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Research Article

Seasonal Length-weight Relationship of *Puntius terio* (Hamilton, 1822) in West Bengal, India

Godhuli Sit[1], Arun Jana[1], Angsuman Chanda[1]

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ABSTRACT

The present study aims to analyse the association among length, weight, condition factor, and relative condition factor of *Puntius terio* (Hamilton,1822), with a focus on seasonal change. The results indicate that the species did not strictly follow the anticipated cube law and had allometric development in all seasons. The length-weight relationship value (b) ranged from 2.14 to 3.21; the condition factor varied between 0.62 and 2.65, and the relative condition factor ranged from 0.61 to 2.98 for *P. terio* in the study area. The average values of 'b' were highest during the monsoon, but the condition factor (K) was highest during the winter. The seasonal association between length, weight, condition factor, and relative condition factor was significant ($P<0.05$) according to the Post Hoc test. The current research will support the development of sustainable management strategies for *P. terio* in its habitats by fishery managers.

Keywords: Fishery, Length-Weight, *Puntius terio*, West Bengal

ORCID IDs of the author:
G.S. 0000-0002-5821-7937;
A.J. 0000-0003-3547-6247;
A.C. 0000-0003-1781-5057

[1]Natural and Applied Science Research Centre, Post Graduate Department of Zoology, Raja Narendralal Khan Women's College (Autonomous), Midnapore, Paschim Medinipur, West Bengal, India

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Correspondence:
Angsuman Chanda
E-mail:
chandaangsuman182@gmail.com

INTRODUCTION

Length and weight, both at the individual and population levels, are two crucial components of species biology. This is particularly important for effectively managing and developing fish populations (Anene, 2005). For stock management and long-term stock utilisation, understanding their biology is crucial. The length-weight relationship is one of the most popular techniques for gathering reliable biological data. In addition to its primary use in converting length to weight and vice versa, the length-to-weight ratio can change within a population. These results are important for fishery biology and management.

The condition factor (CF) is an index of how abiotic and biotic components interact to affect a fish's physiological state. It depicts the health of the population at various stages of life. This relationship allows for comparisons of the fish life cycles between species and populations, as well as an estimate of the fish population's health (Kara & Bayhan, 2008). Studying conditions is necessary to understand the life cycles of fish species, which also contributes to ecological balance and sustainable species management. It also aids in determining the reproductive seasons of fish species without affecting the species, making it a useful tool in developing programmes for monitoring species-specific fisheries and culture (Arellano-Martinez & Ceballos-Vazquez, 2001). The relative condition factor examination is equally important because it reveals a fish's health and resilience. *P. terio* is a small ornamental and food fish species in Asia, specifically India, Bangladesh, Pakistan, and Mayanmar (Talwar & Jhingran, 1991 and Menon, 1999). This species has been gradually declining due to pollution, habitat destruction, and selective captive breeding of commercial fish species. In the world, no study has been conducted on any aspect of *Puntius terio*. In India, Sandhya *et al.* (2020), studied the 7 species in Charkhana, including *P. terio*, but did not observe seasonal variation between the length and weight of

these species. In West Bengal, India, there are some aspects (diversity of fish, length-weight relationship, feeding behaviour, reproduction) of various small indigenous fish species that have been studied by different researchers (Sani & Gupta., 2010; Lim et al.,2013; Palaniswamy et al.,2012; Pal et al., 2013; Gupta & Tripathi, 2017; Jana et al., 2021a; Jana et al., 2021b; Jana et al., 2022a; Jana et al., 2022b; Sit et al., 2020; Chanda & Jana., 2021; Sit et al., 2022a; Sit et al., 2022b; Sahil et al., 2022; Sit et al., 2023a; Sit et al., 2023b; Jana et al., 2024a & Jana et al., 2024 b) but yet to observed length, weight, condition factors of the current studied species *Puntius terio*. Therefore, the present study aimed to determine the length, weight, condition factor, and relative condition factor and analyse the association among length, weight, condition factor, and relative condition factor of *Puntius terio* (Hamilton,1822), focusing on seasonal change. The length-weight and relative condition factors determine the studied fish's proper growth and health.

MATERIALS AND METHODOLOGY

Sampling

Specimens have been collected monthly from selected areas (eight sites) in the Paschim Medinipur district during the Summer (March-June), Monsoon (July-Oct), and Winter (Nov-Feb) seasons from March 2022 to February 2024 (Figure 1).

Length & Weight measurement: Seasonally, the total length (TL or L) is measured using a digital slide calliper with ±0.01 mm accuracy and weighted (TW or W) using a digital balance with ±0.01 g accuracy.

