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GROWTH AND REPRODUCTION OF THAI SHARPUNTI (*BARBONYMUS GONIONOTUS*) IN THE LENTIC WATER HABITAT OF NORTHWEST BANGLADESH

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Abstract

This study evaluated the growth and reproductive activity of Thai sharpunti *Barbonymus gonionotus* in the L-shaped freshwater pond at Rajshahi University campus of northwest Bangladesh during January and August, 2017. Length and weight increment was recorded for the growth study and gonado-somatic index (GSI) with fecundity was estimated for the assessment of reproductive activity. During the study a significant length and weight increment was observed ($p<0.05$). Monthly mean total length (TL) ranged 11.76 to 22.47 cm, fork length (FL) was 10.02 to 19.12 cm, standard length (SL) was 8.87 to 16.83 cm and body weight (BW) was 19.89 to 167.81g. Both the length-length relationship (LLR) and length-weight relationship (LWR) showed a positive allometric growth pattern of the fish and the relationships were TL = 1.1759 FL - 0.035, TL = 1.338 SL - 0.0002, FL = 1.0988 SL + 0.6557 and BW = 0.0051TL 3.347. Gonadal observation showed that the fish initiated sexuality in the month of April and was fully matured in the month of May. During the study male female ratio was significantly different from the 1:1 ratio ($\chi^2 = 3.84$, $p<0.05$) and the overall male to female sex ratio was 1:1.42. The gonado-somatic index (GSI) was ranged from 3.72 to 32.39 and showed significant monthly fluctuations ($p<0.05$). A sharp decline of GSI during May and June indicates the peak spawning of *B. gonionotus* in the study site. During the study the fecundity of the fish was ranged from 46145 to 353969 and the highest fecundity was recorded in the months of May. The findings of the present study would be helpful for the sustainable management of *B. gonionotus* in the freshwater ecosystem of Bangladesh and elsewhere.

***Key words*:** *Barbonymus gonionotus*, Growth, Reproductive activity, Northwest Bangladesh.

Introduction

The silver barb or Thai sarpunti (*Barbonymus gonionotus*) is one of the most important fish species under the family of cyprinidae. This species is well known in South East Asia and is culture in Indonesia, Vietnam and Sri Lanka (Tantong et al. 1980). *B. gonionotus* has now been introduced throughout the tropical and subtropical Asia including China, India, Nepal, Malaysia and Bangladesh (ICLARM 1997). This species has been one of the most popularly cultured freshwater fish in the world, especially in Southeast Asia (Alim et al. 1998, Sarker et al. 2002).

Thai sarpunti was introduced in Bangladesh in 1977 to enhance fish production through inclusion into our carp polyculture system. It is an important tropical fish species due to its fast growth rate, palatability, easy and year-round reproduction, and adaptability to a wide range of aquaculture system (Hussain et al. 1989). It has high market demand and become increasingly popular for its silvery appearance and good taste. The

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main reason for its introduction in Bangladesh are that it is similar to local barb species and the environmental condition of Bangladesh is suitable for growing this fish. Silver barb reaches marketable size within three to four months (Gupta 1990, Gupta and Rab 1994). It needs comparatively low cost and simple management (Akhteruzzaman 1991) and thus making this species suitable for poor and marginal fish farmers. It has been considered to be a good species culturing in seasonal ponds, rice fields etc. and has high production potential in compare to some native carp species in Bangladesh (Karim et al. 1988, Kohinoor et al. 1994).

Studies on the reproductive biology are essential in evaluating the commercial potentialities of population, life history, culture and management of small indigenous fishes (Lagler 1956, Doha 1970). The reproductive potential of a population is one of the basic requirements to select the individuals of that population in respect to their gonadal conditions. Study on seasonal changes in gonadal maturation helps in detecting the breeding season and in selecting phenotype characters of fully mature breeders for a successful artificial propagation. Hence, it is very important to know the yearly reproductive cycle of *B. gonionotus* to assure success in culture practice. Knowledge of gametogenic development and the spawning season of a species allow subsequent studies on spawning frequency of its population, which is very important for its appropriate management. Very few research works have been done in such direction. Few of the research works described different aspects of reproduction for the *Ctenopharyngodon idella* (Jensen and Shelton 1983), *Amblypharyngodon mola* (Afroze and Hossain 1990), *Clupea pallasii* (Koya et al. 2002), *Puntius gonionotus* (Mahmud 1988, Hasan et al. 2009).) *Puntius sarana* (Chakraborty et al. 2007), *Puntius ticto* (Hossain et al. 2012) and *Aspidoparia morar* (Hossain et al. 2013). Still to date there is no comprehensive research work on growth and reproduction on *B. gonionotus*. Therefore, the present study was undertaken to find out the growth and reproductive activity of *B. gonionotus* from the lentic water habitat of northwest Bangladesh. The objectives of this study were (a) to determine the growth performance of *B. gonionotus*, (b) to determine length-length and length-weight relationship of *B. gonionotus* (c) to determine the condition factor of *B. gonionotus* and (d) to determine sexuality, gonado-somatic index and fecundity of *B. gonionotus* in the lentic water habitat of northwest Bangladesh.

