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ASSESSMENT OF FECUNDITY AND GONADOSOMATIC INDEX OF FRESHWATER FISH *CIRRHINUS FULUNGEE* (SKYES) FROM MULA RIVER OF PUNE, MAHARASHTRA

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ABSTRACT

In this investigation ripe and mature females Cirrhinus fulunge (Skyes) were collected from Mula- river of Pune, in June and July 2016. Mean body length and body weight of fish was 12.395± 0.2451186cm and 38.7284±3.023925325gram respectively. The ovaries of fishes were removed, dried and weighed accurately. The mean weight of ovary was 8.6027± 1.3047742grams. The eggs were counted in 500mg weight of ovary and mean number of eggs/gram of ovary was 1602.86±251.58314 and mean number of eggs/gram of fish were 348±77.4056. The mean absolute fecundity was 13244.746±4612.157 and mean relative fecundity was 348±77.4056. The value of gonadosomatic index was 22.1894± 2.92904419 recorded, which suggests breeding and egg laying period of Cirrhinus fulunge (Skyes). The body weight was significantly correlated to body length (r = 0.895305273) and ovary weight (r = 0.770862923). The relationship between fecundity and fish total length was 0.256034645, correlation coefficient of fish weight and ovary weight was 0.850198325and the correlation coefficient values for relationships between Ovary weight and fecundity was 0.384992322. The absolute fecundity of Cirrhinus fulunge (Skyes) was significantly correlated to fish total length and body weight and ovary weight. Though, the ovary weight is the most faithful and better index of fecundity than total length and weight of the fish.

Introduction

The freshwater fishes are important and easily available source of protein. The amount and quality of protein is progressively degrading due to pollution of water bodies. The aquatic pollution has direct or indirect influence on fish reproduction [1]. Due to

pollution number of species has been disappear from many place of Mula-Mutha River. The pollution affects the biochemical content in the body parts including gonads; which may affects process of growth and ripening process of gonads such as oogenesis and spermatogenesis. It may affect the size and weight of ovary, as well as the number of ova (fecundities) and size of eggs in the ovaries of fishes. The reproduction is basic to the survival of the maximum number of young and hence the success of the fish species. The study of fecundity and its relationship with various body parameters such body weight, length, ovary weight are beneficial for effective fish culture, stock management and assessment in any water body. Relative fecundity defined as the number of eggs per unit of body weight is used as an index of fecundity. The fecundity potential is not similar in different fishes. It is depends on many factors including age, size, types of species, food availability, running water and season. Assessment of fecundity is important for acquiring knowledge about different races; each species has characteristic fecundities and egg diameter. This will help in fish culture and maintenance of fish diversity. The fecundity is the capacity of specific fish to produce ripe eggs in one spawning season. This is important to know the reproductive and commercial potential of a fish stock.

The fish fecundity is not similar in every individual of same species due to fish length and weight as well as due to fish food, water currents and impact of vitamins. The fecundity was highly correlated with the total length, and body weight and *P. sophore* may be a medium fecund fish [2]. The studies on fecundity show that an unstable sex ratio existed for fish samples taken throughout the collection period. It very is difficult to explain. Perhaps, it might be credited to differences in behaviour between the male and female fish, which might have made females more susceptible and sluggish to fishing gears [3]. The biochemical contents like glycogen, protein and lipid are essential for the normal development of sperm and ova. But level of biochemical content decrease due to pollution, may affect the process of growth and ripening process of gonads such as oogenesis and spermatogenesis. There will be decline in the ovarian weight as well as decline in fecundity of fish [4]. The sexual age was characterized by the presence of stage III gonads. The two-year old for males and females has about 9.1% and 20.7% of stage III gonads respectively. The frequency of stages III-V increased from three-year old to eight-year old for female and seven-year old for male. The reduction of length at first maturity (*Lm*) and a lower number 50% oocytes production (low absolute fecundity)[5].

