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Sexual Maturity of an Ornamental Himalayan Foot-hill Region Fish *Barilius barna* as Determined by Dobriyal Index and Gonado-somatic Index

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ABSTRACT

The objective of the present investigation aimed to determine the sexual maturity of a commercially important ornamental foothill fish *Barilius barna* from the Tamsa stream of Doon Valley, Uttarakhand, India. To comprehend its maturation biology, the study was carried out for a period of one year by applying the Dobriyal index and Gonado-somatic index. The values of D.I. and G.S.I. for both the sexes were observed maximum in the month of May and June respectively and minimum in August, indicating its absolute spawning period during the month of June to August.

Keyword: Sexual Maturity, G.S.I., D.I., *Barilius barna.*

INTRODUCTION

The knowledge of maturation biology is very useful for fish culture and management. Thousands of small and immature yolkless eggs remain inside the ovaries of the fish. These eggs gradually mature in batches and finally spawn at the time of breeding. *Barilius barna* is a small hill stream minor carp of the Garhwal region. The study on the availability of freshwater fish in the Shivalik mountain region from Doon valley, fecundity and sex-ratio (Bahuguna *et al*., 2021b), and length-weight relation and relative condition factors (Rayal *et al*., 2021a) in freshwater fish *B. barnas* has been worked in the Garhwal region. Few fish and prawn species showed sexual dimorphism (Badola *et al*., 1982; Dobriyal *et al*., 2007; Bahuguna and Kumar, 2013b; Bahuguna *et al*., 2010d), primary and secondary characters in hill-streams but *B. barna* showed bell abdominal side in breeding time.

In order to initiate the domestication process, it is necessary to gain control over all phages of the life cycle, especially maturation. Some of the significant investigations on maturity and spawning in fishes have been conducted (Rayal *et al*., 2021e; Bahuguna *et al*., 2021d; Bahuguna, 2016; Yazdanpanah, 2005; Esmaeili and Shiva 2006; Bahuguna, 2007; Bahuguna and Kumar 2011b; Bahuguna, 2013a,b; Bahuguna and Kumar 2013a; Bahuguna and Dobriyal 2019). In the present study, we calculate the exact time of fish maturity of *B.barna* with the help of two prim indexes like a GSI and D.I.

MATERIALS AND METHODS

Study Sites:

Sampling was done in Tamsa stream, located in the North-Eastern part of the Doon Valley between 30°21'25.84"N Latitude and 78°01'00.45"E Longitude.

Sampling methods:

Ninety-Nine specimens of *B. barnas* were collected from April 2020 to March 2021. Local fishermen used conventional fishing methods; like cast net, gill net, and dragnet (Bahuguna *et al*., 2010b; Bahuguna and Joshi, 2012a; Bahuguna, 2020; Bahuguna 2021; Rayal *et al*., 2021a,b). Details regarding a fish length (mm), weight (mg), ovaries length (mm) and ovary weight (mg) from

freshly collected fish specimens were noted. The fish ovaries were dissected out and were fixed in 5% formalin solution. After proper hardening, it was kept on filter paper for 30-45 minutes to absorb excess water. The weight of the preserved ovaries was carefully recorded.

For macroscopic studies, then gonads were removed when they were hardened in 5% formalin solution. The Gonado-Somatic Index (GSI) indicates the spawning period and frequency. The weight of the body as well as of the gonads (testes and ovaries) was noted. The GSI values were calculated with the help of the following equation:

(A) Gonado-somatic index (G.S.I.) = (Weight of Gonads / Weight of Fish) x 100; Nikolsky (1963).

Dobriyal index was proposed by Dobriyal *et al.* (1999) after removing the factors from GSI, which were sometimes hindering the exact estimation of maturity, month, and spawning frequency. The DI was calculated as follows:

(B) D.I.=GW (cube root of average gonad weight)

Where,

D.I.=Dobriyal Index, GW = Cube root of the average weight of gonads calculated for each month for male and female fish separately.

