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Original Article

Biological features of *Chanda nama* (Ambassidae) in the Old Brahmaputra River, Bangladesh

Zoarder Faruque Ahmed[1], Ferdous Ahamed[*2], Mst. Kaniz Fatema[1]

[1]Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh.
[2]Department of Fisheries Management, Patuakhali Science and Technology University, Patuakhali 8602, Bangladesh.

Abstract: Biological features including sex ratio, length-frequency distributions (LFDs), size at sexual maturity, spawning season, length-weight relationships (LWRs) and condition factor of *Chanda nama* were studied in the Old Brahmaputra River, Bangladesh. There was no significant difference in sex ratio. LFDs indicated no significant differences in size between the sexes. Size at sexual maturity was estimated at ~3.0 cm standard length. Monthly variations in gonadosomatic index indicate that the main spawning season is from July to August. The LWRs showed isometric growth in males and positive allometric growth in females. Fulton's condition factor varied in both sexes and was attributed to variations in GSI with maturity. The findings of this study will be helpful to formulate conservation and management strategies of *C. nama* population in the Old Brahmaputra River and surrounding ecosystems.

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Introduction

Chanda nama (Hamilton, 1822), a member of the family Ambassidae, is commonly known as elongate glass-perchlet (Talwar and Jhingran, 1991). It is a nocturnal or crepuscular fish famous for lepidophagy or scale eating (Grubh and Winemiller, 2004) and one of the important small indigenous fish species and popular food fish having good consumer preference. *Chanda nama* is found in running and standing fresh and brackish water throughout the Indian sub-continent including Pakistan, India, Nepal, Bangladesh, and Myanmar. In Bangladesh, the consumer's interest is vigorously growing towards small indigenous fish species because of their good taste and high nutritional value essential to prevent malnutrition of the rural communities, particularly of vulnerable groups such as poor women and children (Thilsted et al., 1997; Thilsted, 2003). It is also a popular aquarium fish and has high market demand among the ornamental fish hobbyists (Gupta and Banerjee, 2012).

Previous studies on this species have only been concentrated to length-weight relationships and condition factor (Hossain et al., 2012a; Sarkar et al., 2013; Alam et al., 2014; Jahid et al., 2017; Khoso et al., 2018; Bhuvaneswari and Serfoji, 2018), sexual maturity (Grubh and Winemiller, 2004) and spawning season (Jones, 1946; Gupta, 1984; Parween et al., 2000; Grubh and Winemiller, 2004) using seasonal samples. However, the study of biological parameters, including sex ratio, length-frequency distributions (LFDs), size at sexual maturity, spawning season, length-weight relationships (LWRs) and condition factor of this species using year-long large data sets is evidently lacking. Therefore, the present study was conducted to broaden the knowledge of important biological features of *C. nama* in the Old Brahmaputra River, Bangladesh over a year-long study period.

Materials and Methods

Study site and sampling: The present study was conducted in the Old Brahmaputra River of Bangladesh, which is comprised of two channels: the main channel flowing through Bangladesh is known as the Jamuna and the old channel commonly known as the Old Brahmaputra River running through

*Correspondence: Ferdous Ahamed
E-mail: ferdous@pstu.ac.bd
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Mymensingh, a northeastern district of Bangladesh. Monthly samples were collected from the Old Brahmaputra River near Bangladesh Agricultural University, Mymensingh (24º75´N, 90º43´E) for a period of one year. The samples were collected using a combination of fine-meshed (< 2 mm) cast and seine nets by the help of local fishermen. All specimens at each sampling were preserved with 10% formalin and transferred to the laboratory for further analysis.

Fish measurement: Standard length (SL) for all individuals were measured to the nearest 0.1 cm using a measuring ruler, while the body weight (BW) was recorded using a digital balance to 0.01 g accuracy. Sex was determined by abdominal incision of each individual and visual inspection of the gonad. In case of females, the gonads were weighed to the nearest 0.001 g.

