Study of Changes in Gonadosomatic Index and Hepatosomatic Index During Reproductive Cycle in *Schizothorax niger* from Dal Lake, Kashmir

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Abstract

Studies were conducted on the changes occurring in the gonadosomatic index (GSI) and hepatosomatic index (HSI) of *Schizothorax niger* in Dal lake, Jammu and Kashmir from March 2018 to February 2019. This study was aimed to predict fluctuations in GSI and HSI and to correlate them with their breeding period. A total of 120 fish specimens taken were within the range of 24 cm to 43 cm in total length and weight ranging from 115 g to 510 g. During the experimental period, the mean gonadosomatic indices in fish exhibited remarkable variation throughout reproductive cycle. Maximum gonadosomatic index (15.50 ± 0.75%) and minimum hepatosomatic index (1.87 ± 0.05%) were observed in the month of March indicating peak spawning period for *Schizothorax niger*. A significant inverse relationship between GSI and HSI was recorded. The single peak in gonadosomatic index during spawning phase (March) reflected that the fish is a spring spawner and an annual breeder. It was concluded that by knowing the accurate breeding season of the fish we can protect this declining species in natural water bodies by artificial breeding which ultimately leads to population enrichment in natural environment and thus forms a tool for the development and proper management of *Schizothorax niger* fishery in Kashmir.

Keywords: Dal Lake, histology, *Schizothorax niger*, gonadosomatic index, breeding period.

Introduction

Schizothorax niger known as "Ael Gad" in local kashmiri language is an exceptionally valued commercially important fish of Kashmir. This species is the most important and fit for up scaling of the nutritional status of the community. Being endemic fish of Kashmir, it is important economically. As during the past due to many reasons the total population of *Schizothorax* has shown a falling trend (Mir & Channa, 2010). Therefore, the study on reproductive biology of this fish is of major significance for updating information on its successful culture (Shafi *et al.*, 2013) by understanding changes in GSI during its

reproductive cycle. For attaining prosperous fish seed production and breeding practices, it's important to have knowledge about gonadal cycle and their functional mechanism. Therefore, a comprehensive study on gonad maturation is important, as such analysis are intended in knowing the yearly changes of the inhabitants for proper management of fishery practices (Shein *et al.,* 2004). Gonadosomatic index of the fishes has also been broadly used to designate the maturity phases, periodicity of spawning and predicting the spawning season of the fish. Many workers have used GSI value as a tool for determining spawning season and spawning frequency in various fishes (Jan *et al.,* 2014). Reproductive conditions of the fish can be assessed by the evaluating the HSI values as study of HSI is also considered imperative by many workers, because liver produces vitellogenin (yolk precursor) which plays significant role in maturation of oocytes and is considered as good indicator of stored energy and feeding activity of the fish (Tyler and Dunns, 1976). It is also necessary to find out peak time of spawning and to recognize useful techniques for growing capacity of brood stock and thereby raising the production of fish species by histological study of reproduction. The comprehensive information about the changes taking place within ovaries of the *Schizothorax niger* during its annual reproductive cycle is essential to provide valuable information for the management of this species. Hence, this study was conducted to examine the chamges in the gonadosomatic index and hepatosomatic index of *Schizothorax niger* during its annual maturation cycle.

Material and methods

Sample collection

The experimental fishes (24 – 43 cm in total length & 115 – 510 g in weight) were collected from Dal lake, Kashmir (8.44-N, 77.44-E) by a cast net from February 2018 - March 2019 and total of 120 fish specimens were collected during the year then transportation and preparation of fish samples was done at Cytogenetics and Molecular Research laboratory, CORD, University of Kashmir.

Gonadosomatic index and hepatosomatic index

Samples of fishes were first measured (nearest 0.1 cm) and weighed (nearest 0.1 g) and then were dissected to remove the ovaries and liver. Ovarian and liver samples were weighed (nearest 0.1 g) on the electronic digital balance. Gonadosomatic index (GSI) was calculated as the percentage of the gonad weight with respective to the total body weight of the fish (Dias *et al.,* 2005) whereas, hepatosomatic index (HSI) was calculated as the percentage of the liver weight with respective to the total body weight of the fish (Rajaguru, 1992).

