International Research Journal of Natural and Applied Sciences
ISSN: (2349-4077)
Impact Factor- 5.46, Volume 4, Issue 10, October 2017
Website- www.aarf.asia, **Email** : editor@aarf.asia , editoraarf@gmail.com

COMPARATIVE STUDIES ON EVALUATION OF FECUNDITY AND GONADOSOMATIC INDEX OF THREE BONY FISHES CALRIUS GARPIENS (BURCHELL, 1822), MYSTUS BLEEKARI (DAY) AND GARA MULLYA (SYKES)

Dr. N. E. Chandanshive.
Department of Zoology, Fergusson College, Pune, Maharashtra.

ABSTRACT

*The present study deals with the evaluation of fecundity and gonadosomatic index (GSI) of three freshwater fishes **C**alrius garpiens (Burchell, 1822), Mystus bleekari (Day) and Gara mullya (Sykes) for months April, May and June 2017. In Calrius garpiens the mean value of absolute fecundity was estimated during April, May and June 2017 as 41115 (± 15628.13), 24987.4 (± 16139.14), and 41465.5 (± 11254.08) and Relative frequency was 115.79 (± 22.6321), 79.05 (± 41.5956) and 115(± 22.2509). Simultaneously, the mean value of absolute and relative fecundity in Mystus bleekari was estimated as 9788.92 (± 4061.841), 13791.1 (± 1958.724), and 17017.37 (± 2064.939) and 320.3 (± 131.497), 464.75 (± 79.6158) and 478.99 (± 81.5821) respectively. Whereas, in Garra mullya during same period the mean value of absolute fecundity was s 4790.8 (± 1565.954), 5906.5 (± 443.5851), and 7334.55 (± 739.5451) and relative fecundity was 159.86 (± 53.3849), 164.41 (± 16.8549) and 198.57 (± 26.7286) respectively. The correlation coefficient (r) of body weight and fecundity of Clarius grapiens was 0.997353765, 0.287417746, 0.995415008 respectively, in Mystus bleekari is 0.997220859, 0.569114027, -0.27186892 and in Gara mullya is 0.323139974, 0.102029243 and -0.23330115 respectively. The gonadotrophic index in the month of Clarius garpiens was 9.9762, 7.0471 and 9.0593, in Mystus bleekari was 10.434, 16.1506 and 17.3574, whereas in Gara mullya is 13.756, 15.822 and 18.064 respectively. The present studies shows that the fecundity of Clarius garpiens is not related with body length and weight, GSI value is not at highest in the Month of June i.e. in the beginning of monsoon season. However in Mystus bleekari and Gara mullya fecundity is associated with body*

length, body and Ovary weight. GSI values in both were gradually increased and highest in the month of June indicates the maturity of fishes.

Keywords: fecundity, **fishes, C***alrius garpiens, Mystus bleekari, and Gara mullya*.

Introduction

The fishes from fresh water ecosystems are significant and easily available source of protein. The quantity and excellence of protein is gradually deteriorating due to pollution of major rivers. The fish reproduction is directly or indirectly influenced by water pollution [1]. Mula-Mutha River is one of the heavily polluted and a number of fish species have been disappeared from many areas of river. The pollution has direct effects on feeding and respiration as well as physiological process [2]. Pollution affects the nutritional values of fishes like protein and other biochemical contents in the various body parts including gonads. The physiological and biochemical changes may disturb the development of gonads such as oogenesis and spermatogenesis. It may have effects on the size and weight of ovary, as well as the number of ova (fecundities) and size of eggs. The reproduction is basic to the existence of young once and hence the victory of the fish species. The investigation of fertility and its correlation with other parameters of body such body length and weight, ovary weight. These parameters are valuable for active fish culture, stock organization and valuation in any water body. The relative fecundity is used as an index of fecundity and is defined as the number of eggs per unit of body weight. The fertility potential is not identical in other fishes, is depends on many aspects including age, size and types of species, as well as availability of food, flow and quality of water and season. Evaluation of fecundity is significant for obtaining information about unlike species; each fish has characteristic fertilities and egg size. This study will help in fish cultivation and conservation of fish variety. The fertility is an ability of specific fish to produce ripe eggs in one spawning season. This is required to know the reproductive and marketable prospective of a fish.

The study of reproductive behaviour and fecundity of fishes is not only significant for explaining the basic biology of the fishes but it also supports in their managing and protection. The fecundity means the egg laying capacity of a fish or the number of mature eggs produced by a fish during one spawning season. The knowledge of fecundity is essential factor in stock size estimate, stock discernment [3] and coherent use of stock [4]. The study of fecundity and its relationship with various body parameters such body weight, length, ovary weight is beneficial for effective fish culture, stock control and assessment in any water

body [5]. So, study of reproduction behaviour (fecundity) of fish is basic and necessary for enhancement of and effective fishery assets management and preservation [6].

The freshwater catfish *Clarius garpiens* is an important, cheap and easily available source of protein of poor people. However, *Mystus bleekari* and *Garra mullya* are well known fishes for their taste and most important source of protein of local people. But their population in the water of Mula-Mutha river is decline in riverine system due to many factors specially habitat obliteration, over fishing, fight for food and breeding grounds from exotic fishes, water pollution etc. The number of fishes has been reduced due to all above factors by affecting fish migration and spawning. The fecundity is related with age, sex, size, weight, gonad weight and locality of fishes.

The present work was undertaken to establish correlations between fecundity (F) with body weight (BW), body length (BL), ovary weight (OW) and gonadosomatic index (GSI). This investigation will be help to determine the fecundity and its relation with body length, body weight and ovary weight. It is useful in maintaining and management of the fish diversity in riverine system.

