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Study on fecundity and GSI of *Carassius carassius* (Linneaus, 1758-introduced) from Dal Lake Kashmir.

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Abstract
The fish population of Kashmir has been introduced from the Central Asian Highlands during the second inter glacial period**.** *Carassius carassius a* beautifully armoured fish is either used in aquarium as ornamental fish or as food fish.It is an exotic fish to Kashmir, locally known as ''Gang gaad'' and specifically it is known as crucian carp which was introduced accidently with comm carp in Dal lake during 56-58 and since then it established itself successfully to varying environmental conditions of the Lake. The fish in pre-spawning was selected for estimation of fecundity. The mature Specimens ranged in weight from 11.80g to 89.60g and in length from 98mm to 200mm were used for determining the various relationships. Absolute fecundity fluctuated from 661 to 18192 and relative fecundity from 18.5 to 344.5 with a mean value of 127. The ovary of this fish ranged in length from 27mm to 81mm and in weight it fluctuated from 0.74 to 14.50g. Regression analysis was applied to assess the dependence of various body parameters upon absolute fecundity. It was observed that absolute fecundity is highly dependent on the body weight, body length, and ovary weight and ovary length respectively and has positive influence on absolute fecundity. In order to explain these relationships of the mathematical equations were developed to describe these relationships. The equations of these parameters are highly significant ($p<0.001$) and can be used to determine the absolute fecundity with a high degree of accuracy. Gonadosomatic index with highest average value was recorded in April (12.65, 12.99 and 12.82) in male, female and combined ones.The fecundity increased with Increase in size and it obtained its highest values in length group IV, V and VI.
Key Words: Dal Lake, Crassius carassius, Fecundity, Gastrosomatic index

Introduction

Fecundity of fish stock is one of the important components of fishery biology as it has direct bearing on fish production, stock recruitment and stock management. Estimation of fecundity is not only important for these parameters but it is equally important for acquiring knowledge about different races ,as different races have characteristic fecundities and egg diameter, which inturn is helpful in recognizing the population wether it is a homogenous population (with a single species) or a heterogenous type of poulation(including different stocks).

According to Bagenal and Braum, (1978) Fecundity may be defined as the number of mature eggs in the ovary of female fish before spawning. Many fishery biologists have worked on the fecundity of different fish, viz., Naeem et al (2005); Jacobson et al (2009); Mekkawy and Hassan (2011 and 2012); Shinkafi et al (2011). The knowledge of fecundity is one of the important part of the reproductive biology, (Nikolsky (1963). According to Khallaf and Authman (1991) fecundity is not a constant feature but it fluctuated with variations in enviromental conditions and species specific factors.

It is among one of the common cyprinds found in Dal lake Kashmir and is well adapted to wide range of habitats to tolerate the abiotic environmental factors such as low oxygen conditions and fluctuations in water temperature (Holopainen and Hyvarinain, (1985). The present study was aimed at to get knowledge about the breeding biology of fish and the effect of different body measurements on its absolute fecundity.

Materials and methods

The fishes used for the study were collected during December 2006 to December 2007 from the Dal Lake. The traditional fishing gears were used in this includes gill net and cast net. The randomly selected samples were shifted to laboratory for further biological measurement. Identification of species was made based on Day (1878); Kullander *et al.,* (1999). One hundred and seventy three specimens of *Carassius carassius* (98mm to 200mm) were collected from the Lake, and after various body measurements the fishes were dissected and ovaries were collected cautiously and moisture was removed with the help of blotting papers. 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 mono-pan balance (Anamed-Modal No.Mx-730) and then eggs were counted carefully by gravimetric method.

Maturity stages:

The maturity stage of both sexes were distinguished by oozing phase of ova from oviduct of female and milky white fused milt from the urinogenital system of male. In addition to this, both the sexes developed bright reddish colouration on whole body surface especially near the locomotory organelles i.e. fins.

Stage I (immature)

gonads are small and transparent in look. Eggs are invisible to naked eye. Testis was thin thread-like structure in appearance.

Sage II (resting stage):

gonads are still small and extend along half the length of the abdominal cavity. The ovary is still transparent and thin. The eggs cannot be distinguished with the naked eye. The testis looks again thread like in appearance.

Stage III (maturation)

the gonad begins to develop and extend along the whole length of abdominal cavity. Ovary is slightly faint-white in color. Eggs are still in indistinguishable phase to naked eye and the Testis has developing side lobes.

Stage IV (maturity)

Sexual products are clear. The gonads nearly extend along the whole length and reach their maximum weight. Ovaries are with yellowish tinge but the eggs are still in compact form while, the testis lobes are clear, which are pure white in color with full of sperms.

Stage V (reproduction)

The thin ovarian wall contains a voluminous paired ovary,yellow in colour with large number of viable and atretic eggs which could be seen through naked eye. Testes are white in color, with stout lobes containing numberless sperms.

