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Breeding biology of *Schizothorax richardsonii* gray and hard

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Abstract

Breeding biology of *Schizothorax richardsonii* (= *Oreinus plagiostomus*) was studied for a period of two years. It has cystovarian type ovaries with the stroma forming a large number of ovigerous lamellae containing ova at various stages of development. Ovulation depends on the ambient thermal condition. The fish is less fecund in comparison with other carps, the average fecundity being 12,744·3. Relationship between fecundity and other variables has also been calculated.

Key words : Snow trout, cystovarian ovaries, acitve growth, spawning grounds.

1. Introduction

Ever since the publication of first scientific report on the fishes of Kashmir *Fische aus Caschmir* by Heckel[1], the fish fauna has been a subject of great interest and regular periodical contributions have appeared on their systematics, biology and ecology[2–9]. *Schizothorax richardsonii* Gray and Hard (*Oreinus plagiostomus* McClelland), generally called snow trout or Himalayan trout, inhabits the entire network of snow and spring-fed cold water streams and is a representative of the palaearctic elements in the valley[6]. The fish was plentiful and formed the chief food fish but with the introduction of the common carp, *Cyprinus carpio*, in late 1950s its population has declined steeply. With a view to study the various factors responsible for this decline, its biology and ecology were studied for a period of two years. The present contribution forms a part of this study and describes some of the biological

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characteristics, *viz.*, cyclic changes of the ovary and the spawning behaviour of the fish.

2. Material and methods

Fresh specimens of *Schizothorax richardsonii* were collected bi-weekly from Sind Nallah at Ganderbal and from Telbal Nallah about one km ahead of its mouth for a period of two years, from January 1976 to December 1977. Sometimes, fish were also procured from the fresh catches made by local fishermen. Data regarding length, weight and sex of the fish were recorded on the spot. Ovaries were fixed in Bouin's fixative and later processed in the laboratory for histological studies. Estimation of fecundity was done on mature specimens only. Samples of one gram each of ovary preserved in 5% formalin were taken and only mature oocytes counted. The relationships between fecundity and weight of fish, length of fish and weight of ovary of the fish were calculated by the general formula $W = aL^n$.

3. Observations

3.1 *Maturity stages of the ovary*

The ovaries are large, elongated structures, lying on either side of air bladder, ventral to the vertebral column. They show a series of seasonal changes both in macroscopic and microscopic structure (fig. 1 and Table I). Six stages of maturation were observed in the present fish.

(i) Stage I. Ovaries thin, transparent and ribbon shaped. Oocytes not visible. Ovigerous lamellae, though thin, extend deep into the interior of ovary. Oocytes small, about 0·16–0·17 mm in diameter, with a conspicuous large centrally placed nucleus. Nuclear membrane smooth with several nucleoli lying beneath it. Nucleolar extrusion seems to be more or less common in the oocytes of stage I.

(ii) Stage II. Ovary attains its full length but is still thin. Oocytes visible. Vitelline membrane appears and nuclear membrane loses its smooth nature and becomes more or less wrinkled. Number of nucleoli increases.

Second stage of maturation of oocytes continues throughout August when cytoplasm occurs. Outside the vitelline membrane a follicular layer appears. Ovary is full of oocytes and the ovigerous lamellae are reduced. Oocytes large, 0·48–0·51 mm in diameter. Some small oocytes of stage I are also observed.

(iii) Stage III. September and early October mark the beginning of stage III of maturation. Ovaries increase in volume, the two lobes are swollen and approximate to each other. Diameter of the oocytes increases to 1·0 mm and the nucleus

