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Assessment of gonadosomatic index and fecundity of *Schizothorax niger* in Dal lake, Kashmir

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Abstract
The present investigation was carried out to study Gonadosomatic index and fecundity of *Schizothorax niger* in Dal Lake, Kashmir. A total of 360 samples of *S. niger* were collected from Dal Lake from August 2018 to July 2019. The mean values of GSI in case of males was found lowest during July (0.53) and highest mean value of GSI was found during march (11.08), while in case of females lowest mean value of GSI was found during July (1.36) and highest mean value was found during March (15.13). Based on GSI values, peak spawning was observed in March in *S. niger*. Absolute fecundity of *S. niger* varied from 2700 to 16,758 and relative fecundity varied from 28 to 89 ova per gram of body weight. In the present study, positive correlations were observed between fecundity and length and weight measurements of the fish as well as the ovaries in *S. niger*. High positive correlation was found between fecundity and ovary weight in *S. niger* with $R^2 = 0.979$.

Keywords: *Schizothorax niger*, GSI, Absolute Fecundity, Relative fecundity, Dal Lake

1. Introduction
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. Knowledge of fecundity is also an important aspect in stock size assessment, stock discrimination [1] and rational utilization of stock [2] and in explaining the variation of population as well as to make efforts for increasing the amount of fish yield. The study of fish and their stability is important. Fecundity is an important parameter in fishes for determining the reproductive potential of fish species [3]. Also a thorough knowledge on the fecundity of the fish is essential for evaluating the commercial potentialities, stock study, life history, particular culture and the management of fishery [4, 3]. Generally fish fecundity is species specific and varies from one species to another [5]. Fecundity along with other indices such as gonadosomatic index (GSI) is used to access the reproductive condition of a fish. Monthly variations in GSI provide the reasonable indicator of reproductive seasonality of fish. The seasonal timing of reproduction, spawning time is often identified from changes in the GSI which determines the reproductive season of the fish [6].

2. Materials and Methods
2.1 Gonadosomatic index (GSI)
For morphological study of gonads, fish specimens were dissected open and their gonads were collected to record their length and weight. GSI (Gonado Somatic Index) was determined using the following formula [7]:

$$\text{GSI} = \frac{\text{Weight of Gonads}}{\text{Total body weight}} \text{ X } 100$$

2.2 Fecundity
The gravimetric method was used for studying fecundity, which is based on the relation between ovary weight and the oocyte density in the ovary [8, 9]. Fecundity was estimated by counting the number of mature ova from a known weight of mature/ripe ovary. The ovary subsamples were obtained from the anterior, middle and posterior regions of both the ovaries [10]. The subsamples were spreaded evenly on a counting slide with a few drops of water and the number of mature ova were counted and average number of three portions was used to

determine the fecundity by the following formula:

$$\text{Absolute Fecundity} = \frac{\text{No. of Ova in the Subsample X Total Ovary Weight}}{\text{Weight of Subsample}}$$

Relative fecundity i.e. number of eggs/1 g of body weight (unit body weight or ovary weight) was obtained by dividing absolute fecundity with total weight of fish (in grams).

$$\text{Relative Fecundity} = \frac{\text{Absolute Fecundity}}{\text{Weight of Fish}}$$

3. Results

3.1 Gonadosomatic Index

During the present study, GSI value of *S. niger* was recorded highest in the month of March in both males (11.08%) and females (15.13%) and was found minimum in the month of July in both males (0.53%) and females (1.36%) as given in the Table 1 and Fig. 1. The variations in GSI of *S. niger* are presented in Table 1 and Fig. 1.

