ESTIMATION OF THE FECUNDITY OF THREATENED *CHAGUNIUS CHAGUNIO* FROM ATRAI RIVER (DINAJPUR, BANGLADESH)

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ABSTRACT

An investigation was carried out to assess the fecundity of *Chagunius chagunio.* A total of 50 gravid females were collected and then divided into various groups of length and weight, respectively. The fecundity ranged from 1,038 to 22,174 with a mean value of 6,201.46 ± 4,068.25 for a corresponding length and weight of 15.2 cm to 31 cm and 35.98 g to 427.99 g respectively. The fecundity increased with the total length, body weight, and ovary weight following the equation, Y = 1,081.59X-1,6025, (r = 0.76, 0.80, 0.90). The regression line for the TL, BW, GL, and GW of the sample fishes was linear when plotted against their fecundity. The present study's findings will help recognize the proper breeding season of *Chagunius chagunio.*

RÉSUMÉ: Estimation de la fécondité du *Chagunius chagunio* menacé de la rivière Atrai (Dinajpur, Bangladesh).

Une enquête a été menée pour évaluer la fécondité de *Chagunius chagunio*. Au total, 50 femelles gravides ont été collectées puis divisées en différents groupes de longueur et de poids, respectivement. La fécondité variait de 1.038 à 22.174 avec une valeur moyenne de 6.201,46 ± 4.068,25 pour une longueur et un poids correspondants de 15,2 cm à 31 cm et de 35,98 g à 427,99 g respectivement. La fécondité augmentait avec la longueur totale, le poids corporel et le poids des ovaires selon l'équation Y = 1081,59X-16025, (r = 0,76, 0,80, 0,90). La droite de régression pour les TL, BW, GL et GW des poissons de l'échantillon était linéaire lorsqu'elle était comparée à leur fécondité. Les résultats de la présente étude aideront à reconnaître la bonne saison de reproduction de *Chagunius chagunio*.

REZUMAT: Estimarea fecundității speciei amenințate *Chagunius chagunio* din râul Atrai (Dinajpur, Bangladesh).

A fost efectuată o investigație pentru a evalua fecunditatea lui *Chagunius chagunio*. Un total de 50 de femele gravide au fost colectate și apoi împărțite în diferite grupuri de lungime și, respectiv, greutate. Fecunditatea a variat de la 1038 la 22174 cu o valoare medie de 6.201,46 ± 4.068,25 pentru o lungime și o greutate corespunzătoare de 15,2 cm la 31 cm și, respectiv, 35,98 g la 427,99 g. Fecunditatea a crescut odată cu lungimea totală, greutatea corporală și greutatea ovarului în urma ecuației, Y = 1081,59X-16025, (r = 0,76, 0,80, 0,90). Linia de regresie pentru TL, BW, GL și GW ale peștilor eșantion a fost liniară atunci când a fost trasată în funcție de fecunditatea lor. Rezultatele prezentului studiu vor ajuta la recunoașterea sezonului adecvat de reproducere la *Chagunius chagunio*.

INTRODUCTION

Chagunius chagunio (Hamilton, 1822) is a freshwater cyprinid (Cyprinidae) popularly known as keintha puthi, peeth keintha or puthi keintha in Assam. It is well-known in Bangladesh as "Pathorchatta" or "Ghol" or "Daringhi" or "utti" in a different region. (Talwar and Jhingran, 1991) It is a favorite fish amongst the local people of Dinajpur for its beauty, covetable taste, and flavor. The fish inhabits large rivers characterized by rocky bottom, clear and fast running water and little or no vegetation (Rahman, 2005) Adults are found to inhabit stronger current than juveniles. It attains a maximum length of about half a meter, reaches maturity at the size of 200 to 250 mm. It offers a good sport on a small hook and comes out on paste. As per the IUCN (2015) status, this fish species has been categorized as the red list of threatened species, but in the near future, it is likely that over-exploitation and habitat destruction may pose a major threat to it. Fecundity may be expressed in terms of the number of eggs produced per brood fish in a breeding season (Vishwanath, 2010). It is sometimes referred to as total or absolute fecundity or more usually just as fecundity (Ahamed et al., 2020). Fecundity may be expressed per unit body weight of post stripped fish when it is known as relative fecundity because the number of eggs produced for each unit increase in weight shows significant linear variation. However, it is a useful working index for the farmer because it allows egg production capability (Alam, 2005). Knowledge of fecundity may also be used to assess the reproductive potential of the spawning stock. This is important from the point of view of biology and the management of the local fish. To evaluate the commercial potentialities of fish stock, information on the fecundity of the fish composing the stock is essential. This is because there are the fertilized eggs that develop into the subsequent recruits to the fishable shoals.