The fecundity varies from 1125 eggs (for a fish with total length 133 mm and total weight 10.7792 g) to 19636.71 eggs (for a fish with total length 192 mm and total weight 43.9832 g). The mean fecundity of 30 females was recorded as 8433.315 ± 15.155 eggs for a fish with a mean total length 172 mm and mean body weight of 27.176 g. It has been reported that the fish with same size had different number of eggs in their ovaries [6]. Investigation shows that the number of eggs was increased linearly with the increase in total length, body weight, ovary length and weight. The relationship of fecundity with other parameters such as total length, total weight, ovary length and weight were found to be linear and the value of correlation coefficient (r) was 0.965, 0.961, 0.933 and 0.972 respectively. The highest value of GSI was recorded in the month of May 12.56 [7].The study noted remarkable changes in absolute fecundity due to change in the environmental factors such as temperature, salinity and oxygen [8]. The research confirmed that availability of food resources in a given habitat has a direct affect on the egg production and thereby the fecundity. He noticed, that the low food intake in case of stickle backs led them to produce fewer eggs, greater weight at maturity and shorter inter-spawning interval [9].

Materials and methods

The fishes *Cirrhinus fulungee* (Skyes) used for the study were collected from Mula River of Pune by using gill net and cast net. The randomly selected samples were shifted to laboratory for further biological measurement. Identification of species was made based on [10]. They were washed with clean tap water before examination. Each fish was measured in fresh condition for its total length (TL) by Vernier caliper and body weight (BWt) by electronic balance having accuracy 0.001mg and measurements were recorded. The fishes were dissected, ovaries were separated carefully and the moisture was dried with blotting paper. Ovaries were weighed and measured individually. The dry ovaries were preserved in 5% formalin solution for 24 hours [11]. This helped to separate eggs from walls of ovary easily. Three samples, of 500mg portion of ovary from each lob were weighed on Electronic balance. The egg samples were placed in Petri dish separately. Small amount of distilled water was added to each Petri dish containing eggs. This procedure hydrates and completely separates the eggs. The total number of eggs in each sample were counted carefully and recorded for further calculations. Absolute fecundity was calculated according to formula given by [12].

$F = n\ G/g$

F = fecundity; n = mean numbers of eggs in all sample;

G=weight of ovary; g=weight of sample.

The numbers of eggs/kg body weight of the fish (relative fecundity) and number of egg per fish (absolute fecundity) was also calculated by using simple algebraic formula.

Gonadosomatic Index (GSI) was calculated according to formula by [13].

$$GSI = \frac{\text{Weight of ovary}}{\text{Weight of fish}} \times 100$$

The correlation coefficient of fecundity with fish weight, fish total length and ovary weight and ovary length was calculated by regression analysis with computer package.

The relationship between fecundity and some morphometric measurements were determined by relating total fecundity (F_e) data to total length (TL) and total weight (BW) using the following formulae:

$\ln F_e = \ln m + n \times \ln TL$; $F_e = m \times TL^n$

$\ln F_e = \ln m + n \times \ln BW$; $F_e = m \times BW^n$

Here, m and n are constant parameter in the linear regression analysis and ln is the natural logarithm.

Result and discussion

The Relationship between body Length (BL) and weight (BW): The data for two variants i.e., total body length and total body weight of fish is given in table-1. The given data shows a positive correlation between these two variants. Fig.1 shows relationship between these two variants. The correlation coefficient was 0.89535273.

The relationship between total fish length and body weight can be expressed as:

Log BW= 7.69BL+2.5.

Where BW = body weight, BL = body length and SE = standard error.

The Relationship between weight of Ovary OWand body length (BL): Available data from table 1 for the two variants i.e, fecundity and total length. According to this data the body

weight varied from 32.88 for a fish of length 11.2cm to 53.612for a fish of length 13.8cm. The relationship between fecundity and the total length can be expressed as:

Log Ow = 12.935BL-5.7262

Where Ow =Ovary weight and TL= body length in cm.

The number of eggs contained was more or less directly proportional to the total length of the fish body. The regression equation was found to be linear (Fig. 2). The correlation coefficient (r) was 0.770862923 ($p<0.001$) which corresponds to positive correlation and is highly significant.

The Relationship between fecundity (F) and body length (Tl): Available data from table 1 for the two variants i.e, fecundity and body length. According to this data the number of ova varied from 9169.7 for a fish of length 11.8cm to 20083.42for a fish of length 13.5cm. The relationship between fecundity and the total length can be expressed as:

Log F = -783.7+91.303 log TL

Where F= fecundity and TL= total length in cm.