Sex ratio and length-frequency distributions (LFDs): Sex ratio (male/ female) was calculated on a monthly basis and by size (SL) class, and the results were analyzed to compare whether the sex ratio departed from the expected 1:1 using a Chi-square test at 95% significance level. Length-frequency distributions were constructed using 0.5 cm SL intervals for both sexes. The normal distributions were fitted to the pooled length-frequency data for each sex, using a computer analysis based on Hasselblad's maximum-likelihood method (Hasselblad, 1966). Each normal distribution was presumed to represent an age group in the population. In cases where two normal distributions representing two different age groups overlapped, individuals were separated into two age groups using a discriminate function: $Z_i = (L_m \times \sigma_n + L_n \times \sigma_m) / (\sigma_m + \sigma_n) - L_i$, where Lm is the mean SL and σ_m is the standard deviation at age m; L_n is the mean SL and σ_n is the standard deviation at age n; and L_i is the SL of individual i. If $Z_i > 0$, i belonged to the m age group; if $Z_i < 0$, i belonged to the n age group.

Size at sexual maturity and spawning season: The gonadosomatic index (GSI) was calculated as GSI (%) = $(GW/BW) \times 100$. Size at sexual maturity was estimated by the relationship between SL and GSI. Spawning season was estimated based on the monthly variations of GSI (Kamal et al., 2009).

Length-weight relationships (LWRs) and condition factor: LWRs were calculated according to the equation: $BW = a \times SL^b$, where BW is the body weight (g) and SL is the standard length (cm) (Zamani Faradonbeh et al., 2015). The parameters *a* and *b* were estimated by linear regression analysis based on natural logarithms: $\ln(BW) = \ln(a) + b \ln(SL)$. Extreme outliers were excluded from the analyses (Froese, 2006). Significant deviation of *b*-value from the theoretical isometric value ($b = 3$) indicates either positive ($b > 3$) or negative ($b < 3$) allometric growth (Tesch, 1971; Zamani-Faradonbe et al., 2015), which was verified with Student's t-tests (Sokal and Rohlf, 1981). Analysis of covariance (ANCOVA) (Zar, 1984) was used to test for significant differences in slopes and intercepts between sexes. Fulton's condition factor (*K*) was estimated using the following equation: $K = (BW/SL^3) \times 100$ both monthly and by size (SL cm) class (Mouludi-Saleh and Eagderi, 2019).

Results

Sex ratio and length-frequency distributions (LFDs): A total of 1169 specimens of *C. nama* were collected during this study, among them 598 (51.2%) were male and 571 (48.8%) female (Table 1). The SL ranged from 1.9 to 8.1 cm in males and from 2.0 to 8.1 cm in females, whereas *BW* ranged from 0.2 to 11.5 g and 0.2 to 12.9 g for male and female, respectively. Sex ratios were 1:1 throughout the year (Fig. 1) except in February and November when males significantly outnumbered females and in July when females dominated significantly (χ^2 *test,* $P<0.001$). Sex ratios by size classes and overall sex ratio was even between the sexes.

The overall LFDs showed two age groups with similar pattern in both sexes (Fig. 2). The mean SL of smaller size groups were similar (3.4±0.5 cm) in both sexes and therefore, no significant difference was observed between the sexes (t-test, $P>0.05$). The mean SL of larger size group was 4.9 (±1.2) cm in males and 5.4 (±1.4) cm in females. The mean SL of larger size group was 0.5 cm longer in females than males;

Table 1. Collection records of *Chanda nama* from the Old Brahmaputra River, Bangladesh.

Sampling month	Total fish	No. of males	Size range		No. of females	Size range	
			SL (cm)	BW (g)		SL (cm)	BW (g)
January	99	55	2.5-8.1	0.3-11.3	44	2.6-8.1	0.3-10.7
February	100	61	2.4-6.8	0.3-7.2	39	2.9-7.8	0.4-8.9
March	100	45	1.9-5.9	0.3-4.6	55	2.5-6.8	0.3-8.1
April	100	43	2.6-7.6	0.3-9.7	57	2.6-8.1	0.3-12.1
May	81	39	3.1-7.9	0.4-11.5	42	3.7-8.0	1.1-12.9
June	100	47	2.2-5.3	0.2-5.1	53	2.4-7.5	0.3-12.1
July	89	32	2.7-6.6	0.3-6.2	57	2.7-7.8	0.3-8.6
August	100	50	2.7-5.4	0.3-2.7	50	2.8-7.4	0.3-6.9
September	100	56	2.1-5.4	0.2-3.5	44	2.1-6.9	0.2-6.4
October	100	50	2.3-5.8	0.2-3.8	50	2.5-6.6	0.3-7.5
November	100	66	2.3-6.5	0.2-5.4	34	2.6-6.9	0.3-6.8
December	100	54	2.2-5.2	0.2-2.7	46	2.0-6.2	0.2-5.8
Overall	1169	598	1.9-8.1	0.2-11.5	571	2.0-8.1	0.2-12.9

SL, standard length; BW, body weight.