It is important to know the number of eggs, fry and young that could be produced from individual brood fish for the purpose of fisheries management and the aquaculture industry. The number of eggs produced has obvious significance in aquaculture, since the size of brood stock, the number of rearing facilities, and the necessity of equipmentsnt's are dependent on it (Ahamed et al., 2023). Therefore, thorough scientific investigations are of utmost necessity for the conservation of the species in the state on one hand and its propagation through the method of breeding and culture on the other. Such an approach will ultimately help in the restoration of the species as well as boost its economic status. The present research on *C. chagunio* regarding fecundity will be helpful for its successful propagation. Based on the above mentions, the present study was undertaken to estimate the fecundity of *C. chagunio* with imperial relationship between fecundity and other parameters like body length, body weight, gonad length, and gonad weight.

MATERIAL AND METHODS

This study was conducted in the Bangladesh Fisheries Research Institute Freshwater Sub-Station, Saidpur, Nilphamari Biology Laboratory. The specimens of *C. chagunio* were collected from the Atrai River (25°55'N-88°43'N) at Rabar Dam located at Mohonpur in Dinajpur District (Figs. 1a,b). The river is believed to be an important spawning and feeding ground for many riverine fish species of Bangladesh.

Investigation period

In order to study the fecundity of the *C. chagunio* the experiment was conducted during the period from July to December, 2019.

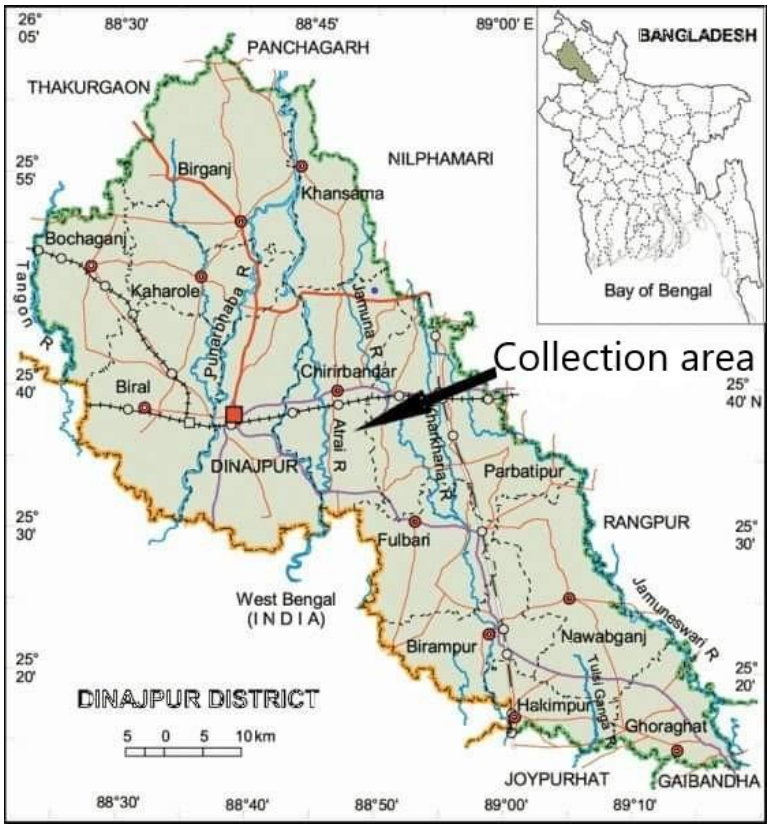

Figure 1a: Map of Atrai River area.

Figure 1b: Sampling site of the Atrai River rubber.