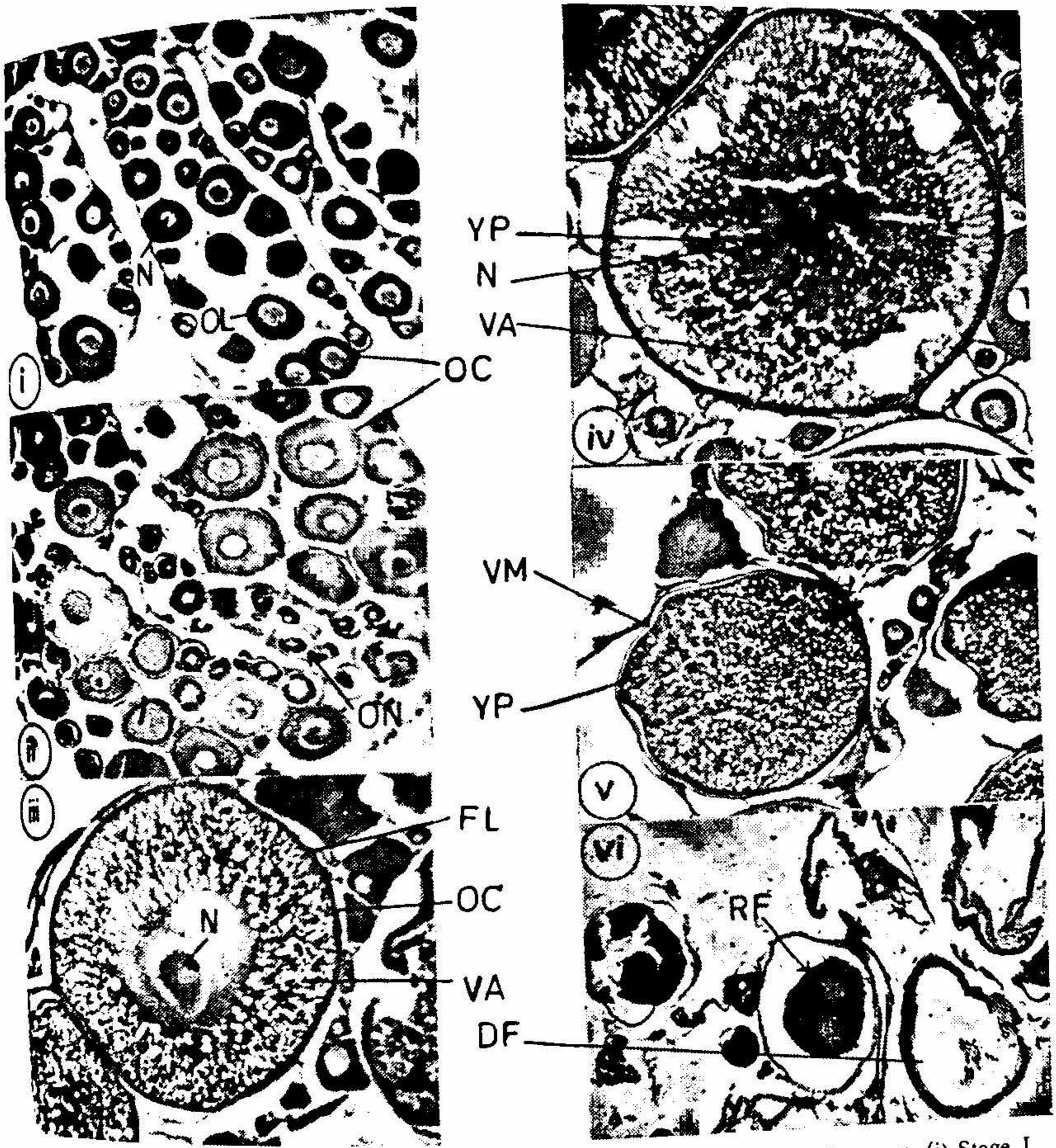

FIG. 1. T.S. ovary of *Schizothorax richardsonii* showing various stages of development. (i) Stage I. (ii) Stage II, (iii) Stage III, (iv) Stage IV, (v) Stage V and (vi) Stage VI. DF = Discharge follicle, FL = Follicular layer, N = Nucleus, OC = Oocyte, OL = Ovigerous lamellae, ON = Oogonial nest, RF = Resorbing follicle, VA = Vacuole, VM = Vitelline membrane, YP = Yolk plate.

becomes acentric. Two perinuclear staining zones are observed in the oocytes, an inner light stained and an outer dark stained ; the cytoplasm is completely vacuolized.

(iv) Stage IV. This stage is characterized by the appearance of yolk plates in the perinuclear region. Towards the end of November and beginning of December

Table I

Monthly variations in the diameter of the oocytes and the gonado-somatic index (G.S.I.) of *Schizothorax richardsonii*

Month	Average diameter of oocytes (mm)	G.S.I.
May	0·160	0·4
June	0·170	0·5
July	0·514	1·0
August	1·001	1·7
September	1·017	3·3
October	1·169	2·9
November	1·515	2·9
December	1·656	7·2
January	1·705	9·1
February	1·763	7·4
March	1·808	10·4
April	1·901	6·4

oocyte measures about 1·5 mm in diameter. By the end of December vitellogenesis is completed and the oocyte is full of yolk plates with a peripheral layer of vacuoles and measures about 1·7 mm in diameter.