Materials and Methods

The dead fishes like *Mystus bleekari and Gara mullya* used for the study were bought from fisherman by using gill net and cast net from Mula River of Pune, during April, May and June 2017. However, *Clarius garpiens* was collected from fish market during same duration. The selected fishes were brought to laboratory for further biological measurement. The fishes were identified by using key given by Talwar and P. K. and Jhingran [7 and 8]. For fecundity assessment about 10 fishes were collected and analysed for fecundity relationship with body parameter and GSI valuation. Only mature fishes were selected, washed with clean tap water before examination. Each fish was measured in fresh condition for its body length (BL) by Vernier calliper and body weight (BWt) by electronic balance having accuracy 0.001mg and measurements were recorded. The fishes were dissected, ovaries were separated carefully. The moisture of ovary was removed with blotting paper and weighed accurately. The dry ovaries were preserved in 5% formalin for 48 hours so that the eggs become hard and swell up for easy counting [9]. This helped to separate eggs from walls of ovary easily. Three samples of 500mg portion from anterior, middle and posterior part of ovary were weighed accurately on Electronic balance. The egg samples were placed in Petri dish separately. Small amount of distilled water was added to each Petri dish containing eggs. This procedure hydrates and completely separates the eggs. The total number of eggs in

each sample were counted carefully and recorded for further calculations. Absolute fecundity was calculated according to formula given by [10].

$$F = \mathrm{n}\frac{\mathrm{G}}{\mathrm{g}}$$

F = fecundity; n = mean numbers of eggs in all sample; G=weight of ovary; g=weight of sample.

The relative fecundity is calculated by dividing the numbers of eggs by body weight of the fish. Absolute fecundity is the number of egg per fish was also calculated by using simple algebraic formula. Gonadosomatic Index (GSI) was calculated according to formula by Vlaming (1982) method [11] for assessing the development of gonads and was calculated as:

$$GSI = \frac{Weight\ of\ ovary}{Weight\ of\ fish} x\ 100$$

The correlation coefficient of fecundity with fish weight, fish total length and ovary weight was calculated by regression analysis with computer package.

The relationship between fecundity and some morphometric measurements were determined by relating total fecundity (Fe) data to total length (TL) and total weight (BW) using the following formulae:

$$In\ Fe = ln\ m + n \times ln\ TL;$$

$$Fe = m \times TLn\ In$$

$$Fe = ln\ m + n \times ln\ BW;$$

$$Fe = m \times BWn$$

Here, m and n are constant parameter in the linear regression analysis and l n is the natural logarithm. Its relation with various body parameters such as body length, body weight and ovary weight was determined by using log transformation of power law,

$$\boldsymbol{Y} = \boldsymbol{a} \times b$$

i.e. $\boldsymbol{Log\ Y = log\ a + b\ log\ x}$

Results

Table-1: *Calrius garpiens* -Monthly variation of mean ± SD of L, Bw, Ow and F and their value of Correlation coefficient 'r'.

Months	Mean body length ± SD	Mean weight of Body ± SD	Mean weight of Ovary± SD	Mean Absolute Fecundity ± SD(F)	Value of Correlation coefficient 'r'					
					Body length and body weight	Body length and ovary weight	Body length and Fecundity	Body Weight and Ovary weight	Body weight and Fecundity	Ovary weight and fecundity
April2017	33.07 ± 4.654	351.6 ±77.74	35.08 ±13.83	41115 ± 15628 .13	0.997 828224	0.994 419113	0.99331 7796	0.997 16561	0.99735 3765	0.99905 8768
May-2017	36.72 ± 3.201	346.63 ±95.31	24.43 ±12.72	24987 .4 ±1613 9.1	0.764 667204	0.124 134402	0.06031 0374	0.266 680981	0.28741 7746	0.97942 2701
June-2o17	35.74 ± 13.89	365.48 ±141.1	33.11 ±12.13	41465 .5 ±1612 1.0	0.998 441767	0.998 538881	0.99504 7499	0.998 741832	0.99541 5008	0.99561 3112

Table- 2: *Mystus bleekari* -Monthly variation of mean ± SD of L, Bw, Ow and F and their value of Correlation coefficient 'r'.

Months	Mean body length ± SD	Mean weight of Body ± SD	Mean weight of Ovary ± SD	Mean Absolute Fecundity ± SD(F)	Value of Correlation coefficient 'r'					
					Body length and body weight	Body length and ovary weight	Body length and Fecundity	Body Weight and Ovary weight	Body weight and Fecundity	Ovary weight and fecundity
April2017	12.9 ± 3.916	30.62 ± 9.429	3.195 ±1.256	9788.92 ±4061.841	0.999872939	0.997206855	0.996523551	0.9977339 7	0.997220859	0.999882559
May-2017	12.71 ± 0.755	30.036 ± 4.236	4.851 ±0.22	15170.21 ±1958.72	0.872026982	0.999472343	0.060310374	0.4317178 6	0.569114027	0.754325362
June-2o17	12.118 ±0.63	32.64 ± 4.3242	5.6654 ±0.623	17017.37 ±2064.9	0.999239343	0.12889944	-0.12059821	-0.011479	-0.27186892	0.874001785

Table. 3: *Garra mullya* **-Monthly variation of mean ± SD of L, Bw, Ow and F and their value of Correlation coefficient 'r'.**

