Meristic and morphometric characteristics relationships, condition factor and breeding biology of Indian potashi (*Neotropius atherinoides)* in the Adjacent River of Chalon Beel, Bangladesh

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Received: April 2020 Accepted: September 2020

Abstract

Neotropius atherinoides locally known as Batasi fish and considered as freshwater small indigenous species (SIS) in Bangladesh. The present study describes the first complete, inclusive description of length-weight relationships (LWRs), length-length relationships (LLRs), condition factors (Fulton's, K_F; Relative, K_R) and the breeding biology in the adjacent river of Chalon beel, Bangladesh. The total number of fin rays was counted using a magnifying glass and different lengths were measured using digital slide calipers with 0.01 cm precision. Bodyweight (BW) was measured by a digital balance to the nearest 0.01 g accuracy, respectively. From the present study few mean differences are observed in fin formula: Dorsal, D. 1/3-6; Pectoral, Pc. 1/4-7; Pelvic, Pv. 3-7; Anal, A. 30-45; and Caudal, C. 16-20. The linear relationship observed in length-length relationships (LLRs) and the value of LLRs ($r \geq 0.94$) indicated that they were highly correlated. While in length-weight relationships equation ($W= aL^b$), calculated b values ($b>3.00$) indicating positive allometric growth with a high correlation coefficient (r) in combined sexes. Condition factor value ($K>1.0$) indicating habitat (Cholon beel) was still in good condition. The maximum mean GSI value was found in the month of April (21.34±4.87) indicating April was the spawning season of the species. Breeding parameters gave better relationships when compared to GSI, fecundity with body weight and standard length. These parameters are essential for evaluating the relative condition of fish and sustainable management as well as their fisheries and species identification.

Keywords: *Neotropius atherinoides*, Meristic Characteristics, LLRs, LWRs, GSI

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[DOI: 10.18331/SFS2021.8.1.4]

Introduction

Neutropius atherinoides under the family of Schilbeidae are native to Asia, including Bangladesh, India, Myanmar, Nepal, and Pakistan (Talwar and Jhingran, 1991; Rahman, 2005). This species is inhabited in freshwater and tidal water rivers specially haors and beels of all over the country of Bangladesh (Galib *et al.,* 2009). It has been considered as data deficit (IUCN, 2000) and now assessed as least concern in the recent red list of IUCN Bangladesh (IUCN, 2015). Globally, population information of this species is scanty. Previously it was available all over Bangladesh but availability is decreasing day by day. In small-scale fisheries a variety of traditional gears are used for target small indigenous fishes in Bangladesh (Craig *et al*., 2004; Ghulam and Ahmed, 2005) and these fishes are good sources of protein and vitamin for rural people in Bangladesh (Rubbi *et al*., 1978; Islam, 2004). SIS (Small Indigenous Species) is threatened due to undiscriminating harvesting of brood and young SIS with using destructive fishing gears. However, many SIS may still be presented in Bangladesh's numerous water bodies such as beels, rivers, khals, haors, baors, etc. but their life is at stake in almost any water body (Rahman, 2005).

Precise identification is the first step towards their conservation in fish. The morphology of fishes is uses for taxonomic and evolutionary studies and also noble sources for conservation of fishes in population (Brraich and Akhter, 2015). Morphometric and meristic features are help to identify and classify fishes (Hossain *et al*., 2016) and also for considering the life history and morphological characteristics of populations across regions (Hossain *et al*., 2013; Parvin *et al*., 2018; Khatun *et al*., 2019). Fisheries management can be virtuous concept for conservation, protect and extinct of fishes and can be lead to the fishing pressure. Fish's length-weight relationships are important in fisheries biology because they allow the estimation of a given length group's average fish weight by creating a mathematical relationship between the two factors (Simon *et al*., 2009; Ndome *et al*., 2012). The state of fish describes its recent physical and biological conditions and varies the interaction between feeding conditions, parasite infections, and physiological factors (Le Cren, 1951). Besides, body condition provides an alternative to the costly, in-vitro proximate tissue examination (Sutton *et al*., 2000). Breeding biology of specific fishes is understand through the reproductive dynamics, fertility, gonadosomatic index (GSI), histology of gonad and hepatosomatic index (HIS). Total number of oocytes of fishes is namely fecundity and lay by individual brood fish during their breeding period (Bagenal, 1957). Reproductive capability of fish stock can be predicted based on the data of fecundity and it can be significant in fisheries (Nandikeswari *et al*., 2014; Jamali *et al*., 2016).

[DOI: 10.18331/SFS2021.8.1.4]

So there is vibrant role to manage and regulate its numerous discrete stocks. There is little information about the length-weight relationship of this species but details information on condition factor, length-length relationship and breeding biology are scanty in Bangladesh especially in the Chalon beel area. Therefore, the objective of this study was to describe the condition factors, Length-Weight, Length-Length relationships and breeding biology of *N. atherinoides* from the adjacent river of chalon beel, Bangladesh. This research will help to prepare a conservation and protection plan for this species in the natural habitat.

Materials and methods

Study area and sampling

The study area was the adjacent river of Chalon beel, Bangladesh (24°30'10.2"N 89°08'23.9"E). In Bangladesh, Chalon beel area is considered as feeding and breeding ground for freshwater fish species. A total of 550 fishes were collected from artisanal fishers at the target area for this study. After collection, specimens were washed well, confirmed to the species label, and then preserved by date in plastic jars with a 10% formalin solution and transported to the laboratory for further analysis.

Measurement of length and weight

Lengths of *N. atherinoides* were measured to the nearest mm using divider and the measuring board. The morphometric characteristics of fishes were measured with digital slide calipers (nearest 0.01mm) along with a small measuring scale from the tip of the snout to the tail. They were represented in Figure 1; the acronyms in the figure correspond to those given below:

Total length (TL), Fork Length (FL), Standard Length (SL), Pre Anal Length (PAL), Pre Pelvic Length (PPLL), Pre Dorsal Length (PDL), Pre Pectoral Length (PPL), Head Length (HL), Anal Fin Length (AFL), Caudal Fin Length (CFL), Body Depth (D), Pectoral Fin Length (PFL), Dorsal Fin Length (DFL), Dorsal Spine Length (DSL).

