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Annual cyclical changes in the gonadosomatic index of *Cyprinus carpio* var. *communis* in Dal Lake, Kashmir

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Abstract
The study deals with the annual cyclical changes in the Gonadosomatic Index of Common carp, *Cyprinus carpio* var. *communis* in Dal lake, Kashmir. Accurate GSI and spawning period estimation play a significant role to evaluate reproductive potential of fish. It also helps to understand the productivity trends, dynamics of fish population and spawning stock biomass. Assessment of the GSI of a fish is essential for evaluating the commercial potentialities of its stock, life history, practical culture and actual management of the fishery. The male GSI ranged from ranged from 2.5±.728 to 9.5±.458 and the female GSI ranged from 3.5±4.03 to 16.3±.12.The peak GSI in both sexes was noted in May. Significant variation in female GSI was found in the month of April, May and June ($p<.01$) whereas, in males significant variation in GSI was found in the months of January, February and March ($p<.05$) and also in the months of April, May, June and July ($p<0.01$).

Keywords: GSI, *Cyprinus carpio* var. *communis*, Dal lake

Introduction
Common carp was introduced in Kashmir in 1956 and since then this fish has shown remarkable adaptation in various water bodies of the state and soon began to constitute a major fishery of flat land temperate waters of Kashmir [6, 16, 3]. *Cyprinus carpio* var. *communis* was found to be the dominant contributor of the total catch from the Dal lake [14]. *Cyprinus carpio* has been reported to be the most dominant fish in the lake both by the number and weight, contributing about 69.13% of the total catch by weight. Of the two varieties of fish which occur in the lake, *Cyprinus carpio* var. *communis* has been reported to contribute 59.2% while the other *Cyprinus carpio*. var. *specularis* has been reported to form 9.11% of the total catch by weight [11]. A number of workers has attempted the work on feeding and breeding biology of Kashmir fishes [8, 5, 15, 13, 17, 18, 2]. *Cyprinus carpio* has been reported to dominate over the endemic fish of Kashmir in terms of reproductive potential also [4]. The fish is found to spawn during spring although the gonads are fully mature at the start of winter, but because of severe winter of Kashmir, the gonads show inactivity or gonadal dispause [8, 7] which remains up to the middle of February. *Cyprinus carpio* has been reported to be the most fecund fish in the lake and shows adaptability to wide range of habitats [17].

Materials and Methods
Source of fish: For the annual cyclical study, 20 fishes (10male and 10 female) were captured from the Dal Lake in each month of the year. Gonadosomatic index was calculated as per the formula given by [19].

$$GSI = \frac{\text{Weight of gonads (g)}}{\text{Total weight of fish (g)}} \times 100$$

Results
Seasonal reproductive development in both the sexes of common carp begin in winter (December, January, February) in the preparation of spring spawning period.

Both the male and female sexes were collected throughout the year. Significant changes in females were not found from August to December (p=0.131) and from January to March (p=0.612)**.** However, significant changes became apparent from April to July (p=.00096) as shown in Table 1, Fig 1. In case of males, no significant change were found from August to December (p=.4619), however significant changes became apparent from January to March (p=.049) and from April to July(p=.00026) Table 2**,** Fig 2. In both sexes, GSI were low in late summer (August, September ,October, November and December) and rises gradually and reaches a peak in May (spring). The GSI then shows a sudden decline with the lower values in June and july in both male and females. The highest GSI was recorded in May with a value of 9.5±.458 (mean± SD)in males and 16.3±.12 in females. Mean GSI value in females ranged from 2.5±.728 (June) to 9.5±.458 (May) whereas in females the value ranged from 3.5±4.013 (June) to 16.3±.12 (May).

