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**Original Research Paper**

# Biology of *Cyprinus carpio communis* from Dal Lake, Kashmir with Reference to Food and Feeding Habits, Length-Weight Relationship, and Fecundity

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## ABSTRACT

A total of 143 specimens of *Cyprinus carpio communis* were collected from Dal Lake, ranging in length from 144mm to 414mm, and in weight from 40g to 4450g. The length-weight relationship of the two sexes exhibited significant differences in growth co-efficient (b) and showed deviations from cube law (Male 'n' = 3.15 and Female 'n' = 2.80). Gut contents of the fish revealed that on an average, decayed organic matter (detritus) formed 45% of total food, while the remaining food consisted of both plant and animal matter. Arthropods and macrophytes formed the main or basic food, whereas, oligochaetes, protozoa, rotifers and algae constituted its secondary food. The molluscan and fish remains formed the incidental food. On the basis of gut content analysis, the fish was designated as detri-omnivore. Gastrosomatic index (Ga.S.I.) recorded highest value in July, while lower values were recorded in February. Condition factor (Kn) recorded highest value during March in both the sexes. Condition factor as well as gastrosomatic index exhibited a decreasing trend from higher length groups to smaller ones. Absolute fecundity of the fish varied from 3173 to 629230 and the relative fecundity fluctuated in the range of 21-230 with a mean value of 91.17. The largest length group exhibited higher fecundity than smaller ones, and its Go.S.I indicated the fish to be spring breeder.

## INTRODUCTION

The valley of Kashmir is bestowed with diverse aquatic habitats, lotic as well as lentic, wherein fish constitute one of the main faunistic component and forming important natural resources of the region. The Ichthyofauna of Kashmir has been categorized into three groups, viz., species of central Asiatic origin, those of Indian origin and exotic species introduced in recent past (Das & Subla 1963). The work related to feeding and breeding biology of Kashmir fish has been attempted by a number of workers (Malhotra 1966, Das & Subla 1969, Subla & Das 1970, Jan & Das 1970, Jyoti & Malhotra 1975, Raina 1978, Sunder 1984, Sunder et al. 1984, Sunder & Subla 1985, Yousuf & Pandit 1992, Yousuf & Firdous 1997, 2001, Yousuf et al. 2003). Although most of the water bodies of Kashmir Himalaya are home to many species of fishes, no detailed study has so far been conducted on the fish and fisheries of any of these aquatic habitats except Anchar Lake (Firdous 1995), and in case of Dal Lake only a brief unpublished report of CIFRI (1977) giving some fishery related data is available.

The Dal Lake is situated between 34°5' to 34°6' N latitude and 74°8' to 74°12' E longitude at an altitude of 1584m above sea level. The lake, sometimes referred to as "liquid heart" of Srinagar city, has been an important fishery resource to the people of the valley, especially to Srinagar city since ancient times. It is a shallow open drainage type water body spread over an area of 11.4 km$^2$, divided into five basins viz. Hazratbal, Nishat, Gagribal, Nigeen and Brarinumbal. Till recent past, the Dal Lake was considered to be one of the finest lakes in the country and also as one of the most scenic spots in the world. However, due to over exploitation during the last fifty years or so this water body has turned into a highly polluted ecosystem. Addition of nutrients from anthropogenic perturbations in the catchment, creation of floating gardens and islands within its basins and anchoring of hundreds of house-boats within the lake have changed the overall ecological setup of this water body. The changed trophic level of the lake has impacted the native fish species significantly and many of them have either been expelled from the system (*Botia birdi*) or are losing ground very fast (*Schizothorax* spp.). It was with this background that a detailed study on the biology of *Cyprinus carpio communis* in Dal Lake was undertaken.

## MATERIALS AND METHODS

The fish were collected from eight sites, which were located in four basins (Sites I and II-Hazratbal basin, Sites III and IV-Lokut Dal basin, Sites V and VI-Gagribal basin, Sites VII and VIII-Nigeen basin near bridge, and site VIII-central part of Nigeen basin).

**Fish collection and identification:** The fishes were collected with the help of an expert fisherman, who used the traditional cast net of different mesh sizes. Identification of fishes was done with the help of standard taxonomic works (Day 1878, Hora 1936, Kullander et al. 1999, Bhat et al. 2010).

**Morphometry:** The various morphometric measurements recorded from the collected fishes were total length, standard length, head length, prepectoral length, prepelvic length and preanal length.

