



Reproductive biology of *Schizothorax esocinus* and *Schizothorax niger* collected from water bodies of Kashmir

Aijaz Ahmad Bhat

Department of Zoology, University of Kashmir, Jammu and Kashmir, India

Abstract

Schizothorax niger and *Schizothorax esocinus* are of the cysto-ovarian type, the ova developing within an ovarian sac, and liberated directly to the exterior by means of a small oviduct. The ovaries are thin, small and wine coloured epithelial ridges, microscopic, transparent oogonia are present but not visible to the naked eye. At stage III, the ovaries are large and yellow in colour. The ova are large and at penultimate stage of maturity. The ova diameter varies in different specimens, but one third of the ova being small. In later stages Ovary was thick, translucent and slightly yellowish in colour. The diameter of the ova ranges between 0.5-2.5 mm. During the winter months of January February, March and even April no conspicuous changes are seen. No eggs are exuded by the application of slight pressure on the abdomen. The ovaries are large and jelly like, very much distended and speckled appearance due to large transparent ova. At stage VI. The ovaries are shrunken, flaccid, bag-like and blood-shot. Ovaries are much reduced in volume and thus occupy little space in the body cavity. Some hard, large pale yellow old ova may still persist in the ovary. Fecundity has shown wide fluctuation with time, age, feeding process and season. Absolute fecundity shown by *S.niger* and *S.esocinus* reared at site Beerwa under controlled conditions was 1292.5. Where as at Akad was 1328.75 and at Kokernag was 1242.5. On artificial *S. niger* has shown 1322.5, and *S.esocinus* has shown 1390.5, respectively.

Keywords: *schizothorax niger*, *schizothorax esocinus*

Introduction

The State of Jammu and Kashmir is rich in streams, lakes and water reservoirs. The Himalayas are the main watersheds in the Indo-Gangetic Region, having numerous rivers, lakes and reservoirs. Most fish species inhabiting the Himalayan region are of small size. Their distribution depends on the environmental conditions such as water current velocity, nature of substratum, and the availability of food. Schizothoracinae the cyprinids (also called snow trout's) are believed to have migrated into lakes and streams of Kashmir from central Asian watersheds (Sehgall, 1999), bordered by inner and southern slopes of Hindukush, Korakoram and inner ends of North Western Himalayas and Suleiman Ranges. These fishes got isolated in the Kashmir region by land upheavals and evolved into a large number of species now regarded as endemic in valley. (Raina and Peter, 1999). In most water bodies of Kashmir like Dal lake, River Jhelum, Manasbal, etc. Schizothoracinae are declining due to various reasons like pollution, habitat degradation, introduction of carp, removal of sand and gravel etc.

The fishes were collected from 2010-2014 and cultured at various hatcheries in collaboration with the fisheries Department Kashmir. Focus was made on reproductive biology in particular besides other parameters. The results obtained were from natural waters as well as those cultured in artificial diet.

Results

Reproduction

Reproduction is one of the most important considerations in

understanding the ecology of animals. The survival of any species in seasonally changing environments depends on the development of mechanisms that permit it to adjust physiological functions to changes in that environment. Reproduction would therefore, be expected to occur during the season that assures maximum survival of young. Information on reproductive cycling i.e., the schedule and duration of the breeding season and the relation of this cycling to the environment is essential for understanding the biology of a species.

Ovaries

The ovaries studied in two species i.e., *Schizothorax niger* and *Schizothorax esocinus* are of the cysto-ovarian type, the ova developing within an ovarian sac, and liberated directly to the exterior by means of a small oviduct. The ovaries are bilobed elongated structures covered by a layer of peritoneal epithelium and are situated ventral to the kidneys. Ovaries lie closely pressed against the ventral wall of the air bladder and are attached to the coelom by a thin mesovarium. The mesovarium extends as a thin black sheet, with a mosaic of white dots within it, from the body wall to the peritoneal covering of the ovaries. Posteriorly the lobes are fused together and supplied with the ovarian arteries, veins and nerves. The right and left ovaries are similar and each is divided into two lobes i.e., the anterior lobe and the posterior lobe. The anterior lobe of each ovary tapers into a sharp point, while the posterior lobe maintains a uniform thickness throughout its length, except for the posterior extremity. The two posterior lobes narrow down slightly (near the posterior