Stage VI (Spent):

The ovary is flaccid, reddish in color and much reduced in size, the testes are ar also reddish in color, empty and fleshy in its appearance.

Gonadosomatic (GSI) and Gonad Indices (GI):

Gonadosomatic index (GSI%) = (gonad weight/total body weight)x100 was calculated for each fish and all values were averaged for each sampling date (Biswas, 1993).

SEX RATIO

Sex ratio of the studied fish species was calculated (Zar, 1984) which revealed female dominance over males.

Statistical Analysis

Fecundity relationships with size, weight, ovary weight and ovary length were analyzed and fitted. The fecundity in relation to TW, TL, OW and OL, was subjected to stepwise multiple linear regression analysis to determine the best variables that control fecundity in a multivariate sense. Correlation and multiple correlation were estimated. SPSS-package release 9 (SPSS, 1998), Statistica package release 5 (Statsoft, 1995) were used in these statistical analyses.

Results

Fecundity and fish length (Fig.1.1)

In this fish species the relationship between absolute fecundity and total length of fish was comparatively less significant (r=0.529) the equations reflecting this relationship were:

$$F = -20397 + 122\ TL \qquad (r = 0.529,\ p < 0.01)$$

or

$$\text{Log } F = -0.074 + 1.75\ \text{Log } TL$$

Fecundity and fish weight

A linear relationship was established between the two variables (Fig.1.2), which was expressed by the equation,

F = 401 + 114 FW **(r=0.750, p<0.091)**

Or

Log F = 2.39 + 0.800 Log FW.

Fecundity and Ovary length

Absolute fecundity showed an increase with increase in length of ovaries (Fig.1.3) and the regression equation expressing the relationship was:

F = -3057 + 1851 OL (r=0.575, p<0.01)

or

Log F = 1.46+1.34 Log OL

Fecundity and Ovary weight

A highly significant relationship was observed between the two variables as shown by the value of co-efficient of correlation (r) and fitted line scatter diagram (Fig.1.4). The relationship was expressed by the equation:

F = 92.4 + 1239 OW (r=0.996, p<0.01)

or

Log F = 3.10 + 1.01 Log OW.

Ovary weight and fish weight

A positive relation was recorded between the two (Fig. 1.5). As also evident from the value of 'r' (r=0.764p<0.01). The equation reflecting the relationship was:

OW= 0.195 + 0.0930 FW. (r=0.764p<0.01)

or

Log OW= -0.758 + 0.828 Log FW

Ovary length and fish weight

The two parameters revealed a highly significant relationship (Fig. 1.6), the obtained equation was expressed as:

OL= 30. 2 +0.339 FW

or

Log OL= 1.13 + 0.319 Log FW.

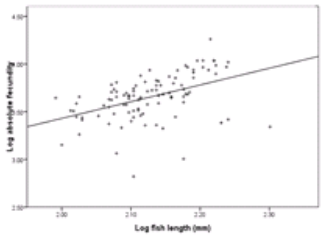

Fig. 1.1: Relationship between fish length and fecundity of *C. carassius*

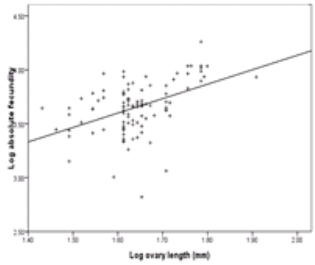

Fig. 1.2: Relationship between fish weight and fecundity in *C. carassius*

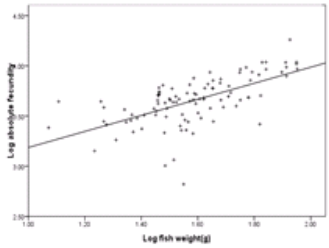

Fig. 1.3: Relationship between ovary length and fecundity in *C. carassius*

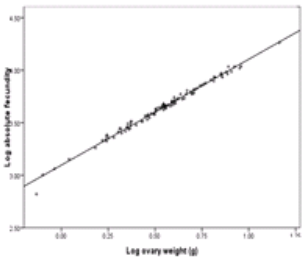

Fig. 1.4: Relationship between ovary weight and fecundity in *C. carassius*

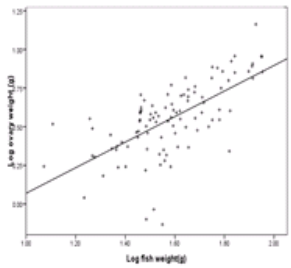

Fig. 1.5: Relationship between fish weight and ovary weight in *C. carassius*

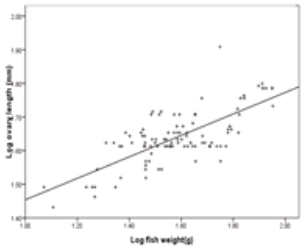

Fig. 1.6: Relationship between fish weight and ovary length in *C. carassius*

Gonadosomatic Index

The GSI fluctuated in different seasons of year Fig.1.7). In April it recorded its maximum value of 12.82 when fish was characterized with fully mature goand , while the minimum value of 5.35 was recorded in July (Table 1.1). The males attained comparatively less GSI than females in various months of the year. As far as the GSI of various size groups of *C. carassius* was concerned, the GSI recorded its highest value (8.07) in one of the higher length group (IV) whereas the minimum value (4.58) was observed in the lowest size group (I.) and (II).

