

Seasonal Length-Weight Relationships and Condition Factors of *Xenentodon cancila* (Hamilton, 1822) from Upper Brahmaputra Basin, Assam, NE India

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ABSTRACT

The present study describes the length-weight relationship (LWR) and condition factor of *Xenentodon cancila* (Hamilton, 1822) on a seasonal basis from upper Brahmaputra basin, NE India. All the relationships between total length and total weight are found to be highly significant ($P < 0.01$) for both the sexes of the species throughout the period of study. The species exhibited allometric growth for most part of the study and found not to be strictly in accordance with the predicted cube law. Seasonal variation in the calculated "b" values for the species also observed ranging from 2.098 (in winter) to 3.401 (in pre-monsoon). Similarly, mean value of relative condition factor (K_n) ranges between 0.991 (in monsoon) and 1.149 (in winter) with minimum seasonal variations for both the sexes while mean value of Fulton's condition factor (K) is found to be slightly higher in females than males except for monsoon.

Key words: *Xenentodon cancila*, Length-weight relationship, Condition factor, Upper Brahmaputra Basin

Introduction

For fisheries research, length-weight relationships (LWRs) are essential for maintaining the taxonomic characteristics of fish species (Pervin & Mortuza, 2008), as well as for assessing growth and stock levels (Petrakis & Stergiou, 1995; Valset *et al.*, 2007). Analysis of length-weight relationship is also necessary to ascertain whether the fish's somatic growth is isometric or allometric (Ujjania *et al.*, 2012). Fish usually grow in an isometric manner in accordance with the Cube law, $W=L^3$ (Lagler, 1956). Divergence from the cube rule, however, can occur due to a variety of external conditions and as such. LeCren (1951) modified the Cube equation to $W=aL^b$ in order to calculate the data from weight and length measurements for their relationship. On the other hand, condition factor is a measurable quantity that

describes the health of the fish (i.e. fish's state of well-being) and determines the success of the population through effects on growth, reproduction, and survival (Hossain *et al.*, 2006). Since it is a reflection of the interaction between biotic and abiotic components on the physiological condition of fish, it also assesses the state of the aquatic ecosystem in which fish inhabit (Anene, 2005).

The Brahmaputra drainage system in Northeastern India is one of the largest hydrographic basins in the world and is known for its exceptionally rich and diversified aquatic gene pool, particularly for fish and thus recognized as a global hotspot of freshwater fish biodiversity (Kottelat and Whitten, 1996). *Xenentodon cancila*, commonly known as needle fish ('kokila' in Assam) is a native fish species of the upper Brahmaputra basin, belonging to the family Belontiidae under the order Beloniformes. Though it

is a freshwater fish, it has been reported from brackish and marine waters as well (Froese and Pauly, 2019). *Xenentodon cancila* has been considered as a potential ornamental fish due to its distinctive shape and unique beak-like mouth. This species has also been exported from India to other countries as ornamental fish (Khan *et al.*, 2002). A significant decline in the natural population of this species over the years has also been observed in this region due to various reasons including habitat degradation and increased fishing pressure (Islam *et al.*, 2016).

Different aspects of *Xenentodon cancila* including the length-weight relationship have been reported by various workers from India, Bangladesh, Nepal and Pakistan (Chandrika and Balasubramonian, 1986; Shrestha, 1994; Nazir and Khan 2007; Khan *et al.*, 2002; Hossain *et al.*, 2013; Subba *et al.*, 2012; Khoso *et al.*, 2018). However, no information is available on seasonal length-weight relationship and condition factor of this species from the North East India so far. This study mainly focuses on seasonal LWRs and condition factor of *Xenentodon cancila* from the upper Brahmaputra basin of Assam, NE India.

Materials and Methods

Study site and Sampling

During the present study, a total of 476 specimens were collected from upper stretches of the Brahmaputra River and its tributaries in Tinsukia, Dibrugarh and Sivasagar districts of upper Assam. Samples were collected twice in a month from different fish landing sites of the study area during the period from March, 2023 to May, 2024. Fishes were caught by the local fisherman using different types of fishing nets. The freshly collected samples were immediately preserved with ice and brought to the laboratory for further analysis. Upon arrival the fishes were taken of ice and clean properly to remove any dirt, before being preserved in 10% formalin for further studies.

Fish measurement

Each individual specimen was measured in the lab using the standard protocol for both total length (TL) and total body weight (BW). Total body length (from the tip of the snout to the tip of the tail) was measured to the closest 0.1 cm using a measuring scale while a digital balance was used to weigh them

precisely to within 0.1 g. Each specimen was dissected ventrally to identify the sex of the individual. All weight and length records are arranged seasonally as pre-monsoon (March–May), monsoon (June–August), post-monsoon (September–November) and winter (December–February).