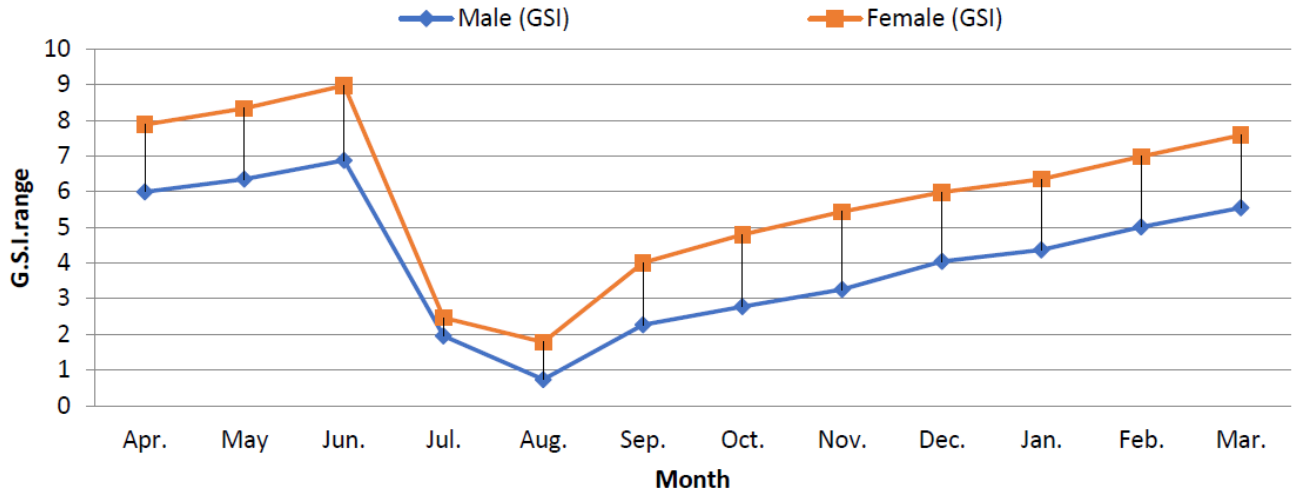

Fig.1: Monthly average values of Gonado-Somatic-Index (GSI) for *B. barna* during April 2020 to March 2021.

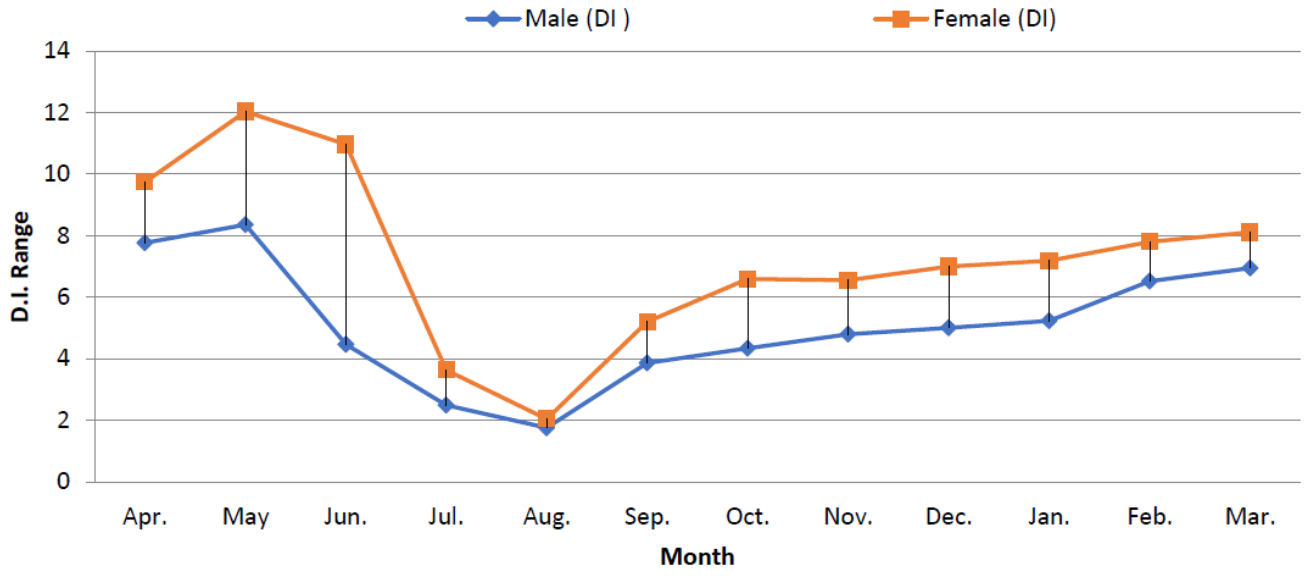

Fig.2: Monthly average values of Dobriyal Index (DI) for *B. barna* during April 2020 to March 2021.