Materials and Methods

Study area and sampling

The present study was conducted in the L-shaped freshwater pond at Rajshahi University campus (24° 22′ 21.56′′ N and 88° 38′ 11.16′′, Fig. 1). Management of this pond is controlled under the Department of Fisheries, University of Rajshahi. In this pond different types of threatened SIS fishes are conserved and partially carp polyculture is practiced. In September 2016 egg fry of *B. gonionotus* was stocked in the study area from the Padma River and reared. From this stock monthly sample was collected during January and August, 2017 to know the growth performance and reproductive activity *B. gonionotus* in the lentic water habitat. Monthly fish sample was taken early in the morning from the study site using seine net. All size groups of fish were made available in the catch. The collected fish samples were transported to the laboratory of the Fisheries Department and washed with tap water to remove dirty materials and preserved with ice.

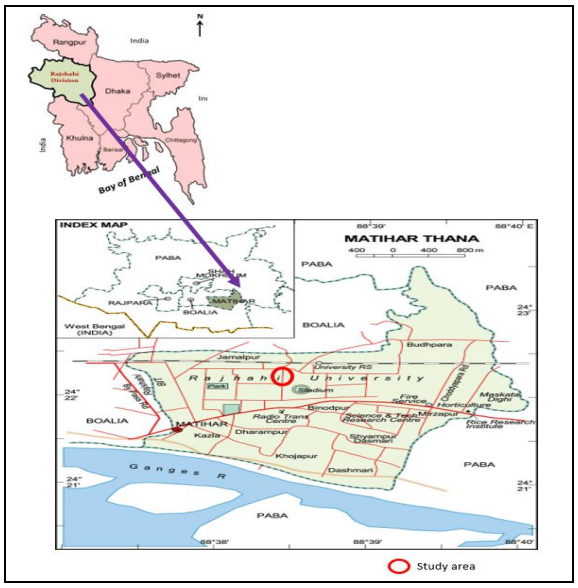

Fig. 1: Map showing the study area.

Biometric measurement

In the laboratory, standard length, forked length and total length were recorded separately by using a special measuring board to the nearest centimeter (Fig. 2). Body weight was taken by an electric balance (0.01 g accuracy) after blot drying with a piece of clean tissue. After recording length and weight of fish, it was dissected to collect gonad and to determine the sex. All gonads were weighted with a digital balance. In some fish's gonad was not developed and sex was unidentified.

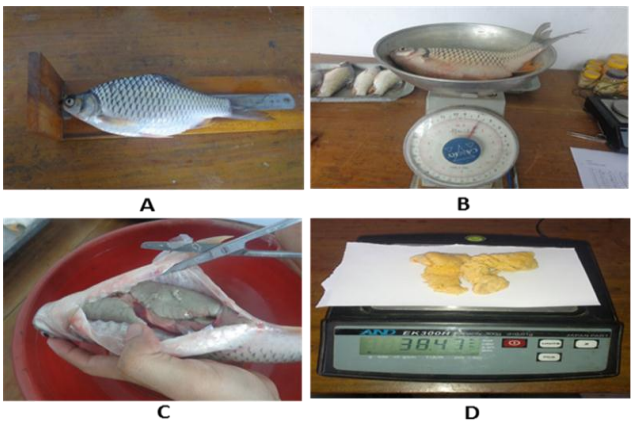

Fig. 2 (A-D): Biometric measurements of *B. gonionotus.* A) Measurement of length (cm), B) Measurement of body weight (g), C) Opening of body for taking out gonad and D) Measurement of gonad weight (g).