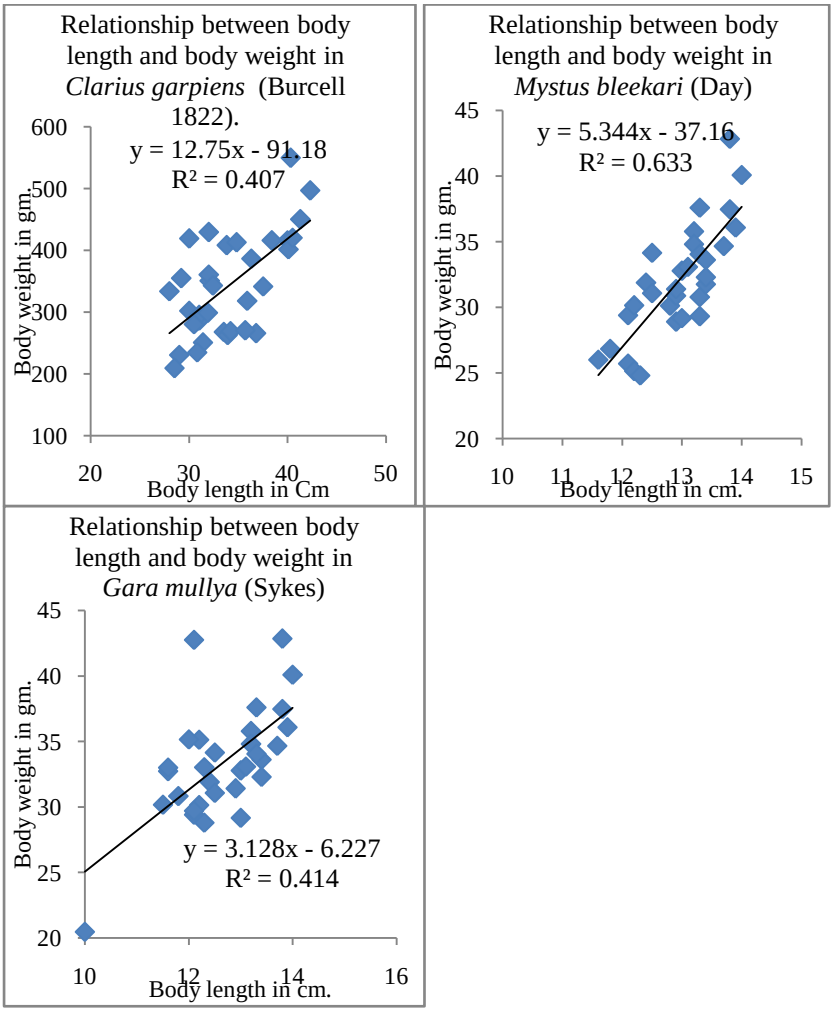
Months	Mean body length ± SD	Mean weight of Body ± SD	Mean weight of Ovary ± SD	Mean Absolute Fecundity ± SD(F)	Value of Correlation coefficient 'r'					
					Body length and body weight	Body length and ovary weight	Body length and Fecundity	Body Weight and Ovary weight	Body weight and Fecundity	Ovary weight and fecundity
April2017	12.32 ± 3.832	30.336 ±9.930	4.173 ±1.375	4790.873±1565.95	0.807078115	0.395995911	0.192619371	0.4619680 1	0.323139974	0.947023791
May-2017	12.509 ± 0.807	32.555 ±2.110	5.1509 ± 0.261	5906.54 ± 443.58	0.633702504	-0.02923711	0.234128039	0.1548942 9	0.102029243	0.698927204
June-2o17	13.41 ± 0.709	37.246 ±3.546	6.728 ±0.534	7334.55 ±739.54	0.149147285	-0.42999538	0.491917939	0.3162978 4	-0.23330115	0.05355013

Table. 4: Monthly variation of mean ± standard deviation (SD) of Fecundity and gonadosomatic index (GSI %) and value of Correlation coefficient 'r'.

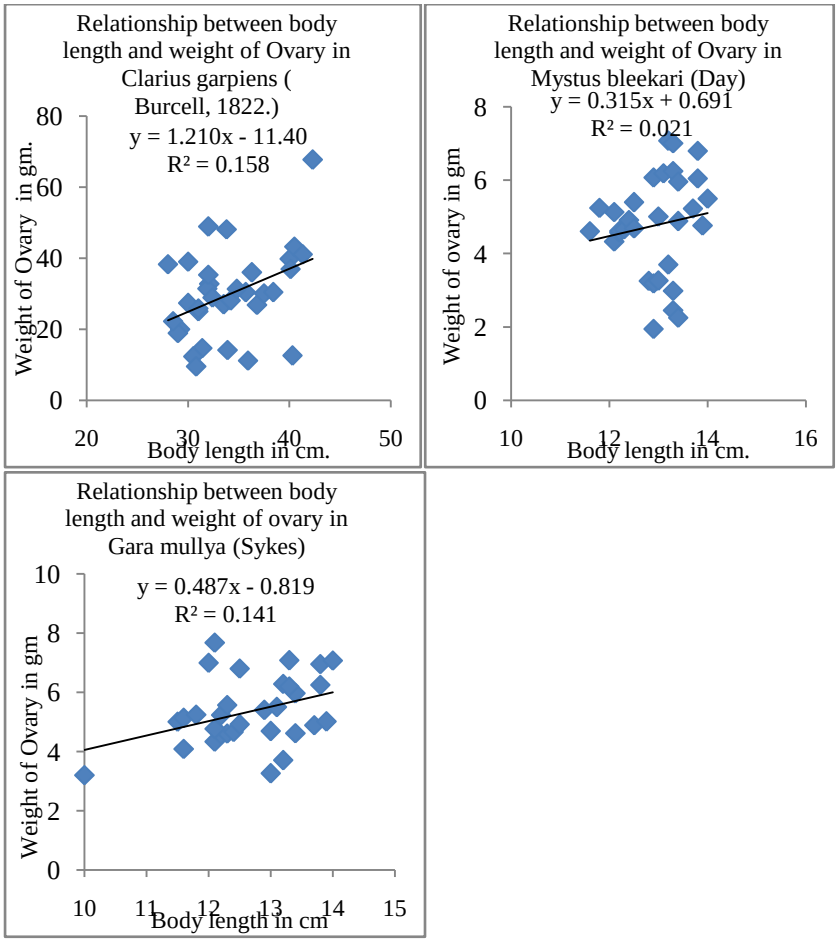
Months	*Clarius garpiens*			*Mystus Bleekari*			*Gara mullya*		
	Mean of Relative fecundity	Mean GSI	Value of correlation coefficient 'r' of Bwt and Fe	Mean of Relative fecundity	Mean GSI	Value of correlation coefficient 'r' of Bwt and Fe	Mean of Relative fecundity	Mean GSI	Value of correlation coefficient 'r' of Bwt and Fe
April-2017	115.79 ± 22.6321	9.9762	0.997353765	320.3 ±131.497	10.434	0.997220859	159.9 ±53.3849	13.756	0.323139974
May-2017	79.059 ±41.5956	7.0471	0.287417746	511.235 ±79.6158	16.150	0.569114027	182.014 ±16.8549	15.822	0.102029243
June-2017	115 ±40.6281	9.0593	0.995415008	478.99 ±81.5821	17.3574	-0.27186892	198.574 ±26.7286	18.064	-0.233301 15