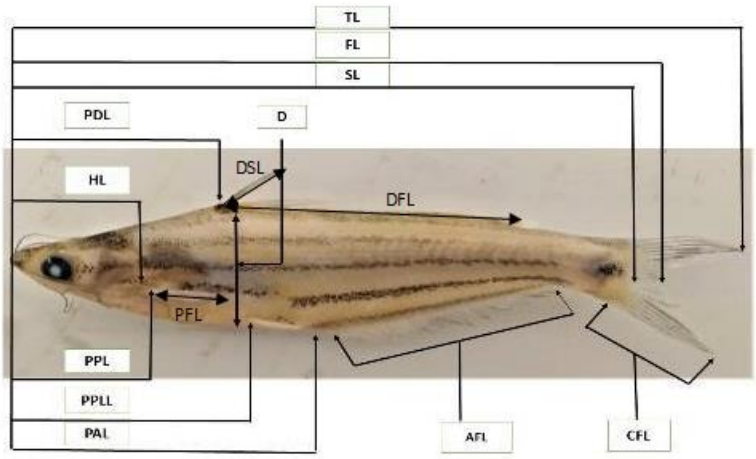

Figure 1: Morphometric measurement of *Neotropius atherinoides*.

[DOI: 10.18331/SFS2021.8.1.4]

Measurement of meristic characteristics

Five meristic characters were studied as described by Hubbs and Lagler (1958): Dorsal Fin Rays (DFR), Pectoral Fin Rays (PcFR), Pelvic Fin Rays (PvFR), Anal Fin Rays (AFR), Caudal Fin Rays (CFR). A magnifying glass was used to count the fin rays and only the principle rays were counted as separate rays.

Length-Length Relationships

The length-length relationship with standard length among different body lengths were determined by the method of least squares to fit a simple linear regression model as Y=a+bX, where Y=various body lengths, X=standard length, a=proportionality constant and b=regression coefficient (Alam *et al*., 2012).

Length-Weight Relationships

The total body weight (BW) of each individual was weighed to the nearest gram on an electronic balance with 0.01 g accuracy (Model: EK600ual). The length-weight relationship was expressed by using the equation $W= aL^b$ (Le Cren, 1951; Froese, 2006) where '*W'* was the body weight (BW, g) and '*L'* was the three different lengths (Total length, Fork length, Standard length) in cm. The parameters '*a'* and '*b'* were estimated by linear regression analysis based on natural logarithms (Arshad *et al*., 2008):

$\ln(w)=\ln(a)+b \ln(L)$ and the coefficient of correlation 'r' were estimated.

Condition factor

Fulton's condition factor (K_F) was calculated by using the formula, $K_F=100\times(W/L^3)$ whereas, the relative condition factor (K_R) was calculated by $K_R = W/aL^b$ (Le Cren, 1951; Simon *et al*., 2013). The parameters '*a*' and '*b*', of the length-weight relationship which had been used in the calculation of relative condition factors K_R. *'W'* was the body weight (BW, g) and '*L'* was the three different lengths (Total length, Fork length, Standard length) in cm.

Gonadosomatic index (GSI) and fecundity

In order to measure the gonadosomatic index (GSI), each fish was sacrificed to collect the ovaries and the ovaries were dried with the help of blotting paper and individually weighed by an electrical balance and stored in 5% formalin to preserve the ovaries for making the eggs to be easier separated. A gravimetric approach was used to assess fecundity. From the anterior, middle and posterior portions of the ovary, three sub-samples were taken. For each sample, the number of eggs was counted and fecundity was calculated by the following formula (Mohammad and Pathak, 2010):

$F=n\times G/g$

Where "F" is fecundity, "n" is the average number of eggs, "G" is the

[DOI: 10.18331/SFS2021.8.1.4]

weight of the gonads and "g" is the weight of the subsample. The GSI was calculated using the following formula:

GSI= $(Total\ weight\ of\ gonad)/(Total\ weight\ of\ fish) \times 100$ (Devlaming *et al*, 1982)

Statistical analysis

After collecting requisite data, relevant tables were prepared. Then the data were processed and analyzed to achieve the objectives of the study. Microsoft EXCEL 2016 was used for all the statistical analysis of the data. The relation between the standard length and other body measurements were subjected to regression analysis using the software SPSS v 23.0 (Statistical Package for Social Sciences).

Results

Morphomeristics

The fish was whitish or almost transparent with 3 or 4 longitudinal bands present on the flank (Figure 1). The total length of collected samples (n=550) ranged from 4.6-7.5 cm with mean value of 5.74±0.71 cm. Meristic counts of *N. atherinoides* showed it had single hard spine in both dorsal and pectoral fins with 3-6 and 4-7 soft rays, respectively. Anal fin counts varied from 30-45 soft rays with 33 mean (Table 1).

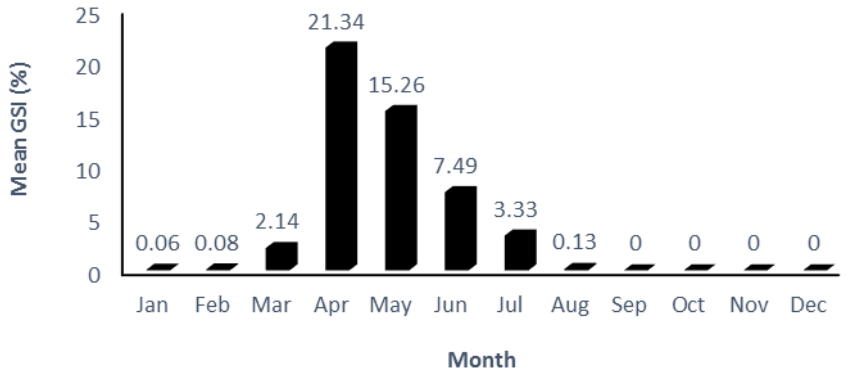

Figure 2: Mean GSI value of *N. Atherinoides*.

Table 1: Meristic counts of *N. atherinoides* (*n* = 550)

Characters		Range		Mean
		Min	Max	
Anal Fin Rays		30	45	33
Dorsal Fin Rays	Hard rays/Spine	1	1	1
	Soft rays	3	6	5
Pectoral Fin Rays	Hard rays/Spine	1	1	1
	Soft rays	4	7	6
Pelvic Fin Rays		3	7	6
Caudal Fin Rays		16	20	17

Dorsal, D. 1/3-6; Pectoral, Pc. 1/4-7; Pelvic, Pv. 3-7; Anal, A. 30-45; and Caudal, C. 16-20

[DOI: 10.18331/SFS2021.8.1.4]

Length-length relationships (LLRs)

The length-length relationships were established with standard length (SL) among the different body lengths of the specimens. Allometric growth pattern (b) of total length (1.21), fork length (1.07), pre dorsal length (0.32), pre pelvic length (0.39), anal fin length (0.30) and pre anal length (0.52) showed both positive (b>1) and negative (*b* <1) and the coefficient of correlation of these relationships were highly correlated for *N. atherinoides* (Figs. 3 to 8). SL and TL were found highest correlation coefficient value (r) among the below mentioned relationships.

