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Studies on fecundity and Gonadosomatic index of *Schizothorax plagiostomus* (Cypriniformes: Cyprinidae)

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Abstract: The present investigation deals with the assessment of fecundity and gonadosomatic index (GSI) of *Schizothorax plagiostomus* collected from the river Jhelum, Kashmir. The mean value of fecundity was estimated as 14599 (SD 9219.7) eggs with a mean total length of 34.340 (SD 6.86) and a mean total body weight of 440.60 (SD267.62). The relationship of fecundity with other parameters such as total length, total weight, ovary length and ovary 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 (SD1.81).

Keywords: Allometric relationship, fecundity, spawning season, *Schizothorax plagiostomus*.

Understanding reproductive behaviour of fishes is not only important for elucidating the basic biology of the fishes but it can also help in their management and conservation. The term 'fecundity' denotes the egg laying capacity of a fish or the number of ripe eggs produced by a fish in one spawning season. Knowledge of fecundity is also an important aspect in stock size assessment, stock discrimination (Holden & Raitt 1974) and rational utilization of stock (Morales 1991) and in explaining the variation of population as well as to make efforts for increasing the amount of fish yield. Thus, studies on reproduction behavior (fecundity) of fish are important and a basic requirement for improvement of and effective fishery resources management and conservation (Marshall et al. 2003; Grandcourt et al. 2009).

Schizothorax plagiostomus Heckel, is one of the most important commercial food fishes of Kashmir. But the decline of *Schizothorax* population in the water bodies of Kashmir is taking place due to many factors especially habitat destruction, over fishing, competition for food and breeding grounds from exotic carps, water pollution, etc. These complex factors have altered the landscape and water flow which in turn have reduced the fish stock in water bodies by affecting fish migration, spawning and nursing grounds. The present study is aimed to determine the fecundity and its relation with total body length, total body weight, ovary length & ovary weight) which are useful in increasing the yield of fish species, stock management and assessment in any water body. Hence, the present study will be useful in understanding the relationship of fecundity with above mentioned body parameters and thus serve as a tool for better management of this resource.

Materials and Methods

Fishes for the present study were procured from three different sites of the river Jhelum (74–75^{0}E & 33.5–34.5^{0}N)—Zero bridge, Chattabal and Kadalbal pampore—using cast net, every month. For fecundity estimation 30 specimens were collected and analysed and for GSI estimation 5 fish specimens were collected 3

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times in a month. The study was carried from November 2010 to October 2011. After noting down morphometric parameters (body length and body weight) of the fishes in fresh conditions, mature gravid fishes were dissected. The ovaries were removed and wiped with blotting paper to remove moisture and then preserved in 5% formalin solution for 24 hours so that the eggs would swell up for easy calculations. The fecundity of the fish was calculated using the gravimetric method (Simpson 1959) as well as the volumetric method (Kandler & Pirwitz 1957). The total number of eggs per gonad was obtained, i.e., absolute fecundity of fish. Relative fecundity was determined by the ratio of total number of eggs per unit weight or length of fish. Its relation with various body parameters such as body length, body weight, ovary length and ovary weight was determined by using log transformation of power law,

$$Y = aX^b$$

i.e., Log Y = log a + b log x

Gonadosomatic index (GSI) expressed according to de Vlaming (1982) method for assessing the development of gonads and was calculated as:

GSI = Gonad weight/body weight *100.

Results

Ovary structure: The ovaries of *Schizothorax plagiostomus* was a bilobed fleshy structure occupying a large part of the abdominal cavity. The two lobes of the ovary were almost uniform in size. The middle portion of the ovary was broader than the anterior and posterior region. The eggs were fully ripe and yellowish in color in the mature ovary. It has been found that the shape, size, and color change in different stages of maturity.

Relationship between fecundity (F) and total length (Tl): Table 1 provides data for the two variables i.e, fecundity and total length..According to it the number of ova varied from 3437 for a fish of length 26.2cm to 34800 for a fish of length 45.3cm. The relationship between fecundity and the total length can be expressed as:

Log F = -0.976 + 3.30 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. 1). The correlation coefficient (r) was 0.96 ($p<0.001$) which corresponds to a very strong positive correlation and is highly significant.