(v) Stage V. During the winter months of January, February and March no conspicuous changes in the oocytes are noted. The ovigerous lamellae disappear and the entire ovary is full of large, yellow coloured oocytes. During April the oocytes are free and ooze when slight pressure is applied on the abdomen. This represents stage V of maturation of the oocytes which are now ready to spawn and measure about 1·9 mm in diameter.

(vi) Stage VI. Ovary is shrunken, somewhat reddish in colour. This stage is represented by several empty follicles and some follicles which fail to ovulate are seen in the process of atresia.

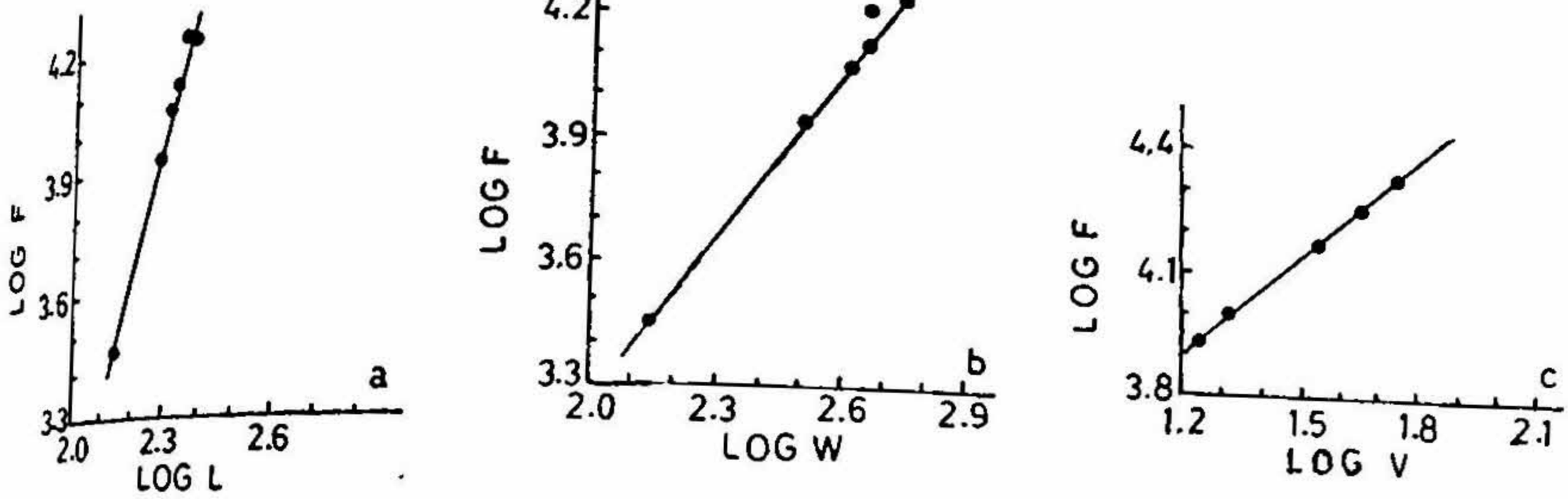

FIG. 2. Relationship between fecundity and (*a*) Length of fish, (*b*) Weight of fish and (*c*) Weight of ovary of *Schizothorax richardsonii*. F = Fecundity, L = Length, V = Ovary weight and W = Total weight of fish.

3.2 *Fecundity*

The fecundity of 20 mature females, ranging from 123 to 922 gm in total weight was estimated. The data obtained are given in Table II. The relationship between fecundity and length of fish, weight of fish and weight of ovary were also determined (fig. 2).

(i) Fecundity and length of fish. When observed weights and lengths were plotted parabolic curve was obtained and when Log L and Log W were plotted a straight line was obtained. The expression showed that length plays an important role for the increase in fecundity. The logarithmic expression of the equation obtained is:

$$\text{Log } F = 4{\cdot}5530 + 3{\cdot}4001 \text{ Log } L$$

$$(r = 0{\cdot}9852)$$

(ii) Fecundity and weight of fish. The two parameters express a more or less linear relationship. The equation obtained can be expressed as :

$$\text{Log } F = 0{\cdot}4738 + 1{\cdot}3789 \text{ Log } W:$$

$$(r = 0{\cdot}9905).$$

(iii) Fecundity and ovary weight. Since the fecundity is the main function of the ovary, there exists a close relationship between fecundity and ovary weight.

$$\text{Log } F = 2{\cdot}8485 + 0{\cdot}8314 \text{ Log } V$$

$$(r = 0{\cdot}9675).$$

Table II

Variations in fecundity of *Schizothorax richardsonii* in relation to weight and length of fish and weight of ovary