narrow end of the air bladder) so that their peritoneal coverings merge into one another, forming a thin walled oviduct which opens outside through the genital aperture. Ovarian sac is present inside the ovary and its walls present a number of folds, the ovigerous folds, which are lined by germinal epithelium. The oocytes are developed and budded off into the cavity enclosed by the lamellae.

Maturity Stages of the Ovary

In the present work the various stages of maturity are as follows:

Stage-I

It corresponds to the stage described in the internationally accepted scale for the ovarian maturity. In this stage, the ovaries are thin, small and wine coloured epithelial ridges. Microscopic, transparent oogonia are present but not visible to the naked eye. The size varies in different species but all the ova are of the same size. The ova diameter ranges from 0.1-0.4mm in *Schizothorax esocinus* and this stage persists during the months of August, September and October. However in *Schizothorax niger*, this stage extends from late April to end of July, and the diameter of ova ranges between 0.01-0.17mm.

Stage-II

The ovaries are pale yellow compact lobes, the right lobe often shorter than the left. This also includes recovering ovaries which are large bag-like and blood shot. The oocytes are with traces of yolk and visible to the naked eye. The diameter of the oocytes and ova varies greatly, half being somewhat large and half small. The ovaries are in reformative phase. The ova are maturing though at a comparatively slow rate. Yolk deposition has commenced in the ova by which they appear translucent. This stage extends from Nov-Dec in *Schizothorax esocinus* and ova ranged between 0.2 to 1.75mm in diameter. However in *Schizothorax niger*, this stage extends from July to the end of September. The diameter of ova ranges between 0.18-2.00.

Stage-III

The ovaries are large and yellow in colour. The ova are large and at penultimate stage of maturity. The ova diameter varies in different specimens, but one third of the ova being small. Ovary is thick, translucent and slightly yellowish in colour. The ovaries gain in size and ova become visible to the naked eye in both the species. In *S. niger* this stage extends during Oct-Nov with ova diameter 2.50mm. In *S. esocinus* this stage lasts till the end of December.

Stage-IV

The ovaries are large and bright yellow in colour. The ova are fully laden with yolk and almost of the same size. Some ova may pass out of the genital pore after lightly pressing the abdomen. The ovaries are fully distended and this represents the mature or stage IV of the ovary in *S. esocinus*. The diameter of the ova ranges between 0.5-2.5 mm. During the winter months of January February, March and even April no conspicuous changes are seen. No eggs are exuded by the application of slight pressure on the abdomen. In *Schizothorax niger* this stage marks the end of the secondary growth phase. The ovary may enter this stage as early as November to

continue till the end of March when the first onset of spawning is initiated. Ova measures about 3.25 mm in diameter.

Stage-V

The ovaries are large and jelly like, very much distended and speckled appearance due to large transparent ova. All the ova are large sized. The mature ova ooze out at slightest pressure. Stripping is successful at this stage only. In May, the ovary is in peak of its activity (spawning season). 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. Thus in *S. esocinus* stage V marks the spawning season of the fish with ova diameter ranging between 0.5-3.0mm. This stage is also called the running stage. In *S. niger*, the two lobes of the ovary are long and flaccid during April, thus showing collapsed condition of an ovary from which all the ova have been discharged, marking thereby spent or stage V of the ovary. During this stage, the undischarged oocytes are seen in the process of regression.

Stage-VI

In this stage the ovaries are shrunken, flaccid, bag-like and blood-shot. Ovaries are much reduced in volume and thus occupy little space in the body cavity. Some hard, large pale yellow old ova may still persist in the ovary. In *S. esocinus*, the ovaries are almost devoid of ova or in a gradual declining condition. During June and July, most of the fishes have such spent ovaries, which contain either immature or a few unspawned ripe ova. No partly spent stage has been observed in *S. niger*.