Length-Weight relationship: The adjusted formula of Le Cren (1951) was used:

$$W=aL^b$$

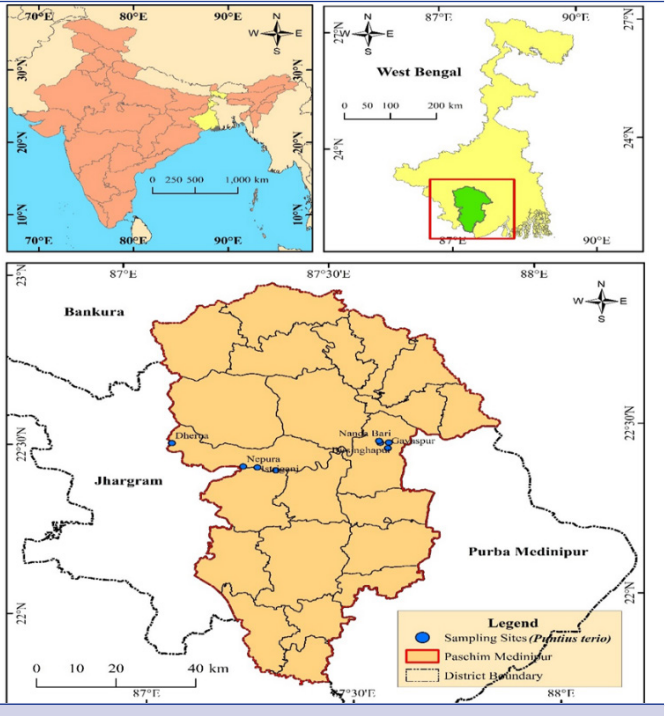

Figure 1. Study area and sampling locations.

Here, W denotes Fish weight (g); L denotes total length of fish (cm); 'a' denotes Intercept and 'b' denotes growth coefficient.

The logarithmic equation is represented as Log W = Log a + b Log L.

Condition factor (K): The following formula of Fulton (1904) was used:

$$K = 100 \times (W/L3)$$

Here, W denotes Weight in gram and L denotes total length in cm.

Relative Condition Factor (Kn): The following formula of Fulton (1904) was used:

$$Kn=W/aL^b$$ Fulton (1904)

Here, W denotes weight in gram, L denotes total length in cm, and a and b denote regression parameters.

Analysis of Data

Data have been analysed (Descriptive statistics, Post Hoc test, Pearson's Correlation and Regression) by SPSS (2021), Microsoft Excel (2019), and Origin Pro (2023) software. Pearson Correlation Coefficient between 1 to + 1; ± 0- 0.10= Markedly low and negligible positive/negative, ± 0.10-0.30= Very low positive/negative, ± 0.30-0.50= Low positive/ negative, ± 0.50-0.70 = Moderate positive/negative, ± 0.70-0.90 = High positive/negative, ± 0.90-0.99 = Very high positive/negative, ±1 = Perfect positive/negative

RESULTS AND DISCUSSION

P. terio's overall size and weight varied from 6.45 ±0.546 to 7.99 ±0.918 cm and 4.26 ±1.36 to 8.46 ±3.87 g, respectively. Table 1 and Figure 2 present the lowest, maximum, and average length and weight data for males and females of *P. terio* for each season. In the current investigation, 'K' and 'Kn' values were 1.31±0.342 to 1.51±0.333 and 1.27± 0.231 to 1.72±0.390, respectively (Table 2). The average 'K' value is highest during the winter season, and 'Kn' is highest during the summer season in *P. terio* (Figure 3). When the fish has 'Kn' values greater than 1 suggests a good nutritional status. On the other hand, the relative condition component remained mostly stable in heavier fish, indicating the fish's health and general well-being. The current results show that 'Kn' is greater after the Monsoon season, but the length-weight ratio is higher in the monsoons, suggesting that the species is not in good health during the Winter period. During the Monsoon season, the highest lengths and weights were observed (Figure 3). The '*b*' and 'R^2' values fluctuated seasonally from 2.138 to 3.216 and 0.510 to 0.756, respectively (Table 3 and Figure 4). The '*b*' value is at its maximum during the monsoon season and lowest during the winter. The parametric and logarithmic length-weight relationships of *P. terio* are shown in Table 4. The r^2 values demonstrate a year-round positive relationship between length and weight. Length has a moderately significant positive correlation with weight, and K has a very low negative and low positive significant correlation with total length and weight, respectively (Table 5). Kn has a high positive significant relationship with K and a very low positive significant relationship with total weight. The post hoc test depicts a significant difference in the total body length, weight, and condition factor (K)

Table 1. Length and weight of *Puntius terio*.

