Reproductive Potential and Egg Development in *Schizopyge niger* (Heckel, 1838) from Dal Lake, Kashmir

Abstract
Fecundity is an important parameter in fisheries that predicts the reproductive capability of fish stock. Information on the fecundity of *Schizopyge niger* is helpful in estimating the amount of offspring produced in spawning season, which is essential for the stock assessment of the species. Assessment of the fecundity of a fish is essential for evaluating the commercial potentialities of its stock, life history, practical culture and actual management of the fishery. A total of 20 gravid females were collected during the spawning season from Dal lake, Kashmir and fecundity was estimated using gravimetric and actual counting methods. The absolute fecundity ranged from 6,318 to 19,375 eggs, while the relative fecundity ranged from 26.74 to 60.34 eggs per gram of body weight, with a mean of 46.96 eggs/g. A strong positive correlation was observed between fecundity and body size parameters, particularly ovary weight ($R^2 = 0.6601$). The ova diameter ranged from 0.21 mm to 2.66 mm, showing a unimodal distribution, which suggests that *S. niger* is an annual spawner with a single spawning event each year.

Comment [F1]: Mention period

Keywords: *Schizopyge niger*, fecundity, ova diameter, spawning

Introduction

Fecundity, or reproductive potential, is a critical biological parameter essential for evaluating the commercial viability of fish populations (Gomezmarquez, 2003). It plays a key role in fisheries management and aquaculture by providing insights into population recovery and sustainability (Lagler, 1956; Tracey et al., 2007). The relationship between fecundity and factors like female size enables estimates of egg production, seasonal offspring numbers, and overall reproductive capacity (Chondar, 1977; Qasim and Qayyum, 1963). Significant variations in fecundity exist across fish species and among individuals of the same species, size, and range (Bagenal, 1957). Variations are further influenced by age, body length, gonadal weight, and genetic diversity, which shape strain-specific maturation and spawning patterns across ecological ranges (Lagler, 1956; Lone and Hussain, 2009). Environmental factors like water temperature, photoperiod, and rainfall also regulate ovarian growth and reproduction cycles. Fecundity estimates are instrumental in fish conservation and management (Shah et al., 2018), since it provides basis for predicting population trends and formulating strategies for stock enhancement.

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Reproductive success is closely tied to environmental changes such as temperature, day length, and food availability (Farooq et al., 2018; Bhat et al., 2010). Key demographic traits, including fecundity and gonadosomatic index, are vital for understanding life history and informing conservation strategies (Shafat et al., 2016). Studies consistently demonstrate linear relationships between fecundity and parameters like fish length, weight, and ovarian metrics (Somdutt and Kumar, 2004; Joshi, 2008; Bahuguna and Khatri, 2009). Ova diameter studies offer further insights into reproductive strategies, indicating uniform ova size within individuals and linking changes in ova diameter to egg development and breeding onset (Bagenal, 1969; Kohinoor et al., 2012). These variations also highlight reproductive strategies and spawning periodicity, shaped by environmental factors like photoperiod, temperature, and food supply (Bromage et al., 2001). Understanding fecundity and ova development is essential for sustainable fisheries management and species conservation.

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The snow trouts, belonging to the Cyprinidae family and the order Cypriniformes, are believed to have migrated into lakes and streams of Kashmir from Central Asia. These migrations likely originated from watersheds bordered by the Hindukush and Karakoram mountain ranges, as well as the inner regions of the northwestern Himalayas and the Suleiman Ranges (Sehgal, 1999). In India, snow trouts are predominantly found in the cold waters of Jammu and Kashmir, Assam, the Eastern Himalayas, Bhutan, and Sikkim, inhabiting altitudes between 1180 and 3000 meters above sea level (Chandra et al., 2012). Among the species, *Schizopyge niger* (Heckel, 1838), commonly referred to as “Ael Gad” or “Alghad,” is native to the cold rivers and streams of Kashmir, as well as parts of Afghanistan and Pakistan.