**Length-weight relationship:** The determination of length-weight relationship was made by applying the log transformation equation $W = aL^b$ to the data (Hile 1936).

Where; W = Total weight of the fish in grams, L = Total length of the fish in millimetres, a = Initial growth constant and b = Regression co-efficient.

**Ponderal index ($K_n$)/Condition factor:** The Ponderal index or Condition factor for each fish was evaluated by Fulton's formula:

$$\text{Ponderal index (Kn)} = \frac{W \times 10^5}{(L)^3}$$

Where, W = Total weight of fish in grams, L = Total length in millimetres, $10^5$ = It has been introduced to bring the value of Ponderal index near the unity.

**Food and feeding habits:** The fishes procured from sampling sites were wiped dry with the help of a cotton cloth or towel. Each specimen was weighed on a monopan balance to the nearest gram. After weighing, the morphometric features were estimated cautiously. This was followed immediately by fish evisceration to avoid regurgitation and/or digestion of food. Each gut was preserved immediately in 4-5% formalin in labelled collection jars of different size and further processed in the laboratory. The gut was stretched out carefully and the attached tissues like adhering fat and viscera were removed with a pair of blunt forceps. Complete care was taken while clearing the attached tissues to prevent either the injury or pressure on gut to avoid the loss of gut contents. The total length of gut was recorded from anterior end to the cloacal aperture. After wiping it with blotting paper, the gut was weighed carefully on a sensitive monopan balance to the nearest milligrams. The gut contents were collected in labelled tubes and the empty gut was again weighed in order to get the weight of the contents contained in the gut. Total volume of gut contents was determined by using centrifuge tubes graduated in millimetres. The gut contents were analysed for qualitative and quantitative estimations.

***Qualitative analysis*:** The gut contents of the whole gut were used as no significant variations were observed between different regions of the gut. Since, the two sexes did not reveal any remarkable difference in feeding, gut contents of several specimens were pooled together and seen under stereoscope. The various food items including semi-digested fragments and other microscopic elements were identified up to generic level as far as possible. Standard taxonomical keys of Edmondson (1959) were consulted for identification of plankton. Oligochaetes and insect larvae were identified with the help of Pennak (1978), Edmondson (1959).

***Quantitative analysis*:** Volumetric method was used for determining the contribution of different food items on quantitative basis. The dilution of gut content sample was done as per the concentration of food items in sample. One mL of diluted sample was taken and scanned under a compound microscope. The sample was placed in a Sedgwick Rafter cell under a magnification of either 40 or 100 X. This was repeated several times. The average number of individuals of each food item/mL of the diluted sample was multiplied by the dilution factor to determine the contribution of each item. The volume of phytoplanktons and zooplanktons was measured from their mean dimensions, assuming that their shape corresponded roughly to simple geometrical solids (Vollenweider 1974, Downing & Rigler 1984). The relative importance of each food item was expressed as its percent volume.

***Gastrosomatic index (Ga.S.I.)*:** Gastrosomatic index was evaluated using the computational formula:

$$\text{Ga. S. I} = \frac{\text{Total weight of full gut}}{\text{Total weight of fish}} \times 100$$

***Fullness index (F.I.)*:** The feeding intensity or degree of satiation was calculated for each fish species by estimating the F.I. with the help of formula:

$$\text{Fullness index} = \frac{\text{wt. of the gut contents}}{\text{Total weight of fish}} \times 100$$

***Relative length of gut*:** Relative length of the gut was calculated by the following formula:

$$\text{Relative length of gut} = \frac{\text{Gut length}}{\text{Fish length}}$$

**Fecundity:** After various body measurements of the fishes, ovaries were taken out with complete care. The length and weight of ovaries was noted down. The collected ovaries were then placed in 10% formaldehyde for at least 24 hours to bring hardness of eggs, so as to make correct calculation of sticky eggs. This was followed by drying of eggs on blotting paper for 1-2 hours, three sub-samples of one gram each from anterior, middle and posterior parts of ovary were weighed on a sensitive monopan balance, and then eggs were counted carefully by gravimetric method.