Sample collection

The fish samples were collected early in the morning in fresh condition directly from the local fisherman. The fishes were caught by operating a cast net (Jhaki Jal). After collecting the fish samples, female fishes were identified according to their special characters on the basis of external features. For this research work, a total number of 50 gravid females were collected to study the fecundity. After collection, the fishes were kept in ice and carried immediately to the laboratory of BFRI, Freshwater Sub-Station, Saidpur, Nilphamari.

Measurements

The total length, standard length and the body weight of each specimen were recorded separately to the nearest cm scale and g respectively. The total length was measured from anterior part of the head with the jaws closed to the posterior end of the caudal fin. The standard length of the specimens was measured from the tip of the snout to the base of the caudal fin. These measurements were recorded in cm by a steel scale. The weight of the specimens was taken by an electric balance and the weights were recorded to the nearest g. For the accuracy of weighing excess moisture attached to the fish was dried off with the help of blotting paper before taking the weight.

Collection of the ovaries

The fishes were washed properly with fresh water. After that the fishes were dissected out by scissors starting from anus to lower jaw and the belly was opened. The whole mass (stomach, intestine, and the ovary) were removed carefully and placed on a petridis. Stomach and intestine were removed carefully from the ovarian wall by means of fine forceps. Ovary was washed and cleaned with distilled water. Weight and length of the ovaries were taken and color of the ovaries were observed and recorded. Ovary was then kept into boiling water for 10 minutes and finally after collecting ovary from the boiling water it was then preserved in 10% buffered formalin solution for fecundity study

Fecundity estimation

There are several methods for the estimation of fecundity of fish in case of highly fecund fishes. When the actual counting of eggs is impracticable, approximate fecundity may be obtained by one of the following methods as outlined by Lagler (1949).

(1) Volumetric Method
(2) Gravimetric method
(3) Van Bayer method

$$Fecundity = \frac{Total\ weight\ of\ ovary \times Average\ number\ of\ egg}{Average\ sub - sample\ weight}$$

Data analysis

The relationship of different parameters such as total length, standard length, body weight, total length on fecundity, standard length on fecundity, body weight on fecundity, ovary length on fecundity, ovary weight on fecundity, were determined as simple linear relationship with the help of Microsoft Excel and coefficient of correlation (r), regression co-efficient (b) and regression equation were also determined.

RESULTS AND DISCUSSION

Morphology of the experimental fish

Body elongated with its depth slightly more than head length, mouth narrow and sub-terminal; barbells two pairs, longer than orbit, eye diameter 5 to 6.5 times in head, dorsal spine strong and serrated, the denticles strong and recurved, tubercles on snout and cheeks of females smaller than those of male. The colour of the body in a living specimen is silvery with a pinkish tinge, black at scale margins, accentuated at bases giving a spotted appearance. Fins are reddish with light outer edges. The apex of dorsal fin is black. The young has black batches of scales developing irregularly causing random crescentic vertical streak along upper part of the body.

Morphology of ovary

The ovary of *C. chagunio* was a paired, laterally compressed structure situated along the body cavity, beneath the air bladder closely allied to the body wall. Although it was paired, it was separated into two lobes by a common membrane which means the ovaries were fused together with a fine layer of membrane. The weight of the ovary ranged from 1.13 to 20.12 g (Tab. 1). The color of the ovaries was yellowish in color. The mature ova were randomly distributed throughout the length of the ovary.

Table 1: Mean ± SD of total length, standard length, body weight, gonad length, gonad weight, and absolute fecundity of *C. chagunio* based on length group.

Class interval (cm)	Parameters					Absolute fecundity
	TL (cm)	SL (cm)	BW (g)	GL (cm)	GW (g)	
15.1-18.0	17.05 ± 1.04	13.88 ± 0.89	67.74 ± 24.85	4.48 ± 0.82	2.61± 1.5	3463.39 ± 2639.34
Range	15.2-18.0	12.5-14.6	35.98-120.6	3.8-6.0	1.25-4.95	1423.24 ± 7729.62
18.1-21.0	19.79 ± 0.75	16.12 ± 0.77	101.95 ± 25.11	5.18± 0.81	4.35± 2.67	5585.83 ± 2726.98
Range	18.5-21.0	15.2 17.4	69.9-182.0	4.2-7.0	1.13 - 12.61	1038.23-10607.24
21.1-24.0	22.1 ± 0.87	18.31 ± 0.58	132.09 ± 22.96	5.79 ± 0.60	5.03± 1.42	6628.14 ± 2487.11
Range	21.1-24.0	17.5-19.5	110.3-177.28	4.8-6.5	2.34-.26	2847.63-10511.88
24.1-above	29.4 ± 2.66	24.85 ± 2.33	352.67 ± 106.53	8.0± 1.41	14.88± 7.42	19186.48 ± 4226.14
Range	27.8-31.0	23.2-26.5	277.34-427.99	7.0 9.0	9.63-20.12	16198.15-22174.81
Mean±SD	20.55 ± 2.85	16.89 ± 2.54	118.13 ± 64.55	5.39± 1.06	4.76± 3.34	6201.46 ± 4068.25
Range	15.2-31.0	12.5-26.5	35.98-427.99	3.8-9.0	1.13-20.12	1038.23-22174.81