	Length(cm)				Weight (g)			
	Mn	Mx	Mean	SD	Mn	Mx	Mean	SD
Summer								
Combined	5.20	7.90	6.86	±0.798	2.18	10.0	4.86	±1.75
Female	5.30	7.90	7.11	±0.895	2.65	10.0	5.01	±1.91
Male	5.20	7.30	6.66	±0.456	2.22	8.95	4.54	±1.45
Monsoon								
Combined	5.80	9.20	7.99	±0.918	3.47	19.11	8.43	±3.69
Female	5.90	9.20	8.11	±0.921	4.32	19.11	8.46	±3.87
Male	5.60	8.40	7.44	±0.812	3.88	15.62	7.99	±2.99
Winter								
Combined	5.60	8.80	6.75	±0.684	3.01	8.69	4.66	±1.52
Female	5.30	8.80	7.11	±0.724	3.12	8.70	4.99	±1.87
Male	5.10	7.10	6.45	±0.546	2.09	7.76	4.26	±1.36

N=480

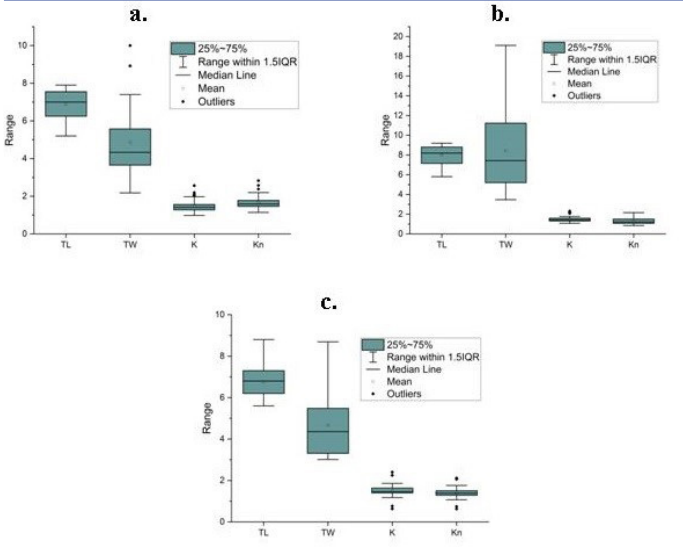

Figure 2. Length, Weight, K, K_n of *Puntius terio*: a. summer; b. Monsoon; c. Winter

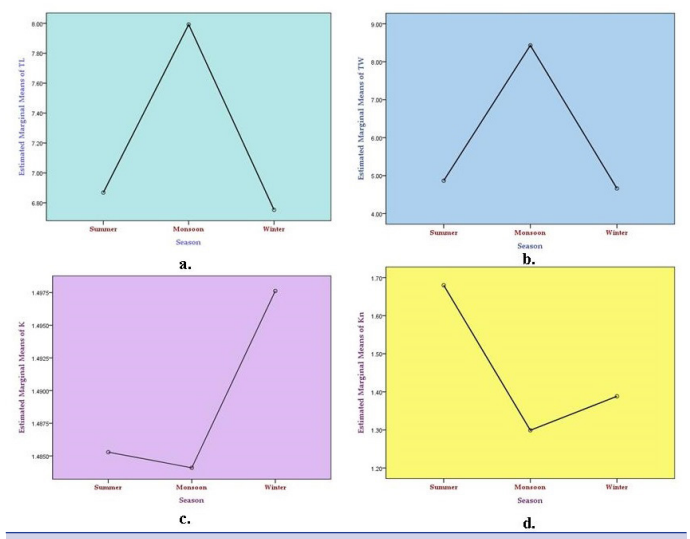

Figure 3. Length, Weight, K, K_n of *Puntius terio*: a. summer; b. Monsoon; c. Winter

of *P. terio* during the summer, monsoon, and winter seasons. Total length and weight significantly differ between summer, monsoon, and monsoon winter; "Kn" is found to differ significantly between summer and monsoon and summer and winter seasons, but not between Monsoon and Winter (Table 6). *P. terio* shows a negative allometric growth pattern (negative) except for the monsoon season. Negative allometric growth may be noticed if food deficiency and the surrounding environment are not suitable for breeding and growth development (Le Cren, 1951; Soni and Kathal, 1953; Weatherly, 1972; Deka and Bura Gohain, 2015).

