Original Research Article

The Fecundity, Total Length, Body Weight, and Gonadal Length-Weight Relationships of Hilsa Shad (*Tenualosa ilisha*) in Bangladesh

Abstract

The present investigation of the fecundity of *Tenualosa ilisha* was conducted to estimate the range and the average number of ova laid by the individual female during the breeding season and to establish a mathematical relationship of the fecundity (F) with total length (TL), total weight (TW), gonadal length (GL) and gonadal weight (GW). To determine the fecundity of Hilsa, ovaries of 20 species ranging from 37.60 cm to 49.90 cm were studied. Only ovaries containing nearly mature eggs were used for this study. The total number of ova was calculated for each specimen by multiplying the estimated number of ova in the sample by the ratio of the total weight of ovary to the weight of the sample. The largest specimen (total length 499 mm and body weight 1252g) was found to carry 22,72,864 eggs, and the smallest sized fish (total length 376 mm and body weight 617g) was found to carry 8,35,461 eggs. Statistical analysis revealed that the relationship between fecundity and TL, TW, GL, and GW was found to be significant at 5% level ($p<0.05$). It was also revealed about significant 't' values that the fecundity increases linearly with the increase of total length, total weight, and gonadal weight.

Keywords: Hilsa, Fecundity, *Tenualosa ilisha*, Bangladesh

Introduction

Estimation of fecundity of a fish is essential for evaluating the commercial potentialities of its stock, life history, practical culture and actual management of the fishery (Rahimibashar *et al.*, 2012). The term "fecundity" can be expressed as the number of eggs present in the ovary that should be laid in a single species, not in a constant number but fluctuates within certain ranges which is species specific. The number of eggs contained in the ovary of a fish is termed as fecundity. Fecundity is an important aspect of the biology of fishes that must be understood to explain the variations in the level of population, as well to make efforts to increase the amount of

harvest. In order to assess the population stock of any species the accurate estimation of the fecundity is essential. Fecundity can also be defined as the number of ova that are likely to be laid by a fish during the spawning seasons. According to Bagenal (1978), it is the number of eggs found in the female just prior to the spawning.

An important aspect of reproductive biology is fecundity which gives information on the number of eggs in the ovary before the next spawning season (Bagenal, 1978). Studies on fecundity of fish species are pertinent and useful for systematics in racial studies related to total population estimation and productivity. Fecundity represents the reproductive potential and estimation of abundance of a population. Few studies have been conducted on the fecundity of hilsa till now. (Saifullah *et al.* 2004) did a fecundity study of Hilsa in Bangladesh water and found that the body weight is the best fecundity indicator. Spawning frequency of female hilsa was high in October (GSI=10.2) and low in April (GSI=6.77). For females, the fecundity was 87,267 to 614,482 in 210 mm to 350 mm length size group of female Hilsa. Geometric mean fecundity of Hilsa was recorded 587,919 by (Panhwar *et al.* 2013). The present investigation of the fecundity of *Tenualosa ilisha* was conducted to estimate the range and the average number of ova laid by individual female during the breeding season and to establish a mathematical relationship of the fecundity (F) with total length (TL), total weight (TW), gonadal length (GL) and gonadal weight (GW).

Materials and Methods

Sampling of fish

Hilsa fish sample were collected from two different locations of Bangladesh, upper Meghna river at Chandpur and Tentulia river at Barisal district of Bangladesh. Sampling was conducted during July 2012 to June 2013 in Meghna river and July 2013 to June 2014 in Tentulia river. Samples were collected once a month and 20 mature female hilsa were collected. Hilsa were caught in the river during night using gill nets primarily. All specimens were preserved with crushed ice in cool fish boxes and brought to the laboratory as soon as possible.

Collection of Gonad and Sex Determination

The body cavity of fish was opened carefully by scissors and gonads were collected with forceps carefully. Other constitutional units such as muscles, fat tissues, digestive organs and blood veins etc. were taken away properly. Body weight (BW) and gonad weight (GW; both left and right gonads) were measured to the nearest 0.001g. Total length (TL) and gonad length (GL) were also

measured to the nearest 0.01cm. After weighing, gonads were preserved with 10% formalin in small vials for further investigation.

Observation of Ovarian External Features

General features and structure as well as month-wise size, shape and color of female gonads of *T. ilisha* were studied during sample collection and preservation. In hilsa gonads, left gonad was larger than right one, both in length and width. External feature of both ovaries were observed by naked eye and under magnifying glass, the various maturity stages were classified based on external observation of ovaries.