Stage I (Immature) :	Testes are thin, small and occupy about 1/4th of the body cavity.
Stage II (Maturing):	Testes grow slightly and occupy 1/3 of the body cavity giving white thread like appearance.
Stage III (Mature) :	Testes thickened, flat white in colour and occupy about Half of the body cavity.
Stage IV (Ripe) :	Testes become very thick, creamy white in colour, lobed and extends to 2/3rd of the body cavity.
Stage V (Spawning):	Testes are creamy white, with oily soft surface; milt comes out on slight pressure. Testes appear shrunken with black spots and occupy about one third of the body cavity.
Stage VI (Spent) :	
GSI=Wt. of Gonad	
Wt. of fish	

By categories based on the state of ripeness of the gonad as determined visually. The range in the number of eggs produced by individual fish in successive spawning, makes for difference in the weight of gonad in similar stages of ripeness with a constant overlapping of the GSI.

It is observed that the gonads regress for at least about a

month after spawning. During this time any unshed ova are reabsorbed and ovary enters spent stage. Thereafter GSI rises slowly and as the gonadal active condition is reestablished by the coming of the next spawning season, it again comes to the maximum value. The high GSI value reflects the superior fecundity of a fish although it cannot replace comparative fecundity in fishery studies. GSI values can be used to determine spawning season of fishes. The comparative gonadosomatic index value of the two species studied is tabulated below:

Table 1: Comparative gonadosomatic index value of *S.niger* and *S.esocinus*

Species		Months											
<i>Schizothorax esocinus</i>		April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
<i>Schizothorax niger</i>		4.51	5.43	6.05	7.64	7.0	2.0	2.21	3.0	3.0	3.0	3.31	4.0
		3.24	3.74	2.90	5.88	5.93	6.0	6.34	7.77	8.00	9.75	10.11	11.3

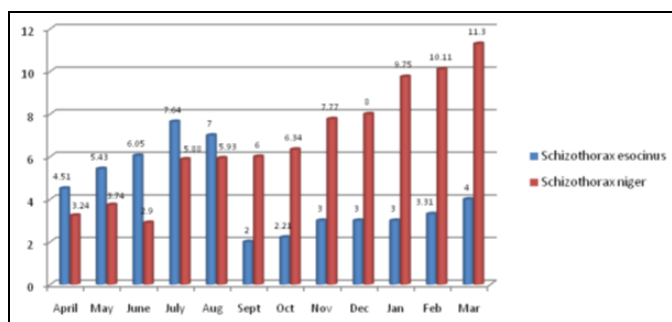
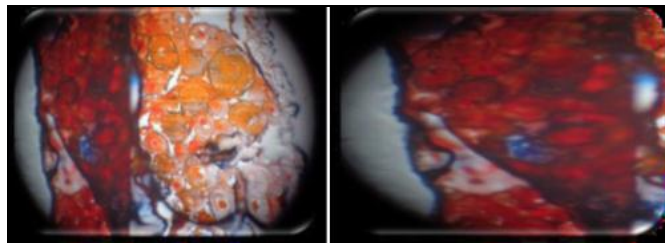


Fig 1: Comparative gonadosomatic index value of *S.niger* and *S.esocinus*

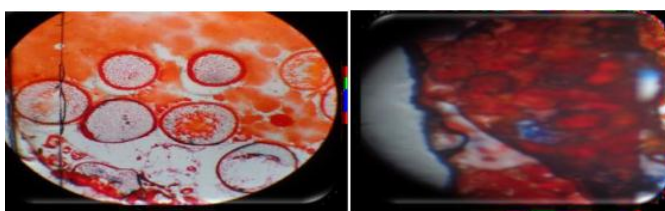
In *Schizothorax esocinus* the highest gonadosomatic index was observed in the month of July with 7.64 and lowest in the month of September with 2.0. Where as in *Schizothorax niger* the highest gonadosomatic index was observed in the month of march with 11.3 and lowest in the month of June with 2.90.

