

Spawning biology of snow trout, *Schizothorax richardsonii* (Gray) from River Gaula (Kumaon, Himalaya)

MADAN MOHAN

National Research Centre on Coldwater Fisheries, Bhimtal-236 136, Uttarakhand

ABSTRACT

Studies on the reproductive biology of snow trout, *Schizothorax richardsonii* from River Gaula revealed that the species spawns twice in a year (July-October and January-February) as evidenced from the occurrence of ripe fishes, high GSI values during the above period and from bimodal ova diameter polygon. The male to female ratio was 1: 1.09. The fecundity ranged from 2248 to 8726 in fishes of 160- 245 mm TL and 40-110gm weight. The relation between fecundity and fish length, fish weight and ovary weight were also attempted.

Introduction

Though *Schizothorax richardsonii* contributes to 60-70% of the total fish catches from upland riverine systems, studies on its reproductive biology are very few except for Bhatnagar (1964) from Himachal Pradesh; Qadri *et al* (1983) from Jammu and Kashmir. Spawning season of *S. richardsonii* has been described from Garhwal region (Badola and Singh, 1984; Singh and Bhatt, 2002) and from the rivers of Kumaon region (Singh, 1990; Bhatt and Pathak, 1992 and Sunder *et al.*, 1995). But the detailed information on the spawning biology of this species from Gaula- an important river in Kumaon Himalaya is lacking hence an attempt has been made.

Materials and methods

Fishes were collected from River Gaula and their sex and stages of maturation were recorded in fresh condition and ovaries preserved in 5%

formalin for further detailed investigations. By external examination in the field, gonads were classified into seven stages of maturity. Ova diameter of about 200 ova in stage I-III and VII and 300 ova in stages IV-VI were measured. Ova below 10 md (1 micrometer division =0.017mm) were not considered after stage II as they were numerous and present in all the stages of maturation. Fecundity was estimated by gravimetric method.

Results

Classification of maturity stages

Based on the superficial examination (external appearance) and ova diameter, the gonads were classified as:

Stage I (Immature): Ovary thin and ova are invisible to naked eyes. The ova diameter ranged from 0.01-0.17 mm. Testes are thin, small and occupy about 1/4th of the body cavity.

Stage II (Maturing) : At this stage yolk deposition has commenced in the ova by which they appeared translucent. Ova ranged between 0.18 and 0.50 mm in diameter. Testes grow slightly and occupy about 1/3 of the body cavity giving white thread like appearance.

Stage III (Late maturing) : Ovary is thick, translucent and slightly yellowish in colour. Ova are visible to the naked eye and measure upto 0.85 mm in diameter. Testes thickened, white in colour and occupy about half of the body cavity.

Stage IV (Mature): Blood vessels appear on ovary and ova measure upto 1.19 mm in diameter. Testes are now flat and white in colour occupying more than half of the body cavity.

Stage V (Ripe) : Ovary has grown fully, turns orange in colour. Vitellogenesis appears to be completed and ova measure upto 1.77 mm in diameter. Testes become very thick, creamy white in colour, lobed and extends to 2/3rd of the body cavity.

Stage VI (Spawning): Ovary wall almost transparent and ova are visible through tunica of the ovary. Ovary is filled with large ova in its lumen due to disappearance of ovigerous lamellae and can come out on exerting slight pressure on abdomen. Ova measure upto 2.21 mm in diameter. Testes are creamy white, with oily soft surface; milt comes out on slight pressure.

Stage VII (Spent) : Ovary becomes small, shrunken and reddish in colour due to the shrinkage of blood vessels. This stage is characterised by the presence of empty follicles and very few large sized collapsed ova during November - December. Testes appear shrunk with black spots and occupy about one third of the body cavity.

Spawning habits

Ova diameter measurements were grouped into five ocular micrometer divisions and frequency polygons have been shown in Fig. 1. In ripe and spawning stages of ova maturation, even before the ripe ova are released in the spawning act, another group of maturing ova had started to mature. It is not clearly known whether these mature ova might also attain full maturity within the current spawning season or might contribute to next years crop.

