2006; Ahirwal *et al.,* 2017; Prajapati *et al.,* 2022; Ahirwal *et al.,* 2023). Hepatosomatic index was found to be the highest in *G. giuris* and lowest in *P. sophore*. Linear regression reveals that the liver weight of *G. giuris* has strong correlation (r = 0.896) with the weight of fish, whereas *P. sophore* has the weakest correlation (r = 0.545). Species-specific changes in the liver weight of fish with respect to their body weight could be attributed to their dissimilar food preferences, *i.e., G. giuris* is highly carnivorous and *P. sophore* is planktivorous. Moreover, energy requirement, seasonal availability of quality food and diet preferences of the species influence the liver weight (Lenhardt *et al.,* 2009; Durigon *et al.,* 2019). However, further research with a larger sample size of fish species is necessary for greater accuracy and precision in the results. In conclusion, this study details the biological indices of six indigenous fish species in the Ganga. These species are important from both commercial fisheries and biodiversity point of view. Therefore, these findings will serve as valuable baseline data for developing effective conservation strategies to protect these species in the Ganga River and its basin in Bihar.

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