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Estimation of Fecundity and Gonadosomatic Index (GSI) of Gangetic Whiting, *Sillaginopsis panijus* (Hamilton, 1822) from the Meghna River Estuary, Bangladesh

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Abstract: Specimens of Gangetic whiting, *S. panijus*, were collected from the Meghna estuary to estimate the fecundity and Gonadosomatic Index (GSI) during April-September, 2011. The morphometric and meristic features of the fish were measured. The co-efficient of correlations between total length and head length with other body measurements were significant ($P<0.01$). The logarithmic length-weight relationship of the fish followed a straight line. The fish followed LeCren's law, the exponential value in the length-weight equation was found to be 3.480 which are within the range from 2.0-4.0. The fecundity ranged from173745 to 374077 with a mean of 310605.1±22833.84 having an average total length of 36.06±0.52cm, body weight of 300.36±24.41g and gonad weight of 28.65±2.98g. The right ovaries of the most specimens were more fecund than the left ones. The relationships between the fecundity and the total length (TL), body weight (BW), gonad weight (GW) were linear (i.e., $Y=20693X-39511$ and $r=0.875464$ for TL; $Y=840.9X+61471$ and $r=0.943848$ for BW; $Y=7546X+94066$ and $r=0.947309$ for GW). Gonadosomatic index was found higher (9.95±0.15%) in peak season, August. Findings of the present study highlighted the importance of fish, *S. panijus* in the fisheries sector of Bangladesh and should be useful for sustainable fishery management in the Meghna River estuary and elsewhere in Bangladesh.

Key words: Fecundity · GSI · *Sillaginopsis panijus*

INTRODUCTION

Bangladesh is a country of deltaic plains dominated by the major river systems like the Padma, the Jamuna and the Meghna. Meghna is the largest coastal plain estuary occupying the whole central coast of Bangladesh [1, 2]. After flowing about 264 km it enters the Bay of Bengal by four principal mouths: Tetulia, Shahbazpur, Hatia and Bamni [3]. The Gangetic whiting, *Sillaginopsis panijus* is a species of inshore marine and estuarine fish of the smelt-whiting family, Sillaginidae.

This fish has commercial importance of white flesh and of good quality. They are occasionally traded as brackish water aquarium fish and have great nutritious value and are an important alternative to other protein sources. They are common in the fishermen's catch in Meghna River near Noakhali of Bangladesh. But this fish is harvested commercially without considering its stock, size and maturity.

Study of morphometric characteristics applicable for evaluating the population structure, identifying stocks, studying short-term, environmentally induced disparities and the findings can be effectively used for improved fisheries management [4]. Estimation of fecundity and GSI of a fish is essential for evaluating the commercial potentialities of its stock, life history, practical culture and actual management of the fishery [5].

Published information about the different aspects of biology of *S. panijus* is very scanty, except a short taxonomy, distribution and occurrence of the species by Mc Kay [6] and Rahman [7, 8]. But no published work has been found yet on the morphological characters, fecundity and GSI of this fish species in Bangladesh. Considering the availability and importance of this fish species to the common people, the present work was undertaken with a view to study the morphological characters and determining the fecundity and gonadosomatic index of this species.

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MATERIALS AND METHODS

Thirty samples were collected for six months from Meghna river estuary, Noakhali, Bangladesh during April-September, 2011. In each month, five samples were collected. Total length (TL), body weight (BW), standard length (SL), head length (HL), pre-orbital length (PreOL), eye diameter (ED), post-orbital length (PostOL), snout length (SnL), mouth gap (MG), maximum body circumference (Max BC), minimum body circumference (Min BC) of fish were measured to the nearest cm using fish measuring board. The fishes were weighed on tanetag, KD-160 balance having one gm precision. The body characters viz. SL, HL, PreOL, ED, PostOL, SnL, MG, Max BC, Min BC, were expressed as percent to total length of the fish as done by Carlender and Smith [9] and Hile [10]. Regression of various body parts against TL of fish were drawn by least square method. Length-weight relationship was calculated by cube law as given by Le Cren [11].

$$\log W = \log a + b \times \log L$$

Where, W is weight, L is length of fish and 'a' and 'n' are constants.