Length-weight relationships and condition factor

The empirical formula $W = aL^b$, where W is the total body weight (g), L is the total body length (cm), and “ a ” and “ b ” are coefficients linked to body form and exponent, is used to calculate the length-weight relationship. The ‘ b ’ value equals to 3 indicates isometric growth while significant deviation from 3 indicates allometric growth (Frosta *et al.*, 2004). The LWR equation can be transformed into the Log $W = \log a + b \log L$ (LeCren, 1951) and the values of coefficients were analysed empirically. The recorded average weight was plotted on the Y-axis and the observed average length on the X-axis to ascertain the characteristics of a parabola. While the relative condition factor (K_n) was determined using the relation, $K_n = W/aL^b$, the Fulton’s condition factor (K) was approximated using the relationship, $K = 100W/L^3$.

Data analysis

Data recorded with respect to length and weight of *X. cancila* during the present study were statistically analysed for relevant relationships (correlation and regression) using the MS Excel (Windows version 11.0).

Results

Length- weight relationships (LWRs)

Different aspects like sample size (N), minimum (min) and maximum (max) total length (TL) and total body weight (BW) during the present study on length-weight relationships and condition factor for *X. cancila*, are presented seasonally (pre-monsoon, monsoon, post- monsoon and winter) in Table 1. Likewise, relationship between length and weight of *X. cancila* in the form of the equation $\log(W) = \log a + b \log(L)$, a and b values, 95% CI of a and b , coefficient of determination (r^2) and growth type for both the sexes of *X. cancila* are also summarized in Table 1. Out of total 476 specimens collected and studied, 191 (i.e. 40.13 %) were male and 285 (i.e. 59.87 %) were female (thus having a sex ratio male:

female is 1:1.49). The TL for *X. cancila* was found within the range of 9.3 – 22.9 cm for males and 10.4 to 25.5 cm for females while the observed range for BW was from 1.18 to 26.78 gm in male and from 1.73 to 31.72 gm in female. Both the maximum TL (i.e., 25.5 cm) and BW (31.72 gm) of the fish species was recorded during the pre-monsoon season.

The relationships between TL and BW of *X. cancila* sex-wise (male, female as well as combined sex) for all the seasons are presented in Figure 1(a-c), Figure 2 (a-c), Figure 3 (a-c) and Figure 4 (a-c) where all the relationships were found to be statistically significant ($P < 0.01$). The calculated allometric coefficient b for male in the pre-monsoon is more than the value of isometry (i.e., $b > 3$) indicating a positive allometric growth of the species while in monsoon and winter the value is less than the isometric value (i.e., $b < 3$), indicating a negative allometric growth. The males of the species, however, show isometric growth during post-monsoon. On the other hand, the b value indicates a negative allometric growth

for females during monsoon and winter while suggests an isometric growth during the pre-monsoon and post-monsoon.

Seasonal variations in LWRs are also observed for both the sexes of *X. cancila* during the study period. The computed b values ranged from 2.098 (winter) to 3.401 (pre-monsoon) for males, from 2.593 (monsoon) to 3.010 (pre-monsoon) for females and from 2.467 (winter) to 3.312 (pre-monsoon) for the combined sex.

The logarithmic equations for length-weight relationship for all the seasons are provided in Table 1. The values for coefficient of determination (R^2) indicate a strongly positive linear relationship throughout the period of study.

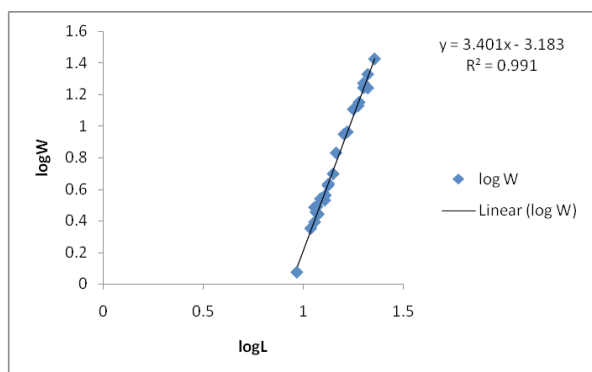


Fig. 1a. Length-weight relationship of *X. cancila* in pre-monsoon (male)

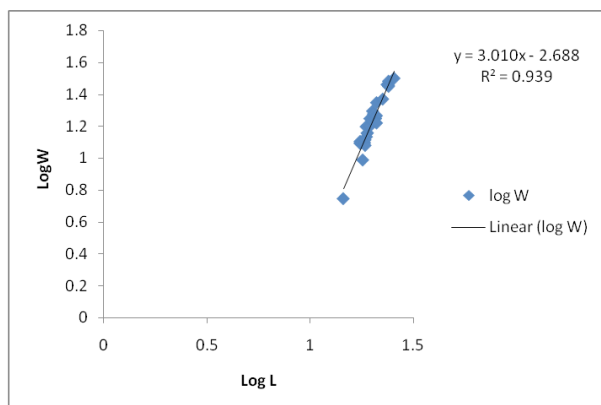


Fig. 1b. Length-weight relationship of *X. cancila* in pre-monsoon (female)