However, positive allometric growth patterns of various tiny fish species, including *Puntius*, were documented by Sani et al. (2010), Palaniswamy et al. (2012), Pal et al. (2013), Lim et al. (2015), Hossain et al. (2015), and Sahil et al. (2022). Certain *Puntius* species exhibit negative allometric growth patterns, as reported by Bahuguna et al. (2021), Khan et al. (2021), Sarkar et al. (2013), Manorama and Ramanujam (2014), and Shafi and Parveen (2012). Hossain *et al.* (2012) reported the isometric growth pattern of *P. sophore* in Bangladesh. Sandhya *et al.* (2020) studied the length-weight relationship of 18 species of freshwater fish; here, four species belonged to the isometric growth pattern, and the other 14 species had equally positive and negative allometric growth patterns, among them, P. *terio*'s length was 2.6 cm 5.8 cm, weight 0.3-3.01 g, *b* value 3.147, R^2 value between total length and total weight is 0.974. Sahil *et al.* (2022) reported length 1.2-9.8 cm, total weight 0.30-7.18 g, *b* value of 1.86, R^2 value of 0.7270 between length and weight, and k value of 2.06 for *P. terio* in North Bihar. In the present study, except during the Monsoon season, *P. terio* exhibited allometric growth patterns (nega-

Table 2. K and K_n of *Puntius terio*.

	K				K_n			
	Mn	Mx	Mean	SD	Mn	Mx	Mean	SD
Summer								
Combined	0.98	2.56	1.48	±0.353	1.14	2.83	1.68	±0.380
Female	0.99	2.65	1.48	±0.371	1.19	2.98	1.72	±0.390
Male	0.97	2.43	1.31	±0.342	1.13	2.82	1.63	±0.373
Monsoon								
Combined	1.08	2.32	1.48	±0.280	0.84	2.15	1.29	±0.311
Female	1.09	2.41	1.49	±0.291	0.86	2.41	1.33	±0.354
Male	1.07	2.26	1.36	±0.273	0.82	2.02	1.27	±0.322
Winter								
Combined	0.63	2.40	1.49	±0.302	0.63	2.12	1.38	±0.272
Female	0.64	2.54	1.51	±0.333	0.66	2.31	1.43	±0.291
Male	0.62	2.43	1.46	±0.299	0.61	2.09	1.27	±0.231

N=480

Table 3. Seasonal regression parameters of *Puntius terio*.

Season	Sex	a	b	R^2
Summer	Combined	0.0643	2.223	0.548
	Female	0.0653	2.226	0.556
	Male	0.0637	2.201	0.534
Monsoon	Combined	0.00971	3.197	0.751
	Female	0.00983	3.012	0.756
	Male	0.00966	3.216	0.750
Winter	Combined	0.0747	2.142	0.510
	Female	0.0751	2.143	0.520
	Male	0.0742	2.138	0.510

N=480

Table 4. Parabolic and logarithmic length weights of the *Puntius terio*.

Season	Sex	Parabolic	Logarithmic
Summer	Combined	W=0.0643^2.223	Log-W=-1.191+2.223logL
	Female	W=0.0653^2.226	Log-W=-1.185+2.226logL
	Male	W=0.0637^2.201	Log-W=-1.195+2.201logL
Monsoon	Combined	W=0.0097L^3.197	Log-W=-2.012+3.197logL
	Female	W=0.00983L^3.197	Log-W=-2.007+3.012logL
	Male	W=0.00966L^3.216	Log-W=-2.015+3.216logL
Winter	Combined	W=0.0748L^2.142	Log-W=-1.126+2.142logL
	Female	W=0.0751L^2.143	Log-W=-1.124+2.143logL
	Male	W=0.0742L^2.138	Log-W=-1.129+2.138logL

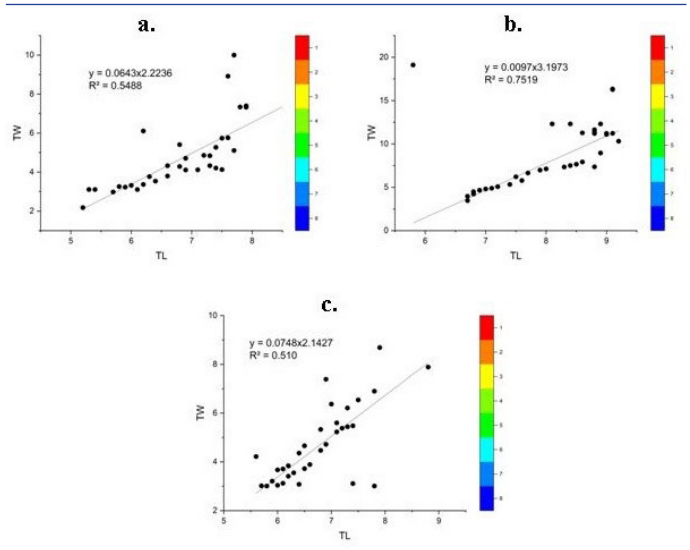

Figure 4. Length-Weight relationship of *Puntius terio*, a. Summer; b. Monsoon; c. Winter

Table 5. Pearson's correlation among Length, Weight, K, and K_n of *Puntius terio*.

