



Studies on the Gonadosomatic Index and fecundity of *Cyprinus carpio* from Indus River near Jamshoro. Sindh, Pakistan

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Abstract: Present investigation was performed on some aspects of reproductive biology of *Cyprinus carpio*. 190 specimen's (33.02 - 48.82 cm and 486.6 - 1947g) were collected from River Indus, Jamshoro during months of January to May 2016 and dissected. The condition of the gonad and sex of each fish was enumerated, the dissected gonads were weighed by using digital balance. It was observed from results of ova diameter measurement that all ova were found to be spherical and uniform in diameter, this indicated that the eggs were released in a single batch during the peak period of spawning (February). Values of Gonadosomatic Index was observed highest (2.97 and 5.27) in male and female respectively in the month of February. Monthly ova diameter measurement showed progressive increase from January to March (1.12 mm) peak in February. The fecundity was estimated from 10 mature fish highest was 390600 eggs 48.8 cm and 1947g at gonad weight of 510 g and lowest was 18280 from a length 33.0 cm and 486.6 g in weight and gonad weight of 53.1 g were recorded and possessing strong relationship with gonad weight. Equation of Length-weight analysis showed ideal growth very near to (3) in all cases and coefficient of condition (Kn) indicated that all samples of both sexes *Cyprinus carpio* found with satisfactory growth from Indus River, Jamshoro, Sindh, Pakistan. It was concluded that *Cyprinus carpio* breeds once in year with peak in February. As indicated from both GSI and ova diameters. The fecundity bears linear relationship with body weight in case of *Cyprinus carpio* from Indus River, Jamshoro, Sindh, Pakistan.

Keywords: Gonadosomatic Index, Fecundity, Length-Weight, *Cyprinus carpio*

1. INTRODUCTION

Indus River system is one of the largest rivers on the Asian continent, being located to the Indus Suture Zone explains the deep exhumation north of that line in the Karakoram, compared with the modest erosion seen further east in Tibet. The Indus represents 18% of the total Neogene sediment in the basins that surround Asia, much more than all the basins of Indochina and East Asia combined. Carp often grow 30 to 60 cm in length and weigh 0.5 to 4 kg (Tomelleri and Eberle 1990); it is not uncommon for common carp to reach 15 to 20kg (McCrimmon 1968). Males are usually distinguished from females by the larger ventral fin. Carp generally spawn in the spring and early summer depending upon the climate. They sergate into groups in the shallows to spawn. Carp prefer shallow waters with dense macrophyte cover. A typical female (about 45 cm) may produce 300,000 eggs, with some estimates as high as one million over the breeding season. Incubation is related to water temperature and has been documented at three days at temperatures of 25 to 32C. Fry average 5 to 5.5 mm in total length. Temperature, stocking density, and availability of food influence individual growth. By the time the fish reach 8 mm the yolk has disappeared and they begin to actively feed. In fisheries investigation analysis of length verses weight possess a

practical value to determined unknown weight of fish from known length and vice versa (Jamali, *et al.* 2018). The deviation in relationship length verses weight is highly influenced through variety of ways such as fatness, feeding intensity and gonadal development of fish (Le Cren 1951). Generally, expected weight of fish could be varied from the cube law at same length (Dastagir, *et al.* 2014; Pathak 1976). The 'b' value termed as exponent usually lies between 2 to 4 that gives an index of growth (positive and negative allometric) (Dars, *et al.* 2010). The use of condition factor (Kn) is an vital biological tool to characterized/ suitability of the water body for stocking purposes (Ujjania, *et al.* 2012). The values of condition factor depend on physiological features of fish mainly maturity, spawning, environmental factors and food availability in a given water body. The common carp, *Cyprinus carpio* was introduced 1964 from Thailand to Pakistan, it is an exotic species widely spread in Europe and Asia (Balon 2004). Due to its hardy nature it can thrive in cold and hot water as well as in adverse water quality so that termed as tropical in nature that's why it introduced many countries as fast growing food fish (Ahmed, *et al.* 2011). It is locally known as Gulfam due to its shape and size with less intra-muscular bones and strong muscles. It is very popular due to its taste and

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palatability (Narejo, *et al.* 2016). Nowadays the lucrative value of this species is rising gradually than ever before. Generally, carps breeds during spring to summer preferably in monsoon depending upon the environmental conditions. Carps used to breed in shallow waters with thick population of macrophytes as kaka ban. No published information is available in the aspect of breeding biology of *C. carpio* from Indus River, near Jamshoro, Pakistan. Therefore, the present investigations on the breeding biology of commercially important exotic fish Gulfam, *Cyprinus carpio* has been undertaken to furnished the basic information regarding the reproductive periodicity in terms of ova diameter, gonadosomatic index (GSI) and fecundity which would be consider as useful for the future research.