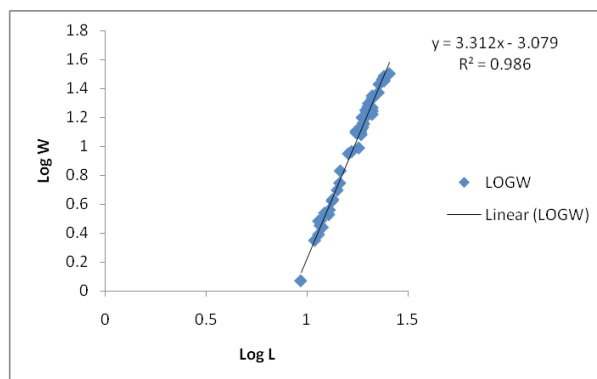


Fig. 1c. Length-weight relationship of *X. cancila* in pre-monsoon (combined sex)

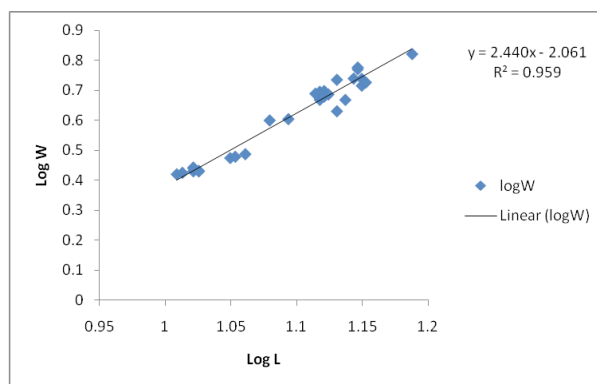


Fig. 2a. Length-weight relationship of *X. cancila* in monsoon (male)

Condition factor

The descriptive statistics of the relative condition factor (K_n) and Fulton's condition factor (K) for male, female and combined sex for different seasons are provided in Table 2. The mean K_n value varies

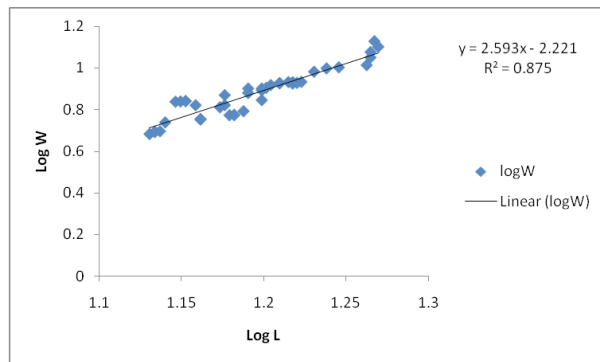


Fig. 2b. Length-weight relationship of *X. cancila* in monsoon (female)

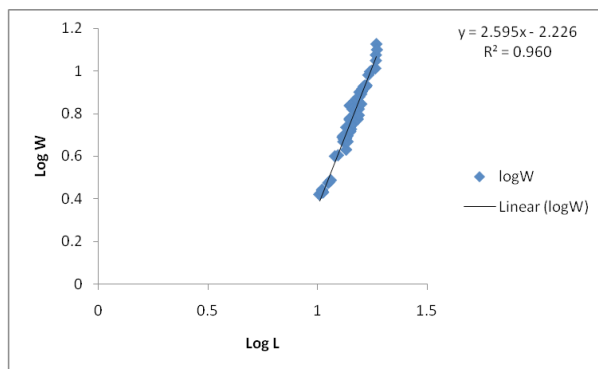


Fig. 2c. length-weight relationship of *X. cancila* in monsoon (combined sex)

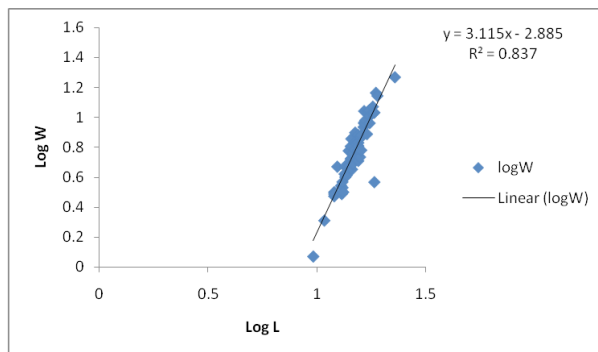


Fig. 3a. Length-weight relationship of *X. cancila* in post-monsoon (male)