Methodology

Fecundity: Female brooders were collected from the Dal Lake during the spawning season. 20 gravid females were studied for estimation of fecundity. Fishes were brought to Fisheries Resource Management (FRM), Faculty of Fisheries, SKUAST-K Laboratory for the estimation of total length,

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body weight, ovary length and ovary weight. Gravimetric and actual counting method was used for the estimation of fecundity. For the estimation of fecundity, fishes were sacrificed and both the ovaries were taken out carefully. The moisture was thoroughly wiped out from the ovaries with a blotting paper. The collected ovaries were placed in 10% formaldehyde for at least 24 hours to bring hardness of eggs, so as to make easy and accurate calculation of sticky eggs. This was followed by drying of eggs on blotting paper for 1-2 hours, three subsamples of one gram each from anterior, middle and posterior region were weighed and then eggs were counted carefully by gravimetric method. The mean numbers of eggs were multiplied by gonad parts of ovary weighed and the total number of eggs per gonad was obtained.

Absolute fecundity was computed using the following equation (Bagenal, 1978)

$$\text{Absolute fecundity} = \frac{\text{No. of ova in a subsample} \times \text{Total ovary weight(g)}}{\text{Weight of sub sample(g)}}$$

The relative fecundity (No. of ova per gram of body weight and ovary weight) was estimated by dividing absolute fecundity with total weight of the fish (g) and weight of the ovary (g).

$$\text{Relative fecundity} = \frac{\text{Absolute fecundity}}{\text{Weight of fish(g)}} \text{per gram body weight}$$

Ova diameter measurements: Diameters of the intra ovarian eggs from the preserved ovaries were recorded after keeping them overnight in Gilson's fluid to remove ovarian muscles as per methods given by Clark (1934). The egg pattern distribution was recorded by measuring ova diameter taken from anterior, middle and posterior part of ovary using digital vernier calipers (Trusize). The measured ova were grouped into convenient class intervals and their frequency polygons were drawn graphically. Representative samples of ovaries in different stages of maturity were selected, and 300 ova measured from each of these ovaries were assorted into modal groups.

Statistical analysis: The data obtained in the research was tabulated and analyzed using standard statistical software-Microsoft Excel and SPSS for windows (version 20).

Results and Discussion:

The range, mean, and standard error of body weight, body length, ovary weight, ovary length, and fecundity are presented in Table 1. The absolute fecundity observed in this study ranged from 6,318 to 19,375 eggs, consistent with findings by Sabha et al. (2017), Hussain et al. (2018), Ali et al. (2020) and Rashid et al. (2024). Relative fecundity ranged from 26.74 to 60.34 eggs/g body weight, with a mean of 46.96 eggs/g, which is lower than the values reported by Yousuf et al. (1992) (53.23 eggs/g), Shafi et al. (2013) (53 eggs/g), and Shafat et al. (2016) (48.90 eggs/g). The decline in relative fecundity over the years may be attributed to deteriorating water quality in Dal Lake, which significantly impacts fecundity (Krishnani et al., 2003; Mansour et al., 2006). Positive correlations were found between fecundity and total body length, body weight, ovary weight, and ovary length in *S. niger* (Table 2). Among these, ovary weight showed the strongest correlation with fecundity ($R^2 = 0.6601$), followed by ovary length ($R^2 = 0.5512$), total body weight ($R^2 = 0.5095$), and total body length ($R^2 = 0.5078$), Fig 1-4. Similar relationships between fecundity and body size parameters have been observed by Kestevan (1942), and others, with weight being a more significant factor than length, as emphasized by Ali and Kadir (1996). The increase in body size allows for greater egg production (Jonsson & Jonsson, 1997), a trend seen across Schizothoracids (Gandotra et al., 2009). In contrast to findings of Varghese (1961) in *Coilia ramcarati*, where egg production decreased with increasing ovary weight, this study found a positive relationship between ovary weight and egg numbers, similar to studies on *Tilapia nilotica* (Soliman et al., 1986) and *Labeo gonius* (Joshi & Khanna, 1980). This highlights ovary weight as a key determinant of fecundity in *S. niger.*

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Table 1: Statistical estimates of reproductive biology of female *S. niger*

Parameters	***Range***	***Mean***	***S.E***
Body weight (g)	137.7-345.0	230.3	12.99
Total length (mm)	147.00-395.00	246.13	12.54
Ovary weight (g)	20.0-72.5	39.8	3.79
Ovary length (mm)	60.22-195.11	117.70	6.07
Absolute fecundity (eggs)	6318-19375	10782	841
Relative fecundity (eggs/ g body weight)	26.74-60.34	46.96	2.15