2. MATERIALS AND METHODS

Sample collection

About 190 experimental fish were procured out of which 90 and 100 were male and female respectively also ranged between 33.0- 56.2 cm and 486.6 – 2327 g in length and weight respectively during January – May 2016. The collected specimens were transported to the Laboratory of Fresh Water biology and Fisheries, University of Sindh, Jamshoro in plastic bags preserved in 10% formalin. The samples were washed, dissected and gutted. After the measurement of length and weight, the condition of the gonad and sex of each fish was enumerated, the dissected gonads were weighed by using digital balance. The gonads then were preserved in vials containing 10% formalin for further analysis. The egg size was determined by using of ocular micrometer fitted with the binocular microscope. According to the methods suggested by Le Cren (1951) about 100 egg from both ovaries were measured. Gonadosomatic Index was enumerated with help of following formula: $GSI = \text{Body weight} / \text{Gonad weight} \times 100$. In the present study enumeration of fecundity 10 fish were used ranging from 33.02 - 48.8cm and 48.6 - 1947.4g in total length and weight respectively. For fecundity study, 1 gram of eggs was taken from three regions of both ovaries like frontal, central and hind. Ova present in 1 gram were counted and it multiply with the total weight of the ovaries, in this way fecundity was enumerated. The fecundity was determined with help of formula given below:

$$F = N \times \text{ovary weight} / 1 \text{ gram}$$

Where

F= fecundity and

N= eggs present 1 gram.

The relationship of fecundity with various parameters like weight of ovary and fish it was plotted and determined as suggested by Le Cren (1951).

Relationship of length verses weight of the experimental fish was determined by the formula given below as suggested by Le Cren (1951). The length-weight relationship (LWR) parameters a and b were estimated by linear regression analysis based on natural logarithms: $\ln(W) = \ln(a) + b \ln(L)$, where the W is the body weight (BW g) and L the total length (TL cm). Additionally, 95% confidence limits of a and b, and the coefficient of determination r^2 were estimated. Relative well-being (Ponderal index) of the experimental fish was reckoned in terms of size group in both sexes separately. The relative well- being (Kn) was calculated at the interval of 5 cm length for the both the sexes. Mean observed weight W and mean calculated weight of each length was divided with help of formula as suggested Le Cren (1951).

3. RESULTS

Breeding Biology Study

a) Egg size

The measurement of egg size in *Cyprinus carpio* procured from Indus River near Jamshoro is exhibited in (Table 1). In five months study from January – May 2016 egg size of *Cyprinus carpio* was ranging from 0.84 to 2.97 mm. It starts increasing from January- April with peak in February (1.12) during the study period. From both the ovaries about 100 eggs were taken into account and noted that all egg were of similar size and spherical in diameter. It therefore inferred that the experimental fish breeds once in the year during the spawning period (February) and shade their gonads in a single batch.

Table 1. Month-wise changes in ova diameter of *Cyprinus carpio* from Indus River, near Jamshoro

S. No	Month	Female	Ova diameter(mm)
1	January		0.81
2	February		1.12
3	March	05	1.07
4	April		0.95
5	May		0.45

b) Enumeration of G.S.I

The enumeration of GSI in *Cyprinus carpio* was noted 0.84-2.97 and 2.85-5.27 in male and female respectively (Table 2). The values increases during January and showed one peak in February (2.97 and 5.27) for male and female (Table 2). In the present study the egg size (1.12 mm) and enumeration of GSI values (2.97 and 5.27) were found to be higher in the month of February it indicated that the fish *Cyprinus carpio* breeds once in a year during January – March with peak in February.

Table 2. Month-wise changes in gonadosomatic index of *Cyprinus carpio*

S.No	Month	Male	%GSI	Female	%GSI
1	January		2.68		3.77
2	February		2.97		5.27
3	March	05	1.9	05	3.36
4	April		0.84		2.85
5	May		0.25		1.5

c) Fecundity

Estimation of egg (fecundity) in the investigations, 10 gravid females of *Cyprinus carpio* collected during January- May 2016. The experimental fish ranged from 33.0 - 48.82 cm and 486.6-1947g length and weight respectively. Number of eggs during the investigation varied 18280-390600 eggs. Lowest egg count in the present investigation was 33.0 cm and 486.6 g fish. While highest egg count was 48.8 cm and 1947g fish (**Table 3**). Fecundity was plotted against various body parameters like weight of ovary and fish and length. Fecundity bears strong association with weight of gonad and total length in comparison to other body parameter.