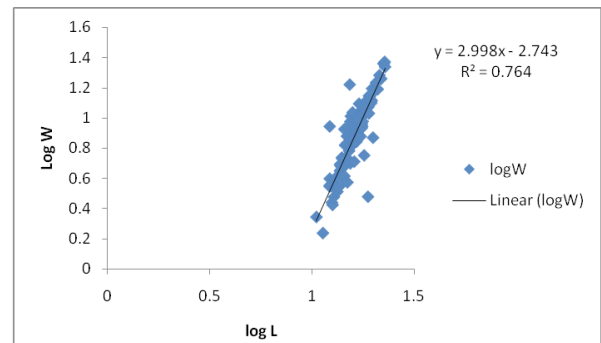


Fig. 3b. length-weight relationship of *X. cancila* in post-monsoon (female)

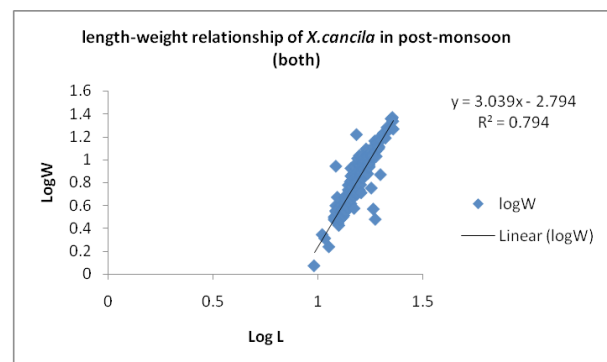


Fig. 3c. length-weight relationship of *X. cancila* in post-monsoon (combined sex)

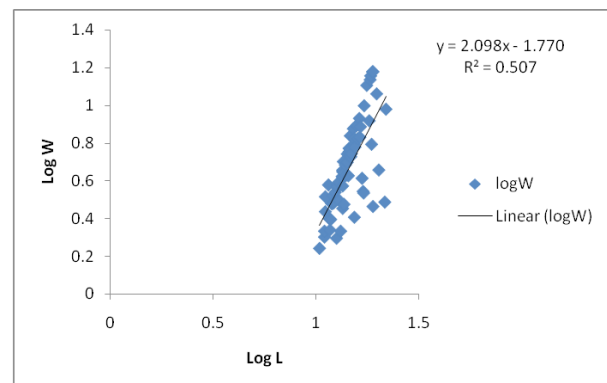


Fig. 4a. length-weight relationship of *X. cancila* in winter (male)

from the 0.994 (monsoon) to 1.068 (winter) for male, from 0.989 (monsoon) to 1.149 (winter) for female and from 0.991 (monsoon) to 1.138 (winter) for combined sex.

Again, the mean value of Fulton's Condition Factor (K) for males ranges from 0.162 (winter) to 0.212 (monsoon), from 0.184 (post-monsoon) to 1.027 (pre-

monsoon) for females, and from 0.183 (post-monsoon) to 0.217 (winter) for combined sex. The values of Relative Condition Factor (K_n) are nearly equals to 1 for both males and females. The highest value for both Relative Condition Factor (K_n) as well as Fulton's Condition Factor (K) are recorded during winter.

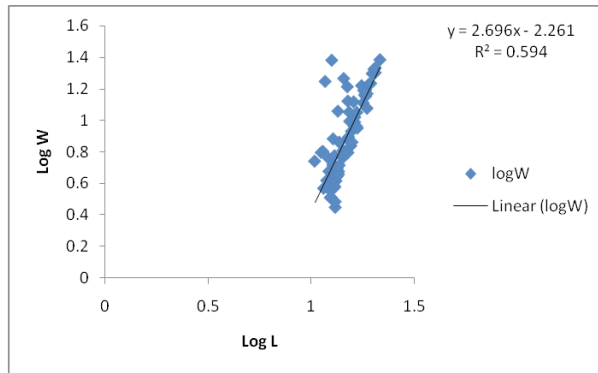


Fig. 4b: length-weight relationship of *X. cancila* in winter (female)

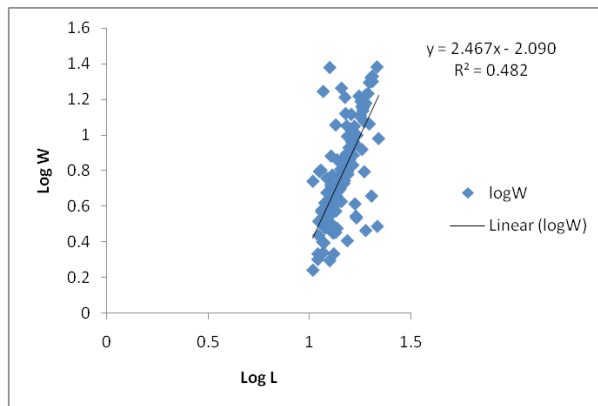


Fig. 4c: length-weight relationship of *X. cancila* in winter (combined sex)

