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Comparative studies on breeding biology of *Schizothorax esocinus* and *Schizothorax curvifrons* in natural conditions

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Abstract

The paper highlights results of experiments conducted on breeding biology of *Schizothorax esocinus* and *Schizothorax curvifrons* in natural conditions. Both the species are annual spawners with slightly different breeding periods and exhibiting migration to nearby upstream regions for spawning. *Schizothorax esocinus* breeds from ending March till July but the peak breeding season is April-May. Whereas the breeding season of *Schizothorax curvifrons* is from May till August but peak breeding season is May-June. Fecundity is significantly high in case of *Schizothorax esocinus* compared to *Schizothorax curvifrons*.

Keywords: Breeding biology, *Schizothorax esocinus*, *Schizothorax curvifrons*, natural conditions

1. Introduction

The valley of Kashmir is a land of lakes, rivers, flowers and fast running streams. The important ones being the Wular Lake, the enchanting Dal Lake, the Mansbal Lake, the Anchar Lake, the Nageen Lake, the. The Jhelum River, snow fed streams like the Sindh stream (District, Gandherbal), the Lidder (District, Anantnag), the Erin and the Madumati (District, Baramulla). These water bodies provide enormous scope for the development of diversified fisheries in the state. The major fish fauna of Kashmir water bodies comprise of exotic carp (*Cyprinus carpio*) and indigenous *Schizothorax* species. *Cyprinus carpio* is presented by two phenotypes, *Cyprinus carpio communis* and *Cyprinus carpio specularis*. The *Schizothorax* species found are; *Schizothorax esocinus* (Chirru) *Schizothorax curvifrons* (Satter gad), *Schizothorax niger*, *Schizothorax plagiostomus*, *Schizothorax longipinnis*, *Schizothorax micropogon*, *Schizothorax planifrons*, *Schizothorax richardsonii*. The other rarely found species are; *Labeo diplostomus*, *Labeo dero*, *Labeo dyocheilus*, *Crossocheilus latius*, *Puntius cirrhonis*, *Botia birdi*, *Glyptosternum reticulatum*, *Nemacheilus kashmirensis*, *Nemacheilus rupicola* and *Nemacheilus marmoratus*. The exotic trout and endemic cyprinids are found to be predominant groups in the mountain lakes [1]. Recently a number of stresses, mostly man made, detrimental to fish species in their once ideal environments have been observed to operate in aquatic ecosystems. The principal factors identified for the decline of fishes include physical habitat loss, degradation or alteration, and chemical pollution or alteration. Due to increase in human population, many of the natural water bodies have either reduced in size or completely disappeared. Environmental deterioration of the water took place by the addition of nutrients which resulted eutrophication. The native fish *Schizothoracine* which is cold and clean water loving find it difficult to cope up with the problem of eutrophication and quite often suffer heavy losses. The development of red bloom with inherent potential of inducing toxicity in aquatic environments endangering fish is a sign of accelerated eutrophication. [2] Due to introduction of common carp in the waters of the Kashmir valley, there has been a sharp decline in the *Schizothorax* catch perhaps due to prolific breeding habit of common carp and its subsequent establishment in the waters of valley as a result of which the shortage of this widely accepted and relished food fish is felt badly in the society [3]. Three varieties of *Cyprinus carpio* L. viz; scale carp, mirror carp and leather carp introduced in the valley led to the predominance of the exotic species over *Schizothorax* population [4]. Besides, the introduction of grass carp (*Ctenopharyngodon idella*) and silver carp (*Hypophthalmichthys molitrix*) in some Kashmir waters (e.g. Trigam Sar) by the J&K Fisheries Department also needs proper ecological monitoring and their impact assessment on indigenous fish.

The introduction of these species has been made without any consideration of the effects on the endemic fish. Brown trout and rainbow trout were introduced predominantly to meet the requirements of the sport fishing. Brown trout is now well established, with a number of self-sustaining populations in streams of Kashmir. Rainbow trout has failed to establish itself in the stream ecosystem but it is cultured in fish farms. It is also clear that sharp decline in the Schizothoracine is the result of brown trout preying upon their younger stages. The potential impact on Schizothoracine due to introduction of exotic fishes in Kashmir is being debated. After the release of common carp fingerlings in Dal Lake in Kashmir, the once abundant Schizothoracine virtually disappeared. It is believed that in Kashmir lakes Schizothoracine are fast losing their ground due to the higher fecundity of common carp and its habitat of spawning in confined waters. The feeding pattern of common carp is almost identical, with that of the lacustrine species of Schizothoracine feeding on detritus and benthos, i.e. sharing the same diet.

2. Materials and methods

2.1 Collection of Fishes

Fishes were collected from Dal Lake, Tailbal Nalla (Srinager), Lidder (Anantnag) and Sindh (Gandherbal). The equipments used for the collection of fishes were drag nets, dip nets and cast nets. The collections were made during the different seasons of the year, usually four times in a month either with the help of fisherman or personally from the collection sites using boats. The maturity of each fish was recorded after the removal of the stomach by Gonadosomatic index measurement (G.S.I).