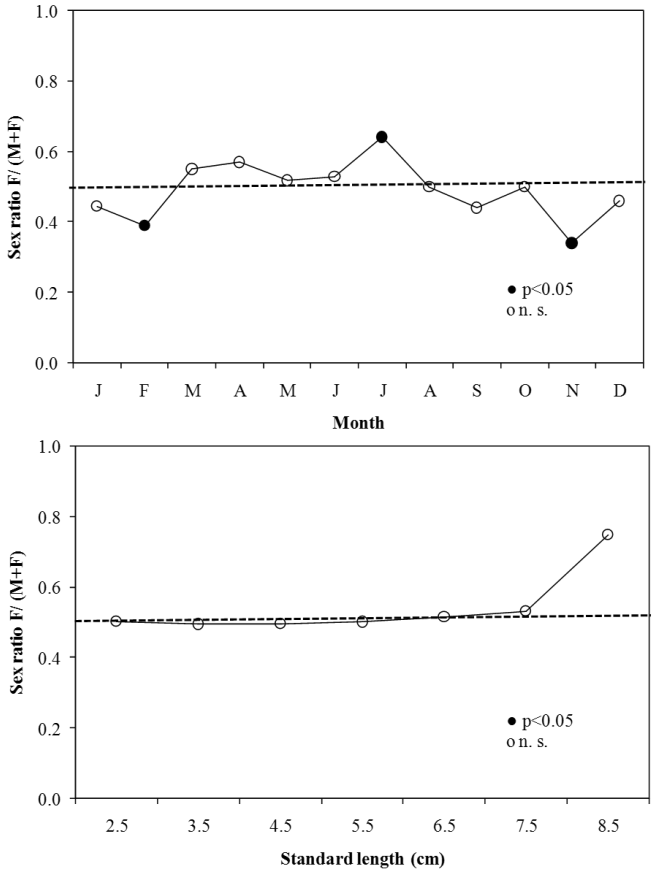

Figure 1. Sex ratio with regard to month and size class (SL, cm) of *Chanda nama* (● statistically significant difference from 1:1 ratio, o not significant) in the Old Brahmaputra River, Bangladesh.

however, the difference was non-significant (t-test, *P>0.05).* In addition, LFDs showed that the 3.0–4.0 cm SL size group was dominant in both sexes, constituting 70 and 53% of its population, respectively.

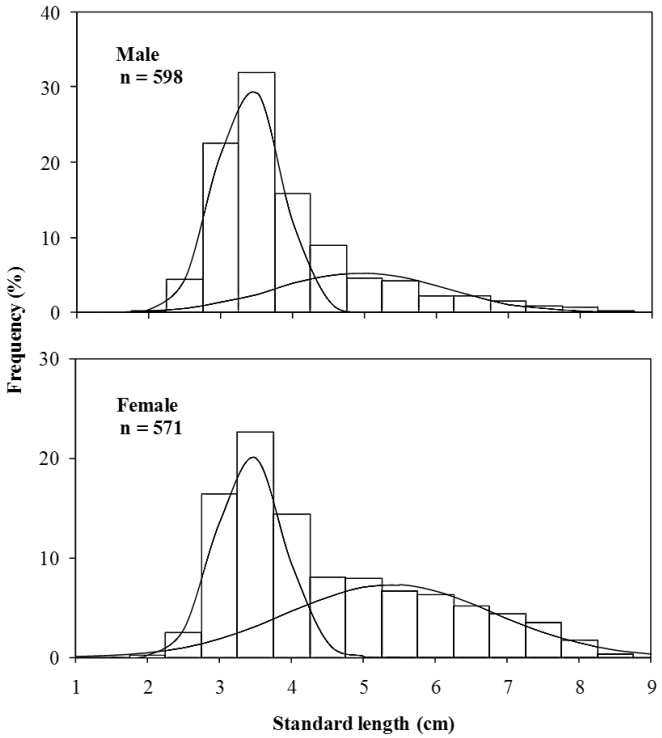

Figure 2. Length-frequency distribution of pooled males and females *Chanda nama* in the Old Brahmaputra River, Bangladesh.