Discussions

The needle fish, *Xenentodon cancila* (Belonidae: Beloniformes) is an important fish species found in the Upper Brahmaputra basin in Assam, NE India. The results on the LWR and its seasonal variation in the present study are provided in Table-1 and Figure 1(a-c) – 4(a-c). The maximum length of *X. cancila* recorded during the study period is 25.5 cm. There have been some reports on the LWR of this species from different parts of south-east Asia (Shrestha, 1994; Khan *et.al.*, 2002; Satrawaha and Pilasamorn, 2009; Hossain *et al.*, 2013; Khoso *et al.*, 2018; Ranjit *et.al.*, 2020 & Ghosh, 2021). Of these, except Khan *et.al.* (2002) and Khoso *et al.* (2018), the maximum length for *X. cancila* recorded by the other workers is found to be less than the maximum length recorded during the present study. Difference in observed length or size for this species may be the result of including pollution, availability of food, as well as

Table 1. Descriptive statistics on sample size, TL_{min-max}, Mean TL $\pm$ SD, BW_{min-max}, Mean BW $\pm$ SD, a, b, LWRs (log a + b log L), 95% CI of a and b, co efficient of determination (r^2) and growth type of *X. cancila* from Upper Brahmaputra basin, Assam, NE India

	Pre- monsoon			Monsoon			Post- monsoon			Winter		
	Male	Female	Combined sex	Male	Female	Combined sex	Male	Female	Combined sex	Male	Female	Combined sex
N	24	30	54	29	42	71	67	134	201	71	79	150
TL _{min-max}	9.3-22.7	14.5-25.5	9.3-25.5	10.2-15.4	13.5-18.6	10.2-18.6	9.6-22.9	10.5-22.8	9.6-22.9	10.4-22	10.4-21.6	10.4-22
Mean TL $\pm$ SD	15.1 $\pm$ 3.918	19.9 $\pm$ 2.455	17.8 $\pm$ 3.964	12.5 $\pm$ 1.500	15.7 $\pm$ 1.471	14.42 $\pm$ 2.147	15.28 $\pm$ 2.184	16.33 $\pm$ 2.403	15.98 $\pm$ 2.379	14.70 $\pm$ 2.696	14.93 $\pm$ 2.632	14.82 $\pm$ 2.656
BW _{min-max}	1.18-26.78	5.58-31.72	1.18-31.72	2.63-6.63	4.82-13.4	2.63-13.4	1.18-18.55	1.73-23.44	1.18- 23.44	1.75-15.15	2.82-24.15	1.75-24.15
Mean BW $\pm$ SD	8.70 $\pm$ 7.293	17.5 $\pm$ 6.567	13.6 $\pm$ 8.16	4.30 $\pm$ 1.243	7.83 $\pm$ 2.067	6.39 $\pm$ 2.469	6.98 $\pm$ 3.248	8.60 $\pm$ 4.027	8.03 $\pm$ 4.027	5.43 $\pm$ 3.205	9.31 $\pm$ 5.662	7.45 $\pm$ 5.034
a	0.00066	0.0020	0.00083	0.0086	0.006	0.006	0.0013	0.0018	0.0016	0.0169	0.0058	0.0081
b	3.401	3.010	3.312	2.440	2.593	2.595	3.115	2.998	3.039	2.098	2.696	2.467
Logarithmic equation	-3.183+	-2.688+	-3.079+	-2.061+	-2.221+	-2.226+	-2.885+	-2.743+	-2.794+	-1.770+	-2.261+	-2.090+
95% CI of a	3.401x	3.010x	3.312x	2.440x	2.593x	2.595x	3.115x	2.998x	3.039x	2.098x	2.696x	2.467x
95% CI of b	-3.34 - -3.01	-3.07 - -2.303	-3.21 - -2.94	-2.27 - -1.84	-2.59 - -1.84	-2.37 - -2.08	-3.28 - -2.48	-3.09 - -2.39	-3.05 - -2.53	-2.34 - -1.19	-2.85 - -1.67	-2.57 - -1.60
r^2	3.25- 3.54	2.71 - 3.30	3.20 - 3.41	2.24 - 2.63	2.28- 2.90	2.46 - 2.72	2.77 - 3.45	2.71 - 3.28	2.82 - 3.25	1.60 - 2.59	2.19- 3.20	2.05-2.88
Growth type	0.986	0.991	0.939	0.959	0.875	0.960	0.837	0.764	0.794	0.507	0.594	0.482
	A+	I	A+	A-	A-	A-	I	I	I	A-	A-	A-

fisheries exploitation (Soomro *et al.*, 2012). Moreover, the availability of larger sized individuals of the species in pre-monsoon may be an indication towards this period as the peak breeding season for the species (Khoso *et al.*, 2018).