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 3437 for a fish of weight 176.5g to 34800 in the fish weighing 1150g.The relationship between fecundity and the total body weight can be expressed as:

logF = 1.26 + 1.09 logBW

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 0.961 (Fig. 2).

Relationship between fecundity (f) and ovary weight (ow): Table 1 provide data for the two variables i.e, fecundity and ovary weight. The weight of ovary ranged from 10.11g to 120g in fish weighing 176.5g to 1150g. Fecundity varied from 3437 in an ovary of weight 176.5g to 34800 in the ovary weighing 1150g.The relationship between fecundity and the ovary weight (Fig. 3) can be expressed as:

logF = 2.69 + 0.917 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 0.972.

Relationship between fecundity (f) and ovary length (ol): Table 1 provides data for fecundity and ovary length. The ovary length ranged from 9.4–22.8 cm in fish ranging from 25.2–45.3 cm. The number of ova varied from 3437 to 34800 in fish ranging in length from 26.2–45.3 cm. The relationship between fecundity and ovary length (Fig. 4) can be expressed as:

logF = 1.45 + 2.37 logOV.

Where F= fecundity and OL = ovary length.

A significant linear relationship was observed between fecundity and the ovary length, i.e., fecundity increased with the ovary length. The correlation coefficient(r) was found to be 0.933.

Length weight relationship: Table 1 provide data for two variables, i.e., total length and total weight of fish. The data showed a positive correlation between the two variables. Fig. 5 shows relationship between these two variables. The correlation coefficient was found to be 0.992. The relationship between total fish length and total body weight can be expressed as:

Log BW = 2.9781 TL - 1.9819 (SE=0.0315; $P<0.05$).

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

Gonadosomatic Index (GSI): The GSI value ranged from 1.87 to 12.66. The maximum GSI value 12.56 was found in the month of May while minimum value 1.87 was obtained in the month of July.GSI exhibited variation in different months of the year (Fig. 6). The GSI value

Table 1. Data for absolute fecundity and relative fecundity with other body parameters for gravid females.

	Body weight (g)	Body length (cm)	Ovary weight (g)	Ovary length (cm)	No. of ova	Absolute fecundity	Relative fecundity
1	157.0	25.2	12.36	9.4	355	4388	27.94
2	162.2	25.5	13.82	9.5	406	5611	34.63
3	166.4	24.7	13.62	9.5	440	5993	36.10
4	170.4	25.8	14.25	9.7	326	4646	27.32
5	176.5	26.2	10.11	9.6	340	3437	19.52
6	178.7	26.7	14.89	9.6	307	4571	25.67
7	194.8	27.2	15.11	9.7	331	5001	25.77
8	206.5	27.3	18.70	9.9	330	6171	29.95
9	234.2	28.6	19.21	10.2	340	6531	27.91
10	242.8	28.4	16.21	10.1	425	6889	28.46
11	260.0	30.0	20.53	10.0	407	8356	32.13
12	262.5	30.2	20.27	10.4	400	8108	30.94
13	280.2	31.4	21.82	10.8	500	10910	38.96
14	300.0	32.3	25.71	11.2	470	12083	40.27
15	370.7	33.7	23.00	10.7	408	9384	25.36
16	389.6	35.4	36.20	12.4	423	15312	39.36
17	412.8	36.7	34.00	13.3	360	12240	29.70
18	445.2	37.0	41.20	13.5	530	21836	49.06
19	472.0	37.3	39.31	13.9	450	17689	37.47
20	535.2	38.5	49.30	15.2	412	20312	37.96
21	576.0	39.3	45.73	15.8	345	15777	27.39
22	592.1	39.8	50.50	14.7	350	17675	29.85
23	600.3	40.1	75.21	16.2	410	30836	51.39
24	646.2	41.5	75.82	16.5	275	20850	32.27
25	715.8	42.3	76.30	15.3	318	24263	33.93
26	760.3	42.8	78.29	17.6	305	23878	31.41
27	803.4	43.0	100.21	18.8	285	28557	35.56
28	840.5	43.8	73.21	19.2	320	23427	27.88
29	915.7	44.2	93.21	20.4	305	28429	31.06
30	1150.0	45.3	120.00	22.8	290	34800	30.26
Mean	440.60	34.34	41.60	13.19	372	14599	32.51
Standard Deviation	267.62	6.86	30.77	3.82	66.08	9219.7	6.79