***Gonadosomatic index (Go.S.I.)*:** In order to assess the gonadal development of fish the Gonadosomatic index of the fish was calculated as per formula:

$$Go.S.I = \frac{\text{Weight of gonad}}{\text{Total weight of fish}} \times 100$$

## RESULTS

**Length-weight Relationship:** The calculated length-weight relationship of the fish was based on 143 specimens from Dal Lake ranging in size from 144mm to 414mm in total length and 40g to 4450g in total weight. The regression equations obtained for the fish species were:

**Male**: Log w = -5.22+3.15 Log L (r = 0.935)
**Female**: Log w = -4.38+2.80 Log L (r = 0.950)
**Combined**: Log w = -4.75+2.95 Log L (r = 0.690)

As is evident from the above regression equations, the two sexes revealed significant differences in growth coefficient *b*. The values of '*b*' indicated that growth was more pronounced in case of males (3.15) than females (2.80). It is also clear from the above equations that cube law was not followed in either of the sexes. Scatter diagram (Fig. 1) also revealed direct relationship between the two parameters.

**Feeding Habits**

**Food composition**: The analysis of gut contents of the fish revealed that on an average 45.20% of it was detritus and 54.78% included plant and animal matter. The animal food was contributed by crustaceans, oligochaetes, insect larvae, insect remains, fish remains, rotifers and protozoans. On the whole the crustaceans (copepods and cladocerans) contributed 26%, oligochaetes 2.7%, insects 6.4%, (insects 2.6%; larvae 3.8%), fish remains 5.8%, molluscan remains 1.2%, ostracods 0.7%, protozoans 0.4% and rotifers 1.7% to the total food. The vegetative matter consisted of macrophytic tissue and algae, former contributing 45.1%, and the latter 6.8% on an annual basis (Fig. 2 & Table 1).

**Monthly fluctuations in dietary elements:** The perusal of data revealed that the fish is detri-omnivore in feeding habit, as on the whole 45.20 % of gut contents were contributed by detritus and remaining by animal and plant matter. The detrital component revealed its peak contribution during January (67.63%) and December (62.48%), while minimum in May (10.68%) (Fig. 2 and Table 1). Among the animal food, crustaceans were present throughout the year with varying contribution. The group contributed the maximum of 42.0% to the animal food in May, while its minimum contribution was recorded during December (9.1%).

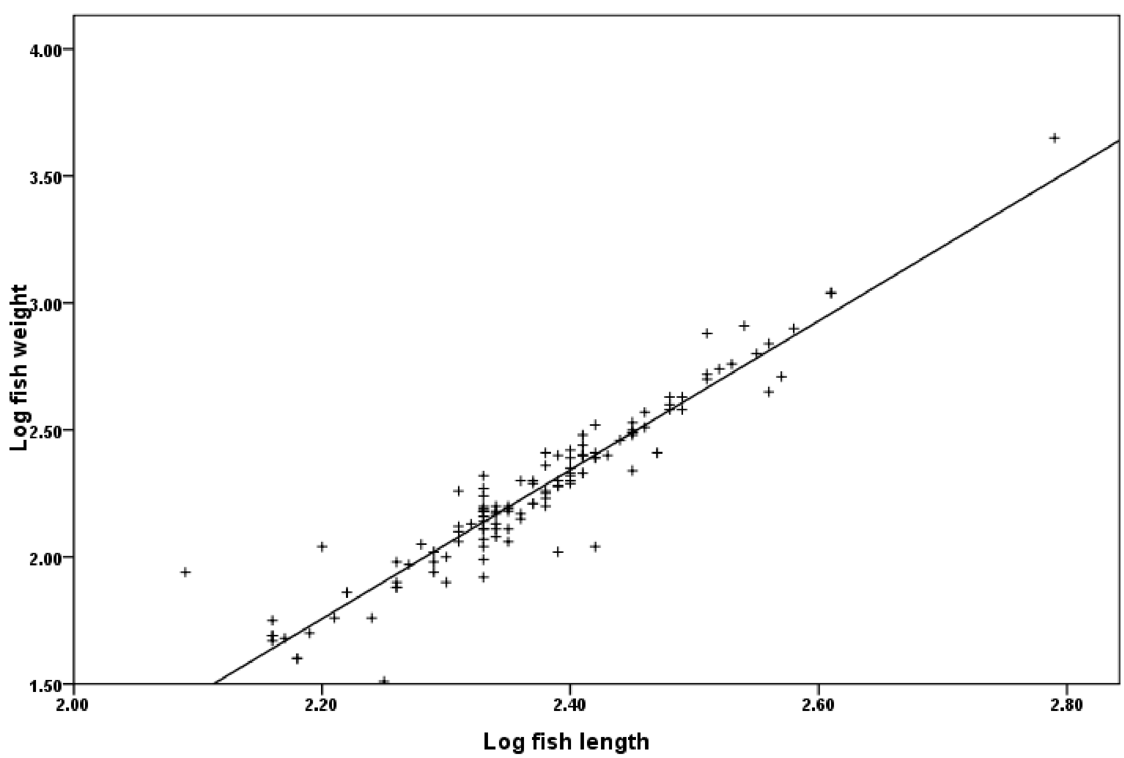


Fig. 1: Length-weight relationship of *C. c. communis.*

Table 1: Monthly fluctuations in the gut contents of *C. carpio communis* other than detritus.