Table 1: Monthly variation in GSI (%) of *S. niger* (Males, Females and combined)

Months	GSI (%)		
	Male (Mean±S.D)	Female (Mean±S.D)	Combined (Mean±S.D)
January	9.44±1.05	10.32±4.02	10.20±3.74
February	10.74±2.28	13.58±4.28	12.16±4.13
March	11.08±4.53	15.13±4.44	13.10±5.65
April	9.56±2.93	13.73±6.23	12.69±5.78
May	3.27±.10	2.62±1.40	2.74±1.33
June	0.88±0.66	1.57±0.70	1.49±0.77
July	0.53±0.61	1.36±1.41	1.12±1.26
August	3.50±1.35	4.01±1.52	3.59±1.43
September	3.84±1.76	4.87±1.67	4.43±1.75
October	4.67±1.76	5.00±1.22	4.85±1.48
November	4.85±1.51	5.52±1.88	5.23±1.73
December	5.52±1.50	6.01±1.20	5.80±1.34

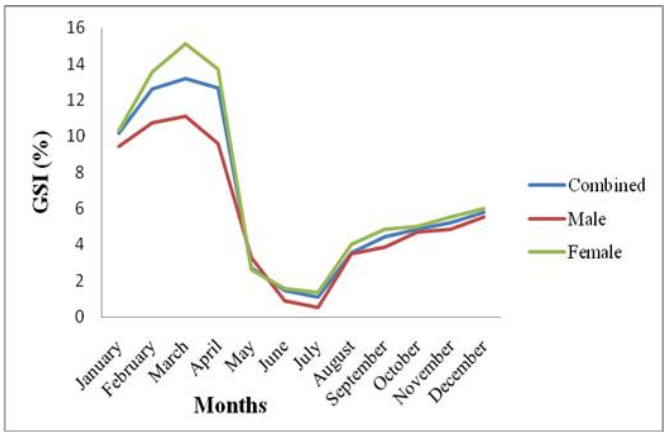

Fig 1: Monthly variations in GSI (%) of *S. niger* (Males, Females and Combined)

3.2 Fecundity

During the study period, the absolute fecundity of *S. niger* varied from 2700 to 16758 (Table 2, 3). The values of relative fecundity per gram of body weight varied from 28 to 89 ova per gram of body weight in *S. niger*.

In the present study, positive correlations were observed between fecundity and length and weight measurements of the fish as well as the ovaries in *S. niger*.

Logarithmic relationship between fecundity and total length (Fig. 2) of *S. niger* has been established as

Log F = -2.647 + 2.782 Log L (R^2 =0.295)

Logarithmic relationship between fecundity and total weight (Fig. 3) of *S. niger* has been established as

Log F = 0.558 + 1.540 Log L (R^2 =0.560)

Logarithmic relationship between fecundity and ovary length (Fig. 4) of *S. niger* has been established as

Log F = -3.597 + 3.783 Log L (R^2 =0.945)

Logarithmic relationship between fecundity and ovary weight (Fig. 5) of *S. niger* has been established as

Log F = 2.197 + 1.346 Log L (R^2 = 0.979)

Table 2: Estimates of absolute and relative fecundity of *S. niger*

Total length of fish (mm)	Weight of fish (g)	Ovary length (mm)	Ovary weight (g)	Absolute fecundity	Relative fecundity (per g body wt.)
228.90	134.00	101.00	22.00	9166	68
280.00	230.00	114.00	32.50	16758	72
195.00	95.00	73.21	9.00	2700	28
240.00	152.00	83.46	14.00	5973	39
210.00	124.00	91.24	17.00	7026	56
227.00	108.00	89.43	15.50	6458	59
265.00	143.00	86.42	13.00	5026	35
220.00	102.80	81.62	11.20	4629	45
215.00	113.00	106.43	21.00	10080	89
225.00	103.00	79.68	10.00	3333	32

Table 3: Descriptive statistics of fecundity in *S. niger*

	Min	Max	Mean	Median	S.E
Total length of fish (mm)	195.00	280.00	230.59	226.00	8.03
Weight of fish (g)	95.00	230.00	130.48	118.50	12.54
Ovary length (mm)	73.21	114.00	90.64	87.92	4.05
Ovary weight (gm)	9.00	32.50	16.52	14.75	2.24
Absolute fecundity	2700	16758	7114	6215	1299
Relative fecundity (per g body wt.)	28	89	52	50	6.3

