

Maturation Biology Of A Rare Hill-Stream Fish *Botia dayi* Hora From Garhwal Himalaya, Uttaranchal

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Abstract

The paper deals with maturation biology and spawning behaviour of a hillstream fish *Botia dayi* (Hora) collected from river Khoh in the foothills of Garhwal Himalaya, Uttaranchal. Seven maturity stages were determined for the fish. Based on GSI, Dobriyal index and availability of different maturity stages during months, it was inferred that the fish spawns during August-September as one time protracted spawner.

Key Words : *Maturation biology, fish, Dobriyal index*

Introduction

The spawning tendency of fish studied by the examination of its ova diameter round the year. A majority of teleost fishes all over the world are seasonal breeders. The Indian fishes are mostly monsoon breeder however in hill stream fishes six different spawning behaviours have been reported by Dobriyal (2005).

According to Lagler *et al.* (1962), the first attainment of ability to reproduce is termed as sexual maturity which is affected by several factors as difference in species, age, size and several environmental factor (temperature, pH of the water etc.). The maturation and spawning biology of fish has been extensively studied by various workers (Sobhna and Nair, 1974; Pathani, 1979; Nautiyal, 1984) Singh *et al.* 1985; Dobriyal and Singh, 89,93; Uniyal *et al.*, 2004) Present contribution is related to one of the most rare species of Garhwal Himalaya.

Materials and Methods

The fish were collected monthly from the two different sampling sites during 2002 and 2003 from the Khoh stream between Kotdwara and Dogadda. Morphometric measurements were taken in the fresh condition and the fish were then preserved in 5% formalin solution for further examination. Prior to preservation the colour of the gonads was recorded.

The present study is based on the macroscopic as well as the microscopic examination of gonads in *B. dayi* (Hora). For the macroscopic studies the gonads were removed and sex, physical appearance, length and weight of the gonads were recorded. For microscopic observation, only ovaries were taken in to consideration.

Gonado somatic index (G.S.I.) was calculated for each fish by the following formula :-

$$GSI = \frac{\text{Wt. of gonad}}{\text{Wt. of fish}} \times 100$$

Dobriyal Index (Dobriyal *et al.*; 1999): A newly designed and well in use index was found to be more accurate for the estimation of maturity, month and frequency of spawning. It was calculated as;

$$\text{Dobriyal Index (DI)} = 3 \text{ GW}$$

Where, D.I = Dobriyal Index, G.W.=average gonad weight calculated for each months for male and female fish separately.

For the determination of maturity stages, the sample of ova were collected from different regions of ovary and were microscopically studied. The ova diameters were measured by means of an ocular micrometer and at least 100 ova from each ovary were measured. The measurements were taken in omd (ocular micrometer division) on the basis of developmental pattern of ova round the year, following stages of the maturity were determined for *Botia dayi* (Hora), which were almost in accordance with the ICES scale (Wood, 1930).

Stage I	Immature I
Stage II	Immature II
Stage III	Maturing I
Stage IV	Maturing II
Stage V	Immature
Stage VI	Spawning
Stage VII	Spent

Month and the frequency of spawning were determined on the basis of percentage occurrence of fish of different maturity stages during different months of the year. Observations of mature, spent stage and occurrence of 1st immature stage are decisive factors of the month and the frequency of spawning. The value of GSI and DI were also used for the determination of the month and frequency of spawning. Month with maximum values of these indices showed month of highest maturity, whereas fall is the indicator of first attempt of spawning.

Percentage occurrence of mature fishes during pre-spawning and spawning seasons were taken for the study of determination of size at first maturity when arrange size wise (Thakre and Bapat, 1981, Dobriyal and Singh, 1987).

Observations

The ovary of *Botia dayi* Hora was elongated and sac like structure. It had varied shape, size and colour during the different months of the year due to different maturity condition. A fully mature ovary was observed as 2.5-3.0 cm long and 4.5-5.0 gm in weight. When mature it was light yellow in colour and light pink during winter to spring season. The weight of ovary gradually increased up to the spawning period. Testes situated in the posterior region of the abdominal cavity were observed as elongated and thin structure with light pink colour which becomes dull and creamy on the advancement of maturity. The size and weight of the testes also increased along with the advancement of maturity (May to August). From October to January the testes were observed as a thread like structures.

Gonado-Somatic Index

The gonado-somatic index (an important macroscopic observation) was calculated for each fish in each month for male and female fish separately. The monthly average values are presented in Fig. 1. The maximum values

were observed in the month of August for both sexes (2.59 ± 0.38 and $25.81.35 \pm 8.91$ for male and female fish respectively). The minimum values of GSI were recorded in the month of December (0.26 ± 0.03 and 3.2 ± 1.80) for male and female fishes respectively.