Table 1: Monthly variation in Gonadosomatic index of female common carp throughout the year

Months	Female Gsi	P Value
August	5±2.3	P=0.131 Non significant
September	8.8±2.15	
October	6.2±0.85	
November	6.2±.22	
December	6.15±.77	
January	8.44±1.51	P=0.6122 Non significant
February	10±7.4	
March	12±.35	
April	15.3±.94	0.00096 Significant
May	16.3±.12	
June	3.5±4.013	
July	3.66±2.77	

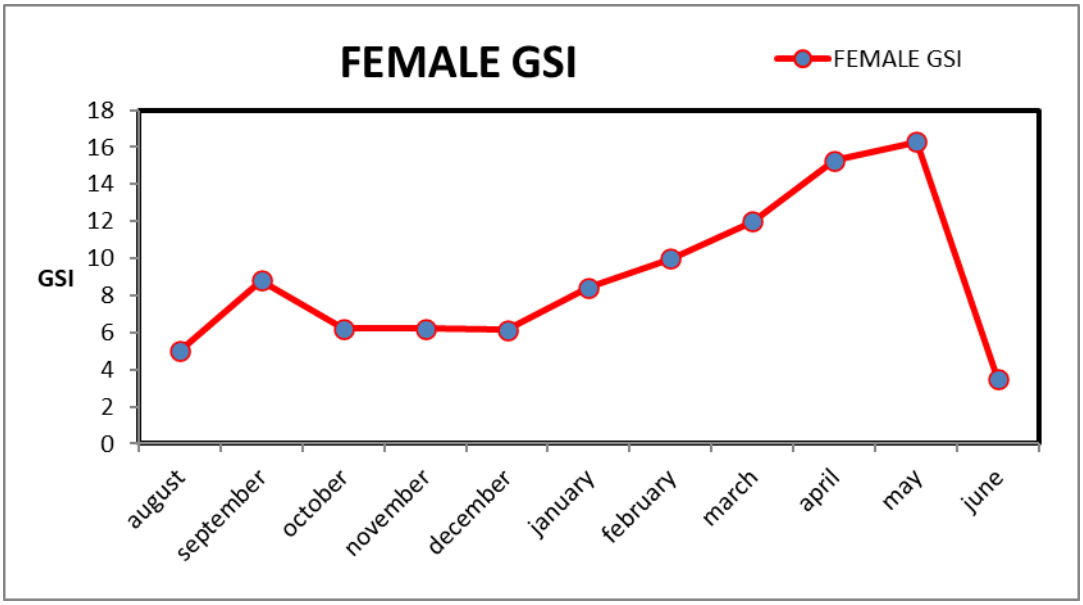

Fig 1: Annual variation in the plasma GSI in female *Cyprinus carpio* var. *communis*

Table 2: Monthly variation in Gonadosomatic index of male common carp throughout the year

Months	MALE GSI	P value
August	4.6±.22	P=0.4619 Non significant
September	5.5±1.903	
October	5.87±.31	
November	5.28±.98	
December	4.59±.1	
January	5.5±.06	P=.049 Significant
February	6.5±.14	
March	6.8±.52	
April	8.05±.414	.00026 Significant
May	9.5±.458	
June	2.5±.728	
July	3.48±2.31	