Sl. No.	Weight of fish (gm)	Total length of fish (mm)	Weight of ovary (gm)	Total no. of ova	No. of ova/gm body wt.
1.	123	241	6·75	3,084	25·0
2.	165	220	6·00	2,598	15·7
3.	230	316	13·30	7,581	32·9
4.	290	320	20·00	7,860	27·1
5.	315	310	23·00	11,753	27·3
6.	326	338	17·00	10,395	31·8
7.	366	344	31·00	13,330	36·4
8.	370	382	20·00	11,767	31·8
9.	390	331	10·00	4,220	10·8
10.	425	344	34·00	12,742	29·9
11.	435	335	28·00	14,000	32·1
12.	460	405	73·00	17,346	37·7
13.	470	370	48·00	27,312	58·1
14.	490	300	15·50	7,371	15·0
15.	493	370	69·50	12,649	25·6
16.	505	331	30·00	16,590	32·8
17.	531	372	44·50	16,824	31·6
18.	535	360	40·00	12,720	23·7
19.	650	401	37·00	16,798	25·8
20.	922	475	110·50	27,846	30·2
Mean	424·5	343·2	33·92	12,744·3	29·56

3.3 *Spawning grounds*

During spawning period, which extends from April to early June, peak values of gonado-somatic index are obtained (Table I). Only a small percentage of fish were noticed to spawn in April, and much less in June. In the majority of cases the spawning takes place in the month of May. Although a resident of hill streams, a slight migration is noticed at the time of spawning the fish ascending to upper reaches of the streams.

The fish abounds greatly in the Sindh Nallah, north of Srinagar. The stream is characterized by several 'V'–shaped valleys with a gravelly bottom and a gentle

flow of water. During the period of spawning, the Nallah is closed and all operations and excavation of sand and gravel stopped. While excavating and prior to spawning, several pools of varying size are formed which act as spawning grounds. Likewise, a large number of spawning grounds are found in the streams Erin, Papchan and Madhumati.

4. Discussion

The cystovarian type of ovaries, though found in several other fishes also, seem to be a characteristic feature of the Schizothoracids. Raina[9] and Malhotra[10] have reported this type of ovaries in *Schizothorax esocinus* and *S. niger* respectively. In *Schizothorax richardsonii*, a member of the same group, the structure and the seasonal variations in ovaries follow very closely those of *S. esocinus* and *S. niger*. The histological studies reveal that the active growth period of *S. richardsonii* extends from July to December during which period oocytes, vitelline membrane, nucleoli and their extrusion from the nuclear membrane and the vitellogenesis are formed and a general increase in the gonado-somatic index of the fish is noticed (Table I). In winter (January-February), the ovary remains quiescent ; no noticeable cytological changes are seen in the oocytes. This is suggestive of a passive vitellogenesis during this period. Such a winter dormancy or diapause has also been recorded in *S. esocinus*[9] and *S. niger*[10].

While studying *S. plagiostomus* (*S. richardsonii*) in Bhakra reservoir, Bhatnagar[11] inferred from the ova-diameter that the fish spawns twice a year, in July-August and again in December-January. Jhingran and Sehgal[12] have recorded the fish to spawn only once but in different months of the year at different elevations in Himachal Pradesh. The present study reveals that the spawning season of *S. richardsonii* depends upon the suitable exteroceptive factors such as temperature of water, food availability and the duration of photoperiod. Inspite of the presence of mature eggs during the winter months of December-February, the spawning did not take place due to very low temperature and low photoperiod and the ripe eggs were carried up to April-May when the conditions became favourable for spawning.

Bisht and Joshi[13] have observed *S. richardsonii* to spawn several times during the breeding season. However, the histological studies of the oocytes and G.S.I. made during the present investigations reveal that all the eggs are released at the same time and the fish thus comes under the group synchronism as per Prabhu's[14] classification. Fecundity of several cyprinid fishes in Kashmir has been described[10, 15, 16] and these studies have revealed the highest fecundity values for *Cyprinus carpio*, *S. richardsonii*, with an average fecundity of 12,744·3 for an average weight of 424·5 gm seems to be less fecund in comparison to these fishes.

Length and weight of fish and the weight of ovary have been shown to have a close relationship with the fecundity of an individual. Bagenal[17] Lehman[18] and May[19]

have recorded a close relationship between these variables. During the present study a linear relationship was evident between the fecundity and the weight of ovary as the weight of fish, whereas the fecundity increased as a cube of the length of the fish.

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