Ten matured female samples were selected in two months (August-September). Then these matured female samples were dissected and the gonads from each specimen were removed out intact. The matured ovaries were weighed nearest gm by a sensitive balance (Model AR 2140, Germany). These ovaries were then split longitudinally and kept in Petri-dish. Then, weights of right and left gonad were measured. Three samples, each was taken from the anterior, middle and posterior regions of each ovary and kept in Petri-dish. All the ovaries were preserved in 5% formalin solution. After some hours eggs were become large and separate from each other. The numbers of eggs in each of the sub-samples were counted under a magnifying glass after 24 hours and mean value of eggs were computed. All estimated fecundities for the experiment are the total number of eggs in both the ovaries as was followed by Hartman and Conkle [12].

$$F = n \times G / g$$

Where "F" is fecundity, "n" is the average number of eggs, "G" is weight of the gonads and "g" is the weight of sub sample. The GSI value was calculated from the ratio of total body weight and gonad weight.

$$GSI = \text{Gonad weight} / \text{body weight} \times 100$$

RESULTS AND DISCUSSIONS

Morphological Characters: From morphometric characters it was observed that the mean values of total length (28.88±7.30), body weight (181.65±142.61), standard length (25.73±6.76), head length (7.63±2.19), pre-orbital length (3.27±0.97), eye diameter (0.67±0.076), post orbital length (3.70±1.15), snout length (1.55±0.51), mouth gap (1.54±0.12), the maximum body circumference (13.38±6.03) and minimum body circumference (4.46±1.09).

Significant ($p<0.01$) relationships were found between total length and other variables *viz.* standard length, head length, pre-orbital length, eye diameter, post-orbital length, snout length, mouth gape, maximum body circumference and minimum body circumference of this species (Figs. 1-6). Again the relationships between head length and other head parameters *viz*. pre-orbital length, eye diameter, post-orbital length, snout length, mouth gape were also significant ($p<0.01$) (Figs. 7-10).

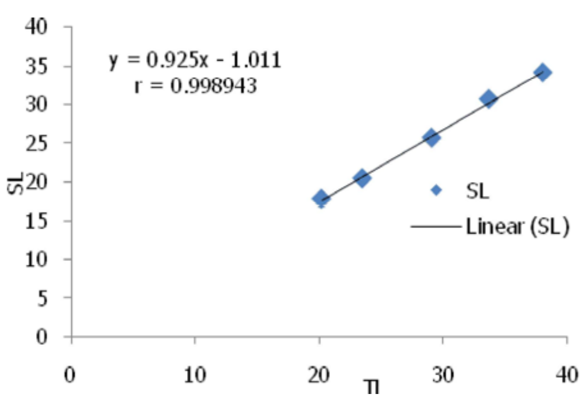

Fig. 1: Relationship between standard length (SL) and total length (TL).

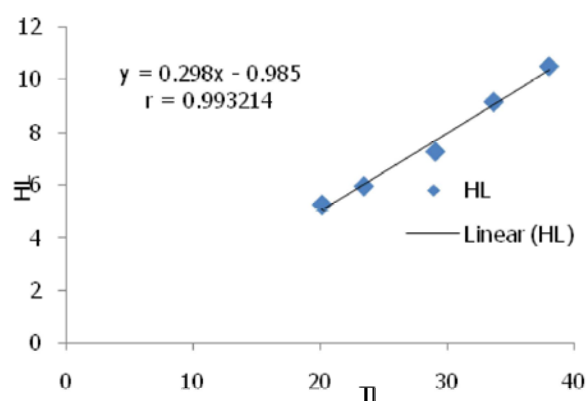

Fig. 2: Relationship between head length (HL) and total length (TL).

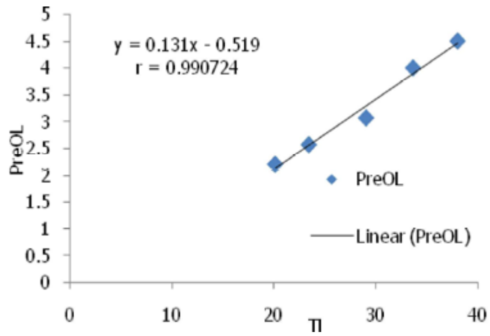

Fig. 3: Relationship between pre-orbital length (PreOL) and total length (TL).