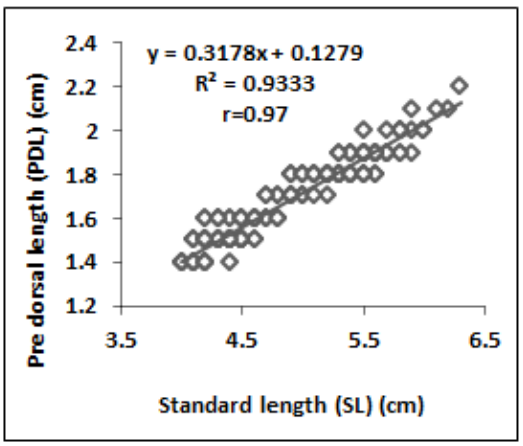

Figure 3: Relationship between SL and PDL.

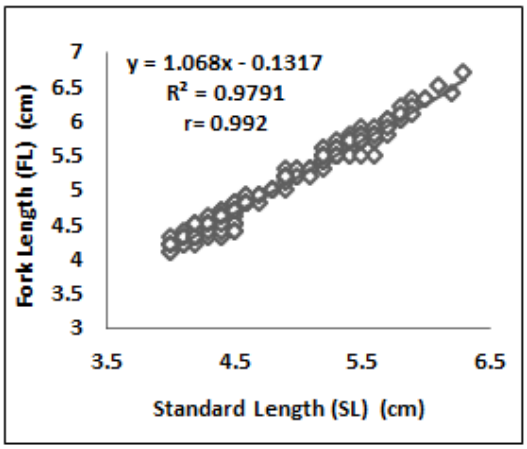

Figure 4: Relationship between SL and FL.

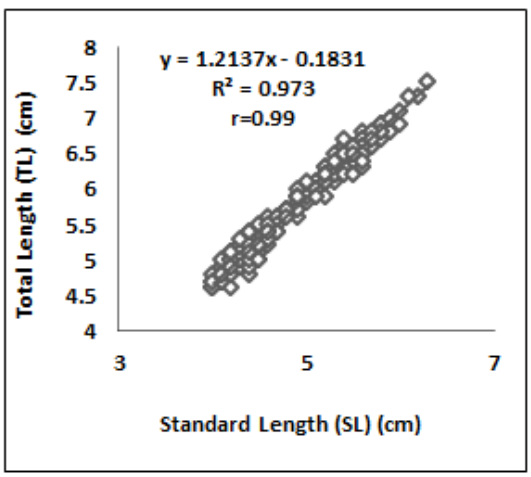

Figure 5: Relationship between SL and TL.

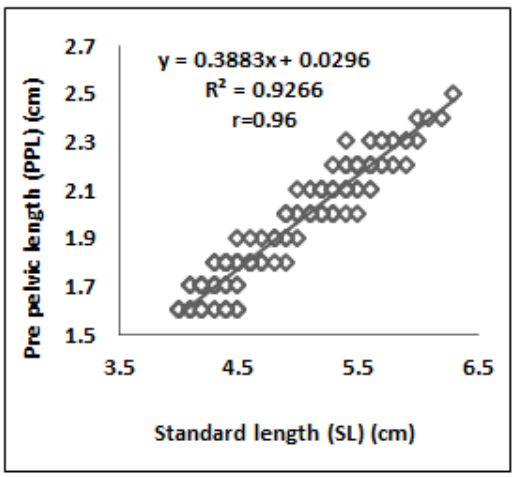

Figure 6: Relationship between SL and PPL.

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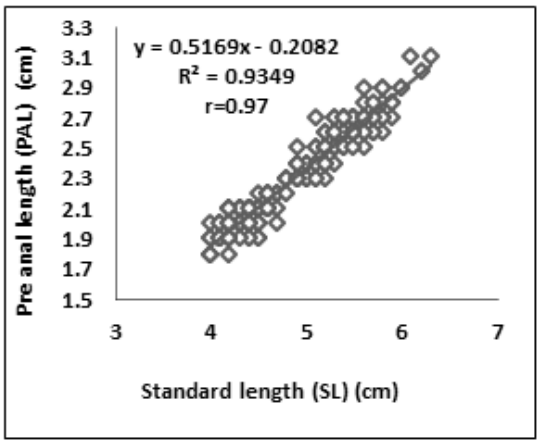

Figure 7: Relationship between SL and PAL.

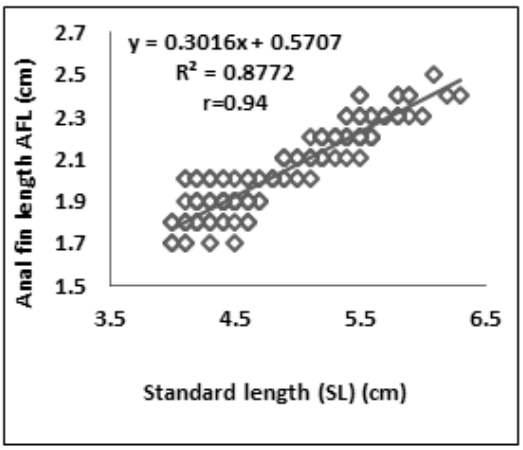

Figure 8: Relationship between SL and AFL.

Length-weight relationships (LWRs)

Length-weight relationships were measured using weight of fish versus TL, SL and FL separately. The species showed significant correlation for all the three pairs of parameters. The slope values were always found greater than three (>3) indicating the positive allometric growth pattern of the species *N. atherinoides* (Table 2).

Table 2: Estimated parameters of the length-weight relationships for *N. Atherinoides*.

Species	Equation	n	Regression Parameters		r	Growth Type
			a	b		
Neotropius atherinoides	$BW = a \times TL^b$	550	0.0021	3.6645	0.97	A^+
	$BW = a \times FL^b$	550	0.0032	3.6874	0.96	A^+
	$BW = a \times SL^b$	550	0.0029	3.8401	0.97	A^+

n, sample size; BW, body weight; TL, total length; FL, fork length; SL, standard length; *a*, intercept; *b*, slope; A^+, positive allometric growth.

Condition factor

The mean highest relative condition factor (2.43±1.86) was found in total length followed to fork length (2.38±1.89) and standard length (2.32±1.73) and the mean highest fulton's condition factor (1.19±0.87) was in standard length followed to fork length (1.05±0.63) and total length (0.73±0.42). Values of Relative and Fulton's condition factors with different types of length were shown in Table 3.