| Month | CLA | COP | I. R. | I. L. | F. R. | M. R. | OST | OLI | PROT | ROT | ALG | M.T. | UID | MIS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. | 9.76 | 13.02 | 2.51 | 5.21 | 14.5 | 3.48 | 1.02 | 4.5 | 0.49 | 2.0 | 9.5 | 30.01 | 0.00 | 4.01 |
| Feb. | 6.57 | 11.72 | 1.51 | 7.51 | 5.71 | 5.03 | 2.32 | 13.75 | 0.92 | 1.38 | 7.0 | 31.5 | 0.01 | 5.07 |
| March | 10.95 | 24.07 | 0.79 | 10.89 | 0.00 | 0.00 | 0.00 | 7.27 | 0.81 | 3.13 | 9.0 | 30.04 | 0.00 | 3.05 |
| April | 11.79 | 17.52 | 0.271 | 3.91 | 0.039 | 0.00 | 1.01 | 0.00 | 0.57 | 1.79 | 7.0 | 54.03 | 0.00 | 2.06 |
| May | 29.20 | 12.8 | 3.03 | 8.42 | 0.00 | 0.00 | 1.00 | 0.00 | 0.07 | 0.97 | 6.5 | 35.0 | 0.00 | 3.01 |
| June | 18.20 | 11.0 | 5.0 | 3.0 | 0.271 | 1.32 | 0.92 | 1.25 | 0.21 | 2.23 | 4.5 | 50.09 | 0.00 | 2.01 |
| July | 30.02 | 9.75 | 9.5 | 00.0 | 0.00 | 0.00 | 0.71 | 0.00 | 0.70 | 2.11 | 2.50 | 43.7 | 0.00 | 1.00 |
| Aug. | 9.01 | 19.50 | 3.21 | 0.10 | 0.01 | 0.00 | 0.21 | 1.71 | 0.035 | 1.13 | 5.25 | 56.30 | 0.14 | 3.41 |
| Sept. | 4.32 | 18.695 | 4.52 | 0.00 | 7.27 | 1.40 | 0.00 | 4.0 | 0.03 | 2.17 | 6.24 | 48.8 | 0.56 | 2.00 |
| Oct. | 8.52 | 10.92 | 0.00 | 2.00 | 8.28 | 0.00 | 0.00 | 0.00 | 0.31 | 1.21 | 7.01 | 57.84 | 1.00 | 3.00 |
| Nov. | 3.52 | 12.12 | 0.00 | 0.00 | 15.71 | 0.00 | 0.91 | 0.00 | 0.03 | 1.57 | 9.00 | 53.12 | 0.00 | 4.05 |
| Dec. | 2.0 | 7.06 | 1.25 | 4.5 | 17.5 | 3.7 | 0.00 | 0.00 | 0.31 | 1.00 | 8.52 | 50.41 | 0.03 | 3.72 |
| Mean | 11.99 | 14.01 | 2.63 | 3.80 | 5.77 | 1.24 | 0.68 | 2.71 | 0.37 | 1.72 | 6.84 | 45.07 | 0.15 | 3.03 |

CLA = Cladocera; COP = Copepoda; I.R. = Insect remains; I. L. = Insect larvae; F.R. = Fish remains; M.R. = Molluscan remains; OST= Ostracoda; OLI = Oligochaetes; PROT = Protozoa; ROT = Rotifera; ALG = Algae; M.T. = Macrophytes; UID = unidentified; MIS = Miscellaneous