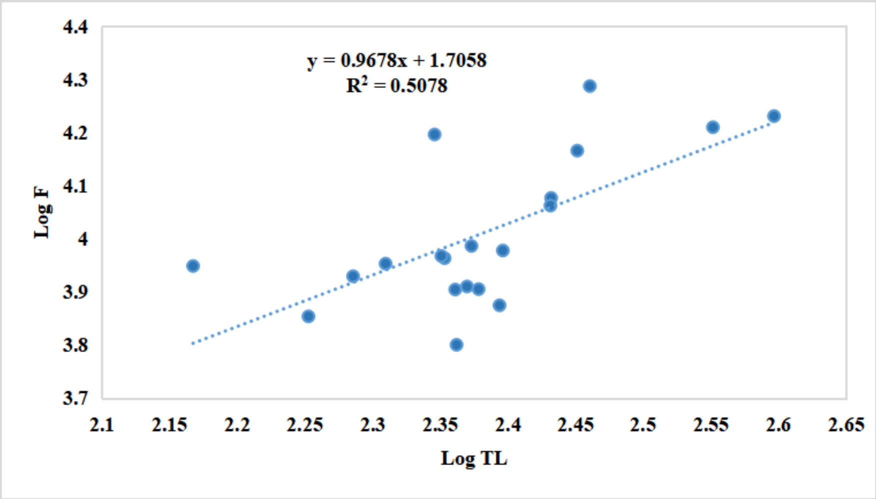


Fig. 1 Logarithmic relationship between absolute fecundity and total length of *S. niger*

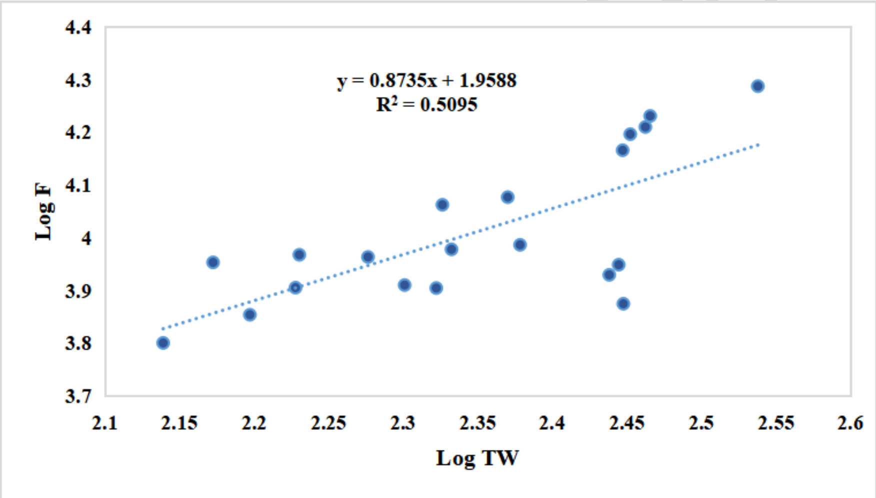


Fig. 2 Logarithmic relationship between absolute fecundity and total weight of *S. niger*

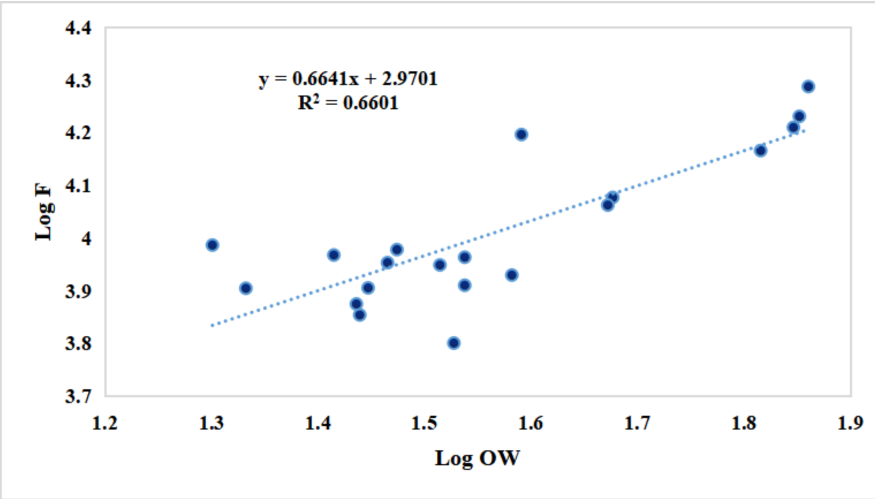


Fig. 3 Logarithmic relationship between absolute fecundity and ovary weight of *S. niger*