The results of the analyses were presented using descriptive statistics as means ± standard error and inferential statistics included ANOVA and post-hoc tests. One-way analysis of

variance (ANOVA) was used to compare various parameters at different maturity phases followed by a pair-wise comparison of the means using Post Hoc tests. The statistical software used for analysis was SPSS (version 16.0).

Results

In the present study, mean gonadosomatic index and hepatosomatic index in fish exhibited remarkable variation throughout different maturity phases (**Table 1**). This study has shown that the value of GSI started to increase as maturation progresses begins in fish and reached highest value in March demonstrating that during this month the ovaries were in ripe phase and therefore is a spring spawner. The GSI decreased abruptly when the fish entered in spent phase while as HSI was found to be lowest during ripe phase (1.87 ± 0.05). Results showed that GSI values showed single peak only during ripe phase which reflected that the fish breeds annually. There was a significant inverse relationship between GSI and HSI (**Figure 1**)

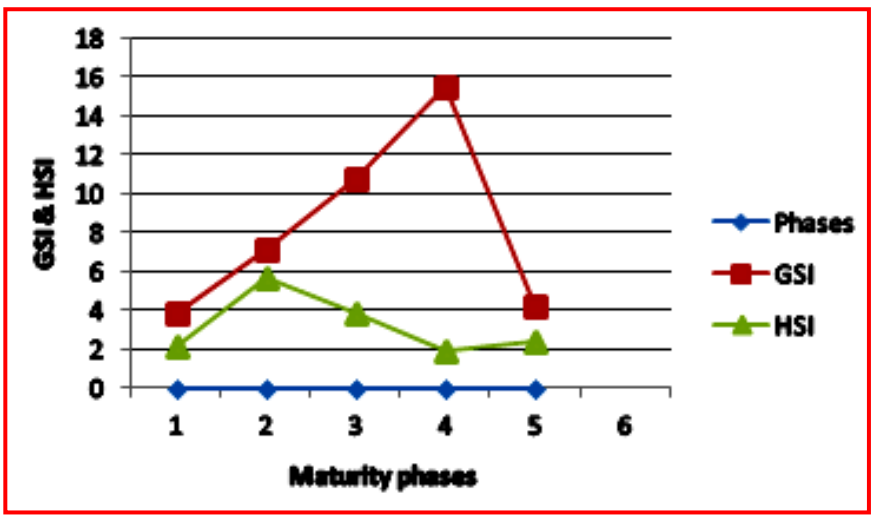

Figure 1: Showing changes in gonadosomatic index and hepatosomatic index during reproductive cycle

3.1. Changes in gonadosomatic index and hepatosomatic index during reproductive cycle

Ovaries were long having varied length, with various shades of colour ranging from light yellow to pink according to the development stage. The level of ovarian development macroscopically was classified into three phases, on basis of different morphological characteristics (weight, length and colour of ovary), changes in gonadosomatic index and hepatosomatic index. The different maturity phases of oocyte development of *Schizothorax niger* determined on basis of morphological features are described in **Table 1**. First phase

was pre-spawning phase which was divided into three sub-phases viz, (a) immature (b) maturing (c) mature. Second phase was spawning or ripe-running phase and the third was post-spawning phase or spent phase. The maturity phases of ovary of *Schizothorax niger* were determined by means of the modified gonad maturity scale developed by Arockiaraj *et al.,* (2004).

Pre-spawning phase:

Immature phase

In this phase, mean gonadosomatic index recorded was 3.80 ± 0.25% which was recorded minimum throughout the reproductive cycle and mean hepatosomatic index recorded was 2.12 ± 0.07% respectively.

Maturing phase

During this phase, mean gonadosomatic index increased and was recorded to be 7.10 ± 0.33% and mean hepatosomatic index was recorded to be 5.71 ± 0.18% respectively.

3.1.1.3 Mature phase

During this phase, mean gonadosomatic index recorded was 10.74 ± 0.31% and mean hepatosomatic index recorded was 3.89 ± 0.09% respectively.

Spawning phase

Ripe-running: During this phase, mean GSI recorded was to be highest among all phases and equal to 15.50 ± 0.75% signifying that during this phase the development in the ovary had reached to maturity and fish was ready to spawn and mean hepatosomatic index recorded was lowest among all phases and equal to 1.87 ± 0.05% respectively.