Comparatively among the two species studied the highest gonadosomatic index was observed in *Schizothorax esocinus* and lowest in *Schizothorax niger*.

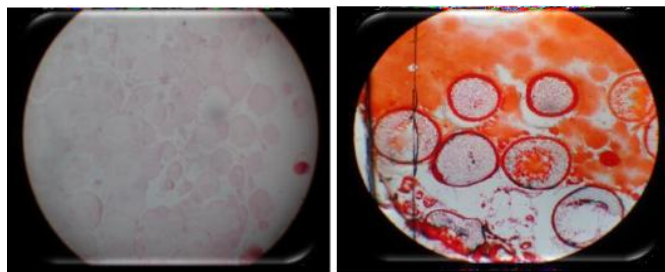
$$\text{Survival rate (SR)} = \frac{\text{Fish quantity at the end of period}}{\text{Fish quantity at the beginning of period}}$$



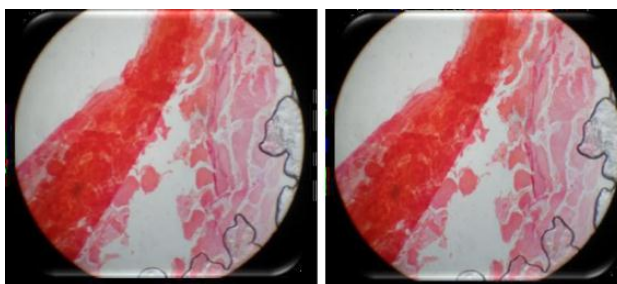
Stage-I & II: Immature ovary of *Schizothorax niger*



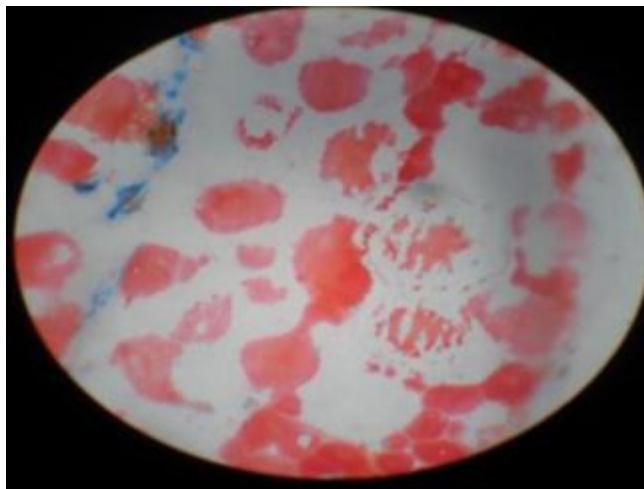
Stage- III: Mature ovary of *Schizothorax niger*
Stage IV: Showing stages of Ovary *Schizothorax niger* (Stage I-III)



Stage-IV: Showing *Schizothorax niger* ovary
Stage-VI: Showing *Schizothorax Esocinus* Spawning Ovary
Stage VI: Showing stages of Ovary *Schizothorax Esocinus*.



Stage-I: *Schizothorax niger* testes, **Stage-I:** *Schizothorax Esocinus* testes



Stage-III: Mature testes *Schizothorax Niger* testes
Stage-III: Showing stages of testes of *Schizothorax Esocinus*r (Stage I-III)