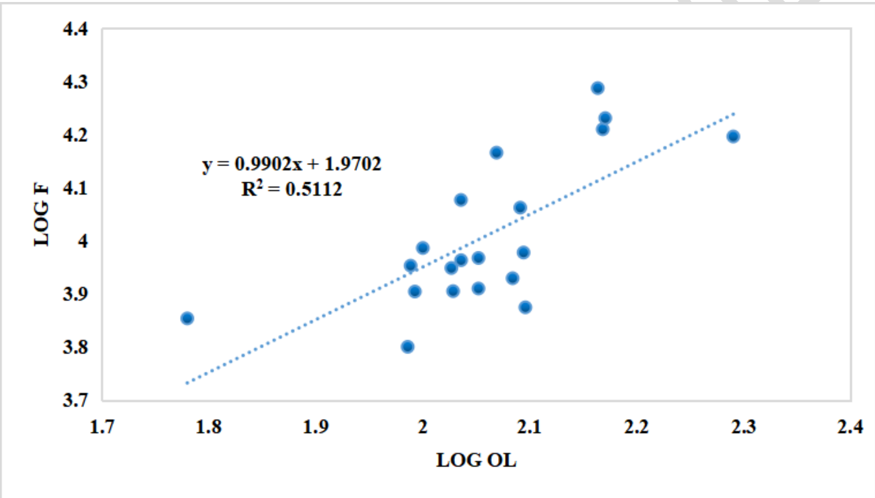
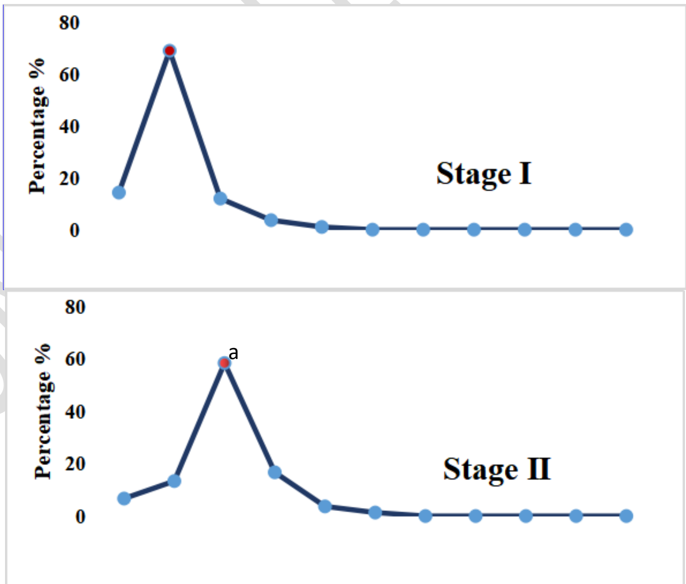


Fig. 4 Logarithmic relationship between absolute fecundity and ovary length of *S. niger*

The study also identified multiple maturity stages in *S. niger,* including immature, early maturing, advanced maturing, mature, late mature, and spent stages (Table 2). Qasim (1973) proposed five maturity stages for Indian teleosts, which aligns with this study's observations. Ova diameter in *S. niger* ranged from 0.21 mm to 2.66 mm, similar to the findings of CIFRI (1977) (0.23 mm to 2.07 mm) and Sabha et al. (2017) (0.2 mm to 2.5 mm). The unimodal distribution of ova diameter further supports the cyclic nature of spawning in *S. niger* (Fig. 5). In this study, the smallest ova size was recorded in June (0.21 mm), and the largest in March (2.66 mm), which closely matches results from Sabha et al. (2017) and Jan & Ahmed (2018) for *S. niger* and *S. plagiostomus* respectively. These observations suggest that *S. niger* is an annual spawner, with a single spawning event each year, in line with findings by Sunder (1986).

