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Assessment of Reproductive Parameters and their Relationship with Some Body Parameters in Brown Trout (*Salmo trutta fario*)

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ABSTRACT: The present study was conducted to estimate the absolute fecundity, relative fecundity, ova diameter and their relationship with body parameters (total length, total body weight) of brown trout (*Salmo trutta fario*) which is an exotic species transplanted to Kashmir more than a hundred years ago. The findings of the present study recorded a positive correlation between the total body length and total body weight with the correlation coefficient (r^2) of 0.9481. Absolute fecundity ranged from 586 to 1424 eggs while the relative fecundity ranged between 1.06 to 1.67 eggs per gram body weight. There was a positive correlation between absolute fecundity values and the parameters of total length and total somatic weight of the fish with fecundity correlating more with fish weight than fish length. Gonado-somatic Index (GSI) ranged from a low of 0.31% in the month of February to a high of 12.40% in November.

Keywords: *Salmo trutta fario*, eggs, fecundity, gonado-somatic index.

INTRODUCTION

Cold-water fish brown trout (*Salmo trutta fario),* belongs to family Salmonidae. They are native to Europe, North America, Africa, Australia, New Zealand and Papua New Guinea Moyle (2002); Bazaz *et al*. (2021). Trout is an important fish species for recreational fishing because of its aquaculture potential, economic worth, and widespread consumer demand. It has been transplanted to Kashmir more than a hundred years back and is well established in most of the valley streams especially in streams like Sindh, Bringi, Lidder, Ferozpur and Erin. Fecundity is sometimes described as total fecundity or absolute fecundity, when expressed in terms of the number of eggs laid by each brood fish. Alternatively, relative fecundity is defined as fecundity expressed per unit body weight of post-stripped fish. With increasing age of the fish, both fecundity and egg size increases Springate *et al*. (1984) although, it is assumed that these changes are primarily due to larger size of older fish. Jan and Jan (2017) reported that large sized fishes contained more eggs as compared to small sized fishes. Egg production is related to the size of the fish. Brown trout (*S. trutta fario*) prefers wild type of environment and accepts less amount of artificial feed which is a big challenge for its culture practice. The results generated in the present study would be useful in the artificial propagation of this fish.

MATERIALS AND METHODS

The present study is based on 58 specimens of brown trout in the length range of 295 mm to 501mm and weight range of 345gm to 1188gm.

A. Estimation of Length and Weight Relationship (LWR)

Total length (TL) was determined using digital vernier callipers (Trusize). The length was measured from the tip of snout to the tip of its caudal fin, and its weight was determined using a digital electronic balance (Thomsons D-112). The parabolic equation, as given by Le Cren (1951), was used to develop a statistical relationship between these fish parameters as

$$W = aL^b$$

Where, W = fish weight (g)
L = fish length (cm)
a = constant
b = an exponent that expresses the length-weight relationship

When the relationship (W = aLb) is represented graphically as (Log W = Log a +b Log L), it becomes a straight line relationship.

B. Fecundity

Fish were sacrificed and both ovaries were thoroughly dissected out for the estimation of fecundity.

With the help of blotting paper, the moisture was removed from the ovaries, and their length and weight were measured. The extracted ovaries were immersed in 10% formaldehyde for 24 hours. The eggs were then dried on blotting paper for 1-2 hours, weighed in three sub-samples of one gram each from the front, middle, and posterior regions, and counted meticulously using the gravimetric technique. The absolute and relative fecundity were determined using the formula provided by (Bagenal, 1978):

$$\text{Absolute fecundity} = \frac{\text{No. of ova in the subsample} \times \text{total ovary weight}}{\text{Weight of subsample}}$$

Individual fecundity for each female fish was estimated using the mean number of three sub sample fecundity (F1, F2, and F3):

$$F = \frac{F1+F2+F3}{3}$$

The following equation was used to estimate relative fecundity (number of eggs per gram of body weight):

$$\text{Relative fecundity} = \frac{\text{Absolute fecundity}}{\text{Weight of fish (gm)}}$$