The calculated b values during the present study found to range between 2.098 and 3.401 reflecting negative allometric to isometric to positive allometric growth for *X. cancila*. This range is in accordance with the values i.e. 2 - 4 as provided by Carlander, 1969. Fish that grow in an isometric pattern maintain the same form and specialized structure throughout their lives (Khan *et al.*, 2002). However, the LWRs vary according to the season as the fat and water content of fish body vary with the temperature and associated environmental variables (Hossain *et al.*, 2006). When there is sufficient food availability in the habitat, the fishes exhibit positive allometric growth pattern whereas, when fishes are not eating enough due to the environment factors (like shortage of food in natural habitat, reproductive seasonality, weight of the gut content of an individual fish prior to sampling, etc.), they show negative allometric growth pattern (LeCren, 1951; Soni and Kathal, 1953; Weatherly, 1972; Pauly, 1984; Yousuf & Khursid, 2008 and Deka

Table 2. Seasonal variation in Kn value and K value for *X. cancila* from Upper Brahmaputra basin, Assam, NE India

	Pre- monsoon			Monsoon			Post- monsoon			Winter		
	Male	Female	Combined sex	Male	Female	Combined sex	Male	Female	Combined sex	Male	Female	Combined sex
Kn _{min-max}	0.844-1.175	0.812-1.179	0.813- 1.167	0.859- 1.106	0.843-1.241	0.843-1.241	0.326-1.416	0.253-2.699	0.252-2.741	0.286-1.879	0.507-4.795	0.191-5.711
Mean Kn ± SD	0.996±0.0814	1.029±0.0943	1.002±0.0924	0.994±0.0063	0.989±0.0968	0.991±0.0849	1.018±0.1693	1.032±0.2749	1.030±0.2466	1.068±0.3444	1.149±0.6575	1.138±0.6477
K _{min-max}	0.146-0.234	0.812-1.179	0.146-0.243	0.173-0.247	0.168-0.250	0.168- 0.250	0.059-0.245	0.045-0.483	0.045-0.483	0.030-0.249	0.125-1.198	0.030-1.198
Mean K ± SD	0.193±0.025	1.027±0.094	0.203±0.023	0.212±0.019	0.198±0.020	0.203±0.021	0.181±0.030	0.184±0.049	0.183±0.043	0.162±0.047	0.266±.0166	0.217±0.135

& Bura Gohain, 2015). Earlier workers- Satrawaha and Pilasamorn (2009) & Subba *et al.* (2012) reported positive allometric growth while Chandrika & Balasubramonian, (1986) recorded negative allometric growth for *X. cancila*. There has been a perfect linear relationship between the variables, as indicated by the negative intercepts (a) for each group. Likewise, a number of other factors including fishing pressure, stage of gonadal maturity, diet and stomach fullness could contribute to variation in the 'b' value of fishes (Ogunola *et al.*, 2018 & Pise *et al.*, 2018). Bagenal and Tesch (1978) also pointed out factors like feeding rate, growth phase, habitat quality as well as health of a fish influence the length-weight relationship to a great extent.

The condition factor can be used as an index to evaluate the state of the aquatic ecosystem in which fish reside since it is a reflection of the interactions between biotic and abiotic elements on the physiological condition of fish (Anene, 2005). During the present study, the calculated mean values for relative condition factor (Kn) for all the seasons are found to around 1 for both the sexes (ranged from 0.989 to 1.149 for females and from 0.994 to 1.068 for males) with minimal seasonal variation, which indicates fishes are in healthy environmental condition. However, the maximum Kn value for the species (combined sex) recorded during winter.

The mean K value, on the other hand, exhibits seasonal variation for both the sexes of *X. cancila*. In case of females K value found to vary between 0.184 (in post-monsoon) and 0.266 (in winter) while in case of males the same is found to vary between 0.162 (in winter) and 0.212 (in monsoon). Fish that have reached sexual maturity frequently experience declining K values as a result of reproductive activity (Ahmed *et al.*, 2019). The Kn value more than 1 indicates fishes are in good health. Temporal variations in the Gastro-somatic Index (GSI) value are also associated with Fulton's condition factor (K) (Ahamed *et al.* 2014, Hossain *et al.* 2012 & 2013).

Conclusion

This study provides the basic information on LWRs and condition factors and their seasonal variation in *X. cancila* from the Upper Brahmaputra basin, NE India. Relationship between length and weight of the species (considering both males and females combined) shows allometric growth for most part of the study (during pre-monsoon, monsoon and win-

ter) while isometric growth is observed during post-monsoon. For the sexes of the species, the relative condition factor is around 1 throughout the period of study, shows overall well being of the fish species. The findings of this study will provide a baseline data for the further studies on different aspects of this species and also helps in formulating better strategies for conservation and sustainable management of the species from this region.