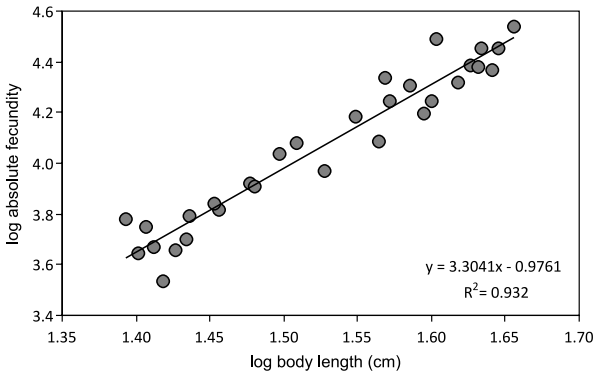

Figure 1. Relationship between fecundity (f) and total body length (tl) in *Schizothorax plagiostomus*.

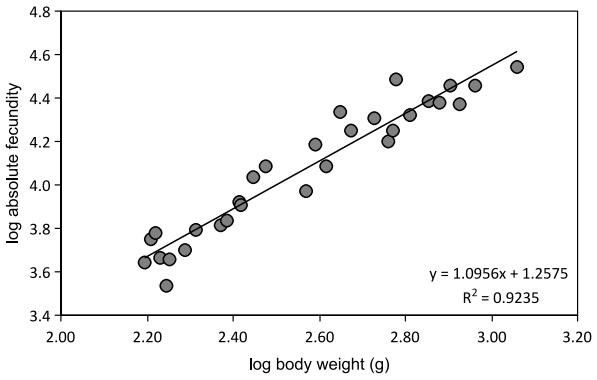

Figure 2. Relationship between fecundity (f) and total body weight (bw) in *Schizothorax plagiostomus*.

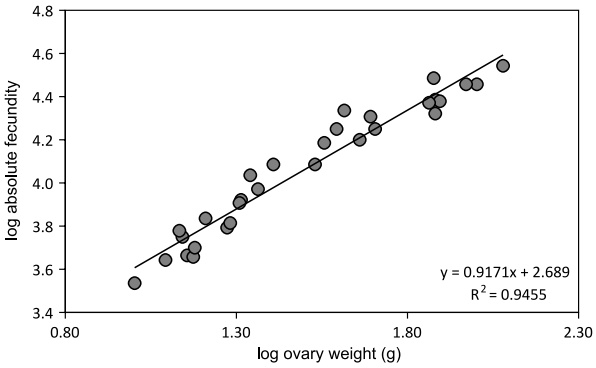

Figure 3. Relationship between fecundity (f) and ovary weight (ow) in *Schizothorax plagiosto*

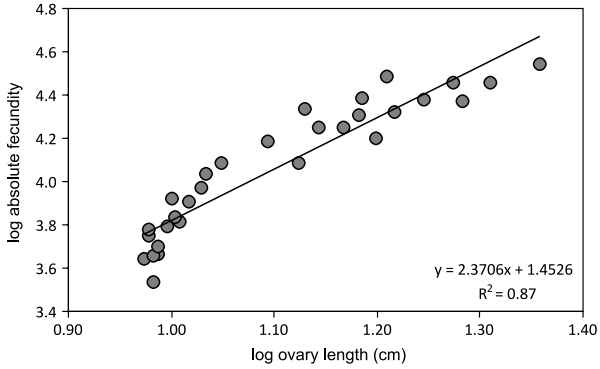

Figure 4. Relationship between fecundity (f) and ovary length (ol) in *Schizothorax plagiostomus*

