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ORIGINAL ARTICLE

Morphometric traits and length-weight relationship of Small Indigenous fish species at low and mid-altitude region, a comparative study from N.E. region, India

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Abstract

The present study aimed to investigate the morphomatric traits of small indigenous fish (SIF) species, *Channa punctata, Mystus vittatus, Notopterus notopterus, Puntius sophore, Labeo rohita* from low and mid altitude regions from north east, India. A total of 50 specimens from each species were collected between March 2023 and May 2024. Fourteen morphometric parameters were chosen for a comparative analysis of the fish species from the two distinct regions. In the low-altitude region, the average lengths recorded for *C. punctata, M. vittatus, N. notopterus, P. sophore* and *L. rohita* were 15.06, 10.22, 19.22, 9.69, and 21.79cm, respectively. The corresponding average weights for the fish species were 44.22 for *C. punctata*, 12.27 for *M. vittatus*, 62.45 for *N. notopterus*, 12.38 for *P. sophore* and 175.95g for *L. rohita*. In the mid-altitude region, the average lengths for *C. punctata, M. vittatus, N. notopterus, P. sophore* and *L. rohita* were 17.41, 12.71, 20.21, 11.81 and 24.98cm, respectively. The average weights recorded for the fish species were 42.54 for *C. punctata*, 12.42 for *M. vittatus*, 62.2 for *N. notopterus*, 12.53 for *P. sophore* and 176.28g for *L. rohita*. *M. vittatus*, *L. rohita* exhibited positive allometry growth in both low and mid altitude region while *C. punctatus, N. notopterus* exhibited negative allometry growth in both regions. *P. sophore* is found to be exceptional indicating positive allometry growth in mid-altitude region and negative allometry growth in low- altitude region.

Keywords: Morphometric parameters, Positive allometry, Negative allometry, Growth

INTRODUCTION

Morphometric study is basic fundamental tool for understanding the development, growth, systematic, variations and population characteristics of fish (Kov & Copp 1999). Morphometric analysis plays an important role to estimate relationship among various body parts (Carpenter et al. 1996). Morphometric characters are useful tool to study morphometric measurement and identify fish stock (Turan et al. 2004). Morphometric characteristics provide a quantitative framework for fish identification and are regarded as dynamic elements frequently employed to measure differences among populations of the same fish species (Cardin 2000; Doherty & McCarthy 2004).

The Length-Weight Relationship (LWR) is utilized for estimating the standing stock biomass and for comparing the ontogeny of fish populations across various regions (Ayoade & Ikulala 2007). It offers valuable information regarding biomass, condition factor, the growth rates and dynamics of fish populations (AL Nahdi et al. 2006; Mouludi-Saleh & Keivany 2018). It is important to note that LWR data can vary among species due to inherent body shapes and physiological factors such as maturity and spawning (Schneider et al. 2000). In addition to the LWR, the condition factor (K) serves as an indicator of fish well-being in relation to their habitat and seasonal changes. The condition factor is a vital quantitative measure used to assess the health of fish and their feeding activity, reflecting recent dietary habits, reproductive status, and overall physiological condition in relation to fitness. Moreover, it is an effective indicator for understanding fat accumulation in fish bodies and for assessing gonadal development (Mehmood et al. 2021). The ratio between length and weight is not a constant across all species; the relationship also facilitates comparison among

