Study on Reproductive Biology of Two SIF's *Puntius sophore* and *Rasbora daniconius*

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Abstract
The study of GSI and seasonal variation of development of ovary of any fish shows the reproductive cycle of fish and it is a very important aspect. The investigation of reproductive biology were carried out to estimate Gonadosomatic Index, Ovary Weight, Ova diameter, and Fecundity during August 2021 to March 2022. Total no. of 200 of each female individuals *Puntius sophore,* and *Rasbora daniconius* species of different size and length were dissected. The peak of average GSI value 10.17±5.33 was recorded in month of August in *Puntius sophore* and 2.82±2.21 in month of October in *Rasbora daniconius.* In *Puntius sophore* maximum average fecundity was 3905.8±3668.1 recorded in month of august and in *Rasbora daniconius* maximum average fecundity was 1332.6±358.83 in month of September. Maximum average ova diameter of *Puntius sophore* and *Rasbora daniconius,* wasc1.99±0.27mm in month of August and 2.5±0mm in month of September respectively, Ovary weight of *Puntius sophore* was recorded maximum in month of august 1.44± 0.82 and in *Rasbora daniconius* 0.22±0.16 in month of October.

Keywords- Reproductive Biology, GSI, Fecundity, Ovary Weight, Ova Diameter

Introduction

Small indigenous fishes are particularly important for nutrition because they are eaten whole, with bone, head and eye, thereby providing a source of calcium and other micro-nutrients (Kongsbak et al.,2008). Small indigenous fishes (SIF's) usually include those species which attain a maximum length of 25 – 30 cm in mature or adult stage of their lifecycle. Some freshwater SIFS are highly nutritious fish like *mola, punti, chanda, chela, tengra, magur, koi, gute, lata*and many types of crabs, molluscs, small prawns etc. The majority of fish eaten by the rural poor peoples are the small indigenous fishes. (Mohanty., 2013).Small indigenous fishes traditionally occupy an unenviable position and an inseparable link in the life, livelihood, health and the general well being of the rural mass, especially the poor. These fishes are also termed as "Nutrient rich small fishes" because they fullfill all the requirements of micro-nutrients and vitamins when they consumed with all their body parts.

Among the SIF's some indigenous species are data deficient like *Puntius sophore,* and *Rasbora daniconius*. small species which is found in freshwater river, ponds, beels etc these species locally called as *punti,* and, *injira* in Hoshangabad district. Both of them is not more than 20cm these fishes are considered as minnows. *Puntiussophore* is also known as Pool barb which is an important SIF's of India, belonging to the family *Cyprinidae* of the order *Cypriniformes*. *Rasbora daniconius or slender Rasbora* is a slim fish with sliver in colour and the undertones are olive coloured. This species have both ornamental and edible value, consumed by the lower income peoples.

The reproductive potential of a population is one of the basic exigencies to designate the individuals of that population in respect to their gonadal conditions (Jhingran and Verma 1972). The time and season when a species normally breed is termed as the "breeding" or "spawning" season of that species. Knowledge of gonadal development and the spawning season of a species allow subsequent studies on spawning frequency of its population, which is very important for its management (Chakraborty 2007). Maturity stages refer to the degree of ripeness of the ovaries and testes of a fish (Saha *et al.,* 2021). The spawning season of female depends on the quantity of eggs and the number of spawning (Chakraborty *et al.,* 2010). The breeding season repeats in cyclic order, in which the organism undergoes maturation changes and thereby gets ready to breed again. This repeated phenomenon is known as the reproductive cycle (Milton and Arthington, 1983).

The fundamental objective of the study was to evaluate the reproductive biology of these nutritive small fishes on which a little data is available. For this purpose the study was conducted to examine the GSI, Fecundity, Gonadal Stages ,Ova diameter etc.

Methods and Material

Study area and sample collection: -

The study of GSI and seasonal variation of development of ovary of any fish shows the reproductive cycle of fish and it is a very important aspect. This study has been conducted at the laboratory of the Department of Zoology and Applied Aquaculture, Barkatullah University, Bhopal, 462026, Madhya- Pradesh, India. (23°12'1'' N; 77°27'11'' E) during August 2021 to March 2022.

The total no. of 200 of each female individuals *Puntius sophore,* and *Rasbora daniconius* species of different size and length were collected with the help of fishermen and some of them collected from Bengali colony market, Hoshangabad, which were caught in fresh condition by using Gill net from Narmada River, Hoshangabad Madhya-Pradesh, India and after collection fishes were kept in 10% formalin solution in plastic jar and transported to the laboratory of the Department. After transportation, fishes were kept in room temperature for 10-20 minutes then washed well, measured for length and weight and dissected. After dissection, the gonads were preserved in 5% formalin solution in small plastic container for further examination.

Gonado-somatic index (GSI):-

For determining the gonado-somatic index (GSI), the total body weight and the weight of gonads were taken in fresh condition using an electronic balance up to the nearest Milligram. GSI was calculated by using the following formula proposed by Hopkins (1979): -

GSI= GW/BW × 100

Fecundity: -

Sub-sampling of ovaries using the weight method of Bagenal and Braum (1978) and Grimes and Huntsman (1980) was applying the following formula:

F= n ×G/g

Here,

F = Fecundity

n = Number of eggs in sub-sample

G = Weight of the ovary (gm)

g = Weight of the sub-sample (gm)

Ova-diameter: -

Ova diameter estimation was performed under the electronic compound microscope in 4X magnification with the help of an Ocular-micrometer 19mm diameter. (Prasad, 2011).

Gonadal Maturity stages: -

To determine the gonadal development of *Puntius sophore,* and *Rasbora daniconius,* the egg's size and colour were observing by using electronic compound microscope and also observing by morphometric characteristics of the ovary.(I.C.E.S. scale (Wood, 1930).