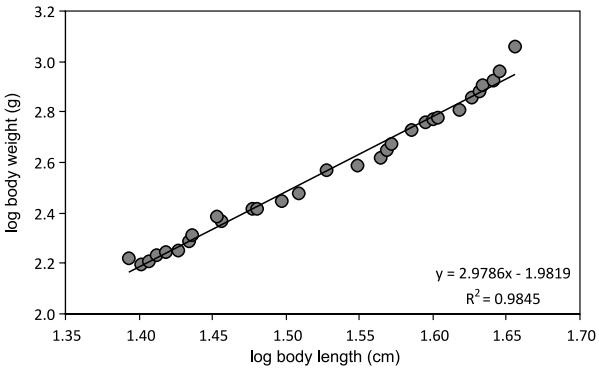

Figure 5. Relationship between body weight and total body length in *Schizothorax plagiostomus.*

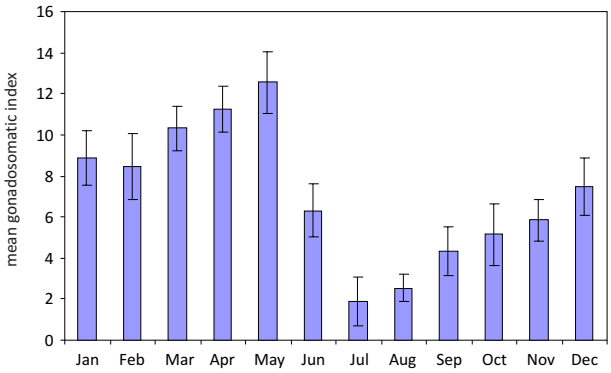

Figure 6. Monthly fluctuations in mean gonadosomatic index in *Schizothorax plagiostomus*. Error bars are standard deviations.

decreased during may to July which suggests that the fish has completely spawned.

Discussion

Fecundity has been defined as the number of ripening eggs prior to spawning (Bagenal 1978) and is a main factor governing the size of a year class of a population. Nikolskii (1965) stated that "fecundity is a specific feature that arises during the evolution of a new species adapted to a certain environment and is directed towards the continuance of the species".

In the present study, the number of eggs was found to increase linearly with the increase in total length, body weight, ovary length and ovary weight. These findings are supported by the findings of previous workers, Jhingran (1968), Raina (1977), Pathani (1981), Sunder (1984), Islam & Hossain (1990), Hussain et al. (2003), Mohan (2005), Offem et al. (2008), Bahuguna & Khatri (2009). All the relationships between fecundity and total length, body weight, ovary length and ovary weight found to be highly significant ($p < 0.005$). Significant relationships between fecundity and these variables were also reported by Das & Singh (1969), Hussain et al. (2003), Bahuguna & Khatri (2009), Alam & Pathak (2010).

The value of correlation coefficient 'r' in the present study indicate that among the above four parameters studied, closest correlation of fecundity was observed with the ovary weight (r=0.972) followed by total body length (r=0.966), body weight(r=0.961) and total ovary length (r=0.933). Similar results were reported by Bahuguna & Khatri (2009).

Length weight relationship of this fish species is in accordance with the model of LeCren (1951). It was observed that fish shows allometric pattern of growth ($b<3$). Similar results were reported by Goel et al (2011) for schizothorax richardsonii and by Sundar (1985) for schizothorax curvifrons. It was also observed that fecundity varies with fish size and it generally increase with increase in body weight and body length.

The gonadosomatic index (GSI) was found in range from 1.87 to 12.56 in this study. The maximum GSI value

was found in the month of May (12.56) which indicated the maximum gonadal growth. A sharp drop in the GSI value had taken place in July (1.87) which might have been caused by spawning. The fish thus spawn during spring season although the gonads were fully mature in the winter season but in a dormant phase because of severe winter and spawned only on return of favorable exteroceptive factors in spring season (Malhotra 1970; Jyoti et al 1972; Sunder 1984).

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