Gonadosomatic index was calculated by the following equation;

$$\text{GSI} = \frac{\text{Gonad weight}}{\text{Weight of fish}} \times 100$$

2.2 Fecundity Measurement

For the fecundity studies fishes were collected about one month prior to spawning, before any of the eggs in the ovaries become translucent and then killed by a sharp blow on the head. Length and weight of each fish was measured prior to the opening of abdominal cavity. The abdominal cavity was opened and both the gonads were removed. The length of each gonad was recorded. The ovaries recovered were fixed in Gilson's fluid (fixative). Fecundity is a measure of reproduction capacity and it was measured by Gravimetric method [5].

2.3 Gonadal Cycle

For assessing the gonadal cycle of fishes, following steps were taken:

2.3.1 Fixation

Gonads removed from the fresh fish specimens were first cut into pieces which were put into Bouins fixative. The fixed tissue pieces were washed in distilled water three times and then dehydrated in ascending alcoholic grades, cleared in xylol for about one to two hours until the material sunk. The hard eggs of ripe ovary were softened in a solution containing acetic acid and 2.5% HCl in 70% alcohol for about 24 hours. 4% aqueous phenol was also used for softening the hard eggs. The ovarian tissue was then transferred in a mixture

containing approximately equal parts of paraffin and xylol. The mixture with material was placed in the oven at a temperature of about 55 °C for four hours. The material was then embedded in pure paraffin wax in the oven at temperature of 55 °C for four to eight hours.

2.3.2 Staining

For determination of gonadal cycle, 5-8µ thick sections were cut on microtome. Mayer's albumin was spread on the grease-free slides and then microtome sections were spread on the slides. The slides were gently warmed on the hot plate so as to melt the wax. The slides having tissue sections were kept undisturbed for overnight and then washed in xylol to remove the wax. The slide sections were stained in following stains:

3. Results

During the present study the fishes were collected from Dal Lake, Jhelum and snow fed streams of Kashmir valley. The reproductive organs of both the species were removed then analyzed. The reproductive organs of *Schizothorax esocinus* were slightly larger in size compared to *Schizothorax curvifrons*. On the basis of reproductive anatomy the fish specimen were classified as:

3.1 Stage I (Immature)

In this stage ovaries were thin and ova were invisible to naked eyes. The ova diameter ranged from 0.1 — 0.16mm in *Schizothorax curvifrons* and 0.1 — 0.19mm in *Schizothorax esocinus*. In both the species testes appeared thin thread like structures and occupied 1/4th of the body cavity.

3.2 Stage II (Maturing)

In this stage ova were translucent due to deposition of yolk. The ova were quite visible and the diameter of the ova ranged between 0.17mm to 0.80mm in *Schizothorax curvifrons* and 0.20mm to 0.90mm in *Schizothorax esocinus*. Testes were slightly thicker and occupied 1/3rd of the body cavity in both the species.

3.3 Stage III (Mature)

The ovaries appeared thicker with visible blood vessels. The ova diameter was also increased which ranged from 0.80mm to 1.30mm in *Schizothorax curvifrons* and 0.85mm to 1.40mm in *Schizothorax esocinus*. The testes of both the species appeared white in colour and no significant difference was observed in thickness.

3.4 Stage IV (Ripe)

Ovaries appeared orange in colour and diameter of ova was up to 2.0mm and 2.20 in *Schizothorax curvifrons* and *Schizothorax esocinus* respectively. The testes were slightly developed and creamy in colour.

3.5 Stage V (Spawning)

Ovaries were transparent and the ova were quite visible through the wall of ovary. Large numbers of ova were found in the lumen of ovary. The ova diameter was up to 2.20mm and 2.32mm in *Schizothorax curvifrons* and *Schizothorax esocinus* respectively. Testes were creamy white with oily surface.

3.6 Stage VI (Spent)

Ovaries were reddish in colour and thread like structures in

the body cavity. This stage was characterized by the presence of empty follicles and very few large sized collapsed ova. Testes were dim creamy with black spots and occupied one third of the body cavity. The ripe and spawning stages of ova maturation showed that, even before the ripe ova released in the spawning tract, another group of maturing ova had started to mature. The study of fecundity and its relation to length and weight of *Schizothorax esocinus* and *Schizothorax curvifrons* revealed a linear relationship between fecundity and somatic weight, fecundity and total weight. In *Schizothorax esocinus* females having somatic weight ranging from 300gm to 500gm produce 14,000 to 21,000eggs. *Schizothorax curvifrons* having somatic weight ranging from 300 gm to 500gm produce 12,000 to 20,000 eggs. The heavy females of *Schizothorax esocinus* and *Schizothorax curvifrons* ranging in weight around 800gm to 900gm which were very rear produce 34,190 to 36,686 and 31,800 to 33,930 eggs respectively.