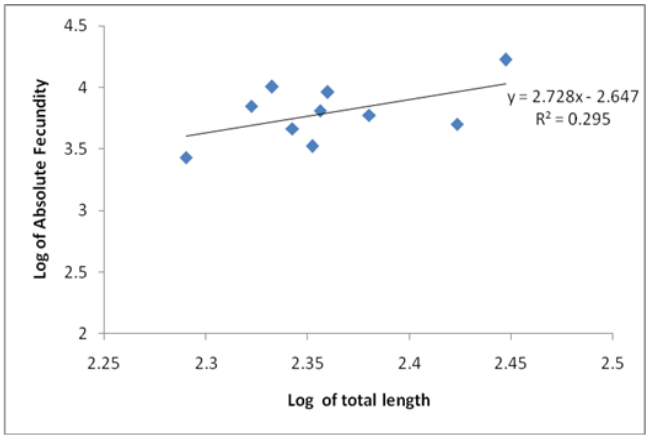

Fig 2: Logarithmic relationship between fecundity and total length of *S. niger*

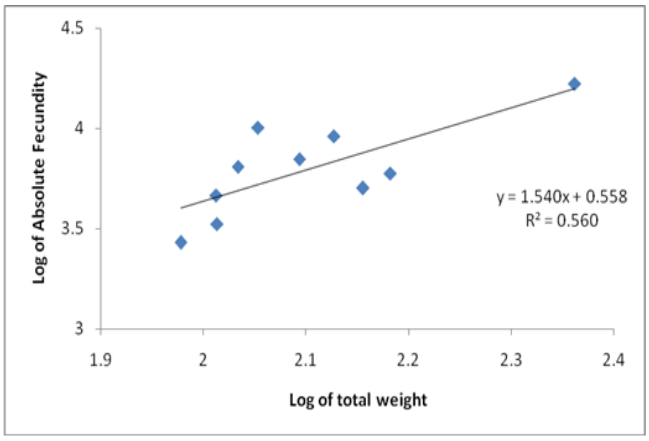

Fig 3: Logarithmic relationship between fecundity and total weight of *S. niger*

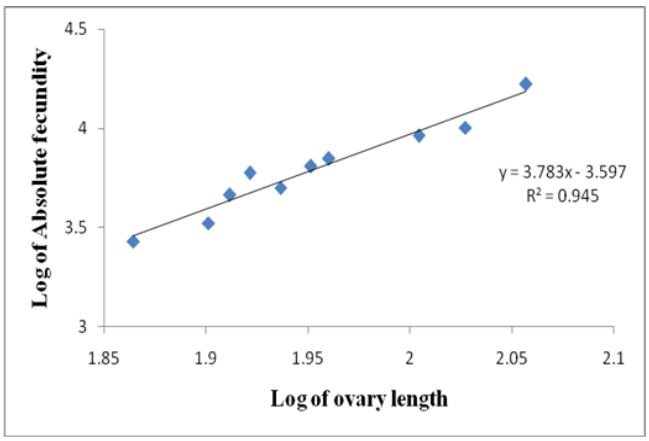

Fig. 4: Logarithmic relationship between fecundity and ovary length of *S. niger*