Fecundity

For the estimation of fecundity, 50 gravid fishes of *C. chagunio* were collected from Atrai River. The fecundity of *C. chagunio* was varying from (1,038 to 22,174) while the total length, standard length, body weight, gonad length, gonad weight, and absolute fecundity were found to a range of 15.2 to 31 cm,12.5 to 26.5 cm, 35.98 to 427.99 g, 3.8 to 9 cm, 1.13 to 20.12 g, and 1,038 to 22,174 eggs respectively. The mean fecundity 6,201.46 ± 4,068.25, mean total length 20.55 ± 2.8, mean standard length 16.89 ± 2.54, mean body weight 118.13 ± 64.55, mean gonad length 5.39 ± 1.06, and mean gonad weight 4.76 ± 3.34 of *C. chagunio* were recorded during the study period (Tab. 1).

Relative fecundity

The relative fecundity values derived in terms of body length, body weight, and gonad length, gonad weight which are given in tables 2-5. Relative fecundity values varied between 204.81 to 648.99 cm^{-1} total length, 51.81 to 58.40 g^{-1} body weight, 712.80 to 2388.94 cm^{-1} gonad length and 1302.13 to 1682.05 g^{-1} gonad weight (Tabs. 2-5).

Table 2a: Mean value of relative fecundity in terms of total length and gonad length of *C. chagunio*.

Class interval TL (cm)	TL (cm)	GL (cm)	Absolute fecundity	Relative fecundity	
				cm^{-1} total length	cm^{-1} gonad length
15.1-18.0	15.2-18.0	3.8-6.0	3463.39±2639.34	204.81±157.34	712.80±396.08
18.1-21.0	18.5-21.0	4.2-7.0	5585.83±2726.98	281.39±134.94	1057.44±460.12
21.1-24.0	21.1-24.0	4.8-6.5	6628.14±2487.11	297.66±105.63	1132.17±399.13
24.1-above	27.8-31.0	7.0-9.0	19186.48±4226.14	648.99±93.79	2388.94±105.95
Mean ± SD	15.2-31.0	3.8-9.0	6201.46±4068.25	290.12±152.03	1081.89±524.56

Table 2b: Mean value of absolute fecundity in terms of body weight and gonad weight of *C. chagunio*.

Class interval (g)	Parameters				Absolute fecundity
	BW (g)	TL (cm)	GL (cm)	GW (g)	
1.0-125.0	94.17±23.36	19.56±1.78	5.11±0.85	3.88±2.86	940.17±2661.91
Range	35.98 -122.0	15.2 -21.7	3.8 -7.0	1.13 -12.61	1038.23 - 10607.24
126.0-250.0	155.37±21.01	22.31±1.55	5.88±0.70	5.75±1.13	000.38±1965.45
Range	126.62 -182.0	19.0 -24.0	4.5 -6.5	4.01 -7.26	4439.64 - 10511.88
251.0-375.0	277.34±0.0	27.38±0.0	7.0±0.0	9.63±0.0	16198.15±0.0
Range	277.34	27.38	7.0	9.63	16198.15
376.0-above	427.99±0.0	31.0±0.0	9.0±0.0	20.12±0.0	22174.81±0.0
Range	427.99	31.0	9.0	20.12	22174.81

Table 3: Mean ± SD of total length, standard length, body weight, gonad length, gonad weight and absolute fecundity of *C. chagunio* based on weight group.