The number of eggs contained was more or less directly proportional to the total length of the fish body. The regression equation was found to be linear (Fig. 3). The correlation coefficient (r) was 0.256034645 ($p<0.001$) which resembles to positive correlation and is highly significant.

The Relationship between Body weight (BW)and Weight of ovary (OW):-Table 1 gives data for the two variants i.e. body weight and weight of ovary. The given data shows a positive correlation between these two variants. As per the weight of Ovary 5.689 gm. varied from for a length of fish 10.9cm to 14.21gm for a fish of length 52.239cm. The relationship between fecundity and the total length can be expressed as Fig.4 shows relationship between these two variants. The correlation coefficient was 0.850198325 ($p<0.001$) which resembles to positive correlation and is highly significant.

Log OW = 1.676Bw+0.1691

Relationship between fecundity (f) and total body weight (bw): Table 1 provide data for fecundity and total body weight. The number of ova varied from 9761.88 for a fish of weight

37.199g to 20083.42 in the fish weighing49.213g.The relationship between fecundity and the total body weight can be expressed as:

logF =-63.47+10.65 log BW

Where F= fecundity and BW =body weight.

The relationship between fecundity and total body weight was found to be linear and highly significant with the correlation coefficient (r) equal to 0.273564776. (Fig. 5).

Relationship between fecundity (f) and ovary weight (ow): The data for two variants i.e, fecundity and ovary weight is available in Table 1. The weight of ovary fluctuated from 5.689g to 14.21in fish weighing 29.239g to 52.239g. Whereas fecundity varied from 9761.88 in an ovary of weight 8.15g to 20083.42 in the ovary weight 13.013g.The relationship between fecundity and the ovary weight (Fig. 6) can be expressed as:

logF = 261.831-10.172 logOW.

Where F= fecundity and OW = ovary weight.

Regression analysis showed that there is a significant relationship ($p<0.01$) between the number of eggs in the ovary i.e., fecundity and the weight of ovary. The number of eggs per female increased with increasing ovary weight. The correlation coefficient was found to be 0.384992322.

Gonadosomatic Index (GSI): The GSI value ranged from 16.9089 for body length 12.6cm, body weight is 40.037gm and ovary weight 7.108gm to 27.32692 for body length 13.4cm, body weight is 49.829 gm and ovary weight 13.89gm. The mean gonadosomatic index value is 22.1894.

The study on fecundity shows that there is lot of differences in reproductive potential in different fish. Fecundity of fish is varying depending on many factors [14]. The reproductive features of each species are different due to changes in environmental conditions, such as temperature, food availability, habitat and predation intensity similarly [15]. The changes in fecundity are associated with age, sex, size weight, gonad weight and locality [16]. The investigation on fecundity of *Crassius carassius* observed that the absolute fecundity is depends on body weight, body length, ovary length and ovary weight and has positive influence on absolute fecundity. The correlation coefficient (r) values reveal fecundity was moderately high in relation to body weight and ovary weight but poorly correlated with total length did not found any relation between fecundity [17].