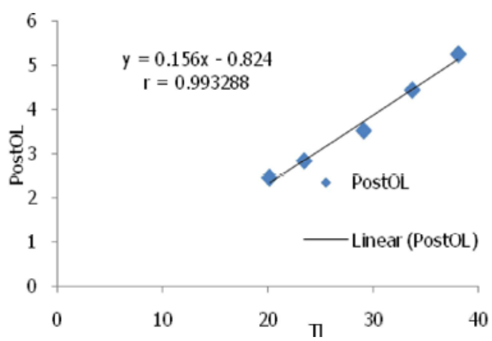

Fig. 4: Relationship between post-orbital length (PostOL) and total length (TL).

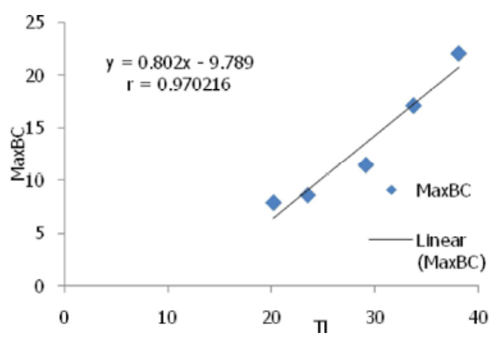

Fig. 5: Relationship between maximum body circumference (MaxBC) and total length.

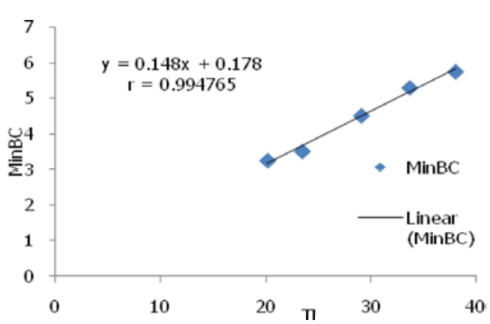

Fig. 6: Relationship between minimum body circumference (MinBC) and total length.

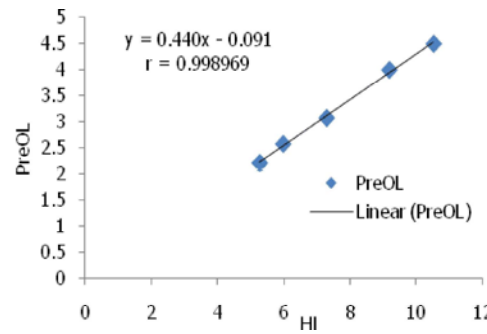

Fig. 7: Relationship between pre-orbital length (PreOL) and head length (HL).

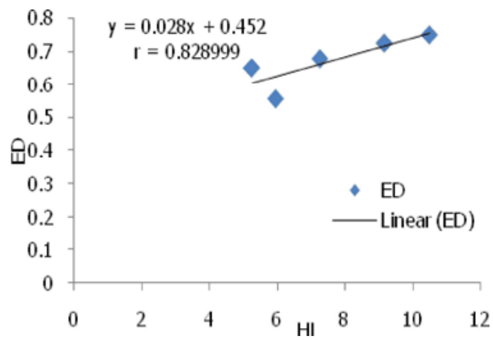

Fig. 8: Relationship between eye diameter (ED) and head length (HL).

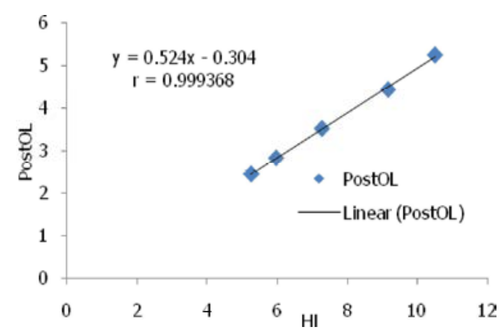

Fig. 9: Relationship between post-orbital length (PostOL) and head length (HL).

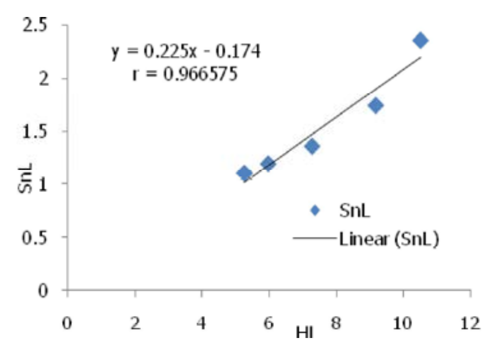

Fig. 10: Relationship between snout length (SnL) and head length (HL).