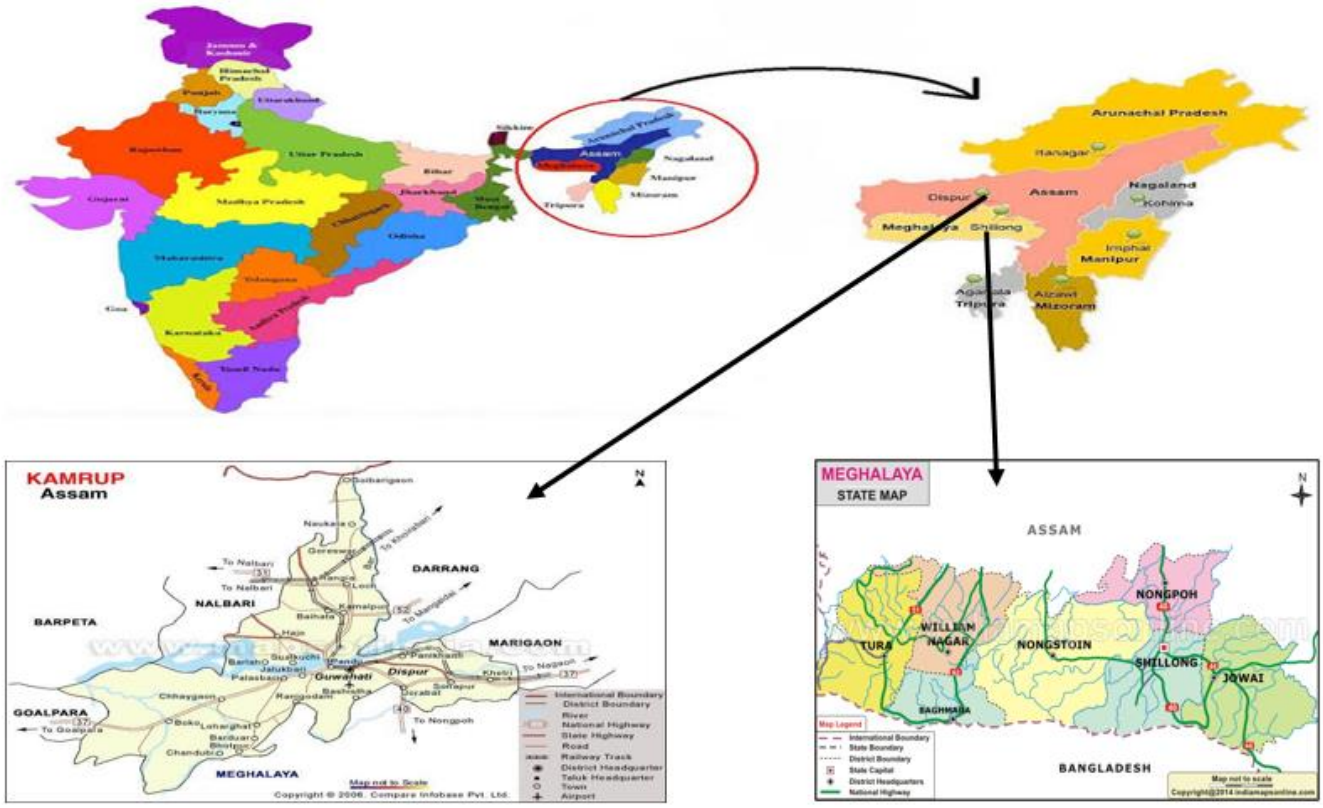

Fig.1. Location map of study area.

individual within and between different fish populations. Keeping the view of the work has been aimed to study the morphometric traits and length-weight relationship of small indigenous fish species i.e *Channa punctata, Mystus vittatus, Notopterus notopterus, Puntius sophore, Labeo rohita* from the low and mid-altitude region from N.E. region, India and comparison among the parameters.

MATERIALS AND METHODS

Study area: To study the morphometric traits and length- weight relationship, the fishes (*Channa punctata, Mystus vittatus, Notopterus notopterus, Puntius sophore, Labeo rohita*) were sampled from the mid-altitude region of Shillong, Meghalaya (26.1°N, 91.7°E; 1520m above sea level) and from the low altitude region of Uzan Bazar, Guwahati, (25.57°N, 91.88°E; 49.5m above sea level), Assam, India.

Fish sample collection, identification and preservation: A total of 500 specimens of fish species (*Channa punctata*, *Mystus vittatus*, *Notopterus notopterus*, *Puntius sophore* and *Labeo rohita*), 50 each of selected species were collected from two above said sites in between March, 2023 to May, 2024.

The collection of fish specimens was carried out in the early morning (between 08:00 to 11:00 AM) due to the better availability of fish. The collected fishes washed thoroughly and preserved in 10% formaldehyde solution on the sampling site. The identification of fish used in the present work was followed after literature of Talwar & Jhingran (1991) and Jayaram (2010) and kept in Fishery Department of Zoology, Bhattadev University.