Table-1

Fish no	Length of fish	Body weight	Weight of Ovary	Number of Ova per gram of Ovary	Absolute Fecundity	Relative fecundity= no of eggs/B.Wt.	Gonadosomatic Index = wt. of Ovary/wt of fish X100
1	13.2	51.239	14.21	1025.4566	11576.46	221.6	27.21089
2	12	37.199	8.15	1565.875	9761.88	262.42	21.90919
3	12.6	40.582	7.586	1442.114	10939.88	269.58	18.69302
4	13.1	41.99	10.443	1158.774	12097.6	288.1	25.4769
5	11.8	34.964	7.639	1503.2988	11483.7	328.44	21.8782
6	12.3	38.781	8.279	1451.2719	12015.08	309.82	21.3481
7	12.7	45.247	8.724	1218.465	10629.89	234.93	19.2808
8	11.8	35.392	7.802	1175.312	9169.7	259	22.04453
9	11.8	36.31	6.826	1698.461	11593.7	438.6	18.799228
10	12.2	36.176	6.97	1929.756	13450.4	371.8	19.266917
11	12.7	42.241	9.136	1239.354	11322.74	268.03	21.62828
12	11.9	36.564	8.549	1458.5916	12469.5	341.03	23.3809
13	12.3	36.799	7.812	1441.5117	11261.09	306.01	21.22884
14	12.2	38.088	9.123	1433.77945	13080.369	343.42	23.95243
15	11.3	30.727	6.228	2501.18	13076.169	425.56	20.268819
16	11.8	32.639	6.742	1771.903	11946.169	366	20.6563
17	11.8	33.057	5.853	2144.815	12553.6	379.76	17.70578
18	10.9	29.239	5.689	2182.8968	12418.5	424.72	19.45689
19	13.9	46.358	8.825	1230.445	10858.68	234.26	19.03663
20	12.3	36.743	10.208	1546.327	15788	429.69	27.78216
21	12.8	39.883	7.512	1597.8235	12002.85	301	18.8351
22	13.5	42.992	10.47	1329.9465	13924.54	309.49	23.2708
23	12.1	36.008	7.678	1363.4644	10468.68	290.73	21.3231
24	12.3	34.35	7.845	1452.678	11396.256	331.77	22.83843
25	12.2	37.027	7.825	1523.6805	11922.802	322	21.13323
26	11.9	34.219	6.847	1885.3512	12909.17	377.25	20.0094
27	13.8	53.612	11.748	1311.074	15405.12	287.34	21.913
28	12.2	33.05	7.246	1603.0213	11668.39	353.05	21.92436
29	11.5	30.931	5.784	2655.038	15356.74	496.48	19.03195
30	12.3	37.706	8.813	1650.996	14550.23	385.89	23.37294
31	13.5	49.213	13.013	1313.099	20083.42	408.09	26.4422
32	13.2	45.135	11.308	1673.72	18929.78	419.4	25.0537
33	12.7	40.251	10.025	1831.709	18372.04	456.43	24.9062

34	13.4	49.829	13.89	1170.868	16263.36	319.96	27.32692
35	12.6	40.037	7.108	2269.149	19129.11	455.05	16.9089
36	11.2	32.88	7.816	2154.3961	16838.76	512.1	23.7713
37	12.8	34.632	9.58	1400.209	13414	347.22	24.798
Total	458.6	1432.09	319.3	59305.81135	490128.36	12876.02	813.864334
Mean	12.395	38.7051	8.6027	1602.86	13244.746	348	22.1894
Standard Deviation	0.24512	3.02393	1.3048	251.58314	4612.157	77.4056	2.92904419

Figure-1:- Relationship between body length and body weight of *Cirrhinus fulungee.*

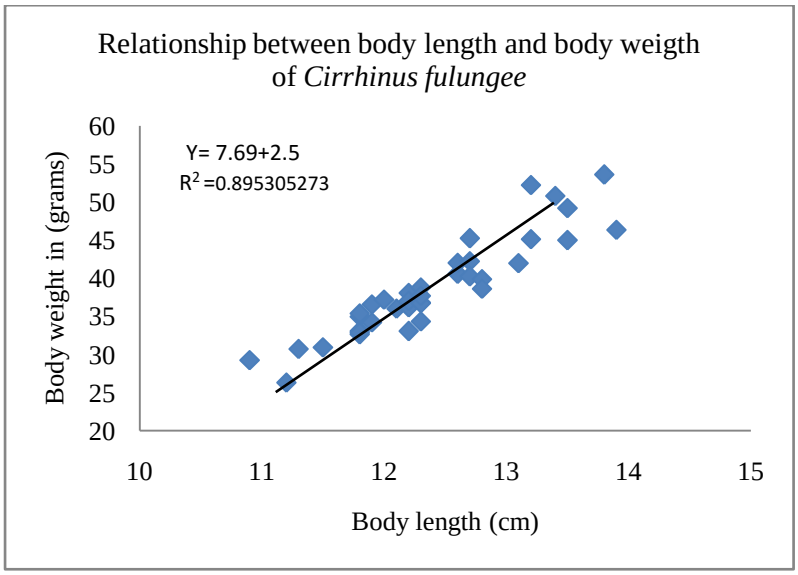


Figure-2:- Relationship between body length and Ovary weight of *Cirrhinus fulungee.*