Graph-1. Relationship between Body length and Body weight of three fishes namely-

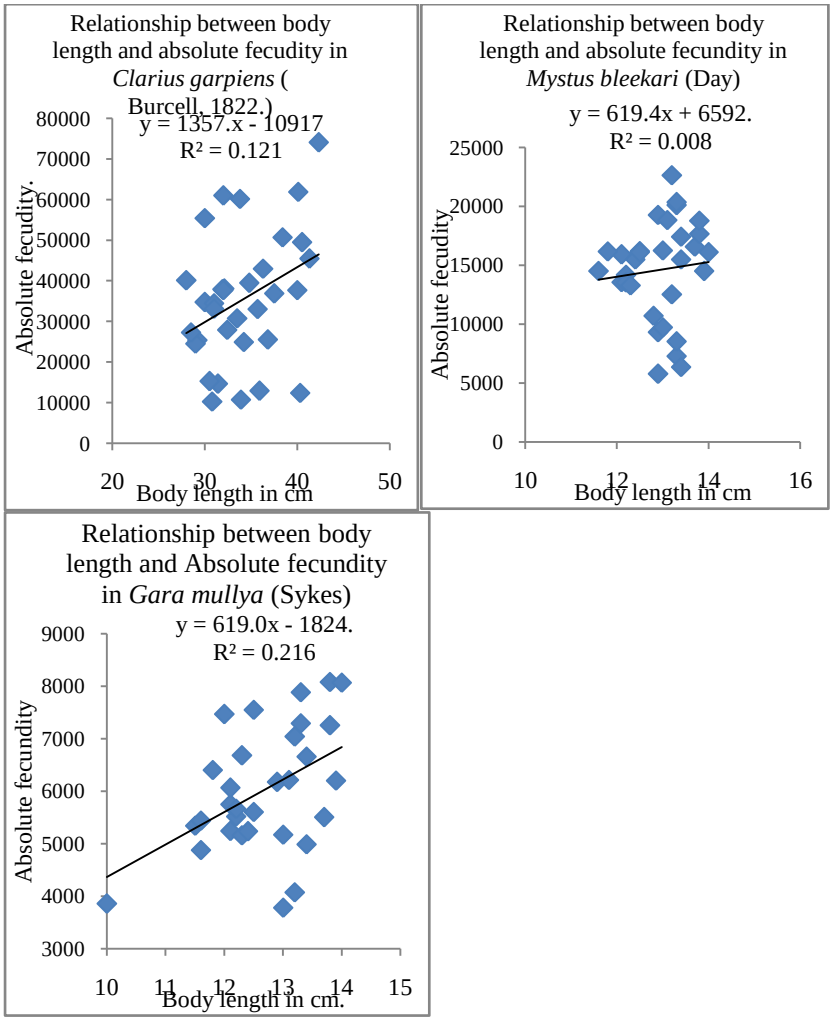
Clarius garpiens (Burcell 1822), *Mystus bleekari* (Day) and *Gara mullya* (Sykes).



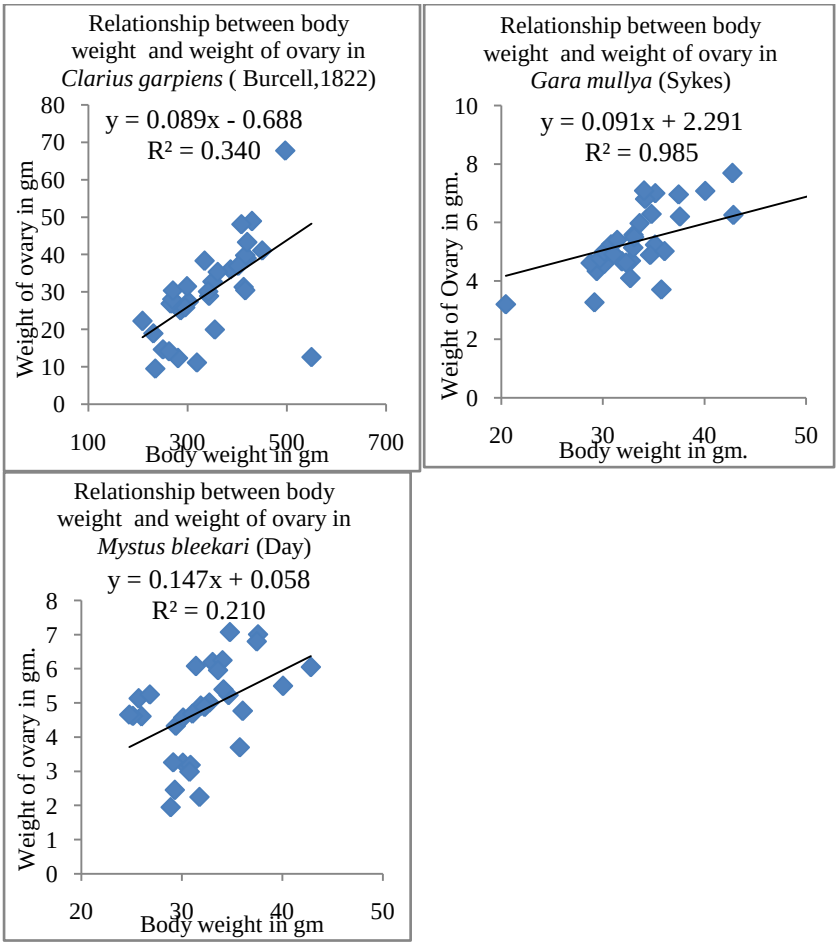
Graph-2. Relationship between Body length and Ovary Weight of three fishes namely-*Clarius garpiens* (Burcell 1822), *Mystus bleekari* (Day) and *Gara mullya* (Sykes).