Fig. 1 Observation of external features of egg

Determination of the Fecundity of Hilsa

For the determination of the fecundity of hilsa, ovaries of 20 species ranging from 37.60 cm to 49.90 cm were studied. Only ovaries containing nearly mature eggs were used for this study. All possible precautions were taken to exclude spent fish or fish that were insufficiently mature. The ovaries were hardened in 5% formaldehyde for a period of not less than a week before estimating the number of ova in each. Only ova visible to the naked eye were counted. After removal of the surface moisture, ovaries were weighted to the nearest milligram in a chemical balance. A small sample of approximately 2.0 g was removed from the central portion and weighed to the nearest milligram. The ova in the sample were teased the follicle and counts were made of all ova composing the mature growing visible to naked eye. The total number of ova was calculated for each specimen, by multiplying the calculated number of ova in the sample by the ratio of the total weight of ovary to the weight of sample.

Statistical analysis of data

The statistical analysis and graphical representation were done using the Microsoft Excel 2017 software.

Results

External Features of Hilsa Ovaries

The ovary of the female *Tenualosa ilisha* is bi-lobed elongated and located in the body cavity. The shape, size and color of the ovary considerably according to the degree of maturation of the oocytes; the immature ovary is small reddish and transparent in nature which turns into yellowish in ripe condition. The immature ova is microscopic in size, transparent and without yolk, but with the advancement of the stages, the ova becomes large and opaque. In the ripe stage, the ova are yellowish in colour attaining maximum size.

Fecundity of Hilsa

From the study of 20 female fish ovaries, it was found that the individual fecundity of fish varied from 8,35,461 eggs (for smallest sized fish with a total length 379 mm and body weight 836 g) to 2272864 eggs (for a fish with a total length 499 mm and total body weight 1252g). The mean fecundity of 20 females was recorded as 14.84.103±97822 eggs with mean total length 41.10±0.94 mm and mean body weight of 818.40± 41.60g (Table 1). The highest GSI value was found 17.65 with a gonad length of 13.90 cm and gonad weight 109.07 g whereas the lowest GSI value was found 12.11 with gonad length of 13.90 cm and gonad weight of 86 g (Table 1). The Adjusted R Square value was observed 0.313 for the Summary Model of F/TL, F/TW, F/GL and F/GW relationships of *T. ilisha* (Table 2). The t value is -0.929 at 0.368 significance level, 1.967 at 0.068 significance level, 0.795 at 0.455 significance level, -0.255 at 0.803 significance level, 0.795 at 0.439 significance level (Table 3). Fecundity of hilsa was found to be significantly correlated with gonad weight at 5% level of significance (.619). Total body length was recorded to be significantly correlated with fecundity and gonad weight at 5% level of significance (0.444, 0.713). Body weight was found to be significantly correlated with total body length at 5% level of significance (0.536) (Table 4).

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Table-1: Total length, total weight, gonadal length, gonadal weight, gonadosomatic index and estimated fecundity of 20 gravid females of *Tenualosa ilisha*.

S.L. No	Total length (TL) (cm)	Total weight (TW) (g)	Gonadal length (GL) (cm)	Gonadal weight (GW) (g)	Gonado Somatic Index (GSI)	No. of ova (Fecundity)
1	37.70	710.00	13.90	86.00	12.11	899732
2	38.50	736.00	14.80	126.00	17.12	1831284

3	39.60	744.00	15.80	114.00	15.32	1574796
4	49.90	874.00	13.70	144.00	16.48	1218096
5	39.80	790.00	13.40	126.00	15.95	1459962
6	39.20	672.00	12.70	102.00	15.18	941868
7	49.90	1175.00	13.70	193.60	16.48	2272864
8	37.80	618.00	14.00	102.00	16.50	1346094
9	39.60	778.00	14.70	112.00	14.58	1342208
10	44.50	1220.00	15.50	195.91	16.06	1834109
11	37.90	836.00	13.90	87.00	10.41	835461
12	39.20	730.00	14.80	125.00	17.12	1193750
13	39.60	810.00	15.80	117.00	14.44	1341054
14	49.90	874.00	13.70	149.00	17.05	2165566
15	40.20	790.00	13.40	121.00	15.32	1671494
16	39.20	672.00	12.70	107.00	15.92	958613
17	44.60	1252.00	17.00	200.00	15.97	2117400
18	37.80	617.00	13.90	109.07	17.65	1007152
19	39.60	768.00	14.60	125.00	16.28	1792500
20	37.60	702.00	14.50	112.00	15.95	1478064
Mean	41.105 ±0.94	818.4 ±41.61	14.32 ±0.24	127.69 ±7.48	15.59 ±0.38	14,84,103 ±97822

Table-2: Summary Model of F/TL, F/TW, F/GL and F/GW relationships of *T. ilisha.*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.677[a]	0.458	0.313	3.18712E5

a. Predictors: (Constant), Body weight (g), Gonad length (cm), Gonad weight (g), Total body length (cm)

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Table-3: Regression co-efficient (b), intercepts (a), in the F/TL, F/TW, F/GL and F/GW relationships of T. ilisha.