Size at sexual maturity: The relationship between SL and GSI of female is shown in Figure 3. The lowest and highest GSI recorded during this study were 0.03 and 14.64, respectively. The GSI of <3.0 cm SL was low. However, the GSI rose sharply at ~3.0 cm SL. Therefore, the size at sexual maturity was considered to be 3.0 cm SL.

Spawning season: The monthly mean GSI with minimum and maximum values of female were

Table 2. Descriptive statistics of LWRs of *Chanda nama* collected from the Old Brahmaputra River, Bangladesh.

Month	Sex	n	Parameters of the LWR		r^2	GT
			a (95% CL)	b (95% CL)		
January	M	55	0.0062 (0.0052-0.0074)	3.20 (3.09-3.31)	0.984	A+
	F	44	0.0054 (0.0042-0.0069)	3.29 (3.14-3.45)	0.978	A+
February	M	61	0.0058 (0.0038-0.0089)	3.27 (3.00-3.53)	0.911	A+
	F	39	0.0057 (0.0046-0.0071)	3.26 (3.13-3.39)	0.986	A+
March	M	45	0.0110 (0.0060-0.0203)	2.87 (2.48-3.26)	0.835	I
	F	55	0.0141 (0.0072-0.0276)	2.74 (2.33-3.15)	0.773	I
April	M	43	0.0066 (0.0037-0.0119)	3.15 (2.79-3.51)	0.883	I
	F	57	0.0066 (0.0051-0.0087)	3.16 (3.00-3.33)	0.964	I
May	M	39	0.0049 (0.0035-0.0068)	3.36 (3.17-3.55)	0.971	A+
	F	42	0.0072 (0.0051-0.0101)	3.15 (2.96-3.34)	0.964	I
June	M	47	0.0095 (0.0057-0.0159)	2.97 (2.63-3.32)	0.871	I
	F	53	0.0062 (0.0052-0.0074)	3.27 (3.16-3.38)	0.986	A+
July	M	32	0.0057 (0.0044-0.0075)	3.26 (3.09-3.44)	0.980	A+
	F	57	0.0062 (0.0052-0.0073)	3.22 (3.11-3.32)	0.985	A+
August	M	50	0.0099 (0.0055-0.0177)	2.89 (2.51-3.27)	0.829	I
	F	50	0.0069 (0.0053-0.0089)	3.12 (2.97-3.28)	0.971	I
September	M	56	0.0121 (0.0076-0.0193)	2.81 (2.50-3.11)	0.863	I
	F	44	0.0099 (0.0075-0.0131)	2.96 (2.78-3.13)	0.964	I
October	M	50	0.0107 (0.0057-0.0200)	2.85 (2.44-3.25)	0.809	I
	F	50	0.0066 (0.0050-0.0086)	3.19 (3.02-3.36)	0.968	A+
November	M	66	0.0078 (0.0060-0.0101)	3.04 (2.87-3.21)	0.952	I
	F	34	0.0057 (0.0043-0.0075)	3.25 (3.06-3.43)	0.975	A+
December	M	54	0.0098 (0.0067-0.0145)	2.93 (2.67-3.19)	0.907	I
	F	46	0.0078 (0.0058-0.0104)	3.08 (2.89-3.28)	0.959	I
Overall	M	598	0.0080 (0.0071-0.0089)	3.06 (2.99-3.13)	0.924	I
	F	571	0.0068 (0.0063-0.0074)	3.16 (3.11-3.21)	0.964	A+

n, sample size; M, male; F, female; CL, confidence limit of mean; GT, growth type; I, isometric; A+, positive allometric.