C. Gonado-somatic Index (GSI)

The Gonado-somatic Index (GSI) was estimated month-wise in order to determine the spawning season of brown trout. The GSI was estimated using equation given by Desai (1970).

$$GSI = \frac{\text{Gonad weight}}{\text{Body weight}} \times 100$$

RESULTS

A. Length-weight relationship

Length-weight relationship for female brown trout was established as $W = 0.0002L^{2.4833}$ while the logarithmic relationship between the two parameters was established as LogW = -3.6136 + 2.4833 LogL. There was a positive relation between the two parameters, with the correlation coefficient (r^2) being estimated at 0.9481. The value of growth coefficient (b=2.4833) was found to be significantly different from 3 which suggests that the fish follows a negatively allometric growth pattern.

B. Fecundity

Absolute fecundity was estimated at 586 to 1424 eggs while the relative fecundity ranged between 1.06 to 1.67 eggs per gram body weight. There was a positive correlation between absolute fecundity values and the parameters of total length as well as total somatic weight of the fish with fecundity correlating more with fish weight (r^2=0.8784) than fish length (r^2=0.8211).

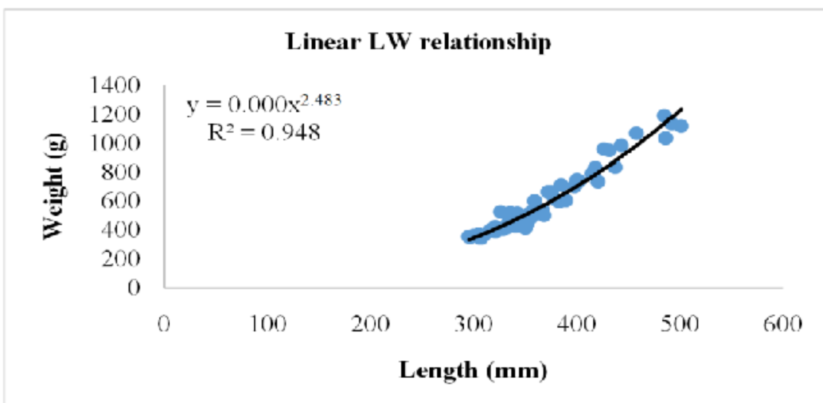

Fig. 1. Length-weight relationship in female *S. trutta fario*.

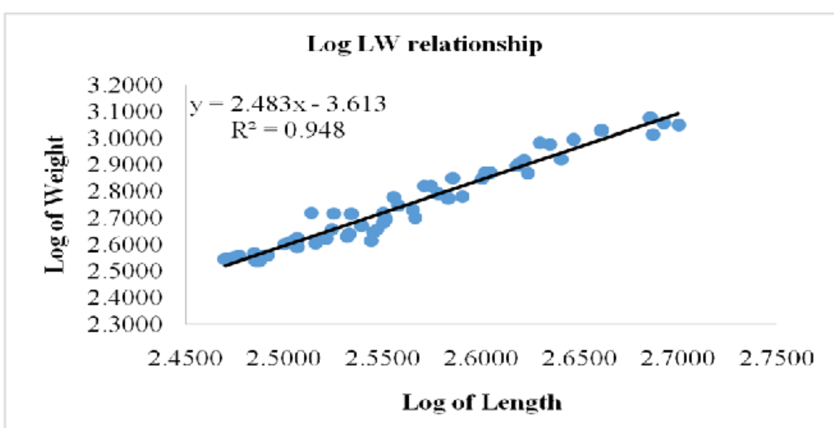

Fig. 2. Logarithmic length-weight relationship in female *S. trutta fario*.

The relationships were established as LogF = -1.6129 + 1.7498 Log L (Fecundity against total fish length) and LogF = 0.8733 + 0.7288 LogW (Fecundity against total fish weight). The value for correlation coefficient (r^2) for the relationships was estimated at 0.8211 and 0.8784 respectively.