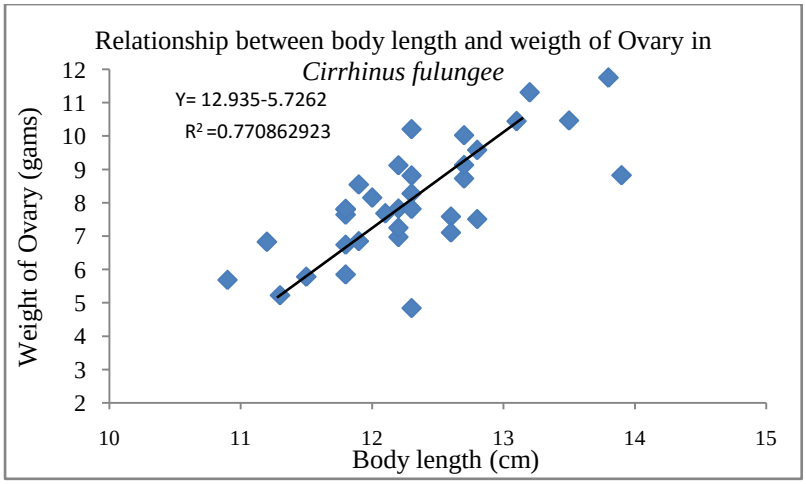


Figure-3:- Relationship between body length and Absolute fecundity of *Cirrhinus fulungee.*

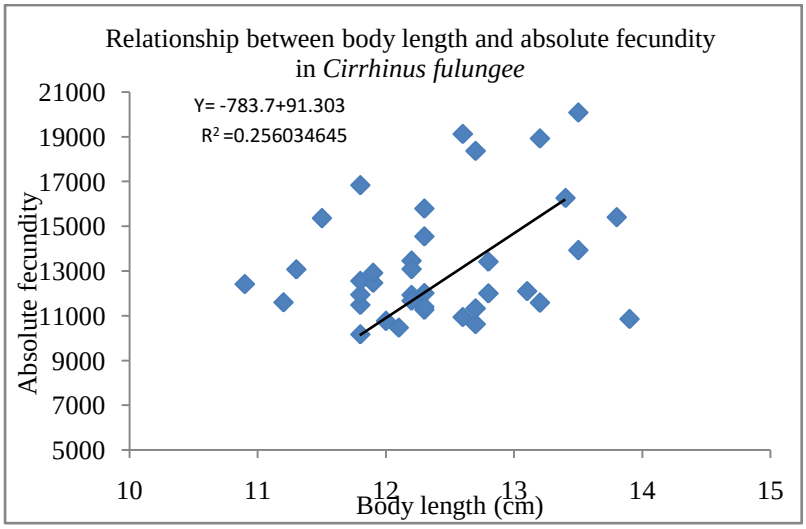


Figure-4:- Relationship between body weight and weight of Ovary of *Cirrhinus fulungee.*

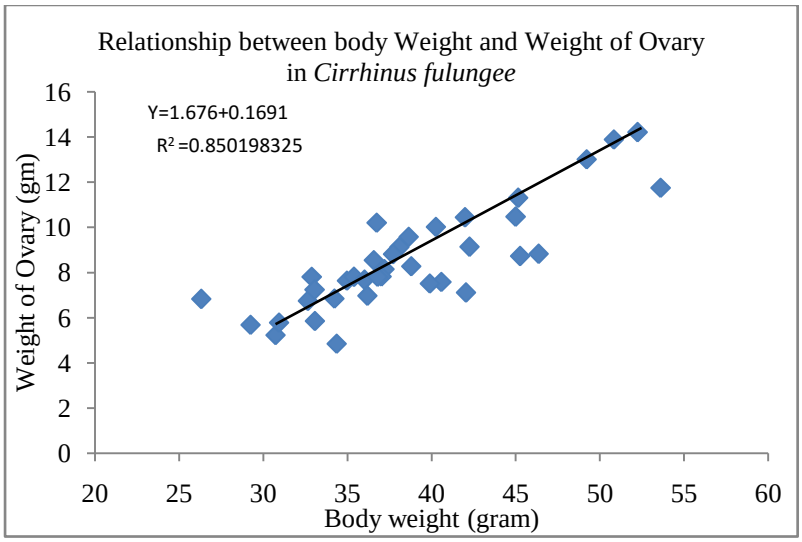


Figure-5:- Relationship between body weight and absolute fecundity of *Cirrhinus fulungee.*