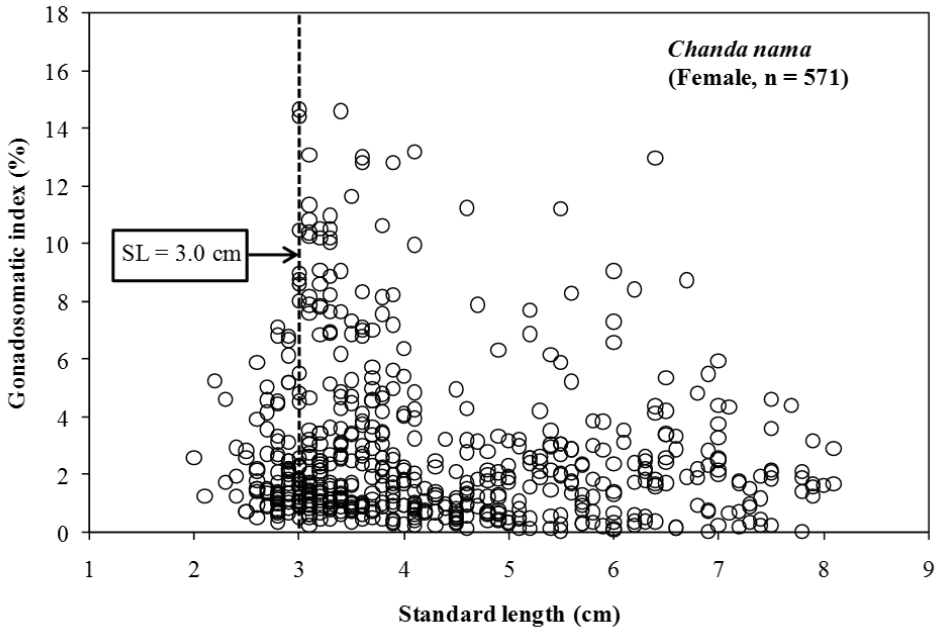

Figure 3. Relationship between gonadosomatic index and standard length (cm) for female *Chanda nama* in the Old Brahmaputra River, Bangladesh.

plotted in Figure 4. The mean GSI varied from 1.17 in January to 5.14 in July. The mean GSI value was around 2 in majority of the months; however, the GSI value was higher during July to August with a peak in July. Therefore, the spawning season of *C. nama* was estimated to be from July to August.

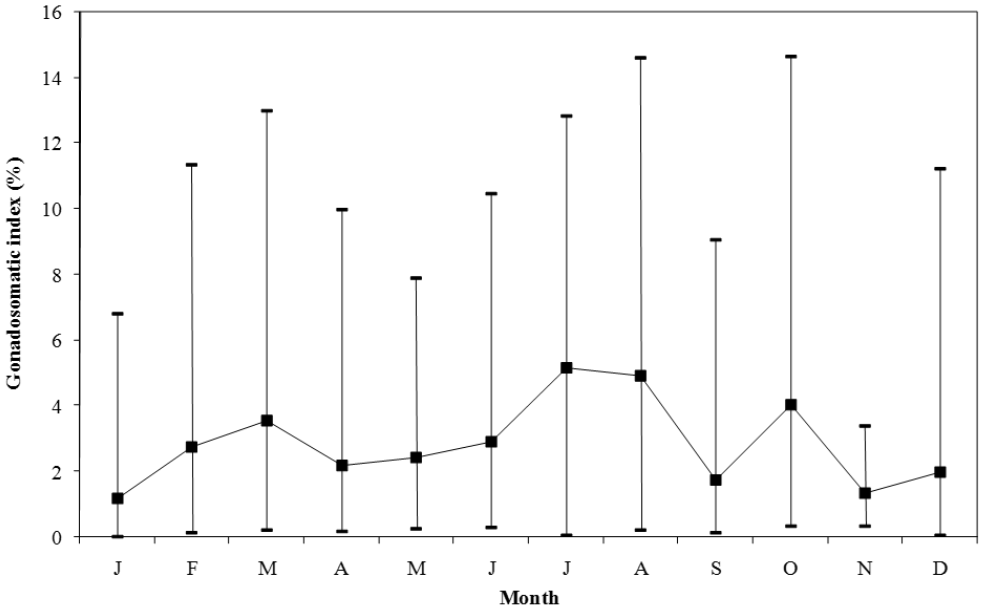

Figure 4. Monthly changes of mean gonadosomatic index (GSI) with minimum and maximum values, for female *Chanda nama* in the Old Brahmaputra River, Bangladesh.

Length-weight relationships (LWRs): The detailed statistics of LWRs of *C. nama* are given in Table 2. The overall LWRs indicated isometric growth in males (t-test, $P>0.05$), while positive allometric growth was observed in females as the allometric coefficient *b* values were significantly larger than the expected isometric value of 3 (t-test, $P<0.05$). Significant difference in both slope (*b*) and intercept (*a*) were observed between sexes (ANCOVA, $P<0.05$). Monthly variations in LWRs were observed with the calculated *b*-values ranged from 2.81 in September to 3.36 in May for males, and from 2.74 in March to 3.29 in January for females. All LWRs were highly significant with r^2 exceeding 0.800.