Dobriyal Index

In the present investigation Dobriyal Index (DI) was used and found very effective to determine the start of spawning in *Botia dayi* Hora. The calculated values of DI were presented in Fig 2. The maximum DI was noted during the month of July for both the male and female fishes (0.67 and 1.51 respectively). A fall in the values of DI was observed in the month of August, which indicated that spawning has started in the month of August. DI was minimum (0.31 and 0.32) in the month of December for male and female fish respectively.

Maturity stages

Maturity stages were determined on the basis of microscopic study of the ovaries of *Botia dayi* Hora in which ova diameters of each fish round the year were recorded. Maturity stages were determined based on the development of ova to maturity. Following stages were determined :-

Stage I (Immature I) : This is the first stage of maturity and it is known as Immature I. In this stage the ova diameter *Botia dayi* Hora varied from 5 to 15 omd with peak value at 10 omd.

Stage II (Immature II) : In this stage the peak values of ova diameter was noted as 15 omd, ranging from 5 to 25 omd, at this stage it appeared in to distinct batches of maturity.

Stage III (Maturing I) : In this stage *Botia dayi* Hora represented a range of 10 to 40 omd ova diameter with a peak of 30 omd from this stage ova could be seen clearly without removing the membrane from the ovary.

Stage IV (Maturing II) : The maximum ova-diameter in this stage was 60 while the minimum was 15 omd. *Ova diameter frequency polygon* whom the peak values in this stage are 45 omd.

Stage V (Mature) : Ova diameter varied from 25 to 80 omd with a peak value of 65 omd. A rapid growth of ova were observed during this stage and single peak during entire growth period was reported during the course of study.

Stage VI (Spawning) : During spawning stage ova diameter ranged from 20 to 60 omd and the peak value was observed as 50 omd.

Stage VII (Spent) : The spent ovary was flaccid and contain the unspawned ova with a ranging diameter of 10-30 omd and peak values of 10 omd.

Frequency and season of spawning

For the study of frequency and season of spawning the percentage of fishes observed in different stages of maturity during different stages of maturity and different month of the year was taken into considerations

(Table 1). The fish belonging to the 1st maturity stage were observed from October to January, the maximum being 100% in October. The minimum percentage of fish at this stage was recorded in the month of January (20%). The fishes placed in the second maturity stage were recorded from the month of November to March. Their maximum and minimum percentages were observed as 80% in January and 25% in March respectively. Fishes belonging to stage third were observed from February to May, highest being 75% during March-April. The fourth stage of maturity was recorded during April (25%), May (40%) and June (20%). Stage V was recorded during May-June (20%). The fish of sixth stage maturity (spawning stage) were obtained in the months of June, July and August. Their maximum number was recorded in the month of July (100%) and the minimum in June (60%). The spent fish (stage VII) were recorded in August and September month with the percentage of 33 and 100 respectively. This observation indicates protracted spawning with single frequency. Gonado somatic Index (G.S.I.) and Dobriyal Index (D.I.) were also used as indicators of spawning and maturation biology of the fish. In present study the value of GSI was noted maximum in the month of August for both male and female fishes of *Botia dayi* Hora. The value was noted as 2.59 ± 0.18 and 25.81 ± 8.91 for male and female fish respectively.

Sudden and heavy fall in the value of GSI was observed in the month of September indicated the spawning attempt in fish. Dobriyal index was much closer to indicate spawning as also observed by other methods. It was at its peak for male (0.67) in the month of July with a slight fall in August and sharp fall in September. The peak value of DI for female fish was noted as 1.51 in the month of July with a fall (1.37) in August. During the present investigation it has been noted that Dobriyal Index was much accurate for the study of spawning season and frequency of spawning in fish *Botia dayi* Hora.

Size at first maturity

The percentage occurrence of mature fish in various size groups during prespawning and spawning period are presented in Fig. 3 and 4 for male and female fish respectively. 40% male mature fish were observed in the size group 9.5-10.4 cm while 62.5% in size group 10.5-11.4 cm. This percentage increased up to 87.5% in the size group 11.5-12.4 cm and to 100% in size group of 12.5-13.4 cm. In female fish 44.5% fishes were observed mature in size group 10.1 cm, 87.5% in size group 11.1-12.0 cm and 100% in the size group 12.1-13.0 cm. Fifty percent level of maturity calculated after interpolation was considered as size at first maturity and was found to be 10.4 cm for male and 10.6 cm for the female.