Class interval (g)	Parameters				Absolute fecundity
	BW (g)	TL (cm)	GL (cm)	GW (g)	
1.0-125.0	94.17 ± 23.36	19.56 ± 1.78	5.11 ± 0.85	3.88 ± 2.86	4940.17 ± 2661.91
Range	35.98-122.0	15.2-21.7	3.8-7.0	1.13-12.61	1038.23-10607.24
126.0-250.0	155.37 ± 21.0	22.31 ± 1.55	5.88 ± 0.70	5.75 ± 1.13	8000.38 ± 1965.45
Range	126.62-182.0	19.0-24.0	4.5-6.5	4.01-7.26	4439.64-10511.88
251.0-375.0	277.34 ± 0.0	27.38 ± 0.0	7.0 ± 0.0	9.63 ± 0.0	16198.15 ± 0.0
Range	277.34	27.38	7.0	9.63	16198.15
376.0-above	427.99 ± 0.0	31.0 ± 0.0	9.0 ± 0.0	20.12 ± 0.0	22174.81 ± 0.0
Range	427.99	31.0	9.0	20.12	22174.81

Table 4: Mean value of absulate fecundity in terms of body weight and gonad weight of *C. chagunio*.

Class interval BW (g)	BW (g)	GW (g)	Absolute fecundity	Relative fecundity	
				g^{-1} body weight	g^{-1} gonad weight
1.0-125	35.98	1.13-12.6	4940.17±2661.9	52.36±25.40	1323.01±500.1
126.0-250.0	126.62-182	4.01-7.26	8000.38±1965.4	52.41±13.88	1388.25±226.3
251.0-375.0	277.34	9.63	16198.15±0.0	58.40±0.0	168205±0.0
376.0-above	427.99	20.12	22174.81±0.0	51.81±0.0	1102.13
Mean ± SD	35.98-42.9	3.8-9	6201.45±4068.2	52.50±22.84	1338.73±450.3

Table 5: Mean value of relative fecundity in terms of body weight and gonad weight of *C. chagunio*.

Class interval BW (g)	BW (g)	GW (g)	Absolute fecundity	Relative fecundity	
				g^{-1} body weight	g^{-1} Gonad weight
1.0-125	35.98	1.13-12.61	4940.17±2661.91	52.36±25.40	1323.0±500.13
126.0-250.0	126.62-182	4.01-7.26	8000.38±1965.4	52.41±13.88	1388.25±226.3
251.0-375.0	277.34	9.63	16198.15±0.0	58.40±0.0	168205±0.0
376.0-Above	427.99	20.12	22174.81±0.0	51.81±0.0	1102.13
Mean±SD	35.98-42.99	3.8-9	6201.45±4068.2	52.50±22.84	1338.73±450.3

Establishment the mathematical relationship between fecundity and other parameters

To establish the mathematical relationship between fecundity and other parameters, the values of correlation coefficient (r) were established (Tab. 6) by using the statistical formula:

$$y = a + bx$$

Table 6: Co-relation co-efficient (r) regression equation and significant of co-relation of fecundity with total length, body weight, gonad length, gonad weight and body weight with gonad weight between dependent and independent variable of *C. chagunio*

SI No	Dependent variable Y	Independent variable X	Regression equation	Corelation co-efficient 'r'
1.	Fecundity	Fish Length	y = 1081x – 16025	0.76
2.	Fecundity	Fish Weight	y = 51.94x + 64.83	0.80
3.	Fecundity	Gonad Length	y = 3208x – 11109	0.83
4.	Fecundity	Gonad weight	y = 1095x + 984.20	0.90
5.	Body weight	Body Length	y = 20.0911x – 294.73	0.88
6.	Gonad weight	Fish Weight	y = 0.042x – 0.280	0.82

Length-weight relationship

The values of length (cm) and weight (g) were equated to X and Y respectively. The total length of the fishes was plotted against their body weight. A linear relationship was found in the length-weight values of *C. chagunio* (Fig. 2) and shows the regression to be positive as in the co-relation (r = 0.88). The relationship between length and weight of *C. chagunio* was highly significant.