	Season	TL	TW	K	Kn
Season	1	-0.048	-0.027	0.016	-0.330**
TL	-0.048	1	0.684**	-0.153*	-0.083
TW	-0.027	0.684**	1	0.388**	0.263**
K	0.016	-0.153*	0.388**	1	0.844**
K_n	-0.330**	-0.083	0.263**	0.844**	1

N=480; ** 0.01, level of significance; 0.05, level of significance; 0.05, level of significance

Table 6. Post-hoc test seasonally comparisons of length, weight, K, and K_n of the *Puntius terio*.

Dependent Variable	(I) Season	(J) Season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TL	Summer	Monsoon	-1.1234*	0.14254	**0.001**	-1.4602	-0.7867
		Winter	0.1156	0.14254	0.697	-0.2211	0.4524
	Monsoon	Summer	1.1234*	0.14254	**0.001**	0.7867	1.4602
		Winter	1.2391*	0.14254	**0.001**	0.9023	1.5758
	Winter	Summer	-0.1156	0.14254	0.697	-0.4524	0.2211
		Monsoon	-1.2391*	0.14254	**0.001**	-1.5758	-0.9023
TW	Summer	Monsoon	-3.5641*	0.44511	**0.001**	-4.6156	-2.5126
		Winter	0.2042	0.44511	0.891	-0.8473	1.2557
	Monsoon	Summer	3.5641*	0.44511	**0.001**	2.5126	4.6156
		Winter	3.7683*	0.44511	**0.001**	2.7168	4.8198
	Winter	Summer	-0.2042	0.44511	0.891	-1.2557	0.8473
		Monsoon	-3.7683*	0.44511	**0.001**	-4.8198	-2.7168
K	Summer	Monsoon	0.0012	0.05542	1.000	-0.1297	0.1321
		Winter	-0.0123	0.05542	0.973	-0.1433	0.1186
	Monsoon	Summer	-0.0012	0.05542	1.000	-0.1321	0.1297
		Winter	-0.0135	0.05542	0.968	-0.1445	0.1174
	Winter	Summer	0.0123	0.05542	0.973	-0.1186	0.1433
		Monsoon	0.0135	0.05542	0.968	-0.1174	0.1445
Kn	Summer	Monsoon	0.3809*	0.05738	**0.001**	0.2453	0.5164
		Winter	0.2916*	0.05738	**0.001**	0.1561	0.4272
	Monsoon	Summer	-0.3809*	0.05738	**0.001**	-0.5164	-0.2453
		Winter	-0.0892	0.05738	0.268	-0.2248	0.0463
	Winter	Summer	-0.2916*	0.05738	**0.001**	-0.4272	-0.1561
		Monsoon	0.0892	0.05738	0.268	-0.0463	0.2248

tive). These findings contrast those of Sani and Gupta (2010), Rahman et al. (2012), Palaniswamy et al. (2012), Lim et al. (2013), Hossain et al. (2015), Kaushik and Bordoloi (2015), Muhammad et al. (2016), and Gupta and Tripathi (2017). The results demonstrate observations similar to those of Manorama and Ramanujan (2011), Shafi and Yousuf (2012), Sarkar et al. (2013), Vishal and Gaur (2015), Khan et al. (2021), Bahuguna et al. (2021), and Moglekar et al. (2022). These discrepancies can be explained by several factors, including sample size structure, reduced feeding proficiency, gonad maturity, sex, and a high proportion of small specimens (Franco *et al.*, 2014; Froese, 2006). Seasonal variation in the condition factors and relative condition factors for this species was supported by the study of Manorama and Ramanujan (2014). Therefore, fluctuations in growth factors in different seasons are an important concern for the maintenance of these two species populations in the study area.

CONCLUSION

The results indicate that the species did not strictly follow the anticipated cube law and had allometric development in all four seasons. The objectives of this study were met, and the information gathered can be used to guide the creation of future biometric research studies for other fish from the study region. Fishery managers will be able to create growth management strategies for *P. terio* in their habitats using only current findings.

Conflict of Interest: The authors declare no conflicts of interest.

Ethics Committee Approval: This Ethical clearance from the IAEC (Approval no. 08/1AEC(1)/S/RNLKWC/2023, dated-15/06/2023.

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