Morphometric measurement: A total of 14 morphometric traits were measured by using the measuring tape, scales and digital calipers following Jayaram (2010). The length of large fish was estimated with measuring tape and the length of small fish with the scales and digital calipers. All the morphometric measurements were expressed in cm except weight. The body weight of the fishes was measured in electric or manual balance and expressed in gram (g).

Statistical analysis for length-weight relationship: The relationship between the length (L) and weight (w) of fish was expressed by Froese (2006) as follows: $W= aL^b$, Where, W = total body weight (g), L= total length of fish (cm), a= initial growth coefficient, b= slope or the growth coefficient. The parameters 'a' (intercept) and 'b' (regression coefficient slope) were derived by using the following formula of Le Cren (1951): Log W= Log a + bLog L. The coefficient of condition 'K' was calculated using the equation of Fulton (1904): $K= W\times100/L^3$, Where, W= weight (g), L= length (cm) and 100 is a factor to bring the value of K near unity (Froese, 2006). To calculate the coefficient of correlation (r), the following formula was used: Karl Pearson method (1885), $= \frac{\sum x.y}{\sqrt{\sum x^2.\sum y^2}}$, where; x= $X-\bar{X}$, y= $Y-\bar{Y}$.The statistical analysis was performed using Microsoft Excel 2019.

RESULTS AND DISCUSSION

In case of low altitude region: For *C. punctata* (Bloch, 1793), the average mean value of length has been found to be 15.06 cm. The average mean value of weight is 44.22cm. The condition factor (K) value is 12.3603. The growth type is negative allometry (Table 2). For *Mystus vittatus* (Bloch, 1794), the average mean value of length has been found to be 10.22cm. The average mean value of weight is 12.27cm. The condition factor (K) value is 11.4459. The growth type is positive allometry (Table 2). For *Notopterus notopterus* (Pallas, 1769), the average mean value of length has been found to be 19.32cm. The average mean value of weight is 62.45cm. The condition factor (K) value is 8.9078. The growth type is negative allometry. (Table 2) For *Puntius sophore* (Hamilton, 1822), the average mean value of length has been found to be 9.69cm. The average mean value of weight is 12.38cm. The condition factor (K) value is 13.5766. The growth type is positive allometry (Table 2). For *Labeo rohita* (Hamilton, 1822), the average mean value of length has been found to be 21.79cm. The average mean value of weight is 175.95cm. The condition factor (K) value is 16.9655. The growth type is positive allometry (Table 2).

In case of mid altitude region: For *C. punctata* (Bloch, 1793), the average mean value of length has been found to be 17.41cm. The average mean value of weight is 42.54. The condition factor (K) value is 8.0637. The growth type is negative allometry (Table 2). For *Mystus vittatus* (Bloch, 1794), the average mean value of length has been found to be 12.71 cm. The average mean value of weight is 12.42cm. The condition factor (K) value is 6.0207. The growth type is positive allometry (Table 2). For *Notopterus notopterus* (Pallas, 1769), the average mean value of length has been found to be 20.21cm. The average mean value of weight is 62.2cm. The condition factor (K) value is 7.5359. The growth type is negative allometry (Table 2). For *Puntius sophore* (Hamilton, 1822), the average mean value of length has been found to be 11.81cm. The average mean value of weight is 12.53cm. The condition factor (K) value is 7.5814. The growth type is negative allometry (Table 2). For *Labeo rohita* (Hamilton, 1822), the average mean value of length has been found to be 24.98cm. The average mean value of weight is 176.28 cm. The condition factor (K) value is 11.2866. The growth type is positive allometry (Table 2).

Comparison at low and mid-altitude region: Though the weight has been taken in a constant range for both the sites, the average mean value of total length of each fish species is found to be more in mid altitude region compared to low altitude region. For *C. punctata* (Bloch, 1793) the difference in total mean length is found to be 2.35cm, for *Mystus vittatus* (Bloch, 1794) the difference is 2.49cm, for *Notopterus notopterus* (Pallas,1769) the difference is 0.89cm, for *Puntius sophore* (Hamilton,1822) the difference is 2.69 cm, and for *Labeo rohita* (Hamilton, 1822) the difference is 3.19cm (Table 1).

In the mid-altitude region, fish species exhibit a streamlined body shape, with a total length that is comparatively greater than that of low altitude region's fish (Table 1). They possess a pointed head and their body depth is more compressed when contrasted with fish from lower altitudes, accompanied by elongated fins.