Condition factor: The variations of Fulton's condition factor by month and size class for both sexes are presented in Figure 5. The monthly *K*-values varied for both sexes, ranging from 1.63 to 2.09 in males and from 1.63 to 2.21 in females. The lowest *K* was found in November, whereas the highest was in June for both sexes. By size class, males showed minimum *K*-value at 3.5 cm SL and maximum at 7.5 cm SL, whereas females showed minimum value at 3.5 cm SL and maximum at 8.5 cm SL. *K* tended to be lower at ~3.5 cm SL, thereafter started to increase in the subsequent size class for both sexes. *K* in females was always higher than males.

Discussions

The present study investigated some basic biological features of *C. nama* necessary to develop the management and conservation strategies. There was no significant difference in overall sex ratio in the present study, even no temporal (except February, July and November) and size class variations in sex ratio were observed. Usually deviation from 1:1 sex ratio is not expected for most fish species, although some fish populations may present a strong bias in this ratio. Such variation in sex ratio might be due to (a) different growth rate and longevity between sexes or (b) sex change (Oh et al., 2002; Chilari et al., 2005; Ahamed et al., 2014, 2018). Analysis of LFDs is important to know ecological and life-history traits of a fish population (Ranjan et al., 2005). In the present study, the LFDs revealed two size groups in both sexes; however, no significant differences in size were observed between the sexes.

Determination of size at sexual maturity is very crucial for fisheries management as it indicates the minimum permissible capture size (Lucifora et al., 1999; Ahamed and Ohtomi, 2011, 2014; Hossain et al., 2013; Ahamed et al., 2014, 2015). In the present