Ecology of spawning niche

During present study, the observed breeding months for the fish *Botia dayi* Hora were July and August. In these months the rising water level, low values of pH and high turbidity influenced the spawning. The habitat preference of fish substratum heterogeneity in the spawning site indicated that the fish spawns in the side pool under the boulders, stones and pebbles well covered or protected by the macrophytic vegetation. It was noticed that usually all the monsoon breeders in Khoh stream prefer the similar spawning ground. Physico-chemistry of these spot indicated the qualitative habitat as velocity of water current 0.90-1.0 meter/second, Dissolved oxygen 7.8-9.5 ppm, water temperature 26-28°C and pH 7.1-7.5.

Discussion

In life cycle of fish the spawning is an important act. There is a great diversity in spawning behaviour of fishes and the duration of spawning is variable from species to species. In each species the time of breeding is so naturally managed that the chances of survival for the egg and fry are maximal. The majority of freshwater fishes in India breed around monsoon months of heavy rainfall. The time of spawning has a protective significance because the developing eggs grow when the environmental conditions are most congenial and

predators are least active.

According to Hickling and Rutenberg (1936) the spawning behaviour of fishes can be studied by the size of egg present in the ovary. The size of ova diameters were used as an important tool for identification of spawning stages of *Botia dayi* Hora. Seven different maturity stages were identified based on the pattern of ova diameters were used as an important tool for identification of spawning stages of *Botia dayi* Hora. Seven different maturity stages were identified based on the pattern of ova development.

Many workers have studied the ova development in the hill stream fishes of Garhwal himalaya (Singh, *et al.*, 1985; Dobriyal and Singh, 1989; Negi and Dobriyal, 1997; Uniyal, *et al.* 2004).

Generally the fish biologists follow ICES scale (Wood, 1930) and report seven maturity stages as done in the present case also. However there are reports who described less than seven stages of maturity depending upon slow growth rate of ova at a particular period or season (Malhotra, 1967 for *Schizothorax niger* and Bahuguna, 2004 for *Tor putitora*).

The present study indicate that the fish *Botia dayi* Hora spawn for a limited period (August-September) with a single batch of development eggs showing a single spawning frequency. On the other hand some species have a prolong breeding period as *Tor chelynooides* (Uniyal, *et al.*, 2004) or they spawn twice a year as *S. plagiosomus* of the river Pinder (Bisht, 1985) and *B. bendelisis* of river Nayar (Dobriyal and Singh, 1987).

On the basis of collected fish during pre-spawning and spawning time, a regression line was drawn for the percentage of occurrence of mature fish with different size groups. It was then interpolated with 50% level in maturing for the determination of size at first maturity. It was observed that the male fish (*B. dayi*) matures at a size of about 10.4 cm and the female at a size of 10.6 cm. Some other studies conducted on hill stream fishes indicated that *Glyptothorax pectinopterus* mature at a size of 125 mm (male) and 121 mm (female) as reported by Dobriyal and Singh (1989). Dobriyal and Singh (1987) reported size at first maturity for *Barilius bendelisis* as 83 mm (female) and 104 mm (male). Uniyal, *et al.* (2004) reported 96 mm and 148 mm for male and female *T. chelynooides*.

The tabulation of percentage occurrence of fish of various maturity stages in different months is the best indicator of frequency and season of spawning. Dobriyal and Singh (1987,89) and Negi and Dobriyal (1997) studied the tabulation of percentage occurrence of fish of different maturity stages for determination of frequency and season of spawning. The macroscopic indicator like Gonado-somatic index (GSI) and Dobriyal index (DI) were studied in present investigation. It was observed that GSI had its peak in August and first spawning fall in September which was exactly not in accordance with other observation (microscopic studies) that fish had already started spawning in the late August month. However, the Dobriyal index (DI) was found closer to microscopic confirmation which showed highest value in July and first fall, though very slight, in August that indicates starting of spawning somewhere at last week of August. This might be due to fact the calculation of GSI involves body weight also which is not only affected by gonadal maturity but also by the physiological body stress and ecologically unstable habitat during monsoon. On the other hand DI is improved version of GSI in which body weight is not involved for calculating index and thus becomes much susceptible to any sort of egg release.

The fish *Botia dayi* Hora spawns in the flooded river in the side water under stones and boulders during August and September. The ecology of habitat during that particular period indicates condition of water temperature in a range of 25-28°C, the dissolved oxygen ranging from 7.8-8 ppm and the velocity of water current 0.90-1.0 meter/second. Singh *et al.* (1985) concluded that a consortium of several factors like turbidity, velocity of water current, pH alkalinity and water temperature is responsible for stimulation as well as act of spawning in hillstream fish depending upon the nature of their habitat and genetic instinct. Substratum also plays an important role. Dobriyal and Singh (1987,89, 93) reported the nature of fish opting for side pools under stones and shade of macrophytes for spawning.