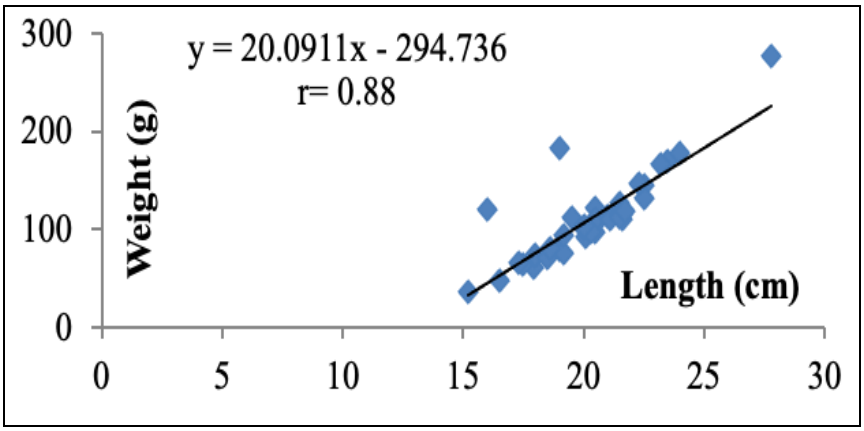

Figure 2: The relationship between length and weight of *C. chagunio*.

Fecundity and total length relationship

The fecundity of the fish was increasing with the increase of the total length following the equation Y = 1081.59x – 16025, r = 0.76. When this equation was plotted on scatter diagram, a straight line was obtained and the regression line was significantly fitted (Fig. 3). The regression equation and value of co-relation coefficient (r = 0.76) denotes that there is a positive linear relationship between fecundity and body length of the fish.

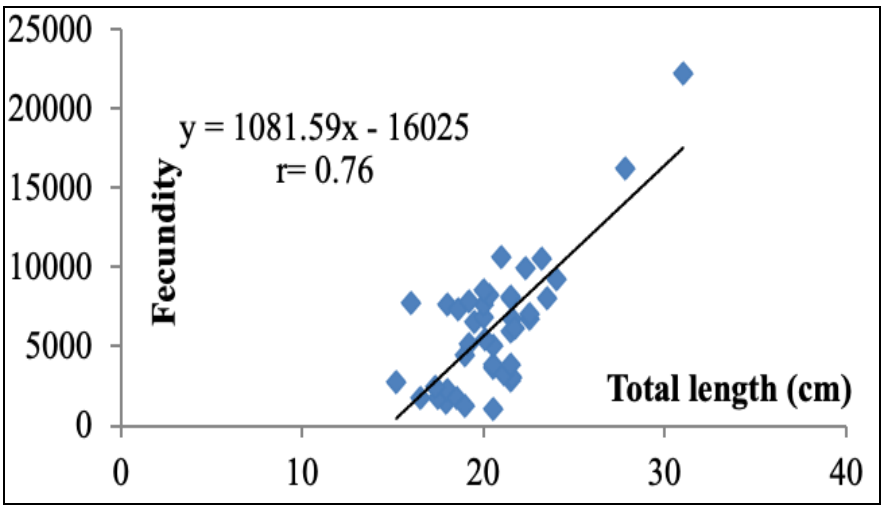

Figure 3: Showing the relationship between fecundity and total length of *C. chagunio*.

Fecundity and body weight relationship

In this study, weight of fishes was recorded before removing the ovaries. The fecundity of the fish was increasing with the increase of body weight following the equation Y = 5 1.94x + 64.83, r = 0.80. When this equation was plotted on scatter diagram, a straight line was also obtained and the regression line was significantly fitted (Fig. 4). The scatter diagram showed a highly positive relationship between fecundity and body weight of *C. chagunio.*

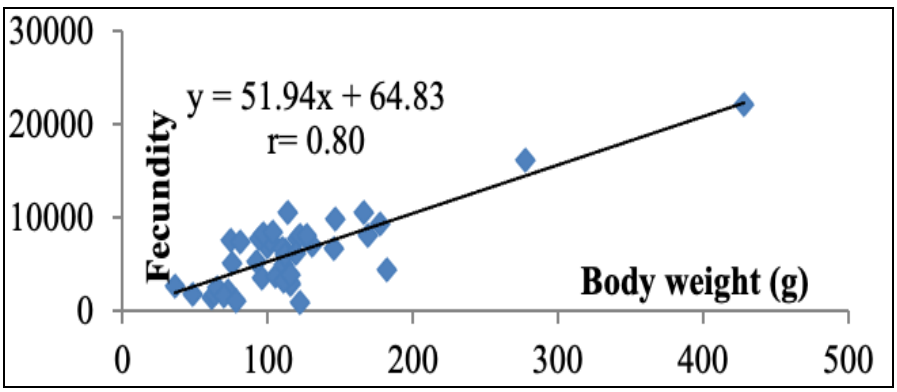

Figure 4: Showing the relationship between fecundity and body weight of *C. chagunio*.