Table 1. Scientific name of species, morphometric traits of low and mid altitude region *Channa punctata*, *Mystus vittatus*, *Notopterus notopterus*, *Puntius sophore* and *Labeo rohita*. (Note.SD: Standard deviation)

Morphological parameters	*Channa punctata*) (Mean±SD)		*Mystus vittatus* (Mean±SD)		*Notopterus notopterus* (Mean±SD)		*Puntius sophore* (Mean±SD)		*Labeo rohita* (Mean±SD)	
	Low altitude region	Mid altitude region	Low altitude region	Mid altitude region	Low altitude region	Mid altitude region	Low altitude region	Mid altitude region	Low altitude region	Mid altitude region
Total length	15.06±0.2154	17.41±0.3477	10.22±0.2315	12.71±0.4036	19.32±0.3027	20.21±0.2385	9.69±0.1513	11.81±0.4721	21.79±0.3754	24.98±0.4331
Standard length	12.67±0.2648	14.82±0.260	7.86±0.2764	8.37±0.3662	17.49±0.2427	18.02±0.2522	7.64±0.1497	9.38±0.3370	16.77±0.3743	19.81±0.3807
Head length	4.05±0.211	4.14±0.2059	2.26±0.2332	2.97±0.2532	3.61±0.1758	3.79±0.1814	2.13± 0.1487	2.89±0.1972	4.69±0.333	5.26±0.2417
Body depth	2.66±0.1855	2.04±0.12	2.18±0.204	2.71±3.0001	5.61±0.2300	4.86±0.120	2.95±0.1803	2.12±0.1833	1.35±0.1746	3.11±0.2071
Snout length	0.67±0.1005	0.73±0.1269	0.56±0.1625	0.63±0.11	0.64±0.102	0.58±0.1077	0.39±0.1578	0.66±0.1114	0.39±0.1578	1.62±0.147
Pre- dorsal length	4.66± 0.196	4.19± 0.1921	3.19±0.2022	3.44±0.1855	9.37±0.1269	9.76±0.1428	4.00±0.1789	4.86±0.1855	8.18±0.3219	9.57±0.2369
Caudal peduncle length	1.61± 0.1221	1.32± 0.0979	0.92±0.1249	0.53±0.09	0.82±0.0748	0.78±0.1166	1.19±0.1044	1.06±0.1019	2.18± 0.260	2.03±0.21
Caudal fin length	2.39±0.0943	2.59±0.2071	2.34 ±0.1428	4.34±0.2417	1.822±0.103	2.19±0.170	2.05±0.1118	2.43±0.2571	5.02± 0.3187	5.17±0.11
Fork length			8.57±0.1952	10.82±0.5546			8.72±0.1249	9.59±0.3858	17.57± 0.3494	20.99±1.2716
Pre –pelvic length	4.56±0.1625	4.88±0.1721	4.19±0.1921	4.51±0.1814			3.87±0.1676	4.67±0.09	9.09± 0.3562	9.42±0.1833
Pre-orbital length	1.23±0.1676	1.02±0.1663	1.07±0.2795	1.08± 0.1833	1.33±0.1735	1.23±0.1417	1.01±0.2982	1.24±0.1281	2.57±0.2795	2.82±0.204
Post- orbital length	2.82±0.1077	3.12±0.2039	1.19±0.3419	1.89±0.2119	2.28±0.3027	2.46±0.2245	1.12±0.2315	1. 65±0.2617	2.12±0.2561	2.44±0.18
Eye diameter	0.56±0.0917	0.29±0.1044	0.51±0.1446	0.45±0.1025	0.69±0.0831	0.65±0.1024	0.62±0.1536	0.58±0.1077	1.22±0.1166	1.21±0.1446

Table 2. Mean length, mean weight, length- weight relationship, condition factor (K value) and growth type for low and mid altitude region of *Channa punctata*, *Mystus vittatus*, *Notopterus notopterus*, *Puntius sophore* and *Labeo rohita.*