Table 2. Statistical estimates of ova diameter of *S. niger*

Maturity stages of ovary Number of observations Ova diameter (mm)	**Number of observations Ova diameter (mm)**	**Ova diameter (mm) Mean ± S.E***Immature (I)*3000.41± 0.00*Maturing (II)*3000.69± 0.01*Mature (III)*3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02
*Immature (I)*3000.41± 0.00*Maturing (II)*3000.69± 0.01*Mature (III)*3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02	3000.41± 0.00*Maturing (II)*3000.69± 0.01*Mature (III)*3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02	0.41± 0.00*Maturing (II)*3000.69± 0.01*Mature (III)*3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02
*Maturing (II)*3000.69± 0.01*Mature (III)*3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02	3000.69± 0.01*Mature (III)*3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02	0.69± 0.01*Mature (III)*3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02
*Mature (III)*3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02	3001.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02	1.23± 0.01*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02
*Ripe (IV)*3002.01± 0.02*Spent (V)*3001.24± 0.02	3002.01± 0.02*Spent (V)*3001.24± 0.02	2.01± 0.02*Spent (V)*3001.24± 0.02
*Spent (V)*3001.24± 0.02	3001.24± 0.02	1.24± 0.02



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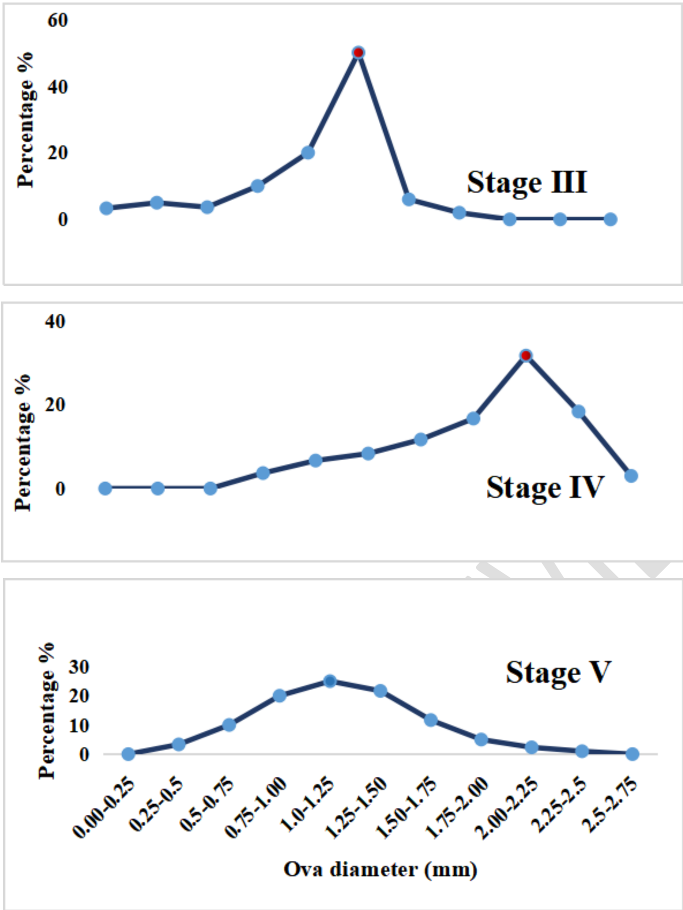

Fig. 5: Ova diameter frequency in different maturity stages of *S. niger*

Conclusion:

This study highlights the reproductive characteristics of *Schizopyge niger* from Dal Lake, Kashmir, revealing essential insights into its fecundity and egg development. The observed fecundity ranges and correlations with body size parameters emphasize the role of ovary weight as a primary determinant of fecundity. The decline in relative fecundity over time suggests that environmental factors, particularly water quality, may negatively impact reproductive success in *S. niger*. The unimodal distribution of egg diameters confirms that *S. niger* is an annual spawner, with a single spawning event per year. Fecundity is of great importance in aquaculture because it influences recruitment into fisheries. These findings are crucial for developing effective conservation strategies and managing fish populations in Dal Lake, ensuring the sustainability of the species in the face of environmental challenges.

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