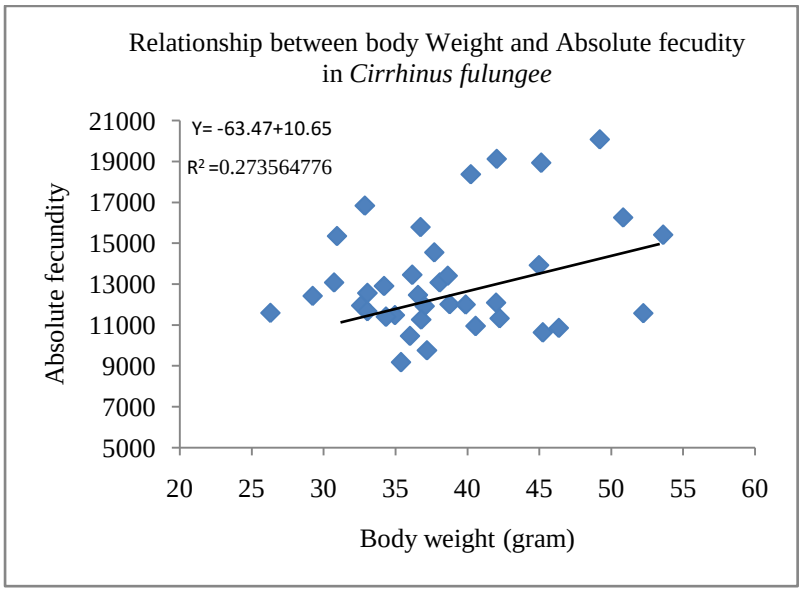
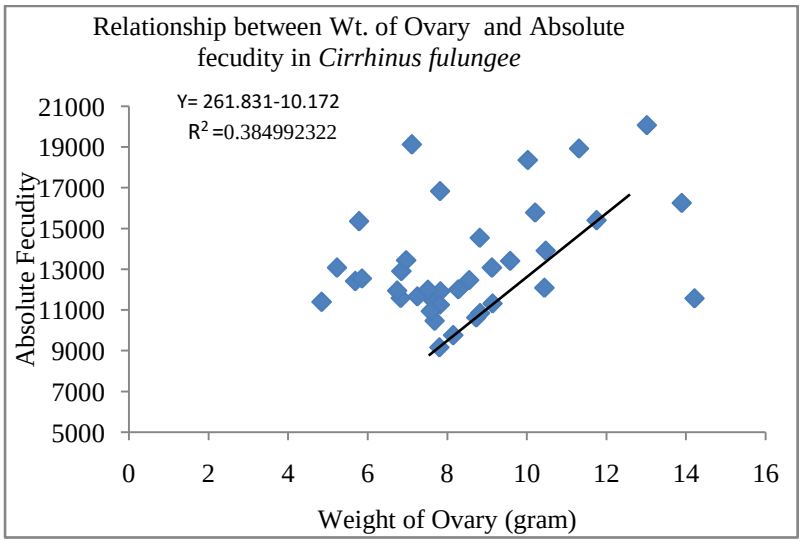


Figure-6:- Relationship between Weight of Ovary and absolute fecundity of *Cirrhinus fulungee.*



The research on monthly changes in gonadosomatic index suggests that the fish species have a prolonged spawning period beginning from March to October for both sexes. Gonadosomatic index has been considered as reliable estimation method for gonad maturity and spawning of any species. The gonadosomatic index has increased with the maturation of fish and reaches to its maximum at the peak period of maturity. Its sudden decrease indicates beginning of spawning [18]. Studies on fecundity showed that body weight had positive

influence on the absolute fecundity and relative fecundity remained fairly constant to the wet body weight of *H. molitrix* [19]. In *M. Pancalus,* fecundity is moderately lower than the other species. The ovary weight of smallest mature female was 0.77 g and its absolute fecundity was 881. The highest absolute fecundity was 1182 eggs with a body length and totals weight of 163.50 mm and 10.52 g respectively [20].