In Stage V and VI ovaries, maturing and ripe ova are present with distinct modes. The ova diameter studies indicated that about 42% ova become ripe, while about 58% is maturing ova. When ripe ova are spawned, their place is taken by the maturing stock of ova. Mature ova have progressed to spawning stage in very quick succession. Hence, it is quite possible that maturing ova might also attain maturity and be ready for spawning. No partially spent female fish have been observed from Gaula River which indicates that entire stock of ripe ova is released in a single burst though their size range is quite wide from 0.87 mm to 2.21 mm.

Spawning season

The average percentage occurrence of fishes in different stages of maturity have been presented in Table 1. Males with oozing gonads occurred from July till January, while ripe and spawning females occurred from July till February. The smallest male in spawning stage of maturity measured 130 mm, while mature female in stage IV of maturity measured 160 mm which suggests that females mature sometimes later than males. Spent fishes in both the sexes occurred from November to January with peak in December. A good number

of mature and ripe fishes were available in February. The availability of ripe and spawning fish from July to February suggested an extended period of spawning for this species with two peaks in monsoon months as well as in winter months.

The monthly average gonadosomatic index showed a consistent annual cycle (Fig. 2). GSI values were high from July to October and during January- February which also confirm two peak spawning seasons in this species.

Sex ratio

The percentage occurrence of both the sexes in different months from July 1992 to December 1993 is given in Table 2. Females outnumbered males during majority of the months. Ratio of male to female for the entire period was estimated to be 1 : 1.09.

Fecundity

Fecundity ranged from 2248 to 8726 for the fish with length range 160-245 mm and weight 40-110 g. The ripe ova per kg of fish body weight ranged from 39500 to 91853.

Fish length- fecundity relationship : Fecundity in *S. richardsonii* increased with the increase in fish length. However, fishes of same length as well as different length evinced variations in fecundity. The value of fecundity has been plotted against fish lengths and shown in Fig. 3. The straight line regression equation of this relationship obtained is given below.

$$\text{Log } F = -9259.53 + 69.26683 \text{ Log } L$$

where F is fecundity and L the total length of the fish.

The value of correlation coefficient (r) for this relationship was observed as 0.89725.