4. Discussion

In the present investigation *Schizothorax esocinus* and *Schizothorax curvifrons*, female specimen below 180-185mm length were found to be immature and almost all fishes with 300mm length were found to be sexually mature. However, the smallest ripe male specimens measuring 200-225mm indicating that the males mature at an earlier size than females. It was further seen during the present study that gonads of male specimens of both *Schizothorax esocinus* and *Schizothorax curvifrons* matured about a month earlier than those of the females. Similar observations were recorded in case of *Cyprinus carpio communis* from Dal Lake of Kashmir, India [6]. It was observed *Schizothorax esocinus* and *Schizothorax curvifrons* under study breed once in a year. *Schizothorax esocinus* becomes sexually mature at the age of two years whereas *Schizothorax curvifrons* matures only after one year. *Schizothorax plagiostomus* matures in 2nd year of its life when it attains size of 300-400mm [7]. The breeding season of *Schizothorax esocinus* starts from late March up to ending May and that of *Schizothorax curvifrons* starts from early May up to late June. As the breeding season approaches, the fishes begin to show excitement. They move from Dal Lake and migrate upstream to Tailbal Nalla in search of shallow spawning grounds along the banks of streams. Our observations are in accordance with pervious workers [8] who stated that *Schizothorax richardsonii* migrates upstream regions for spawning. Observations of the present study indicate that both the species spawn only once during spawning season. According to pervious workers [9], breeding season depends upon the factors like food, temperature and light. The present study reveals that although the ovary remains in quiescent stage in both the species during winters but the ova showed active ripening after winter. There was a significant change in histological structures of ova even in the extreme winter months. The present findings are in contrary to pervious worker [10], who reported that active growth does not continue during the winter months in the mature oocytes of *Schizothorax niger*. Ovarian activity of *Schizothorax curvifrons* and *Schizothorax esocinus* followed a cyclic pattern which can be divided broadly into six stages viz, immature, maturing, mature, ripe, spawning and spent. In stage II and IV of ovaries, the maturing and ripe ova were present with distinct modes. The ova diameter studies indicated that about 40% ova become ripe and 60% are

maturing. 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 are ready for spawning. No partially spent female fish have been observed during the course of study which indicates that entire stock of ripe ova are released in a single burst, though their size ranges from 0.94-2.63mm. This suggests that entire egg mass is withdrawn from ovary and there is no spawning periodicity. Pervious worker [11] observed two peaks of spawning for *Schizothorax plagiostomus* from river Gaula Uttaranchal. The mean gonad weight of the two species showed a regular seasonal cycle in gonad weight. From November onwards both testes and ovaries of *Schizothorax curvifrons* begin to increase in weight. The gonads reach their maximum in March. From March onwards the ratio in both sexes begins to fall and reaches its minimum in the month of June. From June onwards there was a slow recovery in weight of gonad. This seasonal cycle in gonad weight clearly suggests that the fish reaches peak maturity in April and spawning begins from ending April to July. In *Schizothorax esocinus* the gonad weight reach at their peak in the month of February and then starts declining from March onwards, reaching minimum gonadal weight in the month of May. From August onwards the recovery period starts again. This suggests that spawning of *Schizothorax esocinus* starts in the month of March and continues up to May. The fecundity of *Schizothorax esocinus* (14,500-36,686eggs) and *Schizothorax curvifrons* (12,000-33,930eggs) weighing between 300 to 900gm in the present study indicates that fecundity directly depends on the body weight and gonad weight. This fecundity is much lower than the estimate given by Raina (1970) who calculated the fecundity of *Schizothorax niger* ranging from 3910-53106 weighing 479-1332 gm. This might be attributed to the ecological disturbance in the breeding grounds. It has been stated that fecundity also varies with the season, climatic conditions and habitat environment, nutritional status and genetic potential [12]. Fecundity of a fish indicates breeding potential of a species on which strength of the future population depends. Fecundity of *Schizothorax richardsonii* ranges from 1578-14,316 eggs for the size ranges of 190-560mm [13]. Pervious workers [14] estimated the number of mature eggs in a fish from Kumaon rivers and found that the fecundity ranged from 8216-48490 eggs for the fish ranging 219-541 mm, There was a prominent increase of gonadosomatic index (GSI) values of 14.78 and 11.93 in *Schizothorax esocinus* and *Schizothorax curvifrons* respectively. Slight drop of GSI (11.46 in April and 11.03 in May) suggesting the commencement of spawning in *Schizothorax esocinus* and *Schizothorax curvifrons* respectively. The GSI value further had an abrupt fall (3.51 in May in *Schizothorax esocinus* and 4.24 in June in *Schizothorax curvifrons*) indicating peak of spawning in both the species of *Schizothorax*. While the minimum values (2.35 in June in *Schizothorax esocinus* and 2.42 in July in *Schizothorax curvifrons*) confirmed the end of spawning season. Testes underwent little changes in weight but the patterns of fluctuation in the index were more or less same in both the species. The present observations are in agreement with the views of pervious worker. [15] According to him, the gonadosomatic index increases with the maturation of fish, being maximum during peak maturity and declining abruptly thereafter, when the fish becomes spent.

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