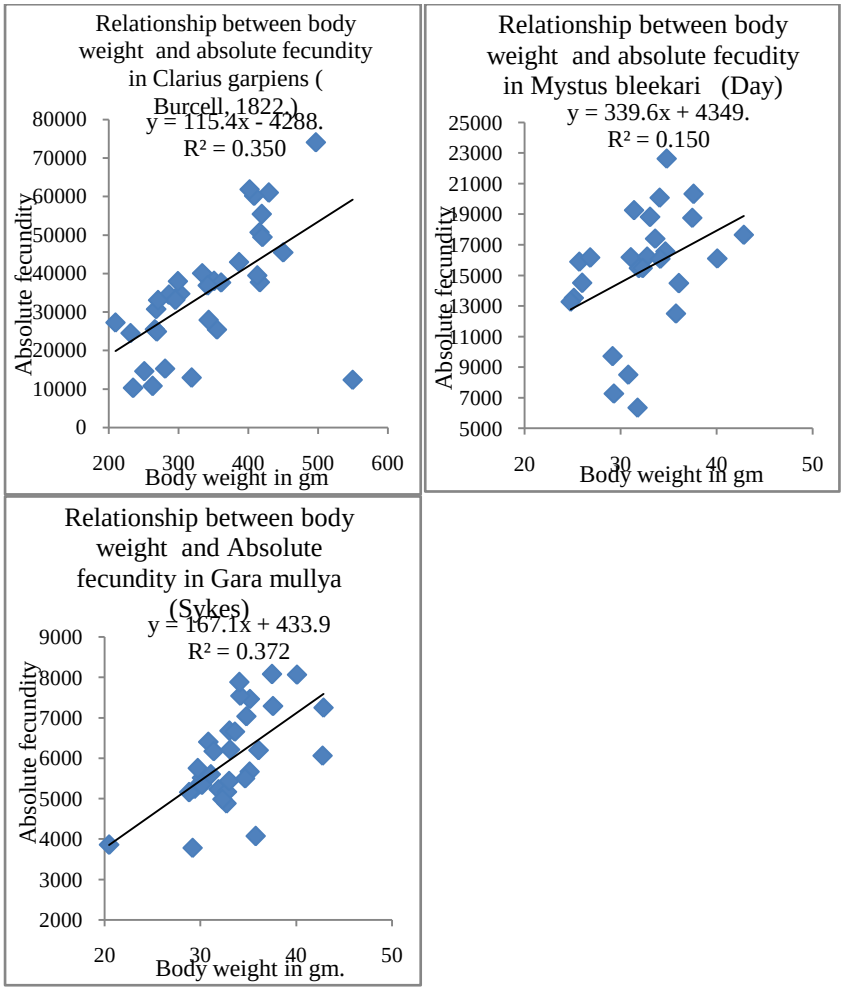
Graph-3. Relationship between Body length and Absolute Fecundity of three fishes namely- *Clarius garpiens* (Burcell 1822), *Mystus bleekari* (Day) and *Gara mullya* (Sykes).



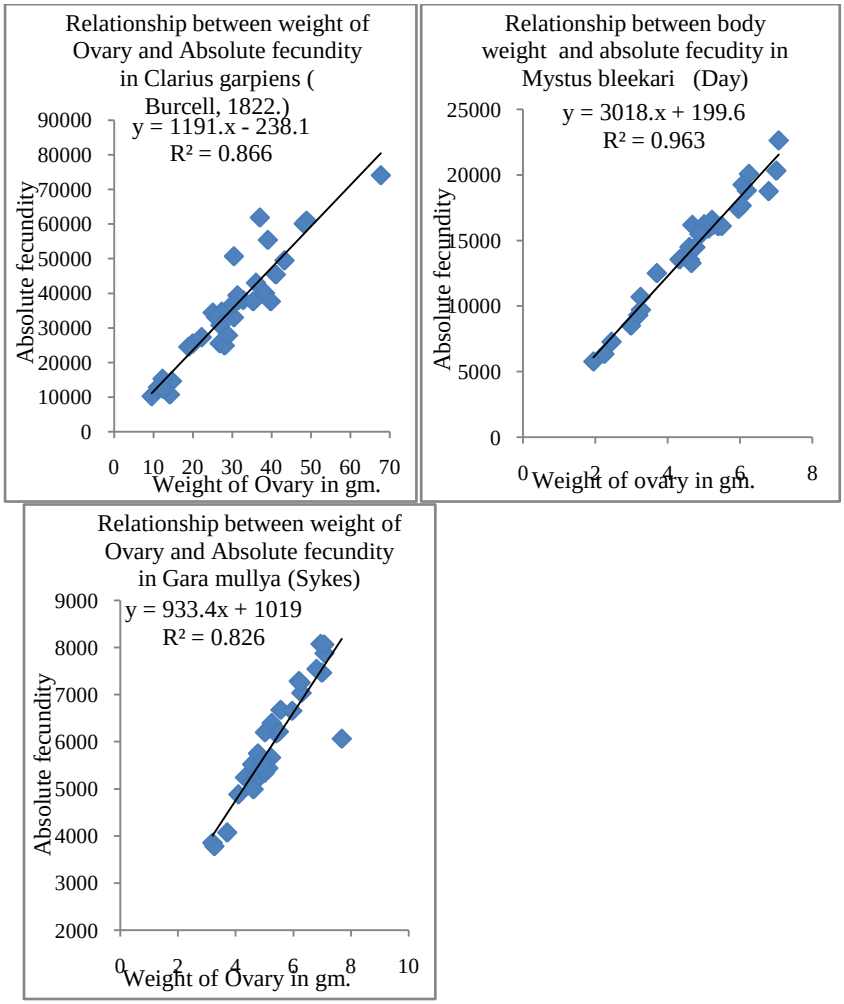
Graph-4. Relationship between Body Weight and Ovary Weight of three fishes namely- *Clarius garpiens* (Burcell 1822), *Mystus bleekari* (Day) and *Gara mullya* (Sykes).



Graph-5. Relationship between Body weight and Absolute Fecundity of three fishes namely- *Clarius garpiens* (Burcell 1822), *Mystus bleekari* (Day) and *Gara mullya* (Sykes).