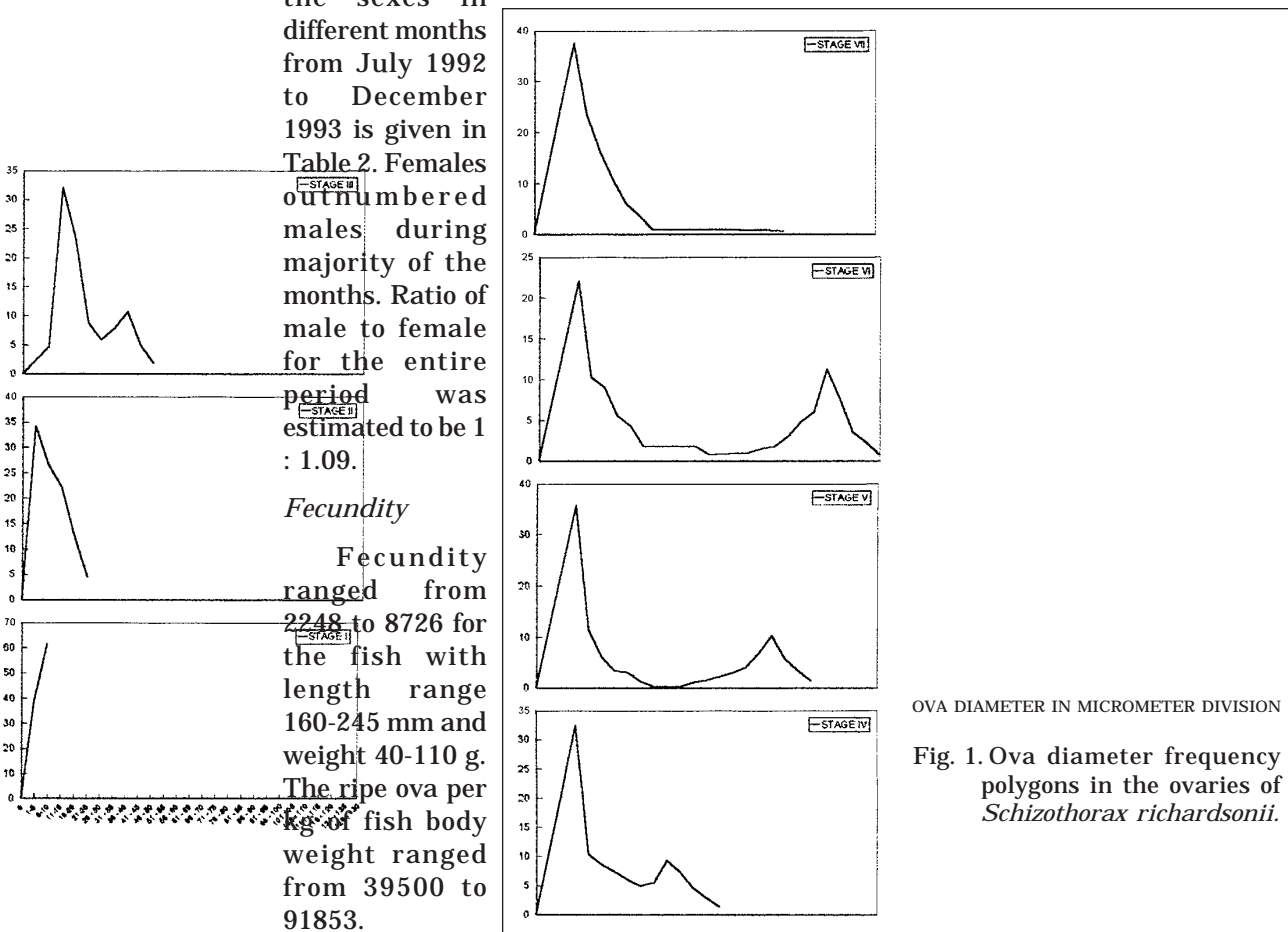


TABLE 1: Average monthwise maturity stages of *S. richardsonii* in Gaula River

Months	Sample size	Maturity stages (%)						
		I	II	III	IV	V	VI	VII
July	14		28.57	28.57	14.29	21.43	7.14	-
Aug.	11		-	18.18	36.36	45.46	-	-
Sep.	7		-	14.29	42.87	14.28	2.86	-
Oct.	23	4.35	4.35	21.74	4.34	13.05	52.17	
Nov.	10	-	-	30.00	20.00	-	30.00	10.00
Dec.	24	-	12.50	33.33	-	-	4.17	50.00
Jan.	6	-	-	-	16.67	-	66.66	16.67
Feb.	14	-	7.69	23.08	38.46	30.77	-	-
March	1	Indeterminate						
April	1	-		100.00	-	-	-	-
May	17	5.88	23.53	70.59	-	-	-	-
June	7	-	28.57	71.43	-	-	-	-

Fish weight- fecundity relationship: Total weight of the fish were taken to plot against fecundity which generally vary slightly at the same length. Though fecundity increased with the increase in fish body weight, yet variations were observed even within the same weight range. The fecundity values have been plotted against fish body weight and shown in Fig. 4. Fecundity plotted against weights gave the following linear relationship.

$$\text{Log F} = -2034.40 + 80.54681 \text{ Log W}$$

where F is fecundity and W the total weight of the fish.

The correlation coefficient (r) for this relationship was observed as 0.88486.

Ovary weight- fecundity relationship : Ovary weight of the fish varied considerably even within the same length range which had direct impact on ovary weight-fecundity relationship. Like in previous cases, the fecundity increased

with ovary weight still evincing variations in similar ovary weight range. The value of fecundity have been plotted against ovary weights which shows a linear relationship (Fig. 5). The regression equation obtained is given below.

$$\text{Log F} = - 1625.146 + 277.714 \text{ Log O W}$$

where F is fecundity and OW is ovary weight.

The value of correlation coefficient for this relationship was 0.85778.

Fig. 2. Gonado-somatic index in *Schizothorax richardsonii*.

TABLE 2 : Sex ratio of *S. richardsonii* in Gaula River

Months	Sample size	% of males	% of females
July	14	42.86	57.14
Aug.	11	54.55	45.45
Sep.	7	42.86	57.14
Oct.	30	56.52	43.48
Nov.	10	40.00	60.00
Dec.	24	45.83	54.17
Jan.	6	83.33	16.67
Feb.	14	35.71	64.29
March	1	Indeterminate	
April	1	100	-
May	17	41.18	58.82
June	7	42.86	57.14