Fecundity and gonad length relationship

The fecundity of the fish was increasing with the increase of gonad length following the equation Y = 3208.5x – 11109, r = 0.83. When this equation was plotted on scatter diagram, a straight line was obtained and the regression line was significantly fitted (Fig. 5). The figure showed a highly positive relationship between fecundity and ovary length.

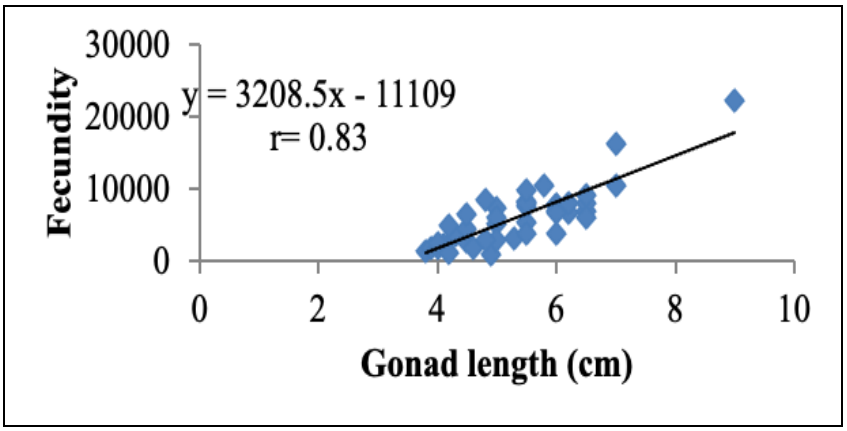

Figure 5: Showing the relationship between fecundity and gonad length of *C. chagunio*.

Fecundity and gonad weight relationship

The fecundity of the fish was increasing with the increase of ovary weight following the equation Y = 1095.35x+984.2, r = 0.90. When this equation was plotted on a scatter diagram, a straight line was obtained and the regression line was significantly fitted (Fig. 6). The value of 'r' shows a strong positive relationship between fecundity and gonad weight.

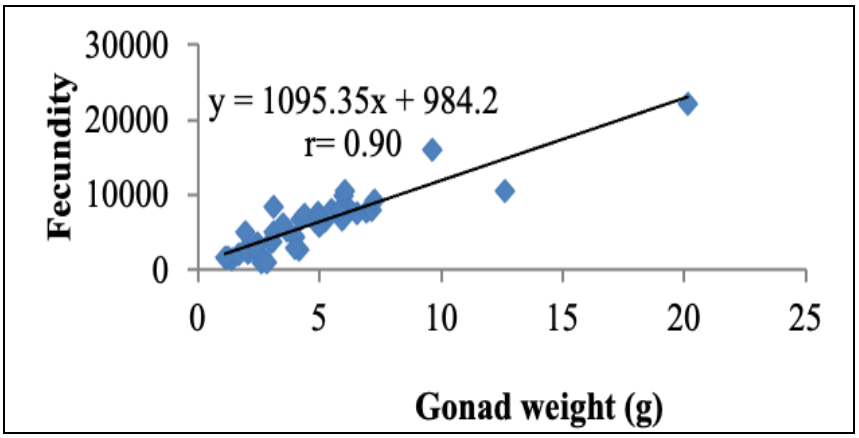

Figure 6: Showing the relationship between fecundity and gonad weight of *C. chagunio*.

Body weight and gonad weight relationship

The gonad weight was increasing with the increase of body weight following the equation Y = 0.042x – 0.280, r = 0.82. When this equation was plotted on a scatter diagram, a straight line was obtained and the regression line was fitted (Fig. 7). The scatter diagram shows highly positive linear relationship between body weight and gonad weight of fish.