Growth pattern

The length-length and length-weight relationships were determined to know the growth pattern of *B. gonionotus*. The following equation was used to know the length-length relationships-

$$Y = a + bX$$

Where, X= Length in X axis; Y= Length in Y axis; a= Proportionality constant and b = regression coefficient.

The length-weight relationship was calculated by using the following formula (Le Cren 1951):

$$W = aL^b$$

Where, W = Body weight of fish (g); L = Linear measure of the fish length (cm); a = Intercept (constant) and b = exponent (slope).

The Fulton's condition factor (K) for each fish was calculated using the formula (Fulton 1904):

$$K = \frac{W}{L^3} \times 100$$

Where, K = Condition factor; W = Weight of fish (g) and L=Total length of fish (cm)

Reproductive activity

Gonado-somatic index (GSI) and fecundity were measured to know the seasonal changes in reproductive activity of *B. gonionotus.* Gonado-somatic index (GSI) was calculated by the following formula (Lagler 1956).

$$\text{Here, GSI} = \frac{\text{Weight of gonad}}{\text{Weight of body}} \times 100$$

Fecundity was estimated by the following formula-

$$F = \frac{N \times \text{Gonad weight}}{\text{Sample weight}}$$

Where, F = Fecundity of fish; N = Number of eggs in sample

Statistical analysis

All the statistical analysis were performed on SPSS (ver. 20) at $p<0.05$ level of significance. Monthly significant differences of growth parameters, condition factors and gonado-somatic index were analyzed through ANOVA with DUNCAN *posthoc* ranking and the difference between sex ratio was analyzed through the chi-square (χ^2) test.

Results

Growth performance

Table 1 and Fig. 3-6 represent the growth performance of *B. gonionotus*. A one way ANOVA with DUNCAN *Posthoc* test showed significant monthly increase of length and weight ($p<0.05$). During the study, total length was ranged from 9.20 to 28.50 cm, fork length was ranged from 7.80 to 24.10 cm and standard length was ranged from 6.70 to 21.10 cm. At the beginning of the study, in the month of January, the total length was 11.76±1.47 cm and standard length was 8.87±1.23 cm, which were significantly increased up to 22.47±1.39 cm and 16.83±1.08 cm respectively in the months of August ($p<0.05$, Table 1 and Fig. 3-6).

Table 1: Descriptive statistics of length and weight measurements of *B. gonionotus* during the study period.

Months	*n*	Total length range (cm)	Fork length range (cm)	Standard length range (cm)	Body weight range (g)
January	71	9.2-16.0	7.8-14.0	6.7-12.5	8.74-54.9
February	46	14.4-21.9	13.1-18.9	11.7-16.0	44.7-142.7
March	56	12.3-23.2	10.1-20.1	9.0-17.5	28.1-134.2
April	32	15.7-19.5	12.3-17.0	10.6-15.3	54.6-137.2
May	40	17.1-26.6	14.6-22.8	12.8-20.8	74.7-260.0
June	33	17.3-28.5	14.7-24.1	12.7-21.2	68.7-332.0
July	21	19.2-27.7	16.1-20.2	14.3-17.2	100.0-174.2
August	22	20.4-28.5	17.2-21.7	15.5-19.3	122.3-260

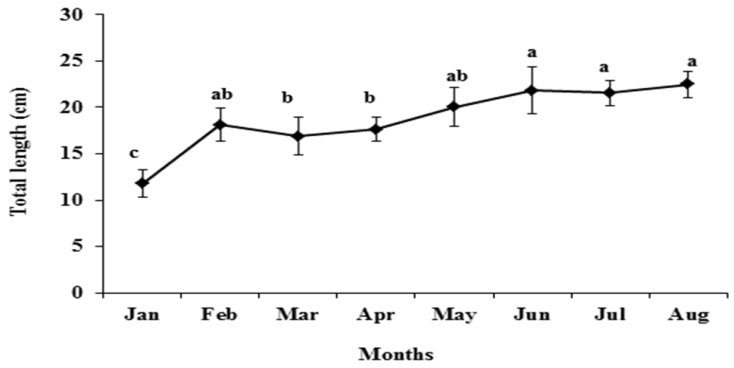

Fig. 3: Monthly variation in total length of *B. gonionotus* during the study period. The vertical bars represent standard deviation and different alphabets indicate the significant variation (ANOVA, Duncan's, $P<0.05$).