Table 3: Relative condition factor (K_R) and Fulton's condition factor (K_F) values of *N. Atherinoides*.

Species	N	Type of Length	Relative condition factor (K_R)			Fulton's condition factor (K_F)		
			Min	Max	Mean	Min	Max	Mean
Neotropius atherinoides	*550*	TL	0.81	6.09	2.43±1.86	0.47	0.82	0.73±0.42
	550	SL	0.77	5.81	2.32±1.73	0.72	1.38	1.19±0.87
	550	FL	0.79	5.97	2.38±1.89	0.67	1.15	1.05±0.63

n, sample size; TL, total length; FL, fork length; SL, Standard length; Min, Minimum; Max, maximum

[DOI: 10.18331/SFS2021.8.1.4]

Gonadosomatic index (GSI) and fecundity

Only female fishes were studied to determine the Gonadosomatic Index (GSI) and fecundity of *N. atherinoides*. The highest GSI was found in April (21.34±4.87) and showed a gradual decrease in the value up to the month July (3.33±2.87) indicating April-July is its spawning season with a peak in April (Figure 2). GSI value from September to December cannot be measured because of small size fish and hence very tiny gonad which is nearly invisible to naked eyes (Figure 2). At the same time, the fecundity of this species was consequently increased in the later of March (4553.07±1755.66) to mid-June (1805.17±965.71) and thereafter decreases the value. The fecundity value can not be identified for the rest of the month.

Relationship between mean GSI with body weight and standard length

The linear relationship between mean GSI with body weight (r=0.91) and standard length (r=0.97) showed a strong positive correlation (Figs. 9 and 10). A straight line through the origin would fit the points well, showing that mean GSI was highly proportional to the standard length (r=0.97) than body weight (r=0.91) of the fish. The regression equation of mean GSI with body weight and the standard length was found as presented in Figures 9 and 10.

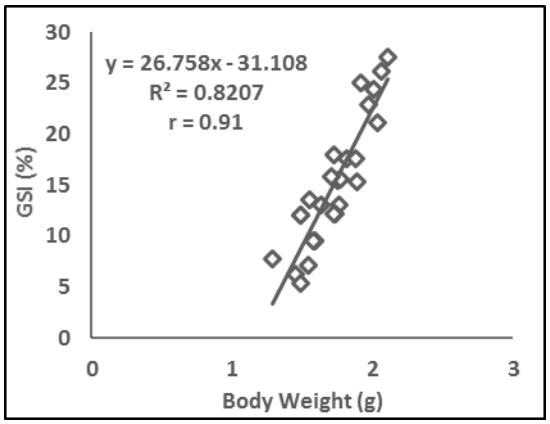

Figure 9: Relationship between GSI and Body Weight of female *N. Atherinoides.*

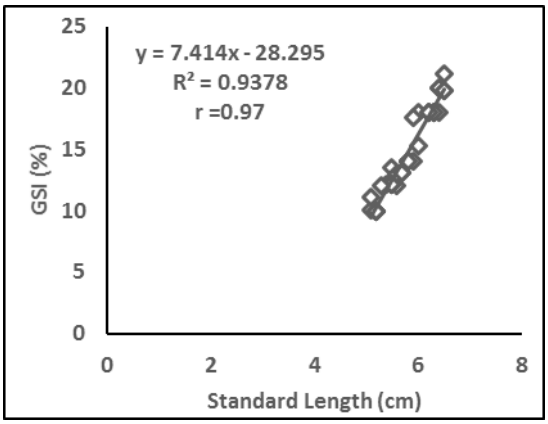

Figure 10: Relationship between GSI and Standard Length of female *N. Atherinoides.*

Relationship between mean fecundity with body weight and standard length

The linear relationship between mean fecundity with body weight (r=0.92) and standard length (0.89) showed a positive correlation (Figs. 11 and 12). A straight line through the origin would fit the points well, showing that mean fecundity was highly proportional to the body weight (0.92) than standard length (0.89) of the fish. The regression equation of mean fecundity with body weight and the standard length of fish were found as presented in Figures 11 and 12.

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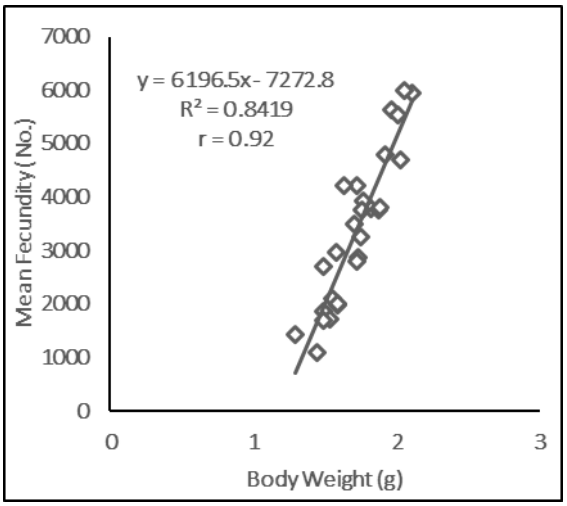

Figure 11. Relationship between mean Fecundity and Body Weight of female *N. atherinoides*

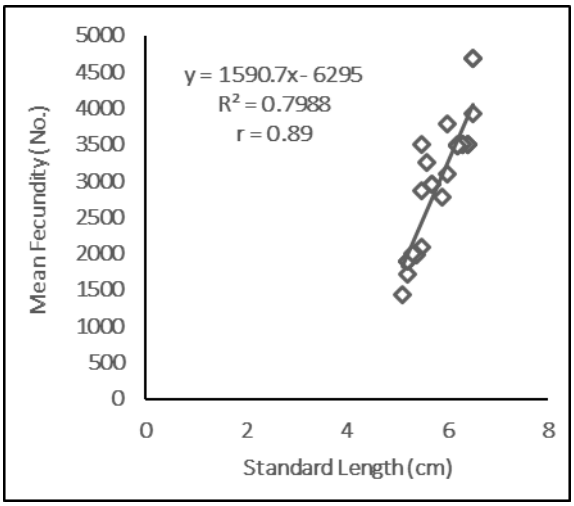

Figure 12. Relationship between mean Fecundity and Standard Length of *N. atherinoides*

Discussion

Meristic characters are fixed in the early embryonic life of the individual and remain unchanged (De Silva *et al.*, 2009). From the present study few mean differences were observed in fin formula: Dorsal, D. 1/3-6; Pectoral, Pc. 1/4-7; Pelvic, Pv. 3-7; Anal, A. 30-45; and Caudal, C. 16-20 (Table 1) which is quite similar to previous studies as D 1/5-6; P_1 1/7; P_2 6; A 33-40 (Rahman, 1989); D I 5-6; A iii 30-43; P I 7; V i 5 (Talwar and Jhingran, 1991); D 1/5-6; A 33-41 (3/30-38); P 1/7; V 6; C 17 (Bhuiyan, 1964). These characters do not show much variation other than anal fins which are in range of 30-45 in the present study. Langer *et al.* (2013) suggested that *Tor putitora's* meristic parameters in the entire length category were almost constant. Many factors also influence the variations in meristic characters particularly by temperature and genetic factors (Al-Hassan *et al.*, 1987).