Post-spawning phase

Spent phase: During this phase, mean gonadosomatic index recorded was 4.21 ± 0.27% and mean hepatosomatic index was 2.38 ± 0.07% respectively.

Table 1: Changes in the gonadosomatic index and hepatosomatic index of female *Schizothorax niger* during different maturity phases

Maturty phases	Maturity sub-phases	Sample size (n)	Weight (g) ± SE	Length (cm) ± SE	Ovary weight (g) ± SE	GSI (%) ± SE	Liver (g) ± SE	HSI (%) ± SE
Pre-spawning phases	Immature phase	24	188.50±7.44^{a}	26.57±0.25^{a}	7.37±0.69^{a}	3.80±0.25^{a}	4.13±0.33^{a}	2.12±0.07^{a}
	Maturing phase	23	255.91±22.49^{b}	29.16±0.99^{b}	18.41±1.90^{b}	7.10±0.33^{b}	14.37±1.17^{b}	5.71±0.18^{b}
	Mature phase	25	275.18±15.64^{b}	29.16±0.70^{b}	29.21±1.54^{c}	10.74±0.31	10.71±0.63^{c}	3.89±0.09^{c}
Spawning phase	Ripe phase	23	285.69±12.36^{b}	29.65±0.46^{b}	43.67±2.33^{d}	15.50±0.75^{d}	5.46±0.33^{da}	1.87±0.05^{a}
Post-spawning phase	Spent phase	25	286.92±12.08^{b}	30.02±0.51^{b}	12.29±1.03^{e}	4.21±0.27^{a}	6.90±0.40^{d}	2.38±0.07^{a}

The values in the table are mean ± standard error of means of triplicates. Mean values in the same columns with different superscripts differ significantly ($P < 0.05$)

Discussion

In the present study, the GSI in fish fluctuated between 3.80 ± 0.25 to 15.51 ± 0.76 during different maturity phases (**Table 1**). This study has shown that the value of GSI started to increase as maturation progresses and reached maximum when the fish is in ripe phase (March) signifying that during this phase the development in the ovary has reached to maturity which depicts that the fish is spring spawner. Thus, in the present study the peak time of reproduction was found in ripe phase (March). All these observations are supported by the findings of earlier workers, as according to Ahmad *et al.,* (2019) who studied cyclic variation of gonad development of snow trout, *Schizopyge niger* from river Jhelum and recorded GSI to be maximum during March and also Hussain *et. al.,* (2018) who studied both breeding biology and fecundity of *Schizothorax niger* from Dal lake and recorded the GSI to be maximum during March i.e., peak development period of the fish, then it declines gradually up to June showing its minimum value in July which is the spent phase of fish. Shafi, Yousuf & Parveen, (2013) also studied breeding biology of *Schizothorax niger* from Dal lake and concluded that the GSI value was recorded highest during February and decreased abruptly when the fish becomes spent and also similar observations were recorded in other species of *Schizothorax, S. labiatus* as well in which the maximum GSI was found in April (11.12%) and minimum GSI was found in August (1.8%). In present study, inverse relationship was found between gonadosomatic index and hepatosomatic index which means that the peak value of GSI does not correspond with the peak value of HSI and this condition implied the fact that the liver undergoes weight loss due to mobilization of vitellogenin and increase in gonad weight due to transporation of vitellogenin from liver during maturation of gonads (Zin *et al.,* 2011) and the present results were in accordance with those found by Qi-Kang Bo *et al.,* (2021). Thus, this study suggested that the reproductive cycle of *Schizothorax niger* follows a cyclic pattern. This study also helps in providing comprehensive information on changes occurring in ovaries of the *Schizothorax niger* through its annual reproductive cycle which thereby provides practical data for the conservation and management strategies of this species.

Conclusion

Thus, *Schizothorax niger* spawns for a short duration of time extending from February to April with peak period in March in the Dal Lake and undergoes in spent phase in July. It is concluded that by knowing the accurate breeding season we could protect this declining species in natural water bodies by artificial breeding which ultimately leads to population enrichment in natural environment and thus forms a tool for the development and proper management of *Schizothorax niger* fishery in Kashmir.

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