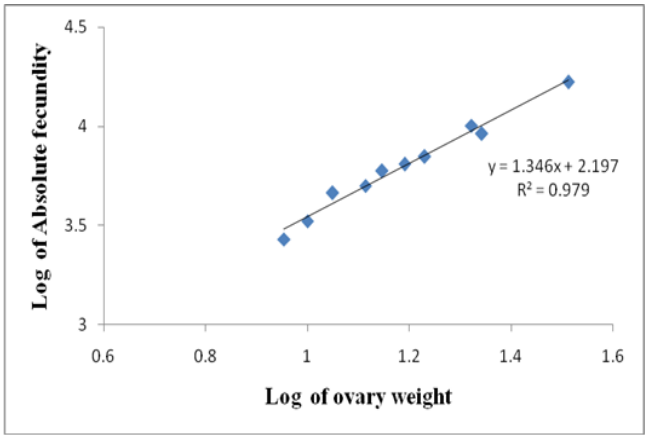

Fig 5: Logarithmic relationship between fecundity and ovary weight of *S. niger*

4. Discussion

4.1 Gonadosomatic index (GSI)

The ability to reproduce determines the success of any fish species in a fluctuating environment [11]. GSI is an important aspect which determines fish spawning, in both temperate as well as tropical regions. It increases with the maturation of fish and becomes high during peak of maturity and then decreases abruptly when the fish reaches spent phase. In the present study, GSI value of *S. niger* was found highest in the month of March in both the males (11.08%) and females (15.13%) indicating its spawning season and minimum was found in the month of July in both males (0.53%) and females (1.36%). Bhat [12] observed highest GSI in *S. niger* in the month of March with value of 11.3% and lowest in the month of June with a value of 2.90%. Similar results have been reported by Hussain [13] while studying breeding biology and fecundity of *S. niger* from Dal lake. The author reported highest GSI during March (13.80%), which decreased gradually upto June attaining its lowest value in July (3.13%). He further reported that the females exhibit higher GSI value than males. Similar results have been found in our study in case of *S. niger*. Shafi *et al*. [14] while studying breeding biology of *S. niger* from Dal Lake revealed that GSI recorded its highest value during February (14.35%) which is the peak breeding season of the fish, then it decreased gradually upto June attaining its lowest value in June (3.88%), females exhibiting higher GSI value than males. Saba [15] observed higher mean GSI values in females (15.75%) as compared to males (12.5%) in *S. niger*. Highest GSI was recorded during February indicating that the fish matures during this month. Shafi [16] recorded highest GSI in *Carassius carassius* in the month of April with highest value of (12.99%) in females and (12.65%) in males.

4.2 Fecundity

Fecundity is one of the most important biological aspects of a fish species. This must be known to assess the reproductive potential of the fish and to evaluate the commercial potentialities of a fish stock [17]. Fecundity of fish is important for efficient fish culture and effective management practice [18] and it is also helpful in determining the index of density dependent factor affecting population size [19]. According to Khallaf and Authman [20] fecundity does not remain constant but it fluctuates with variations in environmental conditions and species specific factors.

In the present study, absolute fecundity in *S. niger* varied from 2700 to 16, 758 while relative fecundity varied from 28 to 89 ova per gram of body weight. Similar results have been reported by Saba [15] and Shafi *et al.* [14] in *S. niger* with absolute fecundity values ranging from 5691 to 17, 645 and 1550-3444 and relative fecundity at 29 to 64 and 24 to 124 ova per gram of body weight respectively. Jan *et al.* [21] reported that the absolute fecundity ranged from 3437 to 34800 and relative fecundity varied from 19 to 51.39 ova per gram of body weight in *Schizothorax plagiostomus*. Wali *et al*. [22] estimated the average fecundity of rainbow trout from Kashmir at 1746.9 eggs, while as Ali *et al*. [23] reported values of absolute fecundity ranging from 3559 to 15712 ova and relative fecundity (per gram of body weight) ranging from 30.52 to 63.45 ova in *S. niger*. In the present study, positive correlations were observed between fecundity and length and weight measurements of the fish as well as the ovaries in *S. niger*. High positive correlation was found between fecundity and ovary weight in *S. niger* with $R^2 = 0.979$. Similar results were recorded by Jan *et al*. [21] with correlation coefficient of 0.972 between fecundity and ovary weight in *Schizothorax plagiostomus*. Various workers including Jyoti and Malhotra [24], Raina [25], Misra [26] correlated fish weight with fecundity and obtained straight line relationship between the two, in different *Schizothorax* species. Qadri *et al*. [27] reported the linear relationship of fecundity with total length, total weight and ovary weight and the value of correlation coefficient (R^2) at 0.68, 0.67and 0.55, respectively. Shah *et al*. [28] also found that fecundity displayed better relationship with ovary weight (R^2=0.67) followed by fish weight (R^2=0.54) and fish length (R^2=0.52). Ali *et al*. [23] reported strong correlation of fecundity with total weight, total length and ovary weight with coefficient of correlation values of 0.6375, 0.5379 and 0.5804 respectively, while low correlation was observed with ovary length (R^2=0.2880).

5. Conclusion

From the present study it was observed that GSI value of *S. niger* was found highest in the month of March in both the males (11.08%) and females (15.13%) indicating its spawning season and minimum was found in the month of July in both males (0.53%) and females (1.36%). Absolute fecundity of *S. niger* varied from 2700 to 16, 758 and relative fecundity varied from 28 to 89 ova per gram of body weight. High positive correlation was found between fecundity and ovary weight in *S. niger* with $R^2 = 0.979$.

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