The regression equation of LLRs is defined for *N. atherinoides* to test the symmetrical growth of atherinoides to standard length. Since most researchers often used the standard fish length in their work instead of the total length, because the caudal fin typically becomes fragile over timis e and breaks off during fish sampling (Onsoy *et al.*, 2011). The 'b' value of different variable characters (Y) on standard length (X) of *N. atherinoides* indicates that the rate of growth (b) in total length (TL) was highest (b=1.21) and the lowest (b=0.30) in anal fin length (AFL) (Figures 5 and 8). So, here total length (TL) was the fastest and anal fin length (AFL) was the slowest growing parameter from the collected samples. Similar finding was found on the mudskipper *Boleophthalmus boddaerti* (Gore, 2007). The length-length relationship was previously stated by Hossain *et al.* (2006) as TL=1.168 SL+0.187 (r^2=0.901), SL=0.709

[DOI: 10.18331/SFS2021.8.1.4]

FL+0.822 (r^2=0.868) and FL=1.014 TL-0.553 (r^2=0.936) for both sexes of *A. mola* in the River Mathabhanga, southwestern Bangladesh. The 'b' value or slope will be negative or positive to 1, when the value of 'b' equal to 1, there is an isometric growth. Hence in standard length, morphometric regression showed two positive algometry in fork length (1.06) and total length (1.21) and the rest of these showed negative allometry. Similar observations are made by Dasgupta (1991) in *Tor putitora*.

The morphometric characters of *N. atherinoides* were calculated to find a relationship, with standard length indicating a linear relationship with all 'r' values of morphometric characters within the range of 0.94 to 0.99 for combined sexes. The value of correlation coefficient (r) was higher (r=0.992) in fork length (Fig. 4) meaning fork length highly correlated with standard length. At the same time, the correlation value lower (r=0.94) in anal fin length (Fig. 8) means a lower relationship with standard length. High values of correlation coefficient 'r' indicated a high degree of positive correlation with the reference length (standard length) (Dasgupta, 1991). The equation values showed that the lengths of the sections of the body are proportional to the standard length agreed with Tandon *et al*. (1993) while working with the morphometry of *Cirhinus reba* of Kanjli wetland of India. The results of present study's LLR analysis are close to those of Hossain *et al*. (2009) for *Amblypharyngodon mola*, *Puntius ticto*, and *Glossogobius giuris* at Rajshahi district, Bangladesh.

For most fishes, the regression coefficient 'b' values are within the limits (2 to 4) stated by Tesch (1971). When 'b' is close to 3, it indicates that fish grow isometrically; allometric growth is indicated by values slightly different from 3. The b>3 value demonstrates positive allometry and b<3 implies negative allometry (Leonart *et al*., 2000; Sangun *et al*., 2007). The present study also indicates positive allometric development for the combined sexes of *N. atherinoides* in the adjacent river of chalon beel, Bangladesh. In the current analysis, the values 'b' are 3.66 (TL vs. BW); 3.68 (FL vs. BW); 3.84 (SL vs. BW) indicated a positive allometric growth, and a strong positive linear relationship (r=0.97, r=0.96, r=0.97) was also found (Table 2). There was no literature available on this species in Bangladesh, so it is difficult to equate it with present study. A recent study (Hossain, 2010) recorded negative allometry, with a 'b' value of 2.89 (TL vs BW); 2.92 (FL vs BW) for *N. atherinoides* in Padma river, NW Bangladesh, because of the number of sampled fish, time, position, sexes and so on, the present 'b'-value was higher than those observed. Baishya, *et al.* (2010), also published similar findings the value of 'b' as 3.30 for males and 3.61 for females in *Amblypharyngodon mola* from various Garjan beel landing sites. Azadi and

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Naser (1996) recorded the 'b' value in Bangladeshi *Labeo bata* as 3.16 for males and 3.20 for females. Narejo *et al*. (2002) defined the meaning of 'b' in *Mastacembalus armatus* from Bangladesh as 3.13 for males and 3.22 for females.

Population condition factors may rely not only on age, length, weight, and gender composition, but also on environmental factors and seasons (Pravdin, 1966). In the summer and rainy seasons, however, the fish display optimum robustness due to the availability of food and the adequate condition of the climate (Dadzie *et al*., 2008; Hossain *et al*., 2012). According to Le Cren (1951), conditions values greater than 1 indicate the good general condition of the fish whereas values less than 1 denote the reverse condition. Fulton's condition factor (K_F) which was free from regression parameters (a and b) involving length and weight data of fishes are used to know their physical fitness. The mean 'K_F' values obtained for *N. atherinoides* of this study was 0.73±0.42 to 1.19±0.87 either lower or greater than the expected value (K_F=1.0) (Table 3), those values indicated that some fishes were in good and some fishes were in bad condition. But in relative condition factor (K_R), mean K_R values obtained for *N. atherinoides* of this study (2.32±1.73 to 2.43±1.86) greater than the expected value (K_R=1.0) (Table 3) therefore, they are in good condition. Changes in the values of condition factors due to variations in gonad maturation, considering whole population, increases or decreases in feeding behavior, fat volumes, or changes in population that may occur due to changes in food products, as stated by Akombo *et al*. (2014).

The value of GSI was measured between January to December, which is representative of the breeding season of the fish. This index is an effective predictor for the assessment of maturity, i.e. the degree of maturity of the ovary and gonadal development. (Nandikeswari *et al*., 2014). The GSI variance is also used to assess the peak of the spawning cycle (Hasan *et al*., 2020). Female fish captured between April and July had higher GSI (21.34±4.86 to3.33±2.87) in the current analysis, while specimens taken from other months could not be measured. The highest mean gonado-somatic index of female *N. atherinoides* was 21.34±4.86 in April. These GSI values suggested that the potential time of spawning was *N. atherinoides* began in April and finished in August. The relationship between mean GSI with body weight and standard length was highly correlated. The correlation coefficient value (r) was higher in relationship between mean GSI and Standard length (r=0.97) (Fig. 10) than in body weight (r=0.91) (Fig. 9). Similar observations were recorded by Nabi and Hossain (1996) and Islam *et al.*, (2012) for freshwater spiny eel, *Macrognathus aculeatus* and *Sillaginopsis panijus*, respectively.