Graph-6. Relationship between Weight of Ovary and Absolute Fecundity of three fishes namely- *Clarius garpiens* (Burcell 1822), *Mystus bleekari* (Day) and *Gara mullya* (Sykes).



Discussion

The study of fecundity and gonadosomatic index is the understanding of breeding periods and reproductive potential of fishes. The present investigation reveals significant correlations between fecundity vs. body weight vs. ovary weight vs. body length. In *Clarius garpiens* the value of 'r' between fecundity and body weight and ovary weight and body length and fecundity are not significant (Table-1). In C*alrius garpiens* the mean value of absolute fecundity was estimated during April, May and June 2017 as 41115 (± 15628.13), 24987.4 (± 16139.14), and 41465.5 (± 11254.08) and Relative frequency was 115.79 (± 22.6321), 79.05 (± 41.5956) and 115(± 22.2509). The correlation coefficient (r) of body weight and fecundity of *Clarius grapiens* is 0.997353765, 0.287417746, 0.995415008 respectively. It has been observed even in large size fishes (body weight 549.623 gms.)

contains small ovary (ovary weight is 12.582gm) and relative fecundity is 22.51. However, in small fishes (body weight is 209.3gm) contains ovary (weight is 22.236gm) and relative fecundity is 130.32. It was found during experiment that the fish with same size shows more deviation in the weight of ovary and number of ova (Bwt 549g Owt 12.582g no of ova 12372, vs Bwt 536, Owt 67.745g and no of ova 74068). It indicates non relationship between body weight vs ovary weight vs fecundity. The gonadotrophic index of *Clarius garpiens* in April, May and June-2017 is 9.9762, 7.0471 and 9.0593 respectively.

While, the mean value of absolute and relative fecundity of *Mystus bleekari* during same duration as 9788.92 (± 4061.841), 13791.1 (± 1958.724), and 17017.37 (± 2064.939) and 320.3 (± 131.497), 464.75 (± 79.6158) and 478.99 (± 81.5821) respectively was reported. The mean ± SD of relative fecundity gradually increases from the month of April (320.3± 131.497) exhibiting its highest peak in the month of June (478.99± 81.5821). The correlation coefficient (r) of body weight and fecundity of *Mystus bleekari* is 0.997220859, 0.569114027, -0.27186892. Fecundity shows correlation with body length and weight, as well as with ovary weight. The gonadotrophic index of *Mystus bleekari* is 10.434, 16.1506 and 17.3574; it is found to be increasing gradually and highest in month of June. However, in *Garra mullya* the mean value of absolute and relative fecundity was estimated during April, May and June 2017 as 4790.8 (± 1565.954), 5906.5 (± 443.5851), and 7334.55 (± 739.5451) and 159.86 (± 53.3849), 164.41 (± 16.8549) and 198.57 (± 26.7286) respectively. The correlation coefficient (r) of body weight and fecundity of 0.323139974, 0.102029243 and -0.23330115 respectively was noticed. The mean ± SD of relative fecundity gradually increases from the month of April (159.9± 53.3849) exhibiting its highest peak in the month of June (198.57± 26.7286). Fecundity shows correlation with body length and weight, as well as with ovary weight. The gonadotrophic index of *Gara mullya* is 13.756, 15.822 and 18.064; it is found to be increasing gradually and highest in month of June.

The present studies shows that the fecundity of *Clarius garpiens* is not related with body length and weight, GSI value is not at highest in the Month of June, show variation of climatic condition in culturing ponds. However in *Mystus bleekari* and *Gara mullya* fecundity is correlated with body length, body and Ovary weight. GSI values in both were gradually increased and highest in the month of June. It indicates that both fishes attained maturity.

In *L. rohita,* the correlation coefficient values between fish body weight and total length of and ovary weight and fish body weight showed that the fish is well maintained. Fecundity

in *L. rohita* has been found to increase with increasing fish length, fish weight as well as ovary weight. The absolute and relative fecundity 965.40±60.829 and 152.09 ± 22.90 were observed. [**12**]. In *Terapon puta*; the fecundity varied from 20,002 to 1,23,042 based on 47 ovaries of fishes ranging in total length from 134 – 219 mm and weight 30 -78 gm. The relationship between total length and fecundity, standard length and fecundity, total weight of fish and fecundity, gonad weight and fecundity were estimated by least square method. The monthly change in gonadosomatic index suggests that the fish species have a prolonged spawning period beginning from March to October for both sexes. Gonadosomatic index has been considered as reliable estimation method for gonad maturity and spawning of any species. The gonadosomatic index has increased with the maturation of fish and reaches to its maximum at the peak period of maturity. Its sudden decrease indicates beginning of spawning [13]**.**

It is noticed that the fecundity is varied from 4,652 eggs in a fish with total length 86 mm and total weight 7.8 g to 57,932 eggs in a fish with total length 167 mm and total weight 54.25 g. The absolute fecundity of 172 females was recorded as 23,611.688±15,427.139 eggs for a fish having an average total length of 125.889±25.586 mm and average body weight of 25.652±15.155 g. [14]**.** The value of correlation coefficient between fecundity vs. body weight (r=0.95) vs. ovary weight (r=0.88) vs. total length (0.60) vs. gonadosomatic index (r=0.51) is found to be the highest in the month of June and then it value decreases. The gonadosomatic index or maturity index is an indirect method for estimating spawning season of a species. The rise and fall in GSI% and structural changes in the gonads besides progression of the size of the ova is an indicator of spawning season. The mean ± SD of gonadosomatic index increases from April (6.42 ± 2.52) to reach the highest peak in the month of June (9.43 ± 1.61) thereafter the GSI% is found to be decreased in the month July (8.63 ± 2.63). The value of GSI% is normally found highest during May - June when majority of the fishes attain their maturity [15]. Value of correlation coefficient between fecundity and body weight (r=0.95) shows very significant positive correlation followed by ovary weight (r=0.88). However, it exhibits a moderate correlation with total length (r=0.60) of the species. The mean ± SD of fecundity gradually increases from the month of April (3947.91 ± 506.42) exhibiting its highest peak in the month of June (10957.47 ± 3031.49) and thereafter it gradually declining from the month of July (6021.02 ± 1571.54). It is further stated the gonadosomatic index or maturity index is not direct method for estimating spawning season of a species. The increase and reduction in GSI% and physical changes in the gonads besides progression of the size of the ova is an indicator of spawning season. The

variation of GSI% in *Clarias magur* is stimulated by seasonal change in monsoon and variation of climatic condition. Depending on the monsoon and differential climatic condition, the variation of GSI% value in the same species may take place [16].