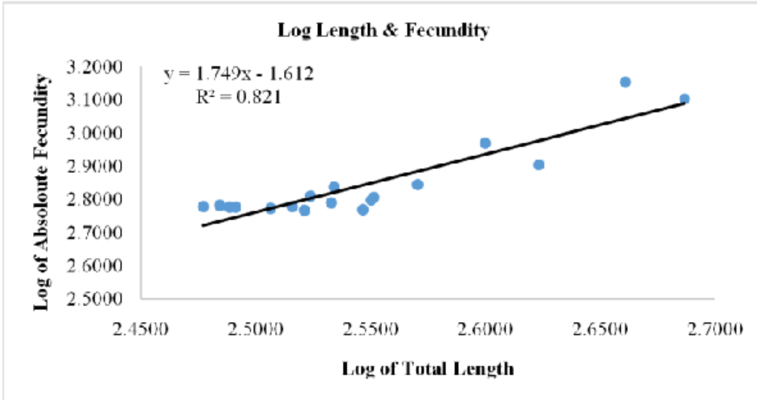

Fig. 3. Logarithmic relationship between total length and absolute fecundity in female *S. trutta fario***.**

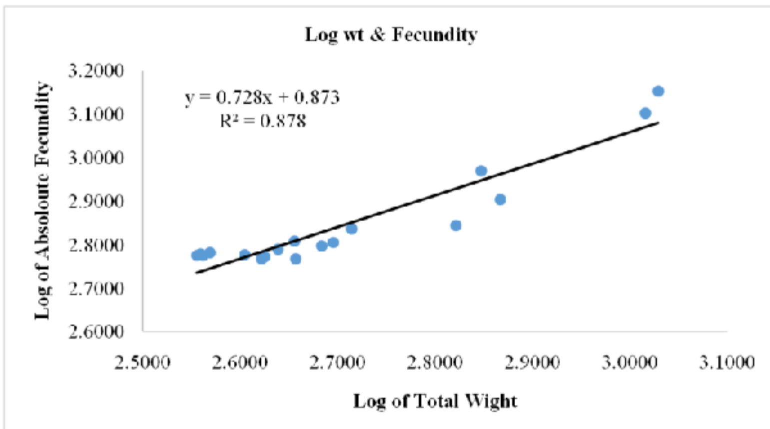

Fig. 4. Logarithmic relationship between total weight and absolute fecundity in female *S. trutta fario*.

C. Gonado-somatic Index

The Gonado-somatic Index was estimated month-wise to determine the spawning season of brown trout. It ranged from a low of 0.31% in February to a high of 12.40% in November. Based on Gonado-somatic Index (GSI) and the evidence of running as well as spent fish, the spawning season of the fish can be said to extend from October to January with peak in November and December.