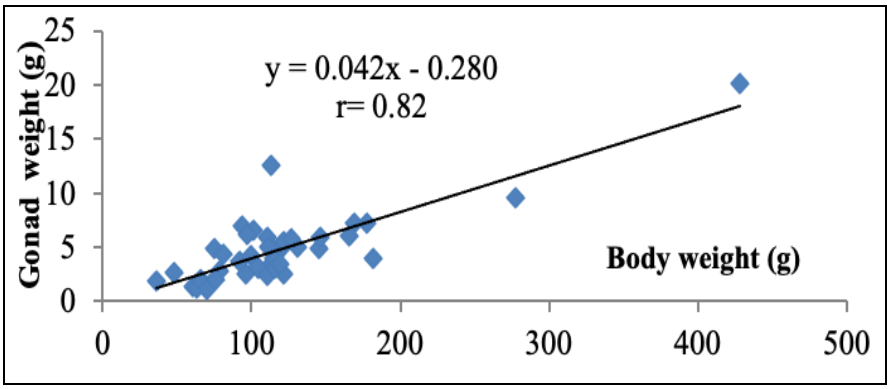

Figure 7: Showing the relationship between ovary weight and fish weight of *C. chaguni*.

The range of fecundity of *C. chagunio* varied here from 1038 to 22174 for a corresponding length and weight 15.2 to 31.0 cm and 35.98 to 427.99 g. A study on *C. chagunio* showed that fecundity range from 14,738 to 89,640 eggs in the fish length groups of 15.30 cm to 36.20 cm. (Singh et al., 2014). The fecundity estimated in this study is different by the previous study. This difference is common in terms of fecundity and occurred due to different geographical region having different climate and difference in the availability of food which affects the fish physiology (Jabeen et al., 2016). The average number of eggs 6201.46±4068.25 of *C. chagunio* indicates that the fish is moderate fecund strip fish. However, when it is compared to other freshwater fishes, it is relatively low. For example in *Labeo bata* fecundity ranges from 3,01,861-5,76,251 eggs in the length group of 441 to 544 mm (Pawar and Supugade, 2017), in *Labeo gonius* (Ham.) 3.01,861 to 5,76,251 eggs in length group of 280 to 480 mm (Brahma 2008), and *Hypohthalmichthys molitrix* (Val.) 1.14 to 2.53 lacs in 436-495 mm length groups We observed that the ovaries of same size of fishes contained different numbers of eggs. This may be due to the variations in environmental conditions and food intake; this has been reported (Bhuiyan et al., 2006). The regression equation between fecundity and total length was found Y = 1081.59X – 16025 and the value of r = 0.76 which shows a significant linear relationship. Variation in the fecundity of the fish in the same length class indicates that the fecundity of a fish is not solely dependent on its length. This comment agrees with the findings of Hasan et al. (2020). Strong positive relationships between fecundity and body weight have been reported, which supports the findings of Pawar and Supugade (2017). In the present study, the fecundity was found to grow with the increase in the length of the gonad. The value of r = 0.83 and the regression equation Y = 3208.5x – 11109 shows a highly positive relationship between fecundity and gonad length (Hasan et al., 2020). This result is agree with Kumar et al. (2017). The relationship between body weight and gonad weight was found to be linear (r = 0.82) and the equation was Y = 0.042x – 0.280, r = 0.82 (Fig. 12). Body weight and gonad weight relationship were highly positive and significant. Gonad weight was increased with increasing body weight and this happened till maturity of the gonad. The result of the present study supports the outcome of Sinha et al. (2018).

CONCLUSIONS

The present study was conducted on the fecundity of *C. chagunio*, for the estimation of the fecundity and determination of relationship between various parameters. A linear relationship was established between fecundity and this parameter. Among all the relationships there was a positive relationship. Among all the relationships the gonad weight and fecundity relationship was found to be the most prominent. The coefficient of correlation (r = 0.90) of gonad weight and fecundity was highly significant at 5% level of significance. In conclusion, this study has provided some basic information on the size at sexual maturity and fecundity for *C. chagunio* that will be helpful to evaluate reproductive potential of individual fish. Further, it would be useful for fishery biologist/manager to impose adequate regulation for sustainable fishery management for the control of exploiting fishing of young individuals.

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