Discussion

Fecundity

Fecundity has shown wide fluctuation with time, age, feeding process and season. Absolute fecundity shown by *S.niger* and *S.esocinus* reared at site Beerwa under controlled conditions was 1292.5. Where as at Akad was 1328.75 and at Kokernag was 1242.5. On artificial feeding at all the three sites *S. niger* has shown 1322.5, 1352.5 and 1272.5 respectively. Whereas *S.esocinus* has shown 1390.5, 1420.5 and 1357.5 respectively. Specimens of *S.niger* and *S.esocinus* below 170-180mm in length were found to be all immature and almost all fishes were mature at 300mm in length. Nikolskii (1965) stated that fecundity is a specific feature that arises during the evolution of a new species adapted to a certain environment and is directed to the continuance of the species. Nikolskii (1965) stated that there may be marked changes in the fecundity within a population for a given size due to fluctuations in feeding conditions. The irregular fluctuations found in the relative fecundity of *S.niger* could not be attributed to any known environmental factor. The positive relation was found between the fecundity and length and weight of fish. Heidrich (1925) and Kestevan (1942) have shown that the total number of ova (absolute fecundity) holds some experimental relationship with the length of the fish in the same way as it does with the weight. Simpson (1951) ^[5] found in place that the fecundity was related with the cube of the length and was thus directionally proportional to the fish weight. In *S.niger* the value of the exponent is higher (3.56) than the cube of the length as is also the case with the other species of the genus. But these values are not unique because value as low as 2.21 have been reported in *Rita rita* (Saxena, 1972) ^[6] and as high as 5.48 in *labeo calbasu* (Pathak and Jhingran 1978). Sunder and Subla (1984) ^[8] have reported a steady increase in the absolute fecundity of *S. Niger*. Age is reported to be a major factor in the determination of egg size (Nikolskii 1965). In the present fish the egg diameter showed a marked increase with age. Increase in the total weight of the ovary caused a decline in the number of ova produced per unit weight of the ovary. Thus while there was an increase in fecundity with increase in the body weight, the number of ova per unit weight of the

ovary shows decline. Pivnev (1950) also reported a decline in the number of ova per unit ovary weight with increase in the diameter of egg. Bagarals (1978) assumption that fecundity and the egg size are negatively correlated is also true for *Schizothorax Niger*. May (1967) reported that fecundity is greater in fishes which spawn more often. Fishes which have smaller Ova are more fecund than those which have larger eggs (Koul, 1970). The larger eggs have better chances of survival because a good amount of yolk is present. Besides these, fecundity is also dependent on environmental factors i.e. temperature, feeding etc.

S. Niger is a true lacustrine fish and does not show any migration out of the lake during spawning season. (Raina *et al.*, 1985) ^[9]. In comparison to other Schizothoracid species which show spawning migrations, *S. Niger* has lower fecundity. This seems to be related to the non-migratory behaviour, as in the case of migratory fishes high fecundity compensates for the high mortality that take place during migrations. Begenal (1957) pointed out that length is an easier and quicker measure than weight of fish and gonad weight, and one can predict the fecundity on the basis of length. Lehman (1953) and May (1967) have shown that fecundity variations are explained in terms of weight and length as well. In almost all teleosts the relationship of fecundity between weight of fish and weight of ovary comes to be linear, as these two factors are main function of fecundity. However Bagenal (1957) reported a non-linear relationship between the ovary weight and fecundity. In case of *S. Niger* spawning period was found to commence from mid February and lasts till the mid of April. The Schizothoracid fishes in general show distinctive migrations (Raina *et al.*, 1985) ^[9] towards the upper reaches of the rivers and lakes. However in *S. Niger*, which is a true lacustrine species, the spawning grounds are present in the lake itself. Pioneering work on the Spawning behaviour in fish has been conducted by Clark (1934), and Hickling and Rutenbery (1936). A Majority of teleost fishes all over the world are seasonal breeder and in the Indian subcontinent a vast majority of freshwater fishes breed during the monsoon months of heavy rainfall (Jhingran, 1982) ^[11]. However, Schizothoracid is the only interspecific Pisces group, which

has been reported to perform varied kind of spawning behavior in different ecological characteristics. Bhatnagar (1964) while studying ova diameter in *S. plagiostomus* reported that the fish spawn twice in a year i.e. in July-August and again in December-January. Qadri *et al.* (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 (Dec. Feb), 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 favorable for spawning. Sehgal (1988)^[2] observed that rise in temperature in Kashmir streams from near freezing level to 10-17oc induce the fish to spawn and is therefore in conformity with the present observations.

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