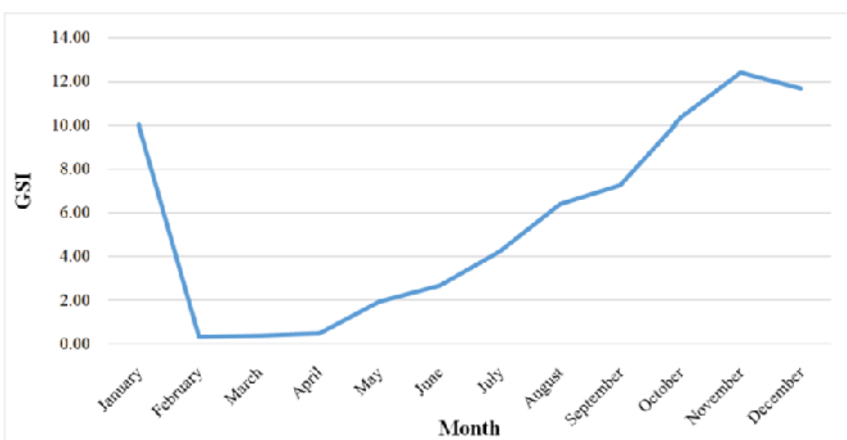

Fig. 5. Month-wise gonadosomatic index (GSI) of *S. trutta fario.*

DISCUSSION

In fisheries biology, the length-weight relationship of fishes is an important tool for determining whether somatic growth was isometric or allometric (Koutrakis and Tsikliras, 2003). These correlations are useful for computing fish stocks and assessing population size. The present study established a positive correlation between the two parameters of length and weight with an estimated correlation coefficient (r^2) of 0.9481, indicating a substantial degree of positive relation between total body length and body weight of brown trout. The value of growth coefficient (b=2.4833) was found to be significantly different from 3 which suggests that the fish follows a negatively allometric growth pattern. Rawat *et al*. (2014) reported similar findings on *S. trutta fario*, estimating the coefficient of correlation (r^2) for the length-weight relationship to be 0.985, indicating a high degree of positive correlation between the length and weight of fish. In brown trout populations, Hao and Chen, (2009) found positive associations between female length, body weight, and gonad weight and fecundity. Similarly, Shah *et al*. (2011) recorded positive allometric growth with a b value of 2.683 for farmed female rainbow trout from Kashmir. Along the Ratnagiri coast of Maharashtra, Shah *et al*. (2014) observed negative allometric growth for *Sardinella longiceps* with a growth exponent (b) value of 2.645. Solomon *et al*. (2016) found a significant negative allometric growth pattern in periwinkile (*Tympanotonous fuscatus*) from the Okrika estuary in Nigeria, with a b value of 2.18.

Fecundity is a measurement of the number of eggs in a mature female's ovary. The present study recorded the maximum fecundity of 1424 and the minimum fecundity of 891 eggs. Fish that were larger were found to be more fecund than those that were smaller in size. Similar findings have been reported by various researchers (Rheman *et al*., 2002; Alam and Pathak, 2010; Qadri *et al*., 2015; Jan and Jan, 2017; Shah *et al*., 2018; Wali *et al*., 2018; Mohamad *et al*., 2018; Ali *et al*., 2020). Variation in fecundity among fishes is common, depending on various parameters such as the fish's size, age, and condition. According to Bagenal (1967), length and weight are reliable indicators of egg production capacity; hence, fecundity increases as the fish grows in size. This trend was also observed in the current study, where the quantity of eggs increased as the length and weight of the fish increased. Shafi *et al.* (2013) reported a straight line relationship between fecundity and total length and body weight. This indicates that when the body and gonad weights increases, the number of eggs in the ovaries increases proportionally. The parameters of total length and total somatic weight of the fish had a positive correlation with absolute fecundity values, with fecundity correlating more with fish weight than with fish length. The value for correlation coefficient (r^2) for the relationships was estimated at 0.8211 and 0.8784 respectively. The results obtained in the current study are in harmony with the above mentioned studies.

The gonado-somatic index (GSI) is a measure of gonadal development and maturity of fish, which increases as the fish matures and then drops abruptly (Parameswarn *et al*., 1974). In the present study, GSI ranged from a low of 0.31% in February to a high of 12.40% in November. The gonadal development was observed to be slow and well-defined, peaking in November. Thereafter, GSI gradually declined. The spawning season of the fish can be said to extend from October to January with peak in November and December. According to Yeldan and Avsar (2000), GSI is extensively employed to investigate the spawning period since its value is directly related to gonad development. Similar results have been reported by Jan and Jan (2017) who reported higher values of GSI in *S. trutta fario* during November- December with the highest value of GSI observed in November and declined gradually from January.

CONCLUSION

S. trutta fario has a positive relationship between length and weight. Growth in the fish is negatively allometric. It is a low fecund fish. Fecundity was found to correlate positively with length and weight of the fish. Spawning season of brown trout (*S. trutta fario*) extends from October to January with peak in November-December. The timing of reproduction and spawning can be identified by the changes in the GSI, which determines reproductive season. Therefore, the study of these indices will not only provide useful knowledge about the effect of season on the reproductive development of the fish, but information about these parameters is also useful for rational exploitation of the fish.

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Conflict of interest. None.

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