RESULTS

The fish *Barilius barna* is an ornamental fish and shows sexual dimorphism throughout the year and also during the spawning season. During the breeding season, the male becomes extra active and slightly bright in color while female fish become light in colors. The monthly average G.S.I. value of male and female fish, *Barilius barna* are presented in Fig 1. The minimum G.S.I. value for males was observed as 0.7370.051 and for females 1.7830.292 in August while the maximum value was noted to be 6.8790.521 for males and 8.975 1.568 for females during June.

The monthly average values of the Dobriyal Index (D.I.) are presented in Fig 2. Dobriyal index (Dobriyal et.al., 1999), was observed more suitable index to indicate the spawning season of fish. Maximum D.I. values for male and female fishes were calculated as 8.354 0.524 and12.0281.504 respectively in May. The minimum D.I. values were recorded in Aug. as 1.7560.123 for males and 2.0390.089 for females. This indicated that spawning started during June itself, as the first fall in the DI value was observed in this month. However, GSI indicated the start of spawning in July.

DISCUSSION

The analysis of G.S.I. and D.I. enabled the researchers to conclude that the spawning season of *Barilius barna* in the Garhwal Himalaya commences during June and extends up to August. Various workers have applied the Gonado-somatic index to indicate the maturity and periodicity of spawning. The maximum values of GSI for both the sexes of *B.barna* were observed in June, the fish has started spawning during this month.

The new maturity index, Dobriyal index (Dobriyal *et al*., 1999) was also applied in this work. Dobriyal Index have been applied by Rautela (1999) on Garra lamta, Thapliyal (2003) in hill-stream catfish *Pseudecheneis sulcatus*, Uniyal (2004) on *Tor chilinoides*, Singh (2005) on *Noeemacheilus botia*, Kumar et.al (2006a) on *Botia dayi*, Bahuguna and Kumar (2011a) on *Puntius conchonius*, Esmaeili et.al.(2009), on endemic Iranian cichlid, *Iranocichla hormizensis,* Abedi et.al.(2011), on *Garra rufa*, Bahuguna and Dobriyal (2013) on *Noemacheilus denisonii*, Bahuguna (2012) on Labeo dyocheilus, Mirghiyasi and Esmaeili (2016) on *Oxynoemacheilus persa*, Esmaeili et.al.(2017), on *Capoeta mandica*, Tahami et.al. (2018), on *Alburnoides qanati* and Rayal et.al (2021d) on Puntius ticto.

D.I. has been found as a better index to specify the exact time of spawning. It was recorded maximum in May and the first fall in the value during June shows that spawning has already started in June itself.

In the present study, it was observed that *B. barna* spawns from June to August in the Tamsa River. The first spent fish was collected in the month of June. The percentage of spent fish in the collection was regularly increasing up to August. From September onwards there were no spent fish and maximum fish were either in the resting phase or started developing new batches of eggs. Further, the fry were observed from July onwards. Our field observations were exactly supported by the Dobriyal index (DI) which was highest in May (for male and female) and the first fall in the value was in June itself (for male and female). This nature of fall in DI was observed continuously up to August. When we analyze the result of GSI we found that this value was high in June and started falling from July-August. This slight variation may be due to the fact that the number of spent fish was so small that it could not have enough impact on GSI to bring it down. Dobriyal index calculated only the gonad weight (not body weight) so probably this is the reason for its more accuracy.

The relative condition factor has also a correlation with the changes and maturity phase, suggesting that the highest relative condition factor range may show the starting of the reproductive period of different fishes in the Garhwal region (Uniyal et.al., 2004a; Kumar et.al., 2006b; Bahuguna *et al*., 2010c; Dobriyal *et al*., 2010; Bahuguna and Joshi, 2012b; Joshi *et al*., 2014; Bahuguna *et al*., 2017; Rashid *et al*., 2019; Bahuguna *et al*., 2021a,c). Rayal et. al. (2021c) reported that fish *B.barna*, Relative Condition Factor for female fish was at the peak in the month of May (1.006±0.058) due to sexual maturity and minimum in the month of August (0.970±0.001). For the male fish value of relative condition factor was also recorded high in May (1.0020±0.081) due to sexual maturity and lowest in August (0.911±0.228).

CONCLUSION

Dobriyal Index was found to be more successful than Gonado Somatic Index. In the sexual maturity observations too the Dobriyal Index showed more accuracy than Gonado Somatic Index when correlated with other observations.

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