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Monthly variation in gonadosomatic index of *Cyprinus carpio* var. *communis* in wild and captive conditions of Kashmir Himalaya

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Abstract
Monthly variation in Gonadosomatic index (GSI) of C*yprinus carpio* var. *communis* in wild and farmed conditions was studied. The GSI values of both male and female fishes were found low from the month of December to February and reached a peak value in May in both the environmental conditions. In case of wild males the minimum and maximum values of GSI were 2.36±0.85 and 11.21±1.22 respectively. In case of farmed males, the minimum value was 1.99±0.74 and maximum value of GSI's 8.5±2.50. The data reveals that significantly higher male GSI's was found in the wild than farmed fishes in the month of January (p<0.01), March (p<0.05) and May (p<0.05). Significant difference in female GSI's between the wild and farmed habitats was found with higher GSI's in wild than farmed and differences was observed in the month of January (p<0.05), February (p<0.01), March (p<0.01), April (p<0.01), and May (p<0.01).

Keywords: Gonadosomatic index, wild, farmed, *Cyprinus carpio* var. *communis*

Introduction
Carps shows variations in the gonad weight—body weight ratio in different countries. The ovaries of the of the mature fish constitute up to 15% of the body weight in Russia, (Nikolsky, 1963) while an average of 10.4% is found in Japan with a range from 3.1 to 16.4% of the body weight (Matsui, 1957) [19]. In India, the carp have very well developed ovaries and the gonads in mature females constitute 26 to 38% of the body weight of the fish. The gonads of the males of Indian and Chinese major carps constitute less than 1% of the body weight whereas the testes in mature healthy carp in India are remarkably highly developed and constitute up to 20 to 30% of the body weight. This could be due to tropical environment where, under favourable conditions, after attainment of maturity, the males continue to be in oozing condition (Alikunhi, 1966) [3]. Gonadosomatic ratio has proved to be a significant tool in the life of fishes. Gonads undergoing regular seasonal cyclic changes in weight, particularly in females which help to indicate the spawning season (Dadzie, *et al.* 2000) [25]. The method of studying the spawning season is to follow the seasonal changes in gonadal weight in relation to body weight which is expressed as the gonadosomatic index (Ahirrao, 2002) [26]. Gonadosomatic index (GSI) is one of the important parameters of the fish biology, which gives the detail idea regarding the fish reproduction and reproductive status of the species and help in ascertaining breeding period of fish (Shankar & Kulkarni, 2005) [27]. The gonadosomatic index measures the cyclic changes in gonad weight in relation to total fish weight, and can be used to determine spawning periods (Smith, 2008) [28].
Hickling (1962) [11] and Alikunhi (1966) [3] reported that carp is a seasonal spawner in temperate waters and a perennial spawner in tropics. The fish may spawn only once in the wild condition while in ponds, it spawns (Alikunhi, 1966) [3].

Materials and Methods
Source of brood stock
Two groups of Scale carp (both male and female) were taken for experiment: the cultured fish were reared under captivity conditions in the hatchery of Faculty of Fisheries and Pandach fish farm (J&K state Govt. owned farm); the wild fishes were captured from the Dal Lake.

Gonadosomatic index
Gonadosomatic index (GSI) of the fish was calculated as per the formula given by (Desai, 1970):

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

Results

Monthly variation in Gonadosomatic index (GSI) of *Cyprinus carpio* var. *communis*

During present study the monthly variation of GSI of male and female specimens of C*yprinus carpio* var. *communis* in both wild and farmed conditions are given in Table-(1, 2) and Figures (1, 2). In wild females, the Gonadosomatic index (Go.S.I) showed a gradual rise from February (6.82±1.008) to May (16.45±0.55). GSI fluctuated from a minimum of 4.124±1.03 in June to a maximum of 16.45±0.55 in the month of May. From May to June the value of GSI showed a decreasing trend. Similar trend was followed by farmed females where the GSI was found to be minimum in the month of June (3.286±1.2) and maximum in the month of May (12.32±1.50). The data reveals that significant difference in female GSI between the wild and farmed habitats occurred in the month of January, February, March, April and May.

In case of wild males the minimum and maximum values of GSI were 2.36±0.85 and 11.21±1.22 respectively. In case of farmed males the minimum value was 1.99±0.74 and maximum value of GSI 8.5±2.50. The data reveals that significant difference in male GSI between the wild and farmed habitats was found in the month of January, March and May. The Gonadosomatic index in wild fish of both the sexes was found significantly higher than the farmed one. The GSI value of males was lower than that of females in both the environmental conditions and the GSI values for both the sexes was higher from March to May with the peak values noticed in May in both the sexes and showed decline from May to June.