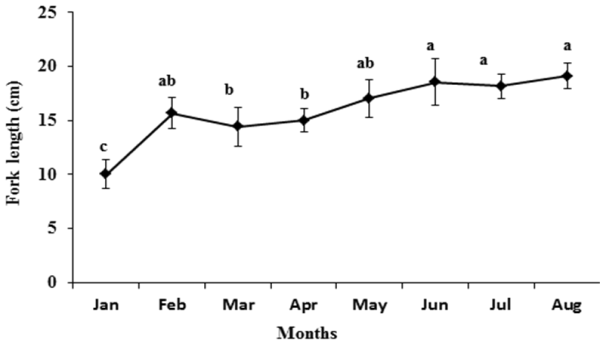

Fig. 4: Monthly variation in fork length of *B. gonionotus* during the study period. The vertical bars represent standard deviation and different alphabets indicate the significant variation (ANOVA, Duncan's, P <0.05).

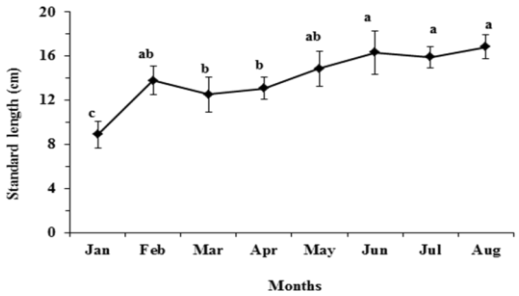

Fig. 5: Monthly variation in standard length of *B. gonionotus* during the study period. The vertical bars represent standard deviation and different alphabets indicate the significant variation (ANOVA, Duncan's, P <0.05).

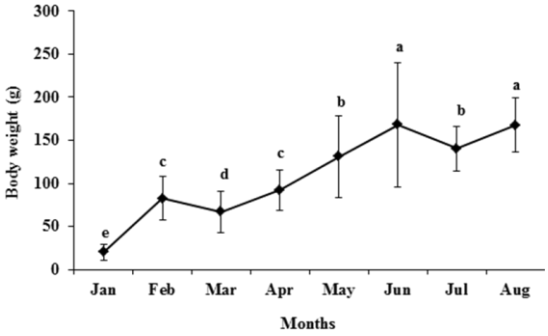

Fig. 6: Monthly variation in body weight of *B. gonionotus* during the study period. The vertical bars represent standard deviation and different alphabets indicate the significant variation (ANOVA, Duncan's, P <0.05).

Growth pattern

Length-length relationships

The scatter diagram obtained from the total length and fork length, total length and standard length showed a significant linear relationship ($p<0.05$, Fig. 7). From the regression equation of total length and fork length relationship the 'b' value was 1.1759, which indicated a positive allometric growth pattern of *B. gonionotus*. The coefficient of correlation (r) was 0.996 (Fig. 7). The value of 'r' indicates that there was a high degree of correlation between total length and fork length since the values were close to 1, and its positive value reflected that the slope is positive.

From the regression equation between total length and standard length, it revealed that the value of 'b' was 1.338, indicates a positive allometric growth pattern (Fig. 7). The coefficient of correlation (r) was found 0.994 (Fig. 7). The value of 'r' indicates high degree of correlation between TL vs. SL. The coefficient of correlation (r) suggested 99.4% of the variation in total length was due to variation in standard length.

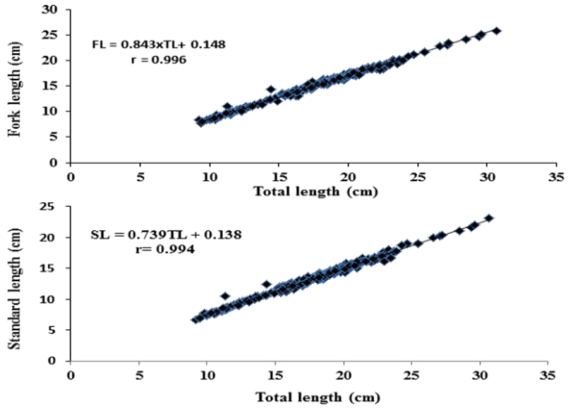

Fig. 7: Total length-fork length and total length-standard length relationship of *B. gonionotus* during the study period.