Competing Interests

The authors declared no competing interests.

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References

- Ahamed, F. and Ohtomi, J. 2014. Relative growth and sexual maturity of the pandalid shrimp *Plesionik aizumiae* (Decapoda, Caridea) in Kagoshima bay, southern Japan. *Crustaceana*. 87: 1567-1577.
- Ahmed, Z., Ahamed, F. and Fatema, M. 2019. Biological features of *Chanda nama* (Ambassidae) in the Old Brahmaputra River, Bangladesh. *International Journal of Aquatic Biology*. 7: 342-350. 10.22034/ijab.v7i6.683.
- Anene, A. 2005. Condition factors of four cichlid species of a man-made lake in Imo state, Southeast, Nigeria. *Turk. J. Fish. Aquat. Sci*. 5: 43-47.
- Bagenal, T.B. and Tesch, F.W. 1978. Age and growth. In: T. Bagenal (ed.), *Methods for assessment of fish production in fresh waters*, 3rd Edn. IBP Handbook No. 3, Blackwell Science Publications, Oxford. 101-136
- Carlander, K.D. 1969. *Handbook of freshwater fishery biology*. Vol. 1. The Iowa State University Press, Ames IO, USA.
- Chandrika, B. and Balasubramonian, N.K. 1986. Lengthweight relation ship of *Xenentodon cancila*. *Proceedings of Indian Academy of Science (Animal Science)*. 95(2): 187-190.
- Deka, P. and Bura, G. A. 2015. Length-Weight relationship and relative condition factor of *Rita rita* (Hamilton, 1822), *Pangasius pangasius* (Hamilton, 1822) and *Chitala chitala* (Hamilton, 1822) of Brahmaputra River system of Assam, India. *International Journal of Fisheries and Aquatic Studies*. 3(1): 162-164.
- Froese R., Pauly D. (eds.). 2019. FishBase. [Version 10/2018] <http://www.fishbase.org>
- Frosta, I.O., Costa, P.A.S. and Braga, A.C. 2004. Length weight relationship of marine fishes from the Central Brazilian Coast. *Naga, the ICLARM Quarterly*. 27: 20-26.
- Ghosh, S.K. 2021. Anatomical, histoarchitectural and topological studies on the olfactory organ of freshwater garfish, *Xenentodon cancila* (Hamilton, 1822). *Int. J. Aquat. Biol*. 9(1): 66-70.
- Hossain, M.Y., Ahmed, Z.F., Leunda, P.M., Jasmine, S., Oscoz, J., Miranda, R. and Ohtomi, J. 2006. Condition, length-weight and length-length relationships of the Asian striped catfish *Mystus vittatus* (Bloch 1794) (Siluriformes: Bagridae) in the Mathabhanga River, southwestern Bangladesh. *Journal of Applied Ichthyology*. 22: 304-307.
- Hossain, M.Y., Ohtomi, J., Ahmed, J., Jasmine, S. and Vadas, R.L. 2012. Life-history traits of the Monsoon River prawn *Macrobrachium malcolmsonii* (Milne-Edwards 1844) (Palaemonidae) in the Ganges (Padma) River, northwestern Bangladesh. *Journal of Freshwater Ecology*. 27(1): 131-142.
- Hossain, M.Y., Jewel, M.A.S., Rahman, M.M., Haque, A.B.M.M., Elbaghdady, H.A.M. and Ohtomi, J. 2013. Life-history Traits of the Freshwater Garfish *Xenentodon cancila* (Hamilton 1822) (Belonidae) in the Ganges River, Northwestern Bangladesh. *Sains Malay*. 42 (9): 1207-1218.
- Islam, M.S., Akter, S., Hasan, M.R. and Seba, S.S. 2016. Some aspects of biology of banded gourami, *Colisa fasciata* in Jessore, Bangladesh. *International Journal of Biosciences*. 9(4): 72-80.
- Khan, Macksood, Miah, MD, Sukhan, Zahid Parvez and Rashid, Professor Harunur. 2002. Length-weight relationship and condition factor of *Glossogobius giuris* and *Xenentodon cancila* collected from 'Haor' area of Bangladesh. *Bangladesh Journal of Fisheries*. 25: 131-134.
- Khoso, K., Baloch, Wazir Ali., Soomro, Anila., Saddozai, S. and Achakzai, W. 2018. Length-weight relationship and relative condition factor (Kn) of freshwater garfish, *Xenentodon cancila* (Hamilton, 1822) from Keenjhar Lake, Thatta Sindh. *Sindh University Research Journal -Science Series*. 50: 183-186. 10.26692/Surj/2018.01.0032.
- Kottelat, Maurice and Whitten, A. 1996. *Freshwater biodiversity in Asia with special reference to fish*. *World Bank Technical Paper*. 343: 1-59.
- Lagler, K.F. 1956. *Freshwater fishery biology*. Second edition. William C. Brown, Dubuque, Iowa, USA.
- Le Cren, E.D. 1951. The length-weight relationships and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *J. Anim. Ecol*. 20: 201-219.
- Nazir, Aafaq, Khan, Mohammad. 2017. Length-weight and Length-length Relationships of *Cirrhinus mrigala* (Cyprinidae) and *Xenentodon cancila* (Belonidae) from the River Ganga. *Journal of Ichthyology*. 57: 787-790. 10.1134/S0032945217050149
- Ogunola, O. S., Onada, O. A. and Falaye, A. E. 2018. Pre-