The fecundity shows correlations with other body parameters. The fecundity was increased with the increase in total length, body weight, ovary length and weight. In this study, the gonadosomatic index (GSI) was reported from 1.87 to 12.56. The GSI value was maximum in the month of May (12.56), indicates the maximum gonadal growth and is suddenly drop in in July (1.87) which might have been caused by spawning. In investigation the value of correlation coefficient 'r' indicate that among the four parameters body length and weight, ovary length and weight studied. It was observed that the fecundity was closely correlated with the ovary weight (r=0.972) followed by total body length (r=0.966), body weight(r=0.961) and total ovary length (r=0.933) [17].

The proportion between the body weight and weight of ovary demonstrates the status of the maturity of ovary and denotes the phase of reproductive cycle, significant linear relationship between fecundity vs. body weight (r=0.95) vs. ovary weight (r=0.88) vs. ovary length (r=0.74) vs. total length (0.60). The gonadosomatic index of fish was increased (55.68) with the ripening of the fish and gonad. During post spawning phase the GSI was found lowest (6.0) and was highest at peak of maturity during spawning phase [18**].** The variation of GSI% in *Clarias magur* is stimulated by seasonal change in monsoon and variation of climatic condition. Depending on the monsoon and differential climatic condition, the variation of GSI% value in the same species may take place [19]. The reproductive features of each species are different due to changes in environmental conditions, such as temperature, food availability and habitat and feeding intensity similarly [20**].** The changes in fecundity are associated with age, sex, size weight, gonad weight and locality [21**].**

The investigation on fecundity of *Crassius carassius* observed that the absolute fecundity is depends on body weight, body length, ovary length and ovary weight and has positive influence on absolute fecundity. The correlation coefficient (r) values reveal fecundity was moderately high in relation to body weight and ovary weight but poorly correlated with total length did not found any relation between fecundity [22]. The study on fecundity and GSI shows that females had higher GSI values than males in all the six stages of gonad maturation. GSI was higher in both sexes in the rainy season than in the dry season. GSI was independent of the size of fish and has significant correlations with total length, total weight and gonad maturation stage in females, but not in males [23].

In fish, the gonads were fully mature in the winter season but in a dormant phase because of severe winter and spawned only on return of favourable exteroceptive factors in spring season [24]. Study on fecundity shows that there is lot of differences in reproductive potential in different fish. Fecundity of fish is varying depending on many factors [25]. Studies on fecundity showed that body weight had influence on the absolute fecundity and relative fecundity remained fairly constant to the wet body weight of *H. molitrix* [26].

Conclusion

This study on fecundity and Gonadosomatic index of three bony fishes C*alrius garpiens* (Burchell, 1822)**,** *Mystus bleekari* (Day) *and Gara mullya* (Sykes) was estimated during April, May and June 2017. In *Clarius garpiens* the value of 'r' between fecundity and body weight and ovary weight and body length and fecundity are not significant, the mean value of absolute fecundity was 2017 as 41115 (± 15628.13), 24987.4 (± 16139.14), and 41465.5 (± 11254.08) and Relative frequency was 115.79 (± 22.6321), 79.05 (± 41.5956) and 115(± 22.2509) respectively. The correlation coefficient (r) of body weight and fecundity is not significant, large size fishes (body weight 549.623 gms.) contains small ovary (ovary weight is 12.582gm) and relative fecundity is 22.51. Whereas small size fishes (body weight is 209.3gm) contains ovary (weight is 22.236gm) and relative fecundity is 130.32. Same size fishes shows more deviation in the weight of ovary and number of ova (Bwt 549g, Owt 12.582g, no of ova 12372, vs Bwt 536, Owt 67.745g and no of ova 74068). It indicates non relationship between body weight vs ovary weight vs fecundity.

Although, the mean value of absolute and relative fecundity and gonadotrophic index of *Mystus bleekari* and *Garra mullya* during May, June and July 2017 shows correlation with body length and weight, as well as with ovary weight. The gonadotrophic index is found to be increasing gradually from April, May and June-2017 and highest in month of June it indicate the fishes attained maturity. The fecundity potential is different in all fish species. Though, it is observed that fecundity of fish progressively increase with the increase of body weight, body length, gonadal weight and gonadal length. These values are found to be interrelated. The reproductive potential of fishes is depends on many factors like age, size, types of species, food availability, feeding ability, environmental factors, water current and season. Evaluation of fecundity is essential for getting knowledge about different races; each species has characteristic fecundities and egg diameter. This will be helpful to evaluate fecundity of fish during culture and maintenance of fish diversity. Further, it will help for sustainable fishery management and the control of exploiting fishing of young individuals**.**

Acknowledgement

Author is very thankful to Ishan Pahade**,** Anuja Milind Vartak and Shlok Chandrashekhar Chitre and those help in this investigation.