In freshwater fish *L. rohita* it has been observed the Fecundity and weight of ovary was strongly correlated to weight of fish and length of fish and length of ovary. Therefore, the ovary weight is a better index to estimate fecundity than total length and body weight. The ovaries of two fish with same body weight, contained different number of eggs [21]. The fecundity of ***P. sophore*** ranged from 7951 to 23053 eggs for a body length and body weight of the fish 5.5 cm, 10.12 gm and 10 cm, 26.5 gm respectively [2]. The studies on fecundity of *L. rohita* also reported that two same size ovaries contained different number of eggs [22]. The investigation on fecundity shows that the numbers of eggs in the ovary are increased linearly with the increase of body weight, body length, gonadal weight and gonadal length [23].

During investigation on fecundity it is found that the number of ova varied from 1125 for a fish of length 133 mm and total weight 10.7792 g to 19636.71 for a fish having total length eggs for a fish with total length 192 mm and total weight 43.9832 g. The mean fecundity was as 8433.315 ± 15.155 eggs for a 30 female fish with a mean total length 172 mm and mean body weight of 27.176 g. During search it was reported that same size fishes had varied ovary weight and different number of eggs in their ovaries. The fecundity is increased with the increase of body weight, body length, gonadal weight and gonadal length. All the relationships were found to be linear (t-test of all the relationships showed that the Values of the regression, co-efficient 'r' were significant [6]. After exposure of fish to sublethal concentration of heavy metals, significant reduction in parameters like total length, body weight, ovary weight and fecundity was noticed. In control fish the fecundity has direct relationship with total body length, body weight, length and weight of ovary fish [24].

The study on fecundity and GSI shows that females had higher GSI values than males in all the six stages of gonad maturation. GSI was higher in both sexes in the rainy season than in the dry season. GSI was independent of the size of fish and has significant correlations with total length, total weight and gonad maturation stage in females, but not in males [25]. The proportion between the body weight and the weight of ovary demonstrates the status of the maturity of ovary and denotes the phase of reproductive cycle. The gonadosomatic index of fish was increased (55.68) with the ripening of the fish and gonad.

During post spawning phase the GSI was found lowest (6.0) and was highest at peak of maturity during spawning phase [26].

The value of correlation coefficient between fecundity and body weight (r=0.95) shows very significant positive correlation followed by ovary weight (r=0.88). However it exhibits a moderate correlation with total length (r=0.60) of the species. It is further stated the gonadosomatic index or maturity index is not direct method for estimating spawning season of a species. The increase and reduction in GSI% and physical changes in the gonads besides progression of the size of the ova is an indicator of spawning season [27]. The studies on sex and behavioural differences show that an unbalanced sex ratio existed for samples taken throughout the sampling period. The unbalanced sex ratio found in the present study is difficult to explain. Probably, it could be attributed to behavioural differences between the sexes, which might have made females more vulnerable and passive to fishing gears such as gill nets [3]. The investigation on fecundity was shown that the reduction of length at first maturity (*Lm* 50%) and a lower number of oocytes production (low absolute fecundity) [28].

Conclusion.

In present investigation on fecundity of *Cirrhinus fulungee*, it is found that the fecundity varies from 9169.7for a fish of total body length 11.8cm, total weight 35.392g and weight of ovary 7.802gm to 20083.42 for a fish having total length 13.5cm, total weight 49.213g and weight of Ovary 13.013 gm. The mean absolute and relative fecundity of 37 females was recorded as 13244.746 ± 4612.157 and 348 ± 77.4056 eggs and for a fish with a mean total length 12.395cm, mean body weight of 38.7051 and mean weight of ovary 8.6027gm. The mean Gonadosomatic index of fish was 22.1894± 2.92904419. The fecundity potential is not similar in all fish species. However, it also observed that fecundity of fish increase linearly with the increase of body weight, body length, gonadal weight and gonadal length. All the values are found to be correlated. The fecundity of fishes is depends on many factors including age, size, types of species, food availability, running water and season. Assessment of fecundity is important for acquiring knowledge about different races; each species has characteristic fecundities and egg diameter. This will be helpful to evaluate reproductive potential of fish during culture and maintenance of fish diversity. Further, it will help for sustainable fishery management and the control of exploiting fishing of young individuals**.**

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