Table 3. Data on total length, total weight, gonad weight and fecundity of *Cyprinus carpio* from Indus River, near Jamshoro

S. No	Total length (cm)	Total weight (g)	Gonad weight (g)	Fecundity
1	33	486.6	53.1	18280
2	35.56	610	70	28840
3	40	938	129	40143.6
4	40.3	1007	130	64980
5	40.5	1030	175	71890
6	40.64	1060	206	72275
7	42.6	1170	220	96234
8	43.18	1273.2	225	111375
9	43.18	1425.6	320	140454
10	43.9	1501	346.8	140904
11	45.72	1510	352	148949.1
12	45.72	1600	384.8	153535.2
13	46.6	1657.6	414.9	174944
14	48.2	1694.1	450	179080
15	48.8	1947	510.1	390600

Length and weight relationship

The fish samples were divided into 5cm length groups (**Table 4**). The values of means of weight and length for male and female and combined sexes. Calculated values of both variables when plotted showed straight line in case of male, female combined sexes.

$$\text{Log W} = -1.625 + 2.82 \text{ Log L (Male) (r = 0.91)}$$

$$\text{Log W} = -2.33 + 3.31 \text{ Log L (Female) (r = 0.99)}$$

$$\text{Log W} = -0.74 + 3.06 \text{ Log L (Mix) (r = 0.99)}$$

Identical the coefficient of correlation values (r = 0.99) for female and mix while significantly lowest values (r = 0.91) were found in case of male.

Relative condition factors

The values of condition factor of *Cyprinus carpio* from Indus River near Jamshoro were found to be varied between in all cases. Values of co-efficient of (Kn) indicated that all samples of different sexes of *Cyprinus carpio* found in satisfactory condition from Indus River, Jamshoro, Sindh, Pakistan. (**Table 5**). The month wise condition factor enumerated at different lengths and found to be varied with size and ranged between 0.87-1.13 (1.01±0.20) in males, 0.83-1.20 (0.98 ± 0.18) in females and from 0.83-1.14 (1.15 ±0.20) in sexes combined. In the length weight study it was observed that the male found to be in a good condition as compared to female (Kn= 1.01) than females (Kn= 0.98).

Table 4. Mean length and weight of male female and combined sexes of *Cyprinus carpio* from Indus River near Jamshoro

Length group	Male		Female		Combined sexes	
	Mean length (cm)	Mean weight (g)	Mean length (cm)	Mean weight (g)	Mean length (cm)	Mean weight (g)
30.1-35.0	-	-	33	486.6	33	486.6
35.1-40.0	-	-	35.56	610	35.56	610
40.1-45.0	41.51	890	41.78	1302.85	41.645	1203.61
45.1-50.0	46.48	1104.37	47.2	1387.61	46.84	1388.58
50.1-55.0	52.2	1389.55			52.2	890
55.1-60.0	56.2	2327			56.2	2327

Table 5 Data on condition factor of *Cyprinus carpio* from River Indus near Jamshoro, Sindh, Pakistan

Length group	Male			Female			Combined sexes		
	Obs. Wt.	Cal. Wt.	Kn	Obs. Wt.	Cal. Wt.	Kn	Obs. Wt.	Cal. Wt.	Kn
30.1-35.0	-	-		486.6	467.37	1.04	486.6	467.37	1.04
35.1-40.0	-	-		610	734.38	0.83	610	734.38	0.83
40.1-45.0	890	822	1.08	1302.85	1082.77	1.20	1203.61	893.96	1.14
45.1-50.0	1104.37	1138.15	0.97	1387.61	1623.08	0.85	1388.58	1195.69	0.89
50.1-55.0	1389.55	1587.77	0.87				1389.55	1587.77	0.87
55.1-60.0	2327	2044.9	1.13				2327	2044.9	1.13
Mean			1.01			0.98			0.99