Fecundity knowledge of fish is an important to evaluate stocks economic potential, its history of life, realistic

[DOI: 10.18331/SFS2021.8.1.4]

culture and actual management of fisheries (Lagler, 1956). The fecundity of freshwater small fish *N. atherinoides* was estimated from samples of January to December 2019. The mean fecundity was found highest (4553.07±1755.66) in April and later gradually decreasing. Narejo (2003) stated that the fecundity of *Monopterus cuchia* and *Mastacembelus armatus* range from 260 to 5890 and 580 to 10980, respectively. The fecundity changes with months, dietary habitat, climate and ecosystem variables (Bromage *et al.*, 1992). The mean fecundity was plotted against the standard length and body weight during the present investigation. The correlation coefficient (r) between mean fecundity and standard length was r=0.89 (Fig. 12); mean fecundity and body weight was r=0.92 (Fig. 11) for *N. atherinoides*. In the case of body weight, the relationship with mean fecundity was stronger (r=0.92) than the standard length (r=0.89). Similar findings have been recorded by many scientists, such as Khan *et al*. (2002) for eel tail catfish *Plotosus canius*, Rashed *et al*. (2007) tank goby**,** *Glossogobius giuris* and Rheman *et al*. (2002) grey mullet, *Liza parsia*.

Conclusion

In this study, standard length, total length (TL) are the fastest (b=1.21) and anal fin length (AFL) was the slowest (b=0.30) growing parameter. For the relationship between length-length, the value of correlation coefficient (r) with standard length was higher (r=0.992) in fork length and lower (r=0.94) in anal fin length for combined sexes. All meristic characters remained constant with increasing body length other than anal fins which were in range of 30-45. In this experiment, length-weight relationships (LWRs) 'b' values were 3.66 (TL vs. BW); 3.68 (FL vs BW); 3.84 (SL vs BW) indicated a positive allometric growth and there also found strong positive linear relationships (r=0.97, r=0.96, r=0.97). The current studies also show the highest mean relative condition factor (K_R) value (2.43±1.86) which suggests habitat (Chalon beel) is in a suitable condition. The highest value of GSI and fecundity is found in the month of April. This study presented the basic information on length-length, length-weight relationships, conditions and breeding biology which can be effective information for fishery biologists, fish farm managers, and conservationists to initiate the stock assessments of *N. atherinoides* from the adjacent river of Chalon beel, Bangladesh.

Reference

Akombo, P.M., Akange, E.T., Adikwu, I.A. and Araoye, P.A., 2014. Length-weight relationship, condition factor and feeding habits of *Synodontis schall* (Bloch and Schneider, 1801) in river Benue at Makurdi, Nigeria. *International Journal of Fish Aquature Studies*, 1(**3**), 42-8.

[DOI: 10.18331/SFS2021.8.1.4]

Alam, M.M., Galib, S.M., Islam, M.M., Flowra, F.A. and Hussain, M.A., 2012. Morphometric study of the wild population of pool barb *Puntius sophore* (Hamilton, 1822) in the River Padma, Rajshahi, Bangladesh. *Trends in Fisheries Research*, 1(**2**), 10–13.

Al-Hassan, J.M., Thomson, M., Ali, M. and Criddle, R.S., 1987. Toxic and pharmacologically active secretions from the Arabian Gulf catfish (*Arius thalassinus*, Ruppell). *Journal of Toxicology: Toxin Reviews*, 6(**1**), 1-43. https://doi.org/10.3109/15569548709053860

Arshad, A., Jimmy, A., Nurul Amin, S.M., Japar, B.S. and Harah, Z.M., 2008. Length-weight relationships of five fish collected from seagrass beds of the Sungai Pulai estuary, Peninsular Malaysia. *Journal of Applied Ichthyology*, 24(**3**), 328–329. https://doi.org/10.1111/j.1439-0426.2007.01026.x

Azadi, M.A. and Naser, A., 1996. Length-weight relationship and relative condition factor of a carp, *Labeo bata* (Ham.) from Kaptai reservoir, Bangladesh. *Chittagong University Studies* Part 2, *20*, 19-26.

Bagenal, T.B., 1957. Annual variations in fish fecundity. *Journal of the Marine Biological Association of the United Kingdom*, 36(**2**), 377-382. https://doi.org/10.1017/S0025315400016866

Baishya, A., Dutta, A. and Bordoloi, S., 2010. Morphometry and length-weight relationship of *Amblypharyngodon mola* (Hamilton-Buchanan, 1822). *Indian Journal of Fisheries*, *57*(**1**), 87-91.

Bhuiyan, A.L., 1964. Fishes of Dhaka. Asiatic Society of Pakistan, Dhaka, 148p.

Bromage, N., Jones, J., Randall, C., Thrush, M., Davies, B., Springate, J. and Barker, G., 1992. Broodstock management, fecundity, egg quality and the timing of egg production in the rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 100(**1-3**), 141-166. https://doi.org/10.1016/0044-8486(92)90355-O

Brraich, O.S. and Akhter, S., 2015. Morphometric characters and meristic counts of a fish, *Crossocheilus latius* latius (Hamilton-Buchanan) from Ranjit Sagar Wetland, India. *International Journal of Fisheries and Aquatic Studies*, 2(**5**), 260-265. https://www.fisheriesjournal.com/archives/2015/vol2issue5/PartE/2-5-74-228.pdf

Craig, J.F., Halls, A.S., Barr, J.J.F. and Bean, C.W., 2004. The Bangladesh floodplain fisheries. *Fisheries Research*, 66, 271-286. https://doi.org/10.1016/S0165-7836(03)00196-6

Dadzie, S., Abou-Seedo, F. and Manyala, J.O., 2008. Length–length relationship, length–weight relationship, gonadosomatic index, condition factor, size at maturity and fecundity of *Parastromateus niger* (Carangidae) in Kuwaiti

[DOI: 10.18331/SFS2021.8.1.4]

waters. *Journal of Applied Ichthyology*, 24(**3**), 334-336. https://doi.org/10.1111/j.1439-0426.2008.01061.x

Dasgupta, M., 1991. Length-weight relationship and condition factor (K-value) of *Tor putitora* (Hamilton) from Garo Hills, Meghalaya. *The Indian Journal of Fisheries (India)*. https://agris.fao.org/agris-search/search.do?recordID=IN9200451