Length-weight relationship

Fig. 8 shows the relationship between total length and body weight (BW) during study period. The parameters "a" and "b" in the power curve equation derived from the relationship were estimated at 0.0051 and 3.347.The 'b' value indicated significant positive allometric growth pattern of the fish ($p<0.05$). The coefficient of correlation (r) was found 0.981 which indicates high degree of correlation between TL and BW. The coefficient of determination suggested that 98.1% of the variation in body weight was due to variation of total length.

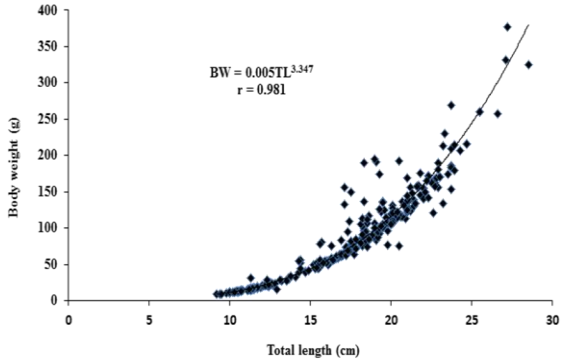

Fig. 8. Total length-body weight relationship of *B. gonionotus* during the study period.

Condition factor

Fig. 9 represents the monthly fluctuations of condition factor (K) of *B. gonionotus* during study period. Condition factor showed significant monthly fluctuations (ANOVA, $p<0.05$). At the start of study in the month of January, the mean condition factor was 1.16±0.15 and it was increased gradually up to 1.68±0.34 in April. From April to onwards it slowly decreased at reaching the lowest value in the months of July and then it again increased in the months of August (Fig. 9).

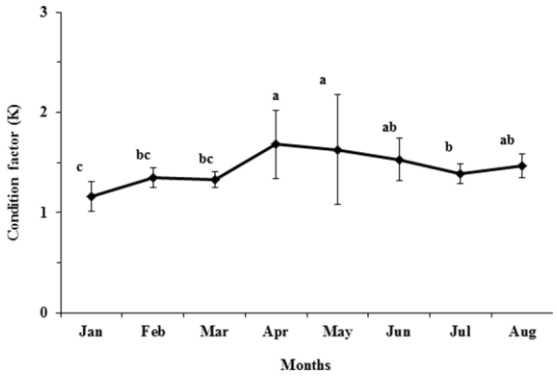

Fig. 9: Monthly variation condition factor of *B. gonionotus* during the study period. The vertical bars represent standard deviation and different alphabets indicate the significant variation (ANOVA, Duncan's, $P<0.05$).

Reproductive activity

Sex-ratio

Table 2 represents the male female ration of *B. gonionotus* during the study. A total of 126 fish were examined during the spawning season, of which 41.27% were male and 58.73% were female. From the results of chi-square test, it revealed that the overall sex ratio was 1:1.42 (M:F) which was significantly different from the expected 1:1 ratio ($p<0.05$).

Table 2: Male-female ratio of *B. gonionotus* during the spawning period.

Months	Male (M)	Female (F)	Total	Ratio (M:F)	χ^2, df=1	Significance
April	12	20	32	1:1.60	2	ns
May	15	25	40	1:1.66	2.5	ns
June	17	16	33	1:0.94	0.03	ns
July	8	13	21	1:1.62	1.19	ns
Total	52	74	126	1:1.42	3.84	s

ns = not significant; s = significant at 5% level ($X^2_{t\ 1,0.05}$ = 3.84 and 1% level ($X^2_{t\ 1,0.01}$= 6.63).

Gonado-somatic index (GSI)

Fig. 10 shows the monthly changes in gonado-somatic index (GSI) of *B. gonionotus* during the study period. In the present study the GSI was ranged from 3.72-32.39. The GSI was firstly recorded in the months of April when the monthly mean GSI was 13.39±3.55. The GSI was sharply increased from April to May reaching the highest monthly mean value 19.75±5.02. From May to onwards GSI was declined at reaching the lowest value in the months of July, indicates the spawning season of the fish during this period. A sharp decline of GSI recorded in the months of June, indicates the peak spawning of the fish. There was no GSI value was recorded in the months of August, indicates resting phase of the fish after finishing the spawning (Fig. 8).