Discussion

Bhatnagar (1964) while making ova diameter studies in *S. plagiostomus* (= *S. richardsonii*) in Bhakra reservoir stated that fish spawn twice in a year i.e. in July-August and again in December-January. Qadri and Yousuf (1983) observed that spawning season of this species in Kashmir waters mainly depends on suitable conditions such as water temperature, food availability and duration of photoperiod. They observed that in spite of presence of mature eggs during winter months (December-February), spawning did not take place due to very low water temperature and low photoperiod and ripe eggs were carried upto April-May when the conditions became favourable for spawning. Sehgal (1988) observed that rise in temperature in Kashmir streams from near freezing level to 10-17°C during May-June induce *S. richardsonii* to spawn. In River Sutlej, this species starts upstream migration with rise in water temperature during March. In upstream migration, the fish finds itself still in very cold waters (0.0-9.5°C) due to the regular addition of snow melt

water. This compels the fish to migrate to side stream which receive warm ground water (17.5-21.5°C) and lay the eggs. In the Ravi River system, the fish spawns in May and in the upper Beas, the fish spawns during July-August due to warming up of the stream water (16.5-18.5°C). In the same drainage, *S. richardsonii* migrate downstream in lower most reaches and spawn during October-December. In Garhwal region, most of the resident and migratory fish species breed once in a year during monsoon months (Badola and Singh, 1984). From the rivers of Kumaon region, Singh (1990) stated that spawning season of *S. richardsonii* extends from March-June and August-October. Bhatt and Pathak (1992) has reported two spawning seasons in this species (August and February) in Kumaon streams. But during the present investigation, it was observed that this species has two spawning seasons from July-October and January-February in Gaula River. Bisht and Joshi (1975) have reported that the spawning season of this species extends from October to December in Nainital lake.