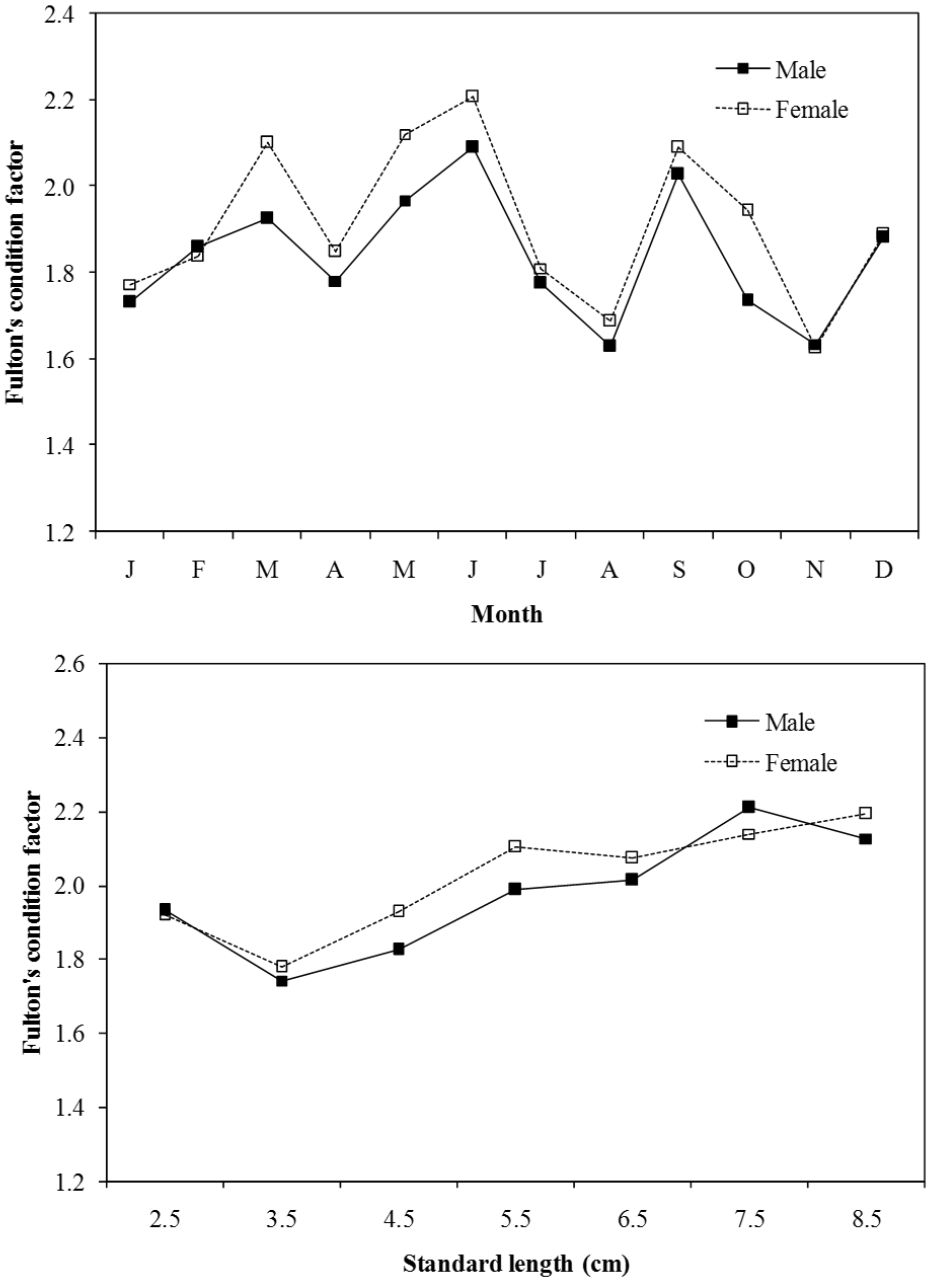

Figure 5. Changes of Fulton's condition factor by month and size class (SL, cm) for both genders of *Chanda nama* in the Old Brahmaputra River, Bangladesh.

study, the size at sexual maturity of *C. nama* was estimated at ~3.0 cm SL. On the other hand, Grubh and Winemiller (2004) reported the size at sexual maturity of this species as 2.5 cm SL from a wetland, Tamilnadu, India. The differences in size at sexual maturity might be attributed to variations in environmental factors, particularly water temperature, population densities and food availability (King, 2007).

Monthly variations of GSI indicated the spawning season of *C. nama* from July to August. A number of studies have also reported the spawning season of this species, e.g. Parween et al. (2000) reported the spawning season as July-November and February-August respectively in Bangladesh, while Jones (1946), Gupta (1984), and Grubh and Winemiller (2004) have documented June-August, April-May and March-July respectively for the same in India. Several studies (Ahamed and Ohtomi, 2012; Ahamed et al., 2014; Allen, 1966; Bauer, 1992; Kikuchi, 1962)

reported the temperature and rainfall as important factors controlling the spawning of fish. However, in the present study, the factor/s controlling spawning season could not be deciphered due to lacking of such environmental data.

The calculated *b*-values of the LWRs were within the expected range of 2.5 to 3.5 (Froese, 2006) with the overall *b* indicating isometric growth in males and positive allometric growth in females. However, numerous studies (Alam et al., 2014; Hossain et al., 2012a; Jahid et al., 2017; Sarkar et al., 2013; Khoso et al., 2018; Bhuvaneswari and Serfoji, 2018) reported negative allometric growth for combined sex of this species using only seasonal samples from different habitats. We also observed some monthly variations in growth types with positive allometric growth recorded during January-February, May and July in males and January-February, June-July and October-November in females. While Isometric growth was observed during March-April, June and August-December in males and March-May, August-September and December in females. The differences in growth types among different populations of the species can be attributed to the seasonal variation in sample collection, maturity status, and size range of the specimens observed (Tesch, 1968).

The condition factor is an index reflecting interactions between biotic and abiotic factors on the physiological condition of the fishes; therefore, it can also be used as an index to assess the status of the aquatic ecosystem in which fish live (Anene, 2005). *K* is generally correlated with the temporal changes of fish GSI (Ahamed et al., 2014; Hossain et al., 2012b, 2013) although we found no definite trends between these two variables. However, *K* across size classes showed a noticeable decrease at 3.5 cm SL for both sexes, which may indicate the start of sexual maturation at 3.0 cm SL for *C. nama*. Decreasing *K*-value after sexual maturity due to reproductive activity is a common phenomenon in fishes.

In conclusion, the present study provides some important baseline information on the population biology of *C. nama*, which will be helpful to formulate conservation and management strategies of this species.

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