In relation to total length the percentage values of standard length (88.90), head length (26.25), pre-orbital length (11.22), eye diameter (2.41), post-orbital length (12.66), snout length (5.30), mouth gap (5.55), the maximum body circumference (44.64) and minimum body circumference (15.49) was calculated. Again in relation to head length the percentage values of pre-orbital length (42.74), eye diameter (9.22), post orbital length (48.23), snout length (20.18), mouth gap (21.24) was also calculated. McKay [6] reported for *S. panijus* that the percentage of values of standard length (90.7), head length (25.6) in relation to total length and eye diameter (11.0) and pre-orbital length (40.7) in relation to head length, which is quite similar to the present study, only simple difference may occur due to geographical variation, stock variation, differences in environmental factors, sex variation etc. Rahman, [7, 8] from Bangladesh reported that the maximum length of *S. panijus* was 27.5 cm. Talwar and Jhingran [13] and Huda *et al*. [14] from India also observed that the maximum length of *S. panijus* was 44 cm. Whereas, the present study showed that the maximum length of *S. panijus* was 38.2 cm which is more or less similar with those findings and only simple difference might be occur due to geographical variation.

In case of dorsal fin spines (10), dorsal fin soft rays (27-28), pectoral fin rays (16-20), pelvic fin spines (1), pelvic fin soft rays (5), anal fin spines (2), anal fin soft rays (24-28), caudal fin rays (17-19), scale on lateral line (83-98), scale above lateral line (6-9) and scale below lateral line (10-15) the meristic variations were observed merely. The first dorsal fin contains nine spines including a large trailing second spine; the second dorsal fin has one spine and 27 to 28 soft rays. McKay [6] reported for *S. panijus* the dorsal spines (total): 11; dorsal soft rays (total): 25-27; anal spines: 2; anal soft rays: 24-27; scales on lateral line: 84–90; vertebrae: 42. Rahman [7, 8] reported for Gangetic whiting as two dorsal fins, second spine of first dorsal fin very elongated and filamentous and showed the fin formula: D1. IX; D2. I/26-27; P. 23-24; P2. 6 (1/5); A. II/25-26; S. 90-93. Talwar and Jhingran [12] from India also observed the morphology of *S. panijus* and showed the fin formula: D X+I 26-27; A II 24-26; P 24; V I 5; S. 84-88. So only the notable variations were observed in case of dorsal fin spines, pectoral fin rays and scale on lateral line. This variation might be due to geographical variation, stock variation, differences in environmental factors, sex variation etc.

In the length-weight relationship the values of 'r' was found to be 0.995756 and the equation was Log BW = 3.480 Log TL–2.913 for Gangetic whiting. The value of coefficient of correlation showed that the relationship between length and weight of the fish was significant ($P<0.01$). The value of exponential in the length-weight equation ($W = aL^b$) was found to be 3.480 for Gangetic whiting respectively which were within the range from 2.0 to 4.0 mentioned by LeCren [14]. Various workers calculated the values of regression coefficient (b) in different fish species and found the value of b>3. Narejo *et al.* [15] calculated the value of regression coefficient, b in *Tenualosa ilisha* were 3.0246 for males and 3.0345 for females. Azadi and Naser [16] reported the values of regression coefficient to be 3.16 for males and 3.20 for females in *Labeo bata* and Quddus [17] reported the value of regression coefficient to be 3.40 in *Gudusia chapra* from Bangladesh. Hile [18] and Martin [19] observed that the value of regression coefficient (b) usually lies between 2.5 and 4.0 in cisco, *Leochthys artedi*. However, a variation in 'b' value might be the result of species variation, stock variation, differences in environmental factors, sex variation etc.

Fecundity: The fecundity of *S. panijus* ranged from173745 and 374077 with the mean fecundity of 310605.1±22833.84. The mean fecundity for the mean total length of 36.06±0.52 cm, mean total body weight of 300.36±24.41 g and mean gonad weight of 28.65±2.98 g. The minimum fecundity (173745) was found in the fish having a total length of 34.6 cm, body weight 155.05 g and gonad weight 11.51 g; while the maximum fecundity (374077) was observed in the fish with a total length of 38.2 cm, body weight 378.22 g and gonad weight 38.89 g. The right lobe was found larger in most cases than that of the left one at the ripe stage.

Monthly Variation of Fecundity and Other Parameters: The values of fecundity and other parameters such as total length, body weight, gonad weight, GSI were showed some differences during the breeding months (August-September).