- liminary evaluation of some aspects of the ecology (growth pattern, condition factor and reproductive biology) of African pike, *Hepsetus odoe* (Bloch 1794), in Lake Eleiyele, Ibadan, Nigeria. *Fish Aquat Sci.* 21(1): 12.
- Pervin, M.R. and Mortuza, M.G. 2008. Notes on Length-Weight Relationship and Condition Factor of Fresh Water Fish, *Labeo boga* (Hamilton) (Cypriniformes: Cyprinidae). *Univ. j. zool. Rajshahi Univ, Rajshahi University.* 27: 97-98. 27. 10.3329/ujzru.v27i0.1964
- Pauly, D. 1984. Fish population dynamics in tropical waters: A manual for use with programmable calculators. *ICLARM Studies and Reviews.* 8: 325.
- Petrakis, G. and Stergiou, K.I. 1995. Weight-length relationships for 33 fish species in Greek waters. *Fish. Res.* 21 (3-4): 465-469.
- Pise, M., Gorule, P. A., Kharat, S., Tapkir, S. D., Verma, C., Kumkar, P. and Gosavi, S. M. 2018. Length weight relationships of four freshwater fishes from northern Western Ghats of India. *J. Appl. Ichthyol.* 34(6): 1394-1396.
- Ranjit, M.M., Jiwan, P.S., Monika, B.G. and Shubhada, S.R. 2020. Length-Weight Relationships of *Xenentodon cancila* (Hamilton, 1822) and *Hyporhamphus limbatus* (Valenciennes, 1847) from Bhima River of Maharashtra, India. *Journal of Aquatic Biology & Fisheries* 8: 90: 92.
- Satrawaha, R. and Pilasamorn, C. 2009. Length- weight and length-length relationships of fish species from the Chi River, northeastern Thailand. *Journal of Applied Ichthyology.* 25: 787-788.
- Shrestha, J. 1994. Fishes, Fishing Implements and Methods of Nepal. Smt. M.D. Gupta, Lalitpur Colony, Lashkar (Gwalior), India.
- Soni, D.D. and Kathal, M. 1953. Length - Weight Relationship in *Cirrhinus mrigala* and *Cyprinus carpio* (Ham.). *Matsya.* 5: 67-72.
- Soomro, A. N., Baloch, W.A., Chandio, T.J., Achakzai W.M. and Saddozai, S. 2012. Condition factor and Length-Weight relationship of Monsoon River prawn *Macrobrachium malcolmsonni* (H. Milne Edwards, 1844) (Palaemonidae) in lower Indus River. *Pak. J. Zool.* 44(5): 1279-1283.
- Subba, B.R. and Meheta, S.N. 2012. Ovarian histomorphology and gonadal cycle of freshwater garfish *Xenentodon cancila* (Hamilton-Buchanan) (Beloniformes: Belonidae). *Bibechana.* 8:96-104.
- Ujjania, N.C., Kolhi, M.P.S. and Sharma, L.L. 2012. Lengthweight relationship and condition factors of Indian major carps (*C. catla*, *L. rohita* and *C. mrigala*) in Mahi Bajaj Sagar, India, *Res. J. Biol.* 2 (1): 30-36
- Valset, A., Bouchon-Navaro, Y., Louis, M. and Bouchon, C. 2007. Weight-length relationships for 20 fish species collected in the mangroves of Guadeloupe (Lesser Antilles). *Appl. Ichthyol.* 24:99-100.
- Weatherly, A.H. 1972. Growth and Ecology of Fish Populations. Academic Press, London: 293.
- Yousuf, F. and Khurshid, S. 2009. Length-weight relationship and relative conditions factor for the halfbeak *Hemiramphus far* Forssk 1775 from the Karachi coast. *University Journal of Zoology, Rajshahi University*, 27: 103-104. <https://doi.org/10.3329/ujzru.v27i0.1967>