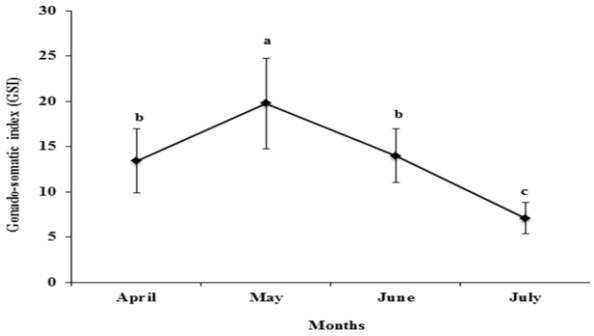

Fig.10: Monthly variation of gonado-somatic index of *B. gonionotus* during the study period. The vertical bars represent standard deviation and different alphabets indicate the significant variation (ANOVA, Duncan's, P <0.05).

Fecundity

During the study period, a total of 74 gravid *B. gonionotus* were collected from the study area during spawning season (April to July) for fecundity estimation. The fecundity was ranged from 46145 to 353969. The average fecundity was recorded 123195.1±50083.14, 207689.4±71280.34, 171579.2±66942.07 and 79317.31±206749.76in April, May, June and July respectively (Fig. 11). The highest fecundity 353969 was recorded in the month of May and lowest fecundity (46145) was recorded in the month of July (Fig. 11).

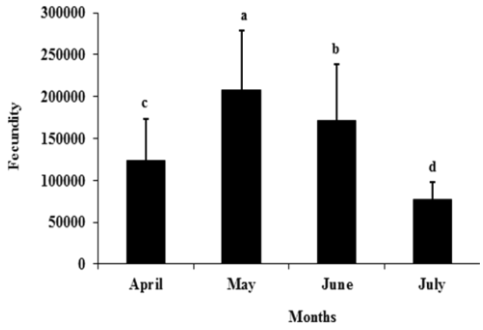

Fig. 11: Monthly variation of fecundity of *B. gonionotus* during the study period. The vertical bars represent standard deviation and different alphabets indicate the significant variation (ANOVA, Duncan's, $P < 0.05$).

Discussion

Growth pattern

The length-weight relationship is an important fishery management tool and used in estimating the average weight at a given length group and in assessing the relative well-being of a fish population. Data on the length and weight of fish have commonly been analyzed to yield biological information. LWR has a number of important applications in fish stock assessment (Morey 2003). Length and weight data are also useful in estimating the growth rates, length and age structures and other components of fish population dynamics (Kolheret al. 1995, Mondol et al. 2019). The present study is an account on the length-weight relationships and growth pattern inference of Thai silver barb, *B. gonionotus.* The relationship between total length and body weight during the study period was found BW = 0.0051 TL 3.347. The 'b' value from the 'cube law' indicated positive allometric growth for the fish. The coefficient of correlation (r) was 0.981, indicated significant correlation between TL and BW ($p<0.01$). For LWRs, all allometric coefficients (*b*) estimated during this study was within the expected range of 2.5 - 3.5 (Froese 2006), but they can vary between 2 and 4 (Bagenal and Tesch 1978). In general, and despite the many variations in fish forms among species, *b* is close to 3, indicating that fish grow isometrically (Tesch 1971, Somers 1991).

The value of b is usually close to 3.0 (Beverton and Holt 1975). For isometric growth the b value would have been equal to 3.0. When the growth is isometric, the form and specific gravity of the fish do not change at all during the lifetime of the species (Doha 1970). Wootton (1990) also described that b value less than 3.0 indicated that fish becomes lighter (negative allometric) and greater than 3.0 as heavier (positive allometric) for a particular length as it increases in size. However, in the present study, the value of "b" was higher than 3.0, which indicates positive allometric growth of *B. gonionotus*. The higher values of "b" also revealed that, the weight might be affected by the seasons, stomach contents or spawning condition of the fish.