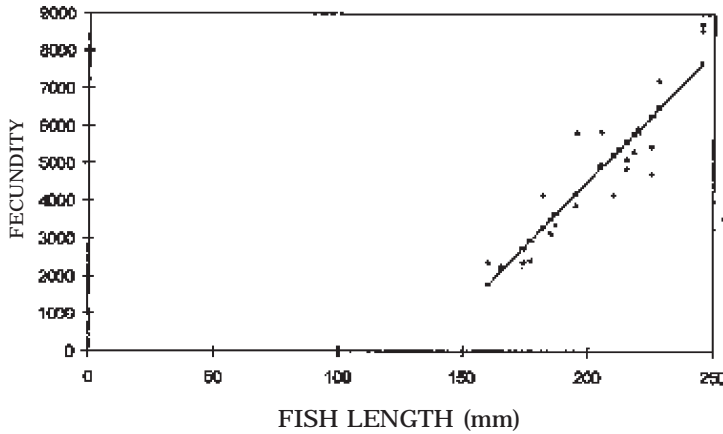


Fig. 3. Fish length-fecundity relationship in *S. richardsonii*

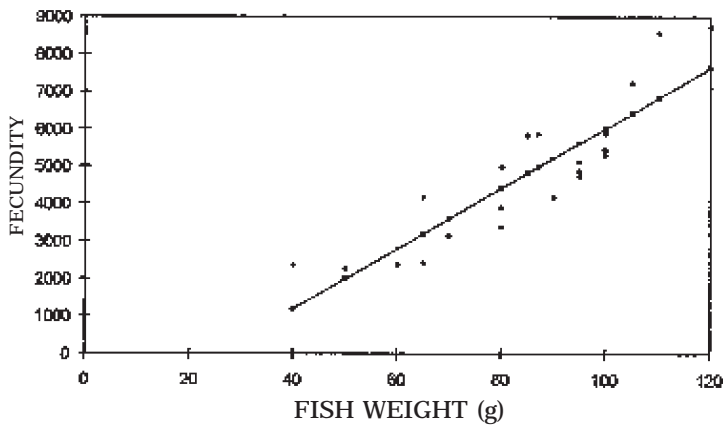


Fig. 4. Fish weight-fecundity relationship in *S. richardsonii*

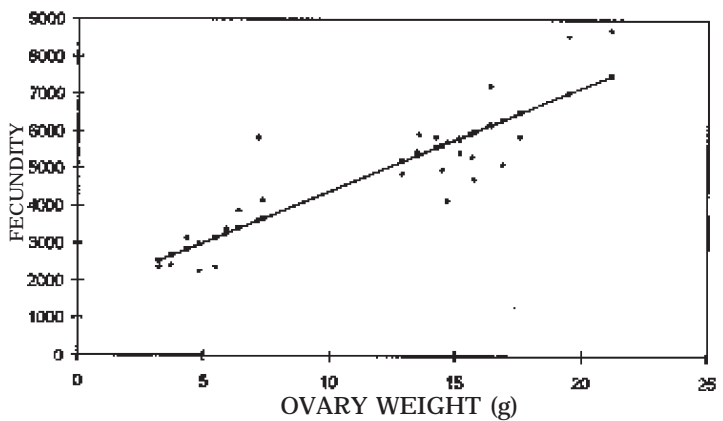


Fig. 5. Fish ovary weight-fecundity relationship in *S. richardsonii*

Fecundity of a fish indicates breeding potentials of a species on which strength of the future population

depends. Qadri and Yousuf (1983) recorded fecundity of *S. richardsonii* from Kashmir waters where it vary from 2598 to 27846 eggs for the fish ranging between 220 and 475 mm with average fecundity of 12744 eggs, while Das and Kaul (1965) reported fecundity between 2600 and 16,605 for 216-331 mm length group. Baloni and Tilak (1985) observed that the fecundity ranges from 1578 to 14,316 eggs for the size range of 190-560 mm. Singh (1990) estimated the number of mature eggs in a fish from Kumaon rivers and found that the fecundity ranged from 8216-48490 eggs for fish ranging 219-541 mm, while Bhatt and Pathak (1992) observed 1311 to 12702 mature ova in the fish size range of 205-510 mm. During the present study, fecundity of *S. richardsonii* ranged from 2248 to 8726 for the fish ranging 160-245 mm.

Acknowledgements

The author records gratitude to Dr. K. L. Sehgal and Late Dr. V. P. Agrawal for their guidance. He is grateful to the Director, National

Research Centre on Coldwater Fisheries, Bhimtal for allowing laboratory facilities.

References

- Badola, S.P. and H.R. Singh 1984. Spawning of some important coldwater fishes of the Garhwal Himalaya. *J. Bombay Nat. Hist. Soc.*, **81** (1), 8-9 : 54-59.
- Baloni, S.P. and R. Tilak 1985. Ecological observations on *S. richardsonii* (Gray and Hard). *J. Bombay Nat. Hist. Soc.*, **82** : 581-586.
- Bhatnagar, G.K. 1964. Observations on the spawning frequency of certain Bhakra reservoir fishes. *Indian J. Fish.*, **11** (1) : 485-502.
- Bhatt, S.D. and J.K. Pathak 1992. *Himalayan Environment: Water Quality of the Drainage Basins*. Shree Almora Book Depot, Almora. pp. 318.
- Bisht, J.S. and M.L. Joshi 1975. Seasonal histological changes in the ovary of a mountain stream teleost, *Schizothorax richardsonii* (Gray and Hard). *Acta Anatomica*, **93** : 612-625.
- Das, S.M. and B.L. Kaul 1965. The gross anatomy of gonads and fecundity of four fishes of Kashmir. *Kash. Sci.* **2** (1-2) : 64-76
- Qadri, M.Y. S. Mir and A.R. Yousuf 1983. Breeding biology of *Schizothorax richardsonii* (Gray and Hard). *J. Indian. Inst. Sci.*, **64** (C) : 73-81.
- Sehgal, K.L. 1988. *Ecology and Fisheries of the mountain streams of North-Western Himalayas*. D.Sc. degree thesis, Meerut University, Meerut.
- Singh, Sunder 1990. The lotic water fisheries of Kumaon Himalaya. In : *Himalaya: Environment, Resources and Development*, N.K.Sah, S.D.Bhatt and R.K. Pande (Eds.). Shree Almora Book Depot, Almora. P. 276-284.
- Sing, N. and K.C. Bhatt 2002. Ecological diversity and behaviour of Schizothoracids: Quantitative assessment at community level. *National Seminar Aquatic Resource Management in Hills*, 4-5th Oct. 2002 NRCCWF, Bhimtal.
- Sunder, Shyam, H. S. Raina, M. Mohan and B. Singh 1995. Ecology and fisheries potentials of the Gaula river with special reference to proposed impoundment (Jamrani dam) of the system. *J. Inland Fish Soc.*, **27** (2) : 33-45.

Date of Receipt : 29-07-2004

Date of Acceptance : 01-11-2004