Obs. Wt. =Observed Weight, Cal. Wt. = Calculated Weight, Kn= Condition factor

4. DISCUSSION

The studies on the breeding biology of *Cyprinus carpio* from Indus River near Jamshoro was undertaken in relation to egg size, enumeration of GSI and egg count (fecundity) to understand the reproductive periodicity and ponderal condition of this commercially important exotic fish from riverine habitat. The finding of the present investigations revealed that the experimental fish prepared for spawning from January – March with peak in February (1.12 mm). The egg size starts developing from January (0.81 mm). (Joadder, *et al.* 2009) furnished information on reproductive biology of *C. carpio* and commented that fish breed during January to March which is in accordance with the present findings. The values of GSI during the course of investigation were also found to be increasing from January to March. (Hailu 2013) reported GSI values of *C. carpio* highest in the month of February that support the present study. Experimental fish *C. carpio* during the course of present investigation found to be spawned once in a year. According to Hailu (2013), *C. carpio* breeds/ spawns once in a year which is in agreement with the present research. Various researchers around the globe are of the view that different fish species breeds/ matured during summer and winter months (Abedi, *et al.* 2011; Chandio, *et al.* 2016; Hamady 2010; Kariman and Hanan 2008; Narejo, *et al.* 1998; Narejo, *et al.* 2015; Narejo, *et al.* 2002; Sivakumaran, *et al.* 2003) that supports the finding of present investigations on *C. carpio*. The egg count (fecundity) in the course of present investigations was ranged from 18280-390600 eggs from the fish ranging from 33.0- 48.8 cm and 486.6-1947 g in length and weight respectively. The fecundity range in the present study is in accordance with the Hailu (2013) from *C. carpio*. The egg count was plotted against different body parameters such as weight of gonad, weight of fish and length during the present studies and it was noted that egg count

(fecundity) exhibited strong correlation with weight of gonad. Similar observation has been reported by number of authors such as (Joadder, *et al.* 2009; Kilambi 1986; Marimuthu and Haniffa 2007) in different fish including *C. carpio*. To determine the ponderal status of the fish under study the LWR was computed for either sex. The better correlation coefficient in regression analysis was observed in females (b= 3.31) rather than male (b= 2.82). As reported by Narejo, *et al.* (2006), Shafi, *et al.* (2012) and Milosevic *et al.*, (2012) female exhibited higher values of regression coefficient than male in different fish species including *C. carpio* which is similar to the present studies. It might be due to the gonadal development during the onset of maturation, which resulted into extra body weight in case of female as compared to male. Number of research workers from elsewhere such as (Aera and Migiro 2014; Britton and Harper 2006; Dhanze, *et al.* 2005; Gerritsen, *et al.* 2003; Narejo, *et al.* 2006; Sarkar, *et al.* 2013) reported that female exhibited large size and heavier than male of same length group during breeding season due to increased ovary weight which is in agreement with the finding of the present research. The regression values in the present study in case of female (b= 3.31) indicated as ideal while in case of male exhibited closed to the ideal (b= 2.82) which termed as positive allometric type of growth in both the sexes. However, the change of b values may also depend primarily on the shape and fatness of the species as well as physical factors such as temperature, salinity, food, sex and stage of maturity (Ayoade and Ikulala 2007; Cox and Hinch 1997; Gerritsen, *et al.* 2003; JW 1992; Pauly 1984; Sarkar, *et al.* 2013). According to Tesch (1971) the regression values in any fish species always between (b=2 - 4). The b values in the present findings are found to be within the ranges as suggested by Tesch (1971). The condition factor of male was 1 and female less than 1 at size range of 33-56.2 cm. This shows that the fish is above average

condition (JW 1992). However, there is a significant difference between the K factor of the male and female ($P < 0.05$). The lower K for the females could be attributed to low gonad maturity since sampling was done on rainy season when the fish are not likely to spawn. This observation is similar to that of Costa and Araújo (2003) who suggested that during such periods, a larger part of the energy is allocated for growth and emptying of ovaries leading to relatively lower condition factor. Further, the difference of the K values between males and females may be attributed to metabolic strain during maturation or spawning as well as changes in feeding activity. Similar condition was observed in several species of fish by earlier studies (Barua, *et al.* 1986; Dasgupta 1988; Dhanze, *et al.* 2005; Jhingran 1972). This indicated that most fish in the river are heavy for their respective lengths therefore their robustness is at best. However significant difference between the condition factor of the male and female *C. carpio* indicates that there is need for critical studies for identification of environmental predictors of this variation to optimize fishery production.

5. CONCLUSION

It could be concluded from the above findings that the *C. carpio* breeds once in year during the months of February. Full grown specimens about 1947g weight could produce about 390600 eggs during the breeding season. Fecundity showed ideal relationship with total length and total weight in comparison to other parameters. The values of length-Weight and coefficient of (Kn) indicated that all samples of different sexes of *Cyprinus carpio* found in satisfactory condition from Indus River, Jamshoro, Sindh, Pakistan. The values of Kn was reported as 1.01 for male, as 0.98 for female and 1.15 for combined sexes respectively that indicated that all the samples of different sexes of *Cyprinus carpio* found in satisfactory condition from River Indus Jamshoro, Sindh Pakistan.

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