Variation of Fecundity: The highest level (339017.81±14676.71) of fecundity was observed in August and lowest value (282192.47±41520.15) was found in September.

Variation of Total Length (cm): In August, the total length of *S. panijus* was 36.04±0.87 cm while in September it was 36.08±0.69 cm. The lowest value was found in August and highest value in September. The total length of *S. panijus* increased with increasing month. The total length in two different months and the mean total length (36.06±0.52 cm) had no significant differences. The author found that the total length of *Polynemus paradiseus* in two months (May and June) was approximately similar.

Variation of Body Weight (g): Two different levels of body weight were found in two different months- August and September. The highest body weight was observed in August (348.48 ± 10.97 g) and lowest level was found in September (252.23 ± 37.40 g). This was due to decrease in gonad weight. Peak gonad weight was found in August.

Variation of Gonad Weight (g): A decreasing trend in gonad weight of *S. panijus* was found in two months. The highest value was found (34.74±1.55 g) in August and the lowest value was (22.56±4.34 g) in September.

Variation of Gonadosomatic Index (%): The gonadosomatic index is an indicator of the state of gonadal development. The highest average value of GSI was found 9.95±0.15% in August and lowest average value was 8.67±0.58% in September. Decreasing in GSI value indicates decreasing development of the gonads during August to September which indicates the peak season in August. It is familiar that the gonadosomatic index increases with the maturation of fish, being maximum during the period of peak maturity and declining abruptly thereafter [20]. Fatima [21] found high value of GSI of *Rhinomugil corsula* in May and June. Breeding season of R. *corsula* extending from July to August at contains coast, West Bengal [22] and June to July at Barracrpore, Krishnagiri and Sathnur [23] based on the large number of fries in these months.

Relationship Between Fecundity and Other Parameters: To establish the mathematical relationship between fecundity and other parameters, the values of correlation coefficient (r) were established by using the statistical formula:

$$y = a + bx$$

Linear and positive co-relationships were obtained between fecundity and total length and expressed as Y=20693X-39511; (r=0.875464), fecundity and body weight and expressed as Y=840.9X+61471; (r=0.943848), fecundity and gonad weight and showed as Y=7546X+94066; (r=0.947309), body weight and gonad weight was also found linear and expressed as Y=0.116X-5.733; (r=0.988880) (Figs.11-14). All the relationship was significant at 1% level. Similarly a linear relationship between fecundity and other parameters has been reported in different fish species like *Mystus gulio* [24]; *Mystus cavasius* [25]; *Etroplus suratensis* [26]; *Channa gachua* [27]; *Labeo boggut* [28]; *Hilsa ilisha* [29] and *Mystus bleekeri* [30].

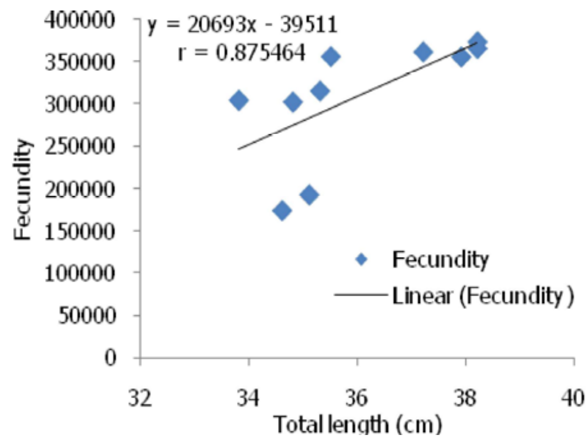

Fig. 11: Relationship between fecundity and total length.

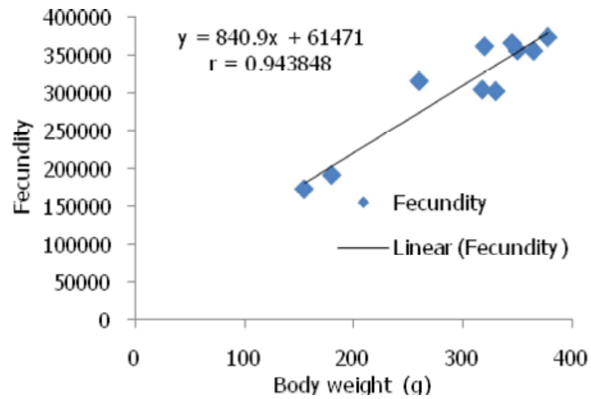

Fig. 12: Relationship between fecundity and body weight.