Table 2 (a): Monthly fluctuations in various indices in *C. c. communis.*

| Sex | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
| **F. I.** | | | | | | | | | | | | |
| Male | 1.612 | 1.854 | 2.150 | 1.916 | 3.808 | 2.646 | 3.887 | 3.889 | 4.52 | 4.688 | 3.52 | 3.060 |
| Female | 1.650 | 1.786 | 2.106 | 1.173 | 2.607 | 2.075 | 3.530 | 3.735 | 4.37 | 2.606 | 2.885 | 2.297 |
| Comb. | 1.631 | 1.820 | 2.128 | 1.545 | 3.208 | 2.361 | 3.709 | 3.81 | 4.445 | 3.647 | 3.202 | 2.679 |
| **Ga.S.I.** | | | | | | | | | | | | |
| Male | 4.692 | 4.318 | 6.415 | 5.958 | 7.058 | 6.578 | 7.680 | 6.65 | 8.0 | 8.022 | 6.50 | 4.775 |
| Female | 4.893 | 4.187 | 5.589 | 4.740 | 5.501 | 5.356 | 7.541 | 6.85 | 7.0 | 7.140 | 5.373 | 6.0 |
| Comb. | 4.793 | 4.253 | 6.002 | 5.349 | 6.280 | 5.972 | 7.611 | 6.75 | 7.51 | 7.581 | 5.936 | 5.388 |
| **$K_n$** | | | | | | | | | | | | |
| Male | 1.463 | 1.457 | 1.700 | 1.582 | 2.582 | 1.528 | 1.667 | 1.60 | 1.62 | 1.084 | 1.68 | 1.360 |
| Female | 1.433 | 1.462 | 1.777 | 1.462 | 1.370 | 1.485 | 1.543 | 1.42 | 1.65 | 1.183 | 1.512 | 1.35 |
| Comb. | 1.448 | 1.460 | 1.738 | 1.449 | 1.976 | 1.507 | 1.605 | 1.51 | 1.635 | 1.140 | 1.596 | 1.355 |

*Ga.S.I. = Gastrosomatic index; F.I. = Feeding intensity; K = Condition factor

Table 2 (b): Fluctuations in various indices in various length groups of *C. c. communis.*

| Type of index | Length groups (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | I<br>141-179 | II<br>180-219 | III<br>220-259 | IV<br>260-298 | V<br>299-336 | VI<br>337-374 | VII<br>375-414 |
| Gastrosomatic index | 7.14 | 6.85 | 6.14 | 6.16 | 4.55 | 4.52 | 2.48 |
| Fullness index | 4.49 | 3.31 | 2.81 | 2.50 | 2.52 | 1.59 | 1.210 |
| Condition factor | 1.80 | 1.35 | 1.36 | 1.63 | 1.47 | 1.49 | 1.90 |

Table 3: Monthly fluctuations in Gonadosomatic Index (Go.S.I.) of *C. c. communis.*

| | Go.S.I. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
| Male | 8.21 | 6.077 | 10.577 | 7.860 | 4.406 | 1.942 | 3.027 | 3.97 | 4.0 | 4.08 | 10.37 | 8.180 |
| Female | 8.062 | 6.593 | 12.149 | 9.271 | 4.636 | 2.661 | 2.926 | 4.52 | 5.72 | 5.912 | 10.60 | 9.285 |
| Comb. | 8.136 | 6.335 | 11.363 | 8.566 | 4.521 | 2.302 | 2.977 | 4.254 | 4.86 | 4.996 | 10.515 | 8.733 |

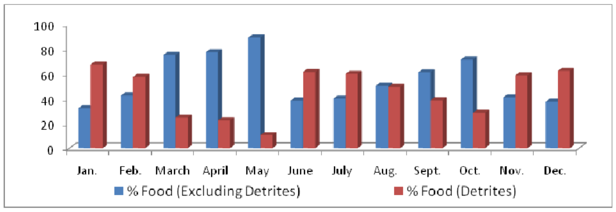


Fig. 2: Monthly fluctuation in percenage of food of detritus and non-detritus food in *C.c. communis.*

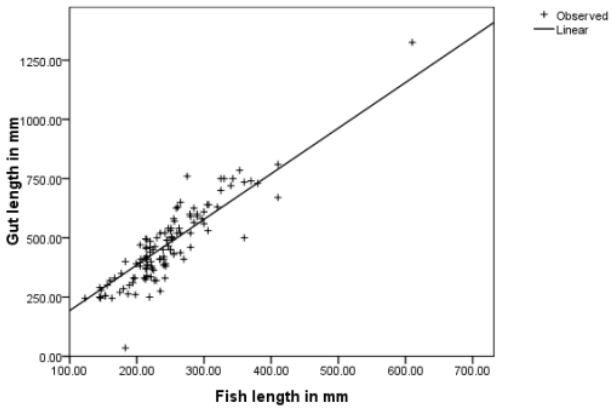


Fig. 3: Relationship between fish length and gut length in *C.c. communis.*

Oligochaetes recorded peak contribution of 13.7% during February, while in June it contributed only 1.2%. The contribution of fish remains in the gut contents of fish was maximum (17.5%) during December, however, during March, May and July these were absent from gut contents. Insect larvae recorded their peak contribution in March (10.9%) but were absent from gut contents during July, September and November. Macrophytes recorded highest contribution in October (57.8%), and a minimum (30.0%) in January. The algae contributed the maximum (9.5%) in January, while minimum in July (2.5%).