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Table 1 : Percentage occurrence of different maturity stages of *Botia dayi* Hora (female) during 2002-2003 from river Khoh.

S.No.	Months	Maturity stage in %							No. of fish examined
		Stage I	Stage II	Stage III	Stage IV	Stage V	Stage VI	Stage VII	
1.	Jan.	20	80	-	-	-	-	-	05
2.	Feb.	-	60	40	-	-	-	-	05
3.	Mar.	-	25	75	-	-	-	-	04
4.	Apr.	-	-	75	25	-	-	-	04
5.	May.	-	-	40	40	20	-	-	05
6.	Jun.	-	-	-	20	20	60	-	05
7.	Jul.	-	-	-	-	-	100	-	04
8.	Aug.	-	-	-	-	-	67	33	06
9.	Sep.	-	-	-	-	-	-	100	06
10.	Oct.	100	-	-	-	-	-	-	04
11.	Nov.	67	33	-	-	-	-	-	03
12.	Dec.	33	67	-	-	-	-	-	03

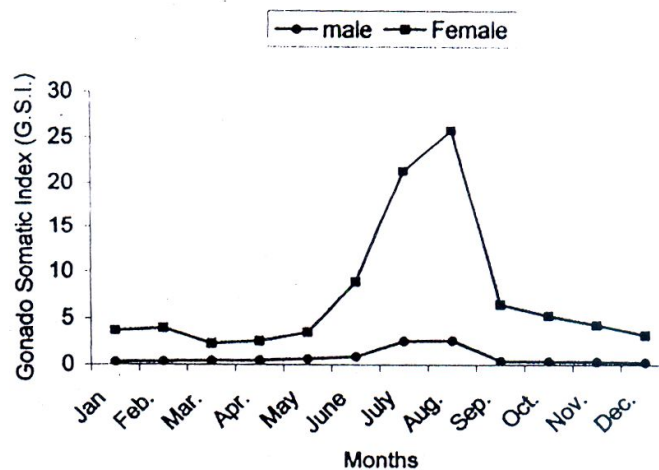


Fig. 1: Monthly variation in Gonado-Somatic Index (G.S.I.) in *Botia dayi* Hora during 2002 - 2003.

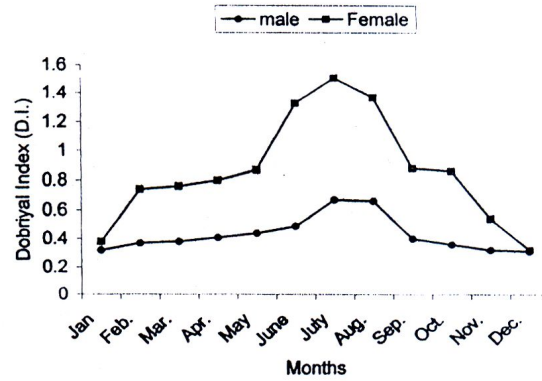


Fig. 2: Monthly variation in Dobryal Index (D.I.) in *Botia dayi* Hora during 2002 - 2003.

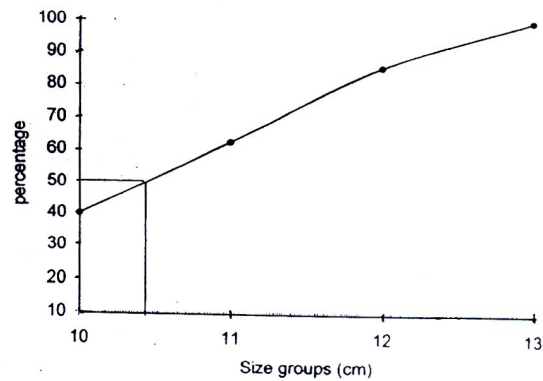


Fig. 3 : Size at first maturity in male *Botia dayi* Hora during 2002 - 2003.

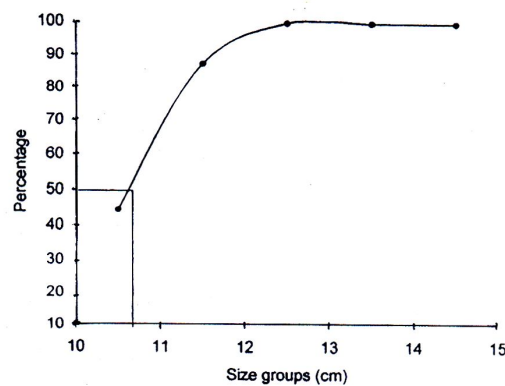


Fig. 4 : Size at first maturity in female *Botia dayi* Hora during 2002 - 2003.