References

1. **Kime, D.E**. The effects of pollution on reproduction in fish. *Reviews Fish Biology and Fisheries,* **3** : 52-96; (**1995**).
2. **Chandanshive Navnath Eknath.** The Seasonal Fluctuation of Physico-Chemical parameters of River Mula-Mutha at Pune, India and their Impact on Fish Biodiversity. *Research Journal of Animal, Veterinary and Fishery Sciences* Vol. **1(1),** 11-16. February **(2013).**
3. **Holden, M.J & D.F.S. Raitt.** Manual of fisheries science part 2: methods of resource investigation and application. *FAO Fish Technical Paper* 115 Rev. 1: 1–214; (**1974**).
4. **Morales, D.A.** *La Tilapia en Mexico. Biologia, Cultivoy Pesquerias.* A G Editor S.A., 190pp; (**1991**).
5. **N. E. Chandanshive .** Assessment of fecundity and gonadosomatic index of freshwater fish *Cirrhinus fulungee* (Skyes) from Mula river of Pune, Maharashtra. International Research Journal of Natural and Applied Sciences Vol. 3, Issue 7; 94-98; (**2016**).
6. **Grandcourt, E.M., T.Z. Al-Abdessalaam, F. Francis, A.T. Al-shamsi & S.A. Hartmann.** Reproductive biology and implications for management of the Orange-spotted Grouper *Epinephelus coioides* in the southern Arabian gulf. *Journal of Fish Biology* 74: 820–841; (**2009**).
7. **Talwar and P. K. and Jhingran A.G**. Inland fishes of India and adjacent countries. Volume **1** and **2** *Oxford and IBH publishing New Delhi*. (**1994**).
8. **Chandanshive N.E.,** Kamble S.M. and Yadav B.E. Fish fauna of Pavana river of Pune, Maharastra, *Zoos' print journal,* **22(5),** 2693-2694; **(2007).**
9. **Bahuguna S. N. and Khatri** S.Studies on Fecundity of Hill Stream Loach *Noemacheilus montanus* (McClelland) in Relation to Total Length, Total Weight, Ovary Length and Ovary Weight. *Our Nature*. **7**;116-121; (**2009**).
10. **Lone, KP. and Hussain** A. Seasonal and age related variations in the ovaries of *Labeo rohita* (Hamilton, 1822): A detailed gross and histological Study of gametogenesis, maturation and fecundity. *Pakistan Journal of Zoology.* **41**(**3**): 217-239; **(2009).**

11. **de Vlaming, V.L.** The effects of temperature and photoperiod on reproductive cycling in the estuarine gobiid fish (*Gillichthys mirabilis*). *Fish Bulletin* 73: 1137–1157; (**1982**).
12. **Zafar Iqbal and Arfaa Batool**. Fecundity of *Labeo rohita* (Teleostei: Cyprinidae) reared in earthen pond in Lahore. SENRA *Academic Publishers, British Columbia* Vol. **7**, No. **2**, pp. 2391-2395, (**2013**).
13. **Nandikeswari. R and V. Anandan.** (2013) Analysis on Gonadosomatic Index and Fecundity of Terapon Puta from Nallavadu Coast Pondicherry. *International Journal of Scientific and Research Publications,* Volume **3(2),** 1-3; (**2013**).
14. **A.S.M. Musa and Abdus Salam Bhuiyan.** Fecundity on *Mystus bleekeri* (Day, 1877) from the River Padma Near Rajshahi City. *Turkish Journal of Fisheries and Aquatic Sciences* 7: 161-162; **(2007).**
15. **A.K. saikia, S.S. Abujam and S.P. Biswas**, Reproductive biology of *Channa punctatus* (Bloch) from paddy field of Sivasagar, Assam, *International journal of current research vol. 5, Issue, 03,* 542-546. (**2013**).
16. **Arup Buragohain1, M. M. Goswami .** Relationship of Fecundity and different body parameters of *Clarias magur* (Hamilton, 1822) in captive condition in the Agro climatic condition of Assam, India. *Journal of Agriculture and Veterinary Science (IOSR-JAVS).* Volume 7, Issue 3 Ver. I, PP 44-50. **(2014).**
17. **Muneera Jan, Ulfat Jan & G. Mustafa Shah.** Studies on fecundity and Gonadosomatic index of *Schizothorax plagiostomus* (Cypriniformes: Cyprinidae). Journal of Threatened Taxa. 6 (1): 5375–5379; **(2014**).
18. **M.V. Gaikwad, V.R., More, S.M. Shingare, D.K. Hiwarale and Y.K. Khillare.** Study on Ganado-Somatic and Fecundity Relationship in Air Breathing Fish *Channa gachua* (Ham.) From Godavari near Aurangabad**.** *African Journal of Basic & Applied Sciences* **1** (**5-6**): 93-95. **(2009).**
19. **S.P. Biswas**, Studies on Some Aspects of the biology of *Labeo pangusia* and *Labeo dero* From North eastern India, doctoral diss., North- eastern Hill University, shillin. (**1982**).
20. **Murua, H., G. Kraus, F. Saborido-Rey, P.R. Witthames, A. Thorsen and S. Junquera,** Procedures to estimate fecundity of marine fish species in relation to their reproductive strategy. *J. Northwest Atlantic Fish. Sci.,* **33**: 33-54. **(2003).**

21. **Mekkawy, I.A.A. and A.A. Hassan.** Some reproductive parameters of *Synodontis Schall* (Bloch and Schneider, 1801) from the River Nile, Egypt. *J. Fish. Aquat. Sci*., **6:** 456-471. (**2011**).
22. **Shaheena Shafi**. Study on fecundity and GSI of *Carassius carassius* (Linneaus,1758-introduced) from Dal Lake Kashmir. Journal of Biology, Agriculture and Healthcare. Vol **2**, No.**3**. (**2012**).
23. **Shinkafi B.A. and Ipinjolu J.K.** Gonadosomatic Index, Fecundity and Egg Size of *Auchenoglanis occidentalis* (Cuvier and Valenciennes) in River Rima, North-Western Nigeria. *Nigerian Journal of Basic and Applied Science*, **20(3):** 217-224. **(2012).**
24. **Sunder, S.** Studies on the maturation and spawning of *Schizothorax curvifrons* Heckel from River Jhelum,Kashmir. *Journal of the Indian Institue of Science* 65(c): 41–51. **(1984).**
25. **Murua, H. and F. Saborido-Rey,** Female reproductive strategies of marine fish species of the North Atlantic. *J. Northwest Atlantic Fish. Sci*., **33**: 23-31; (**2003**).
26. **Muhammad Naeem, Abdus Salam, Noor Elahi,Muzaffar Ali, Abir Ishtiaq And Anna Andleeb.** Effect of Body Weight on Absolute and Relative Fecundity of *Hypophthalmichthys molitrix* with Intramuscular Injection of Ovaprim–C. *International Journal of Agriculture & Biology*. 13: 141–144. (**2011**).