**Feeding intensity (F.I.):** The fish showed a marked reduction in feeding intensity from January (1.631) to April (1.545) at a time when the abdominal cavity was filled with gonadal mass. An improvement in feeding activity was recorded in May (3.208) and the index remained generally high during the warmer months, followed by a gradual decline with the approach of winter (January and February). Comparatively, the feeding intensity was high in case of males throughout the year (Table 2a). When combined (male and female both), the fullness index was minimum in the month of January (1.63), and maximum in the month of September 4.44. The fullness index of various size groups (Table 2b) indicated that lower size groups have comparatively higher feeding intensity than the higher size groups. The minimum feeding intensity (1.210) was recorded in the length group VII (375-414), whereas the maximum fullness index (4.49) was attained by the lowest length group I (141-179).

**Gastrosomatic index (Ga.S.I.):** The Ga.S.I. recorded its highest value during July (7.61), while lower values were recorded in February (4.25). An increase in Ga.S. I. was noticed during March but it dropped again in April. It revealed an improving trend during summer and autumn. The females recorded comparatively lower Ga.S.I. than males throughout the year (Table 2a). Smaller length groups had higher values than large ones. The minimum Ga.S.I. of 2.48 was recorded from fishes belonging to highest length group VII, and the smallest length group I recorded the maximum value (7.14) (Table 2b).

**Ponderal index ($K_n$):** The Ponderal index varied from the minimum of 1.14 in October to the maximum of 1.97 in May. The males revealed higher values than females. The peak value for this index in both males and females was found in March (1.70 & 1.77 respectively), and the lowest value in December (1.36 & 1.35 respectively). The condition factor was found low in smaller length groups but increased in higher length groups.

**Gut length in relation to body length and RLG**: The relationship between gut length (GL) and total length of the fish (TL) is represented by the equation; Log GL = -0.290 + 1.23 Log TL. ($r = 0.898$, $p < 0.01$). The two variables showed a highly significant relationship (Fig. 3). Relative gut length (R.L.G.) fluctuated greatly from fish to fish, ranging from 1.18 to 2.76 with a mean value of 1.87.

**Fecundity:** Fish in high state of maturity either ripe or prespawning phase was selected for the determination of fecundity. In this phase the ovary was completely filled with eggs and it occupied the entire abdominal cavity. Mature specimens ranging in weight from 47g to 4450g and in length from 145mm to 610mm were used. Weight of ovary in the fish fluctuated from 4 g to 707 g with a mean value of 33.47 g. Absolute fecundity of samples varied from 3173 to 629230, and the relative fecundity from 21.00 to 223.00 with a mean value of 91.17.

**Gonadosmatic index (Go.S.I.):** The gonadosomatic index (Go.S.I) fluctuated from a minimum of 2.30 in June to 11.36 in March. The Go.S.I. of this fish exhibited an irregular trend in different seasons as well as in different length groups (Table 3). The length group IV recorded the minimum Go.S.I. value of 5.96, whereas the highest length group VII attained the maximum Go.S.I. of 8.46. The females recorded higher Go.S.I. as compared to males in almost all the four seasons of the year.