	Scientific name	Length (cm) Mean±SD	Weight (g) Mean±SD	L–W relationship constants			K value	Growth type
				a	b	r^2		
In low altitude region	*C. punctata*	15.06±0.2154	44.22±1.2765	0.0151	2.5096	0.99	12.3603	Negative allometry
	M. vittatus	10.22±0.2315	12.27±1.3327	2.8472×10^{-9}	4.7531	0.99	11.4459	Positive allometry
	N. notopterus	19.32±0.3026	62.45±1.5628	51875.4647	-0.1968	0.99	8.9078	Negative allometry
	P.sophore	9.69±1.513	12.38±1.0647	1.7179×10^{-9}	4.9659	0.99	13.5766	Positive allometry
	L. rohita	21.79±0.3753	175.95±14.690	3.3397×10^{-10}	4.7522	0.99	16.9655	Positive allometry
In mid altitude region	*C. punctata*	17.41±0.3477	42.54±1.4974	0.6010	1.7399	0.98	8.0637	Negative allometry
	M. vittatus	12.71±0.4036	12.42±1.4330	2.6593×10^{-7}	3.5752	0.96	6.0207	Positive allometry
	N. notopterus	20.21±0.2385	62.2±1.3015	0.0777	1.743	0.98	7.5359	Negative allometry
	P. sophore	11.81±0.4721	12.53±1.3740	7.9918×10^{-5}	2.6819	0.97	7.5814	Negative allometry
	L. rohita	24.98±0.4331	176.28±13.6155	2.8193×10^{-9}	4.2632	0.94	11.2866	Positive allometry

Table 3. Correlation coefficients (r) between different morphometric characters of low and mid altitude region of *Channa punctata, Mystus vittatus, Notopterus notopterus, Puntius sophore* and *Labeo rohita*.

Percentage in relation to the total length	*Channa punctata*		*Mystus vittatus*		*Notopterus notopterus*		*Puntius sophore*		*Labeo rohita*	
	Low altitude region	Mid altitude region	Low altitude region	Mid altitude region	Low altitude region	Mid altitude region	Low altitude region	Mid altitude region	Low altitude region	Mid altitude region
Standard length	0.94	0.80	0.872	0.80	0.95	0.76	0.72	0.84	0.63	0.97
Head length	0.99	0.77	-0.11	0.28	0.76	-0.02	0.63	0.28	0.51	0.75
Body depth	0.86	-0.46	0.87	0.41	-0.76	-0.71	0.45	-0.21	0.37	0.01
Snout length	0.72	0.08	0.79	0.12	-0.05	-0.03	0.83	-0.08	0.22	0.65
Pre- dorsal length	0.90	0.25	0.94	0.98	-0.45	-0.13	0.70	0.46	0.36	0.42
Caudal peduncle length	-0.33	0.45	0.71	-0.09	0.60	0.18	0.62	-0.05	0.31	-0.10
Caudal fin length	-0.36	0.66	-0.23	0.44	0.68	0.27	0.38	0.72	0.42	0.57
Fork length			0.89	0.71			0.80	0.86	0.63	0.44
Pre –pelvic length	0.93	0.47	0.83	0.10			0.73	0.10	0.48	0.77
Percentage in relation to the head length										
Pre-orbital length	0.86	0.41	0.11	0.56	-0.50	0.08	0.64	0.12	0.66	0.68
Post- orbital length	0.55	0.32	0.58	0.70	0.86	-0.009	-0.19	0.26	0.57	0.56
Eye diameter	0.82	0.66	-0.04	0.32	-0.67	-0.40	0.63	0.10	0.70	0.35

For the species *C. punctata*, there is an increased post-orbital length (3.12cm), smaller eyes (0.29cm), and a smaller peduncle (1.32cm). In the case of *M. vittatus*, the caudal fin is long (4.34cm), and the peduncle is small (0.53cm). For *N. notopterus*, the caudal fin is pointed. In *P. sophore*, the fork length is increased (9.59cm) and for *L. rohita*, both the snout length (1.62cm) and pre-dorsal length (9.57cm) are greater. On the other hand, in low-altitude regions, fish species exhibit a more robust and muscular body shape, with a total length that is slightly shorter than that of mid-altitude fish, particularly in terms of weight (Table 1)

The correlation coefficient was utilized for all morphological characters, excluding pre-orbital length, post-orbital length, and eye diameter, in relation to the total length of the fish. In contrast, pre-orbital length, post-orbital length, and eye diameter were examined in relation to the head length of the fish. Various morphometric characters were investigated across five distinct fish species from low and mid-altitude regions, and the data were subsequently analysed statistically to determine the correlation coefficient (Table 3).