Condition factor

Condition factor based on the LWR is an indicator of the changes in food reserves and general fish condition (Offem et al. 2007). Condition factor reflects interactions between abiotic and biotic factors in the physiological condition of the fishes. It shows the well-being of the population during various life cycle stages (Angelescu et al. 1958). Condition, 'fatness' or well-being of fish is an index to monitor feeding intensity and

growth rate (Oni et al.1983), is based on hypothesis that heavier fish for a given length are in better condition (Bagenal and Tesch 1978). Fish with high value of 'K' are heavy for its length, while with low 'K' are lighter (Bagenal and Tesch 1978). 'K' value greater than 1 indicates better condition of fish (Le Cren 1951). The condition factor of fishes has been reported to be influenced by a number of factors such as the onset of maturity, spawning (Al-Dham and Wahab 1991, Hossain et al. 2012, Rahman et al. 2012), sex and maturity (Doddamani and Shanbouge 2001) and Pollution (Devi et al. 2008).To assess the overall health and productivity of *B. gonionotus*, Fulton's (Fulton 1904) condition factor was used in the present study. The condition factor was ranged from 1.16±0.15 to 1.68±0.34. The value of 'K' indicates better condition of the studied fish *B. gonionotus,* in the study area.

Reproductive activity

The gonado-somatic index of fish increases with the advance of gonadal maturation, being maximum during the period of peak maturity and declining abruptly thereafter, in association of peak spawning events (Le Cren 1951). During this study the gonado-somatic index (GSI) of *B. gonionotus* ranged from 3.72 to 32.39. The monthly mean (±SD) GSI was recorded 13.39±3.55, 19.75±5.02, 13.96±2.97 and 7.07±1.73 in April, May, June and July, respectively. The results of the present study indicated that the GSI of *B. gonionotus* was highest in May when the fish was found to be mature. The sharp decline of the GSI during June indicates the peak spawning of the fish. Jasmine and Begum (2016) studied on biological aspects of *B. gonionotus* in the Padma River and reported the highest mean of GSI was 13.67±0.77 which is lower than that of our present study. They also reported spawning season ranged from April to July which is similar with the present findings and they indicated the peak spawning season was June which is also in agreement with the findings of the present study. Chakrabarty et al. (2007) reported the spawning period of *P. sarana* between June and July. Qasim and Qayyum (1961) reported the breeding season of *P. sarana* to extend from late June to early September with peak in July and August.

In the present study the fecundity of *B. gonionotus* was ranged from 46145 to 353969. The mean fecundity was recorded 123195.1±50083.14, 207689.4±71280.34, 171579.2±66942.07 and 79317.31±206749.76 in April, May, June and July respectively. The highest fecundity was recorded in the month of May (207689.4±71280.34). Jasmine and Begum (2016) reported the fecundity of *B. gonionotus* varied from 13192 to 98325 with a mean value of 58660±29288 which differs much from the present findings. This indicates that food availability and other environmental parameters might be in favorable condition in the study area during the study period than that of the study area of Jasmine and Begum (2016).

During this study the variation of the fecundity of *B. gonionotus* of equal sized fish, which showed that a fish measuring 18.3 cm in total length (gonad weight 24.93 g) produced 207417 eggs; whereas another fish of the same length (gonad weight 8.42 g) produced 75612 eggs in the same month. This type of variation was reported for *Puntius stigma* (Islam and Hossain 1990). This variation was found might be due to variable egg size, stages of maturity and month of the spawning. Variation of fecundity among the population may result largely from selectivity of different environmental factors and temperature is considered the most important factor (Jonsson and Jonsson 1999).

Conclusion

This study provided basic information on the growth performance, length-length and length- weight relationship, condition factor, sex ratio, gonado-somatic index and fecundity of *B. gonionotus* in the lentic water habitat of northwest Bangladesh. In this study, the b-value of the length-length and length-weight relationship of *B. gonionotus* indicated a positive allometric growth pattern of the fish in the study area. This might be influenced by environmental or habitat factors. Gonadal assessment revealed a male dominated

sex ratio and the spawning of *B. gonionotus* extends during May and July with a peak during June. Finally, it can be conclude that identifying the spawning season of *B. gonionotus* will be helpful to hatchery managers for artificial breeding. However, due to environmental changes and man-made intervention, natural breeding grounds of this important fish species have been severely degraded. So, for the production of quality seeds our findings could be helpful and also might be helpful for the sustainable management of *B. gonionotus* in the natural ecosystem of Bangladesh.

Conflict of interest: the authors hereby declare no conflict of interest regarding the publication of this article.

Contribution: Authors contributed equally in the research and writing of this article.

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