Table: 1. 1. Monthly fluctuations in GSI of *C. carassisus*

GSI												
Month	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Male	4.32	5.99	5.52	12.65	9.51	5.634	5.0	5.91	6.75	4.75	7.58	5.881
Female	5.0	5.32	6.07	12.99	8.29	6.63	5.71	6.72	6.94	7.26	9.90	9.964
Comb.	4.66	5.656	5.80	12.82	8.90	6.14	5.35	6.315	6.85	6.01	8.74	7.93

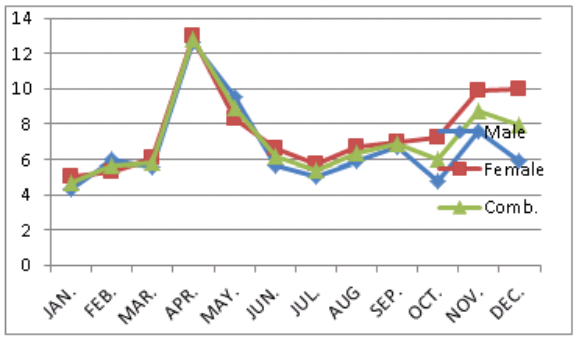

Fig. 1.7: Monthly fluctuations in Go. S.I. of *C. carassisus*

Table: 1.2 : Fluctuations in Go. S.I. of various size groups of *C. carassisus*

Type of index	**I**	**II**	**III**	**IV**	**V**	**VI**
Length grougp	90-105	106-120	121-134	135-149	150-164	165-174
Gonadosomatic index	4.58	4.72	6.46	8.07	6.61	7.42

Discussion

Different fishes exhibite different reproductive potential in terms of fecundity. According to Bagenal and Braum (1978) changes in the environment such as temperature, salinity and oxygen in turn bring remarkable changes in absolute fecundity. Wootton (1973) confirmed that availability of food resources in a given habitat has a direct affect on the egg production and thereby the fecundity. He noticed, that the low **food intake in case of stickle backs** led them to produce fewer eggs, greater weight at maturity and shorter inter-spawning interval.

According to Murua Saborido-Rey, (2003) different fish species present a lot of differences in their reproductive potential. Fecundity of fishes was reported to vary depending on many factors, according to Murua *et al*. (2003) attributed variation in reproductive characteristics of a species to changes in environmental conditions, such as temperature, food availability, habitat and predation intensity similarly, Mekkawy and Hassan (2011) associated changes in fecundity with age, sex, size weight, gonad weight and locality.

As far as the sex ratio of this fish was concerned, there was found preponderance of females over males (1:0.79) similar trend was also reported by Olurin and Savage (2011) in case of African snake head, *Parachanna obscura*, from River Oshun. Fagade *et al.,* (1984) attributed this natural phenomenon as a powerfull mechanism for population regulation.

The present work revealed that the studied species is batch spawner, releasing hydrated eggs over a long period of time, which extend from April to June with peaks in April and May) in the Dal lake. According to Lambert and Ware 1984, batch spawning reproductive strategy may be associated with increase in probability of survival of offsprings.

The gonadosomatic index or maturity index is an indirect method for estimating spawning season of a species (Biswas, 1993).The GSI index of *C.carassius* exhibited higher values in case of females than in males. Buxton (1990) pointed out that low value for this index in case of males is due to low energy investment in gamete production than that spended by females.

Various relationships have been found to exist between length and fecundity of different fish species. The persual of present data revealed a positive linear significant correlation between absolute fecundity and various body parameters like total weight, total length, ovary weight, ovary length, and between ovary weight and fish weight and ovary length ant fish weight. Linear relationships of fecundity with body measurements were also reported by Musallam *et al.*2006). The fecundity of the species increased with fish length and body weight was also reported by Gaur and pathani (1996); Lawson (2011); Naem *et al.,* (2005); Charles and Shutharshan, 2008; However, Olurin and Savage (2011) did not rcorded any relationship between fecundity and fish length and body weight and Phukan and Biswas (2012) The correlation coefficient (r) values reveal fecundity was moderately high in relation tobody weight and ovary weight but poorly correlated with total length.d id not found any relation between fecundity and.

CONCLUSION

On the basis of present experiments it can be concluded that the fish is fairly fecund and a positive correlation was observed among the various body parameters. It has established very well in Dal lake ecosystem by competing for food and habitat with endemic fishes.

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