2. Materials and Methods

A cross-bred buff reducible hernias are suitable for conservative therapies. The hernial ring can be closed using conservative treatments such as belly bandages/ abdominal.

Table 1: Monthly variation in female Gonadosomatic index (GSI) of *Cyprinus carpio* var. *communis* in wild and farmed conditions

Month	Habitat		P value
	Wild	Farmed	
December	9.314±.64	7.87±1.63	>0.05
January	7.154±2.144	4.36±1.35	<0.05
February	6.82±1.008	2.76±1.14	<0.01
March	15.06±0.98	8.7±2.02	<0.01
April	16.015±1.415	10.86±1.55	<0.01
May	16.45±0.55	12.32±1.50	<0.01
June	4.124±1.03	3.286±1.2	>.05

Table 2: Monthly variation in Male Gonadosomatic index (GSI) of *Cyprinus carpio* var. *communis* in wild and farmed conditions

Month	Habitat		P value
	Wild	Farmed	
December	7.18±0.96	6.02±1.1	>0.05
January	8.14±.812	3.63±1.51	<0.01
February	4.05±1.12	3.2±1.4	>0.05
March	8.03±1.66	5.84±1.54	<0.05
April	10.036±1.33	6.84±4.6	>0.05
May	11.21±1.22	8.5±2.5	<0.05
June	2.36±0.85	1.99±0.74	>0.05

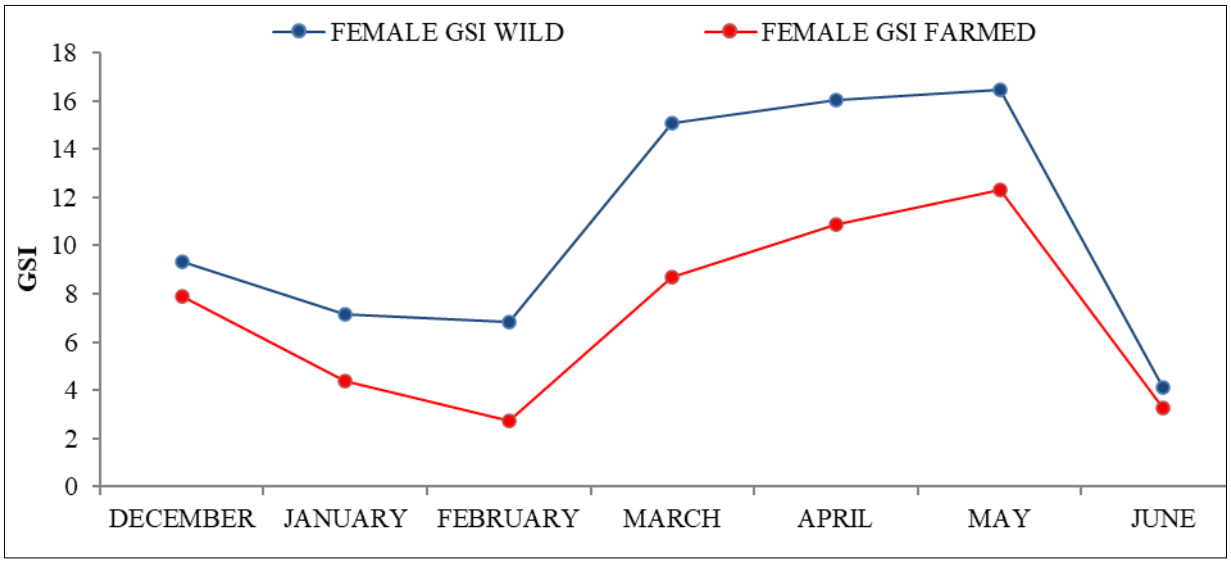

Fig 1: Graphical representation of the monthly variation of GSI of female *Cyprinus carpio* var. *communis* (wild and farmed)