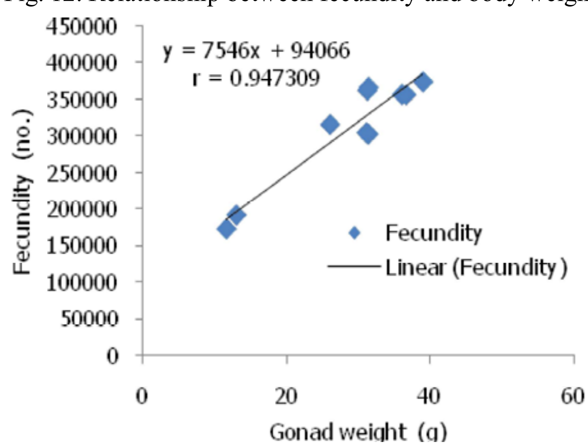

Fig. 13:Relationship between fecundity and gonad weight.

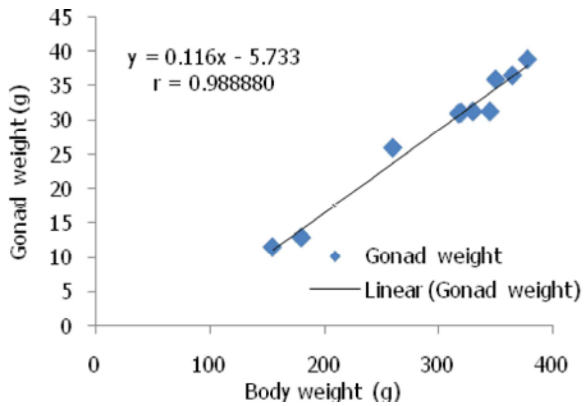

Fig. 14: Relationship between gonad weight and body weight.

The relationship with fecundity was stronger (r=0.943848) in case body weight than total length (r=0.875464) where as strongest correlation was found between fecundity and gonad weight (r=0.947309). This finding agrees with the conclusion reached for catfish, *Mystus tengra* [31], for *Glossogobius giuris* [32].

The largest individual fish with total length 38.2 cm and body weight 378.22 g was observed to carry 374077 eggs and the smallest sized fish with total length of 34.6 cm and body weight 155.05 g was found to carry 173745 eggs. But the variation of fecundity was found even in the similar sized female with equal length. In the present study a fish measuring 38.2 cm in total length, 378.22 g in body weight and 38.89 g in gonad weight produced 374077 eggs, whereas another fish of the same total length 38.2 cm, body weight 345.43 g and gonad weight 31.3 g produced 366490 eggs. Variation in the fecundity of the fish in the same length class was found in the study which indicates that the fecundity of a fish is not solely dependent on its length. This comment agrees with the findings of Kader [33] in *Lepturacanthus savala* and Aziz [34] in *Sillago domina.* This variation may occur due to body weight and gonad weight variation.

The ovaries of quite same size of fishes contained different numbers of eggs. In the present study a fish measuring 31.28 g in gonad weight produced 302880 eggs, whereas another fish of the quite same gonad weight 31.3 g produced 366490 eggs. This variation may occur due to the variations in environmental conditions and food intake by the individual. The variation in fecundity is very common in fish and has been reported by many researchers [35, 36]. Numerous factors like different stock of fish, nutritional status [37], racial characteristics [38] and time of sampling, maturation stage and changes in environmental parameters [35] have so far been reported to affect the fecundity both within the species and between fish populations. Doha and Hye [39] reported that the variation of fecundity is very common and observed in fishes and the number of eggs produced by an individual female is dependent on several factors like size, age, environmental conditions. Reproductive potential of the fishes is also influenced by availability of space and food. So, variation in fecundities during the present study was not an exception.

The right lobe was found larger in most cases than that of the left one at the ripe stage. In the present study, the mean weight of right lobe was found 15.13±1.58g and mean weight of left lobe was found 13.53±1.4g. Hartman and Conkle [11] observed that 90 percent of the left ovaries of Salmon held more eggs than the right side. The data for the king Salmon in Japanese waters [40] do not show significant differences in egg numbers between the two ovaries. This variation might be the result of species variation. As fisheries items are the major protein contributing sources of Bangladesh [41], so their sustainable exploitation and management are badly needed.

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