De Silva, A.P., Amarasiri, L., Liyanage, M.N., Kottachchi, D., Dassanayake, A.S. and De Silva, H.J., 2009. One-hour fast for water and six-hour fast for solids prior to endoscopy provides good endoscopic vision and results in minimum patient discomfort. *Journal of gastroenterology and hepatology*, 24(**6**), 1095-1097. https://doi.org/10.1111/j.1440-1746.2009.05782.x

Devlaming, V., Grossman, G. and Chapman, F., 1982. On the use of the gonosomatic index. *Comparative Biochemistry and Physiology Part A: Physiology*, 73(**1**), 31-39. https://doi.org/10.1016/0300-9629(82)90088-3

Froese, R., 2006. Cube law, condition factor, and weight- length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22, 241–253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

Galib, S.M., Samad, M.A., Mohsin, A.B.M., Flowra, F.A. and Alam, M.T., 2009. Present status of fishes in the Chalan Beel-the largest beel (wetland) of Bangladesh. *International Journal of Animal and Fisheries Science*, 2(**3**), 214-218.

Ghulam Kibria, M. and Ahmed, K.K.U., 2005. Diversity of selective and non-selective fishing gear and their impact on inland fisheries in Bangladesh. *NAGA, WorldFish Center Newsletter*, 28(**1 and 2**), 43-48. https://digitalarchive.worldfishcenter.org/handle/20.500.12348/1927

Gore, B.M., 2007. 'Biometry of mudskipper *Boleophthalmus boddaerti*' PhD Thesis University of Mumbai.

Hasan, M., Hosen, M.H.A., Miah, M.I., Ahmed, Z.F., Chhanda, M.S. and Shahriar, S.I.M., 2020. Fecundity, length at maturity and gonadal development indices of river catfish (*Clupisoma garua*) of the old Brahmaputra River in Bangladesh. *The Egyptian Journal of Aquatic Research*, 46 (**3**), 259-263. https://doi.org/10.1016/j.ejar.2020.08.003

Hossain, M. Y., 2010. Length-weight, length-length relationships and condition factor of three Schibid catfishes from the Padma River, Northwestern Bangladesh. *Asian Fisheries Science*, 23(**1**), 329-339. https://doi.org/10.33997/j.afs.2010.23.3.005

[DOI: 10.18331/SFS2021.8.1.4]

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(**4**), 304-307. https://doi.org/10.1111/j.1439-0426.2006.00803.x

Hossain, M.Y., Jasmine, S., Ibrahim, A.H.M., Ahmed, Z.F., Rahman, M.M. and Ohtomi, J., 2009. Length–weight and length–length relationships of 10 small fish species from the Ganges, Bangladesh. *Journal of Applied Ichthyology*, 25(**1**), 117-119. https://doi.org/10.1111/j.1439-0426.2008.01168.x

Hossain, M.Y., Rahman, M.M., Jewel, M.A.S., Ahmed, Z.F., Ahamed, F., Fulanda, B., Abdallah, E.M. and Ohtomi, J., 2012. Condition- and form-factor of the five threatened fishes from the Jamuna (Brahmaputra River distributary) River, northern Bangladesh. *Sains Malays*, 41, 671–678.

Hossain, M.Y., Rahman, M.M., Abdallah, E.M. and Ohtomi, J., 2013. Biometric relationships of the pool barb *Puntius sophore* (Hamilton 1822) (Cyprinidae) from three major rivers of Bangladesh. *Sains Malays*, 42, 1571–1580. http://journalarticle.ukm.my/6620/

Hossain, M., Naser, S.M., Bahkali, A.H., Yahya, K., Hossen, M., Elgorban, A.M. and Rahman, M., 2016. Life History Traits of the Flying Barb *Esomus danricus* (Hamilton, 1822) (Cyprinidae) in the Ganges River, Northwestern Bangladesh. *Pakistan Journal of Zoology*, 48(**2**), 399-408. https://www.tandfonline.com/doi/abs/10.1577/1548-8659(2000)129%3C0527%3ARAFWBW%3E2.0.CO%3B2

Hubbs, C.L. and Lagler, K.F., 1958. Fishes of the Great Lakes region. Univ. Mich. Press. *Ann Arbor*, 213.

Islam, M.N., 2004. Eco-biology of freshwater Gobi, *Glossogobius giuris* (Hamilton) of the river Padma in relation to its fishery: a review. *Journal of Biological Sciences*, 4(**6**), 780–793. https://doi.org/10.3923/jbs.2004.780.793

Islam, M.R., Sultana, N., Hossain, M.B. and Mondal, S., 2012. Estimation of fecundity and gonadosomatic index (GSI) of gangetic whiting, *Sillaginopsis panijus* (Hamilton, 1822) from the Meghna River Estuary, Bangladesh. *World Applied Sciences Journal*, 17(**10**), 1253-1260. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.389.4988&rep=rep1&type=pdf

IUCN, 2000. Red book of threatened fishes of Bangladesh. IUCN Bangladesh, Dhaka, Bangladesh. 116 P.

[DOI: 10.18331/SFS2021.8.1.4]

IUCN, 2015. Red List of Bangladesh. Volume 5: Freshwater Fishes. IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, xvi+360 pp. RL-549.3-003-v.5.pdf

Jamali, H., Patimar, R., Farhadi, M. and Daraei, V., 2016. Age, growth and reproduction of *Paracobitis malapterura* (Teleostei: Nemacheilidae) from Qom River, Iran. *Iranian Journal of Ichthyology*, 3(**1**), 43-52. http://ijichthyol.org/index.php/iji/article/view/3-1-5

Khan, M.S.A., Alam, M.J., Rheman, S., Mondal, S. and Rahman, M.M., 2002. Study on the fecundity and GSI of brackishwater catfish *Plotosus canius* (Hamilton-Buchanan). *Journal of Biological Sciences*, 2, 232-234. https://doi.org/10.3923/jbs.2002.232.234

Khatun, D., Hossain, M., Rahman, M., Islam, M., Rahman, O., Kalam Azad, M. and Mawa, Z., 2019. Life-History Traits of the Climbing perch *Anabas testudineus* (Bloch, 1792) in a Wetland Ecosystem. *Jordan Journal of Biological Sciences*, 12(**2**), 175-182.

Lagler, K.F., 1956. Enumeration of fish eggs in fresh water fishery biology. *WMC Brown Company Publisher, Dubuque*, 106-110.