## DISCUSSION

The study of length-weight relationship is of paramount importance in fishery science, as it assists in understanding the general well being and growth patterns in a fish population. Basheer et al. (1993) opined that length-weight relationship of fish varies depending upon the condition of life in aquatic environment. Ideally, the regression coefficient 'b' of a fish should be very close to 3.0 (Allen 1938), however, the cube law does not hold good throughout the life period and the weight gain in a fish may not be always cube of its length gain (Rounsefell & Everhart 1953, Lagler 1956). Hile (1936) and Martin (1949) opined that the value of 'b' may range between 2.5 and 4.0. Antony (1967) recorded the value of 'b' within a range of 2.0 to 5.4. LeCren (1951) pointed out that the variation in 'b' value is due to environmental factors, season, food availability, sex, life stage and other physiological factors. The male and female fishes revealed significant differences in the value of 'b' in the fish. The males recorded higher exponential value. High 'b' values in case of males were also reported by Sunder et al. (1984) and Yousuf et al. (2001). Hatikaktoa & Biswas (2004) and Rao & Sreeramullu (2006) reported higher values of 'b' in females, while higher values of 'b' in females were also observed by Sunder (1985), Kulshrestha et al. (1993) and Firdous (1995). The present work revealed that the fish did not follow the cube law completely. Similar departure from cube law has been observed by Subla & Sunder (1981), Sunder et al. (1984), Torres (1991), King (1996), Firdous (1995), Raizada et al. (2005), Rao & Sreeramullu (2006), Singh & Gupta (2008), Devi et al. (2008) and Mandal et al. (2008). The present data make it quite clear that the relationship was influenced by environmental conditions like food and physiological parameters (Muth & Smith 1974, Sunder et al. 1984, Sandhya & Shameem 2003).

According to LeCren (1951) and George et al. (1985), the relative condition factor $K_n$ is an indicator of general well-being of the fish. $K_n$ greater than one (1) is indicative of the general well being of fish, whereas its value less than one (1) indicates that fish is not in a good condition. Carlander et al. (1952) is of the opinion that condition factor may vary with increasing length when average weight of fish does not increase in direct proportion to cube of its length. However, Salam et al. (2005) pointed out that '$K_n$' remained constant with increase in length and weight of fish. The condition factor of fishes has been reported to be influenced by a number of factors such as the onset of maturity (Hoda 1987), spawning (De-Silva & Silva 1979, Al-Dham & Wahab 1991), sex and maturity (Gowda et al. 1987, Doddamani & Shanbouge 2001) and pollution (Bakhoum 1999, Devi et al. 2008). During the present study also, the monthly fluctuations in condition factor of the fish seemed to be influenced by gonadal development, availability of food and gastral activity. The present data revealed that in case of *C. c. communis,* the Ga.S.I was highest (11.363) in March, and condition factor also recorded its peak values of 1.738 and 1.976 during March and May, hence indicating a relationship between K-factor and gonadal mass as has also been reported by Sunder et al. (1984). Another peak in condition factor in this fish was in September (1.635) when feeding intensity was touching its highest value (3.709). Firdous (1990) reported a similar phenomenon in *C. c. communis* and *C. c. specularis* from Anchar lake in Kashmir. From the data, it is clear that feeding intensity, gastrosomatic index and the gonadal development are responsible for the variations in the condition factor. Chakraborty & Singh (1963), Chatterji (1979), Yousuf & Pandit (1989) and Narejo et al. (2002) have also related the changes in condition factor with age, feeding intensity and gonadal development.

Knowledge of food and feeding habits of a fish is important for understanding its biology as well as for the successful management of its fishery. Nature offers a great diversity of food to fishes and accordingly various species are known to differ in their feeding habits, some being the predators like pikes, some others are omnivores like the gold fish, while many others are herbivores (Hoar & Randall 1971). Since 1970, the lake has underwent a tremendous change in its ecology mostly due to unabated pollution, which has ultimately made it now eutrophic and some fishes have now extirpated from the lake due to changing ecological conditions (Yousuf 1996, Bhat et al. 2010). A perusal of the data on food and feeding habits revealed that gut contents of the fish recorded 45.20% of its contents as detritus. On the basis of its importance in the fish diet, Nikolskii (1963) categorized fish food into three categories, (a) basic food which is normally eaten by the fish and forms good proportions of the food, (b) secondary food which is frequently found in the stomach but in smaller amounts, and (c) incidental food which is rarely found in the stomach. In accordance with Nikolskii (1963) classification, arthropods and macrophytes form the main or basic food of the *C. c. communis,* whereas Oligochaetes, protozoans, rotifers and algae constituted its secondary food. The molluscan and fish parts form the incidental food. Oso et al. (2006) recorded the macrophytes, *Chlamydomonas* species, *Spirogyra*, detritus, sand grains and insect parts from gut of *Oreochromis niloticus* and *Sarotherodon galialeaus* and designated these fishes as omnivorous in their feeding habits. As far as the food of this carp is concerned, there was hardly any difference found in the diet of males and females. Rao & Sreeramullu (2006) also noticed the same feature in a planktivorous Gobiid fish. Earlier Jan & Das (1970) and Sunder et al. (1984) reported C. *c. communis* and *C. c. specularis* from Dal Lake, to be herbivorous in feeding habits. However, a perusal of the data presented by Jan & Das (1970) in support of their conclusions in reality gives a different view. For example, the authors indicated that 29% of the food of *C. c. specularis* was of animal nature, while in case of *C. c. communis* animal matter contributed 34% of the food. This being so, the importance of the animal matter in the food of the fish cannot be just ignored. The relative contribution of animal matter in the food of *C. c. communis* clearly indicates that it is omnivorous in its feeding habit, which is also supported by its RLG which was present with a mean value of 1.87. The omnivorous feeding habit of this fish has also been reported by Soni et al. (1981) and Spataru et al. (1980). The detritus forming about 50% of the food of the fish, the fish can be easily categorized as detri-omnivore. Bottom feeding of the fish is supported by the present data as it is a typical bottom feeder in the Dal, as benthic organisms like oligochaetes, insect larvae and ostracods were recorded from their gut contents. Firdous (1995) has also reported omnivorous feeding habit of this fish in the Anchar lake.