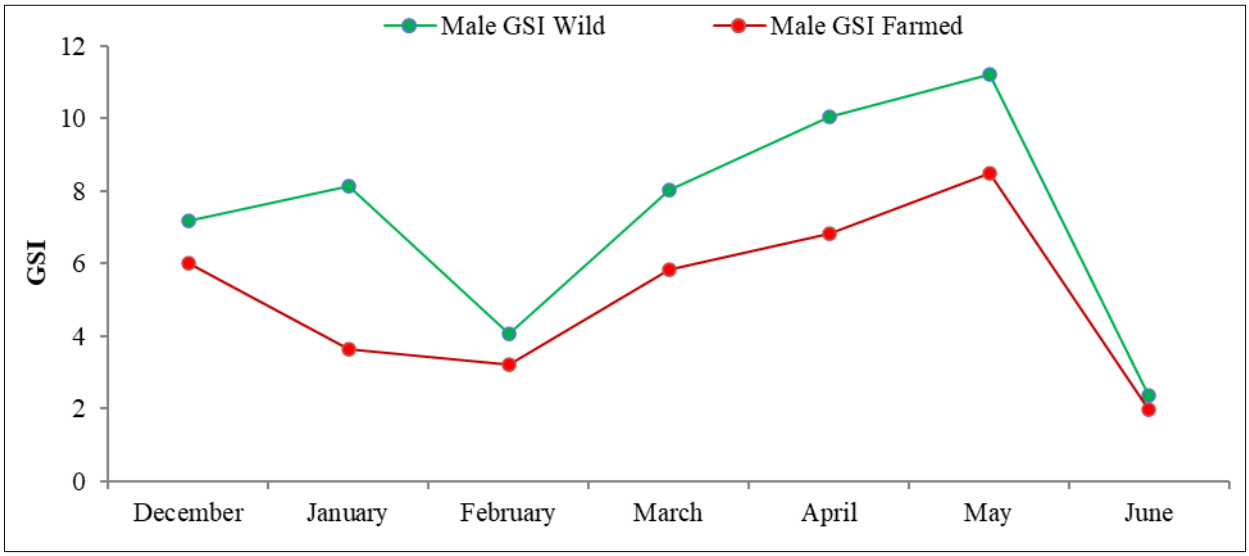

Fig 2: Graphical representation of the monthly variation of GSI of male *Cyprinus carpio* var. *Communis* (wild and farmed)

Discussion

GSI values for both the sexes in both environments was higher from March to May with the peak values noticed in May and showed decline from May to June. Shafi *et al.* (2012) [23] 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. Raina (1978) [21] 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. Abera *et al.* (2015) [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. The GSI of the male fishes varied from 2.36 to 11.21 in wild and 1.99 to 8.5 in farmed fishes whereas in the female fishes it ranged from 4.124 to 16.45 in wild and 2.76 to12.32 in farmed conditions. Parameswaran (1972) [20], Shafi *et al.* (2012) [23], Abera *et al.* (2015) [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.

Higher GSI was found in wild fishes than farmed in the most of the months of the year and in both sexes studied. Kouril *et al.* (1997a) [15]; Fontaine *et al.* (2008); Kristen *et al.* (2012) [16] while comparing the GSI of wild and farmed perch observed the GSI of wild fish of both the sexes higher than the farmed one. Reproductive trait are negatively impacted due to captive rearing (Leung-Trujillo and Lawrence, 1987) [17], and the degeneration of the male reproductive tract (Talbot *et al.*, 1989) [24]. Therefore the present study showed the higher GSI of wild fish than farmed fish in various months of reproductive season, the result are in consent with the finding of Berejikian *et al.* (1997) [5]. They found that captive-reared Coho salmon (*O. kisutch*) were reproductively inferior to wild salmon based on observed spawning behavior. Stress is developed in hatcheries due to transportation, handling, cleaning, crowding, use of chemicals, and problems with water quality are stressors that negatively influence the reproduction (Bromage 1995, Billiard *et al.*, 1981) [7, 6]. Lone and Hussain (2009) [18] reported that some degree of reproductive dysfunction is seen when fishes are kept in captivity for culture purpose which may be due to low quality feed given to fish. Randak *et al.* (2006) [22] while studying the effect of culture conditions on reproductive traits of brown trout *Salmo trutta L* reported no difference in the fecundity (absolute, relative) between the farmed and wild fish.

Conclusion

In captive conditions reproduction of fish can be controlled by environmental manipulations, such as photoperiod, water temperature or spawning substrate. However, the of fishes with environmental biology is not well known, and it is not possible to simulate the required environmental parameters for natural reproductive performance.). In these instances, induced breeding is an effective way to induce reproductive maturation and produce fertilized eggs.

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