Langer, S., Tripathi, N.K. and Khajuria, B., 2013. Morphometric and meristic study of golden mahseer (*Tor Putitora*) from Jhajjar Stream (JandK), India. *Research Journal* of *Animal*, *Veterinary* and *Fishery* Sciences, 1(**7**), 1-4.

Le Cren, E.D., 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *The Journal of Animal Ecology*, 201-219. https://doi.org/10.2307/1540

Lleonart, J., Salat, J. and Torres, G.J., 2000. Removing allometric effects of body size in morphological analysis. *Journal of theoretical Biology*, 205(**1**), 85-93. https://doi.org/10.1006/jtbi.2000.2043

Mohammad, A. and Pathak, J.K., 2010. Assessment of fecundity and gonadosomatic index of commercially important fish, *Labeo rohita* from Ramganga River. *International Journal of Pharma and Bio Sciences*, 1(**3**), 1-6.https://www.cabdirect.org/cabdirect/abstract/20113372371

Nabi, M.R. and Hossain, M.A., 1996. Reproductive biology of the fresh-water Spiny-eel *Macrognathus aculeatus* (Bloch). *Bangladesh Journal of Zoology*, 24, 115-120.

Nandikeswari, R., Sambasivam, M. and Anandan, V., 2014. Estimation of fecundity and gonadosomatic index of *Terapon jarbua* from Pondicherry Coast, India. *International Journal of Nutrition and Food Engineering*, 8(**1**), 61-65. https://publications.waset.org/9997420/estimation-of-fecundity-and-

[DOI: 10.18331/SFS2021.8.1.4]

gonadosomatic-index-of-terapon-jarbua-from-pondicherry-coast-india

Narejo, N.T., Rahmatullah, S.M. and Mamnur Rashid, M., 2002. Studies on the reproductive biology of freshwater spiny eel, *Mastacembalus armatus* (Lacepede) reared in the cemented cisterns of Bangladesh Agricultural University, Mymensingh, Bangladesh. *Pakistan Journal of Biological Science*, 5 (**7**), 809-811. https://doi.org/10.3923/pjbs.2002.809.811

Ndome, C.B., Eteng, A.O. and Ekanem, A.P., 2012. Length-weight relationship and condition factor of the smoothmouth marine catfish (*Carlarius heudelotii*) in the gulf of Guinea, Niger delta, Nigeria. *Aquaculture, Aquarium, Conservation & Legislation*, 5(**3**), 163-167. https://doi.org/10.1111/j.1365-2133.2012.10977.x

Önsoy, B., Tarkan, A.S., Filiz, H. and Bilge, G., 2011. Determination of the best length measurement of fish. *North-Western Journal of Zoology*, 7*(**1**)*, 178-180.

Parvin, M.F., Hossain, M.Y., Sarmin, M.S., Khatun, D., Rahman, M.A., Rahman, O. and Sabbir, W., 2018. Morphometric and meristic characteristics of *Salmostoma bacaila* (Hamilton, 1822) (Cyprinidae) from the Ganges River in northwestern Bangladesh. *Jordan Journal of Biological Sciences*, 11(**5**), 533-536. http://jjbs.hu.edu.jo/files/vol11n5/Paper%20Number%209.pdf

Pravdin, I.F., 1966. Study guide of fishes (mainly freshwater). *The food-processing industry. Science, Moscow, Russia*.

Rahman, A.K.A., 1989. Freshwater Fishes of Bangladesh," Zoological Society of Bangladesh, Department of Zoology, University of Dhaka, Dhaka, p. 364.

Rahman, A.K.A., 2005, Freshwater Fishes of Bangladesh, 2nd edition, Zoological Society of Bangladesh, Department of Zoology, University of Dhaka, Dhaka-1000, pp, xviii-263

Rashed-Un-Nabi, M., Hoque, M.A., Rahman, R.A., Mustafa, S. and Kader, M.A., 2007. Population dynamics of *Polynemus paradiseus* from estuarine set bag net fishery of Bangladesh. *Chiang Mai Journal Science*, 34(**3**), 355-365. http://www.thaiscience.info/Journals/Article/CMJS/10905736.pdf

Rheman, S., Islam, M.L., Shah, M.M.R., Mondal, S. and Alam, M.J., 2002. Observation on the fecundity and gonadosomatic index (GSI) of grey mullet *Liza parsia* (Ham.). *Journal of Biological Sciences*, 2, 690-693. https://doi.org/10.3923/jbs.2002.690.693

Rubbi, S.F., Muslemuddin, M. and Wahab, M.A., 1978. The present status of fish technology and inspection in Bangladesh. FAO. In *DANIDA Workshop of Fish Technology, Colombo, Srilanka*.

[DOI: 10.18331/SFS2021.8.1.4]

Sangun, L., Akamca, E. and Akar, M., 2007. Weight-length relationships for 39 fish species from the north-eastern Mediterranean coast of Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, 7(**1**), 37-40.

Simon, K.D., Bakar, Y., Samat, A., Zaidi, C.C., Aziz, A. and Mazlan, A.G., 2009. Population growth, trophic level, and reproductive biology of two congeneric archer fishes (*Toxotes chatareus*, Hamilton 1822 and *Toxotes jaculatrix*, Pallas 1767) inhabiting Malaysian coastal waters. *Journal of Zhejiang University Science B*, 10(**12**), 902. https://doi.org/10.1631/jzus.B0920173

Simon, K.D., Mazlan, A.G. and Cob, Z.C., 2013. Condition factors of two archerfish species from Johor coastal waters, Malaysia. *Sains Malaysiana*, 42(**8**), 1115-1119.

Sutton, S.G., Bult, T.P. and Haedrich, R.L., 2000. Relationships among fat weight, body weight, water weight, and condition factors in wild Atlantic salmon parr. *Transactions of the American Fisheries Society*, 129(**2**), 527-538. https://doi.org/10.1577/1548-8659(2000)129<0527:RAFWBW>2.0.CO;2

Talwar, P.K. and Jhingran, A.G., 1991. Inland fisheries of India and adjacent countries. *Vol. I & II*, 1-1158.

Tandon, K.K., Johal, M.S. and Bala, S., 1993. Morphometry of *Cirrhinus reba* (Hamilton) from Kanjli wetland, Punjab, India. *Panjab University Research Journal (Science)*, 43(**1-4**), 73-78.

Tesch, F.W., 1971. Age and growth. In: Ricker WE, editor. Methods for assessment of fish production in fresh waters. Oxford (UK): Blackwell Scientific Publications, pp. 99–130. https://onlinelibrary.wiley.com/doi/abs/10.1002/iroh.19690540313

[DOI: 10.18331/SFS2021.8.1.4]