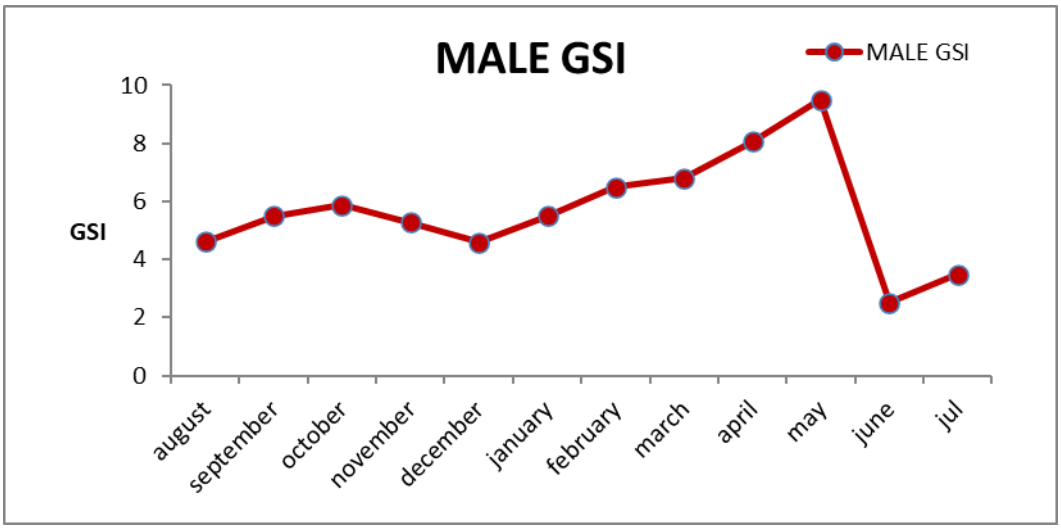

Fig 2: Annual variation in the plasma GSI in male *Cyprinus carpio* var. *communis*

Discussion

The GSI of the male fishes ranged from 2.5±.728 to 9.5±.458 whereas in the female fishes it ranged from 3.5±4.03 to 16.3±.12. [9, 12, 1] reported the GSI of Common carp to be in the range of 3.67 to 37.93%, 2.302 to 11.363% and 13.97 to 17.01%, respectively. The GSI in the present study was found in the same range. A significant difference in both GSIs was found throughout the year. The seasonal factors greatly influence the maturation of ovary resulting in the successive changes in the gonads and body weights [30]. The GSI was also observed to vary with season in *Salmo trutta fario*. Moreover, a gradual and distinct development of gonad was seen reaching its peaks during November afterthat, GSI decline abruptly [20]. *Labeo rohita* also exhibits seasonal cyclic changes in the ovarian histology with peak activity during matured and spawning phases of reproductive cycle [21]. Similar seasonal changes have also been observed in *Cyprinus carpio* [22], *Catla catla* [23], *Labeo rohita*, [24] *Channa marulius* [25], *Lates calcarifer* [26], *Heteropneustes fossilis* [27], and *Labeo bata* [28].

The GSI value of males was lower than that of females and the GSI values for female sexes starts rising from January with the peak values noticed in may whereas, in males sexes, the rise in GSI was noticed from February and showed decline from May [12] have reported the GSI peak in both the sexes in the month of march and reported that the spawning takes place during spring although the gonad were fully mature at the start of winter [10] while studying the reproductive biology of Common carp, *Cyprinus carpio* under temperate conditions in Kashmir, observed that the fishes of both the sexes breed from April to June. However, the GSI values in the month of May and subsequent decrease after June during the present study indicates that the fish breeds may onwards [1]. Have reported that GSI values of females increased from January to April and that of males ranged from December to may, all above finding are in agreement with the present study [29]. Also observed GSI increases with the maturation of the fish and declines abruptly thereafter. The recrudescence of oogonia and primary oocyte take place from January in females and February in males and thereafter oocyte grow and spawning takes place during May when ovary attains the maximum size and contains maximum mature follicles. After spawning period, the ovary undergoes regression [24]. Observed the weight of ovaries started increasing in March and peaked in June in *Labeo rohita*. The GSI was also highest in June with ovaries. The weight of ovaries and GSI declined from July to August, and the ovaries were already regressed by October [31]. Also observed in females of Cyprinid fish, *Salmostoma untrahi*, the value of GSI decreased progressively from July to September 1999 and again increased in October (2.8717) and further decreased from November 1999 to January 2000.

Conclusion

Gonadosomatic index (GSI)) is used to assess the reproductive condition of the fish. GSI is a most useful parameter which provides significant information about the cyclic changes taking place during different months. Changes in the GSI will help to identify the seasonal timing of reproduction and spawning time which determines reproductive season. The index will provide useful information about the effect of season on the reproductive activity of the fish, the information obtained in the present work will help Fisheries Department for obtaining eggs at right time so as to ensure better fertilization and maximum production for seed in ponds.

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