Un-standardized Coefficients		Standardized Coefficients	t Value	Significance level
B	Std. Error	Beta		

-1.681	1.810		-0.929	0.368
13784.057	7008.150	0.642	1.967	0.068
79289.927	103284.297	0.170	0.768	0.455
-11006.776	43152.114	-0.101	-0.255	0.802
978.187	1231.117	0.212	0.795	0.439

a. Dependent Variable: No of ova (Fecundity)

Table-4: Regression correlation co-efficient in the F/GW, F/GL, F/TL and F/TW, relationships of *T. ilisha.*

Comment [5]: Correlation matrix between Feundity and various body parameters of *T. ilisha*

		No of ova (Fecundity)	Gonad weight (g)	Gonad length (cm)	Total body length (cm)	Body weight (g)
No of ova (Fecundity)	Pearson Correlation	1				
	Sig. (2-tailed)					
	N					
Gonad weight (g)	Pearson Correlation	0.619**	1			
	Sig. (2-tailed)	0.004				
	N	20	20			
Gonad length (cm)	Pearson Correlation	0.272	0.094	1		
	Sig. (2-tailed)	0.247	0.692			
	N	20	20	20		
Total body length (cm)	Pearson Correlation	0.444*	0.713**	-0.158	1	
	Sig. (2-tailed)		0	0.507		
	N	20	20	20	20	
Body weight (g)	Pearson Correlation	0.278	0.154	0.12	0.536*	1
	Sig. (2-tailed)	0.236	0.517	0.614	0.015	
	N	20	20	20	20	20

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed).

Discussions

The variation of fecundity is very common in fish (Doha & Hye, 1970) and the number of eggs produced by an individual female is dependent on various factors like size, age, condition and type of species of the sample (Lagler *et al.*, 1967). Mookeerjee & Mazumder (1946) have concluded from the breeding experiments that the reproductive capacity of the species varies according to the availability of space and food etc. The largest specimen (total length 499 mm and body weight 1252g) was found to carry 22,72,864 eggs and the smallest sized fish (total length 376 mm and body weight 617g) was found to carry 8,35,461 eggs. But variation was found in the fecundity of fish of equal length. A fish measuring 441mm in total length, 1018g in body weight and 79.78g in gonadal weight produced 9,24,436 eggs, whereas another fish of the same total length produced 9,48,840 eggs. This type of variation was also found in the fish with total length of 540mm. The same type of variation was also reported by Hamilton (1822) and Hora (1938) in the same species. From the statistical analysis it was revealed that the relationship between fecundity and TL, TW, GL and GW were found significant at 5% level ($p<0.05$). It was revealed from the significant 't' values that the fecundity increases linearly with the increase of total length, total weight and gonadal weight. The values of correlation co-efficient between fecundity and other parameters showed that variation in fecundity can be explained very clearly in terms of body weight of a fish. The significant linear relationships between fecundity and TL, TW and GW were also reported earlier by Doha & Hye (1970) from the same fish, and that the other fish by Kader & Talukder (1978) and Alam *et al.* (1997). Gonadosomatic index (GSI) value was found to vary from 10.41 to 17.65. This research work indicated that the fecundity of *Tenualosa ilisha* from Tentulia River near Chandramohan in Barisal was significantly correlated with the TL, TW and GW and TW was the best indicator of fecundity of *Tenualosa ilisha* and the fecundity was highly correlated with GW. Akter *et al.* (2007) made an experiment on the fecundity of *Tenualosa ilisha* from the river Padma and observed that fecundity (F) was found to vary from 5,58,700 to 18,67,000, mean 12,39,360.35 ± 405068.97 for the fishes with 350-557mm in total length and mean 455.25± 59.94mm and with 600 -1775g in total body weight and mean 1181.85± 356.12g. Saifullah *et al.* (2004) found fecundity (F) was found to be ranged from 10,30,951 to 19,40,620

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(mean 13,77,884±2,90,145) in fishes between 39 and 51 cm total length (TL) with the mean of 44.08±3.84 cm.

Conclusion

The largest specimen (total length 499 mm and body weight 1252g) was found to carry 22,72,864 eggs and the smallest sized fish (total length 376 mm and body weight 617g) was found to carry 8,35,461 eggs. But variation was found in the fecundity of fish of equal length. A fish measuring 441mm in total length, 1018g in body weight and 79.78g in gonadal weight produced 9,24,436 eggs, whereas another fish of the same total length produced 9,48,840 eggs. This type of variation was also found in the fish with a total length of 540mm. From the statistical analysis, it was revealed that the relationship between fecundity and TL, TW, GL and GW was found significant at 5% level ($p<0.05$). It was revealed from the significant 't' values that the fecundity increases linearly with the increase of total length, total weight and gonadal weight. The values of correlation co-efficient between fecundity and other parameters showed that variation in fecundity can be explained very clearly in terms of the body weight of a fish.

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