Fishes exhibit a high level of sensitivity to alterations in their environment, promptly adjusting by modifying essential morphometric features. Morphological characters exhibit significant plasticity in adapting to variations in environmental conditions (Swain et al. 1991; Wimberger 1992; Allendorf & Phelps 1988). The phenotypic plasticity of fish is remarkably high. They adapt quickly by modifying their physiology and behaviour to environmental changes. These modifications ultimately alter their morphology (Stearns 1983).

CONCLUSION

The species i.e. *Channa punctata, Mystus vittatus, Notopterus notopterus, Puntius sophore, Labeo rohita* exhibit the variation in size and body shape in low and mid-altitude region. This is due to water current as the water flow is typically faster in mid altitude region compared to low altitude region, also factors like climatic change, food availability, predator pressure, etc causes changes in body structure. The present study would be beneficial for fishery biologists and conservationists working on the protection of fish biodiversity of different geographical locations of the world under the current and future scenario, would also serve as primary information of the management of different fish stocks of various aquatic habitats.

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مقاله کامل

صفات ریخت‌سنجی و رابطه طول-وزن گونه‌های کوچک ماهیان بومی در مناطق کم و متوسط ارتفاع، یک مطالعه تطبیقی از N.E. منطقه، هند

مانوج کومار راجبونگشی، مانمی کالیتا*، کانگ کان تالوکدار

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چکیده: مطالعه حاضر با هدف بررسی ویژگی‌های ریختی گونه‌های ماهی کوچک بومی (SIF)، *Channa punctata*، *Mystus vittatus*، *Notopterus notopterus*، *Puntius sophore*، *Labeo rohita* از مناطق کم ارتفاع و متوسط از شمال شرق هند انجام شد. در مجموع ۵۰ نمونه از هر گونه ماهی بین مارس ۲۰۲۳ تا مه ۲۰۲۴ جمع آوری شد. چهارده پارامتر ریخت‌سنجی برای تجزیه‌وتحلیل مقایسه‌ای گونه‌های ماهی از دو منطقه مجزا انتخاب شد. در منطقه کم ارتفاع، میانگین طول‌های ثبت شده برای *C. punctata*، *M. vittatus*، *N. notopterus*، *P. sophore* و *L. rohita* به‌ترتیب ۱۵/۰۶، ۱۰/۲۲، ۱۹/۲۲، ۹/۶۹ و ۲۱/۷۹ سانتی متر بود. میانگین وزن مربوط به گونه ماهی *C. punctate* ۴۴/۲۲، *M. vittatus* ۱۲/۲۷، *N. notopterus* ۶۲/۴۵، *P. sophore* ۱۲/۳۸، *L. rohita* ۱۷۵/۹۵ گرم بود. در منطقه ارتفاع متوسط، طول متوسط به‌ترتیب برای *C. punctata*، *M. vittatus*، *N. notopterus*، *P. sophore* و *L. rohita* به‌ترتیب ۱۷/۴۱، ۱۲/۷۱، ۲۰/۲۱، ۱۱/۸۱ و ۲۴/۹۸سانتی‌متر بود. میانگین وزن ثبت شده برای گونه‌های ماهی ۴۲/۵۴ برای *C. punctata*، ۱۲/۴۲برای *M. vittatus*، ۶۲/۲ برای *N. notopterus*، ۱۲/۵۳برای *P. sophore* و ۱۷۶/۲۸ گرم برای *L. rohita* بود. *M. vittatus* و *L. rohita* رشد آلومتری مثبت را در هر دو منطقه نشان دادند در حالی‌که *C. punctatus* و *N. notopterus* دارای رشد آلومتریک منفی بودند. گونه *P. sophore* یک گونه جالب با رشد آلومتریک مثبت در منطقه میانی و رشد آلومتری منفی در منطقه کم ارتفاع است.

کلمات‌کلیدی: پارامترهای ریخت‌سنجی، آلومتریک مثبت، آلومتریک منفی، رشد