The present data revealed that feeding intensity fluctuated throughout the year. Fish with almost empty guts were observed during extreme winters, however, an improving trend was observed on the approach of spring and summer months. Besides winter, feeding index also recorded low values in relation to breeding pattern, as during peak breeding season, low F.I. values were recorded. Kiran & Puttaiah (2004) also related the feeding intensity to the development of gonads and the low feeding activity during fully developed gonads has been referred to as "spawning fast" by many workers (Geetha et al. 1990). Basudah & Vishwanath (1999), Baloni & Tilak (1985) and Schulz & Schoonbee (1999) also related decline in F.I. with breeding activity of fish. In case of present fish, low feeding activity was also recorded during winter. During winter months, the low feeding intensity can be attributed to less metabolic activity of the fish as well as to non-availability of food due to low temperature conditions.

Study on the fecundity forms an important part of fishery science as it has a direct bearing on fish production and exploitation. Norman & Greenwood (1963) reported that *Molva* produces as many as 28,361,000 eggs; *Gadus* 66,52,000, while in case of Stickle backs the number of eggs ranges from 30 to 100 per female per season. However, in the present fish, the eggs ranged from 3173 to 6,29,230. Fecundity is also known to vary within species with latitude and location (Cushing 1968, Mann et al. 1984) and also with spawning time (Ware 1975). On the basis of fecundity it was found that *C. carpio* dominated over the native species in terms of reproductive potential (Das & Malhotra 1964) as the relative fecundity of the fish on the average was 91. The fish was found to spawn during spring although the gonads were fully mature at the start of winter. But because of severe winter of Kashmir, the gonads show inactivity or gonadal diapauses (Malhotra 1966, Jyoti 1973) which remain up to the middle of February. While comparing the previous work of Das & Singh (1969) with the present work, there was a decrease in absolute fecundity in *C. c. communis*. This may be attributed to the declining environmental quality, which leads to physiological stress in the fish.

## CONCLUSIONS AND RECOMMENDATIONS

Since 1970, the lake has underwent a tremendous change in its ecology mostly due to unabated pollution which has ultimately made it now eutrophic, and some fishes have now extirpated from the lake due to changing ecological conditions (Yousuf 1996, Bhat et al. 2010). The detritus formed about 50% of food of the fish and rest consisted of both animal and plant matter and thus, the fish is categorized as detri-omnivore. Fish with almost empty guts were observed during extreme winters, however, an improving trend was observed on the approach of spring and summer months. Besides winter, feeding index also recorded low values in relation to breeding pattern. During winter months, the low feeding intensity can be attributed to less metabolic activity of the fish as well as to non-availability of food due to low temperature conditions. The fish did not follow the cube law completely and it is quite clear that the relationship was influenced by environmental conditions like water quality, food and physiological parameters.

Condition factor in the fish species seemed to be influenced by gonadal development, availability of food and gastral activity. The fish spawned during spring although the gonads were fully mature at the start of winter but severe winter rendered inactivity or gonadal diapauses up to the middle of February. A decrease in absolute fecundity in *C. c. communis* was observed during the present study. This may be attributed to the declining environmental quality, which has lead to physiological stress in the fish. In order to thrive the fish and other organisms well in the lake, the restoration of the lake for improving the water quality and ecology is the prime need of the hour, besides the effluents and other wastes have to be stopped before they find their way into the lake.

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