Results-

The total no. of 200 female individuals of *Puntius sophore*and *Rasbora daniconius* species of different size and length were dissected (I.e. total 400 fishes). During the tenure of research work maximum and minimum length, weight, fecundity, ovary weight, GSI and ova diameter was shown in tab-1.

Fish Species	Fish Length (cm)	Fish Weight (gm)	Ovary Weight (gm)	GSI	Fecundity	Ova Diameter (mm)
Puntius sophore	16.5-7.5	21-6	4.19-.02	24.7-.59	17380-329	2.2-1.5
Rasbora daniconius	10.5-5.3	10.4-3.2	0.65-.01	6.23-.10	2580-224	2.25-0.5

Table-1 *Showing Maximum -Minimum Fish length, Fish weight, Ovary Weight, GSI, Fecundity and Ova diameter of Puntius sophoreand Rasboradaniconius*

The maximum average length of *Puntius sophore* was 11.93±2.61 cm and *Rasbora daniconius*was 8.22±0. 85cm.While Average minimum length of *Puntius sophore*and *Rasbora daniconius*was 9.56± 1.16cm and 7.85± 1.18cm respectively. Maximum average weight of *Puntius sophore* 14.39±2.48gm in month of August and minumum was 10.8±2.17gm in month of november, and *Rasbora daniconius*maximum average weight 7.36±1.55gm in month of september, and minimum average weight was 6.32±1.40gm in month of December.(table 1,2 &3)(Fig 1&2).

GSI-

In *Puntius sophore*maximum average GSI was found in month of August 10.17±5.33 and minimum in month of November 2.55±1.88. And in *Rasbora daniconius* maximum average GSI was 2.82±2.21 in month of October and minimum 0.82±0.53 in month of December.Similarly, maximum average Ovary weight of *Puntius sophore*in month of

August 1.44±0.82gm and *Rasbora daniconius* in month of October 0.22±. 16gm.While minimum Ovary weight of *Puntius sophore*in month of November0.3±0.23gm and *Rasbora daniconius* in month of December was 0.05±.04gm, respectively.(table 2 &3) (Fig-3&4)

Fecundity-

In *Puntius sophore* maximum fecundity was 3905.8±3668.1 in month of august and and minimum1023.6±122.78 in month of November. In *Rasbora daniconius*maximum fecundity was 1332.6± 358.83 in month of September and minimum was 824.16±266.99 in month of October.Present investigation results was observed that both fishes breeds twice or thrice in a year and its depends on habitat and seasonal variations (table 2 &3) (Fig-5)

Ova Diameter-

In *Puntius sophore* and *Rasbora daniconius*maximum average ova diameter was, 1.99±0.27mm in month of August and 2.5±0mm in month of September respectively. The minimum ova diameter *Puntius sophore*and *Rasbora daniconius*was 1.43± 0.06mm in month of November and 0.59±0.09mm in month of October.(table 2 &3) (Fig-6)

SN	Particulars	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	**Fish Length**	10.44± 1.37	11.1± 2.16	10.42± 1.87	9.56± 1.14	10.74± 1.77	11.93± 2.56	11.93± 2.56	11.42± 2.59
2	**Fish Weight**	14.39± 2.48	14.17± 3.18	10.10± 1.91	10.8± 2.17	11.73± 2.36	12.3± 2.59	12.4± 2.43	11.58± 2.57
3	**Ovary Weight**	1.44± 0.82	1.17± 1.18	0.32± 0.28	0.3± 0.23	0.41± 0.25	0.83± 0.38	1.38± 0.92	1.39± 0.72
4	**GSI**	10.17± 5.33	7.33± 6.85	2.64± 2.36	2.55± 1.88	3.14± 2.04	6± 2.34	8.58± 3.35	9.43± 5.4
5	**Fecundity**	3905.8± 3668.1	3617.36± 4097.21	1671.2± 974.15	1023.6± 122.78	1357.69± 1156.12	1836± 800.15	2928.13± 1004.52	3220.82± 1028.39
6	**Ova Diameter**	1.99± 0.27	1.87± 0.18	1.5± 0	1.43± 0.06	1.44± 0.06	1.65± 0.15	1.64± 0.17	1.81± 0.25

Table –2.Shows Average Fish length, weight, Ovary Weight, GSI, Fecundity and Ova diameter of Puntius sophore

SN	Particulars	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	**Fish Length**	8.19± 0.93	8.13± 1.17	7.97± 1.11	7.92± 0.80	7.83± 0.96	8.22± 0.84	7.85± 1.16	7.87± 0.98
2	**Fish Weight**	8.52± 1.42	10.8± 1.55	8.4± 1.20	9.93± 1.05	10.1± 1.40	8.5± 1	9.5± 1.35	10.2± 1.26
3	**Ovary Weight**	0.15± 0.15	0.19± 0.19	0.22± 0.16	0.19± 0.21	0.05± 0.04	0.07± 0.06	0.18± 0.17	0.16± 0.17
4	**GSI**	1.87±1. 68	2.40± 2.33	2.82± 2.21	1.90± 2.35	0.82± 0.53	1.12± 0.76	1.80± 1.75	2.57± 1.99
5	**Fecundity**	1263.32 ±621.84	1332.6± 358.83	824.16± 266.99	1084.66± 180.06	1094.63± 182.53	1272.3± 327.4	1049.24± 428.31	1256.28± 545.75
6	**Ova Diameter**	2.22± 0.24	2.5± 0	0.59± 0.09	0.97± 0.42	1.44± 0.46	1.56± 0.41	1.47± 0.39	2.02± 0.27

Table –3.Shows Average Fish length, weight, Ovary Weight, GSI, Fecundity and Ova diameter of Rasbora daniconius.

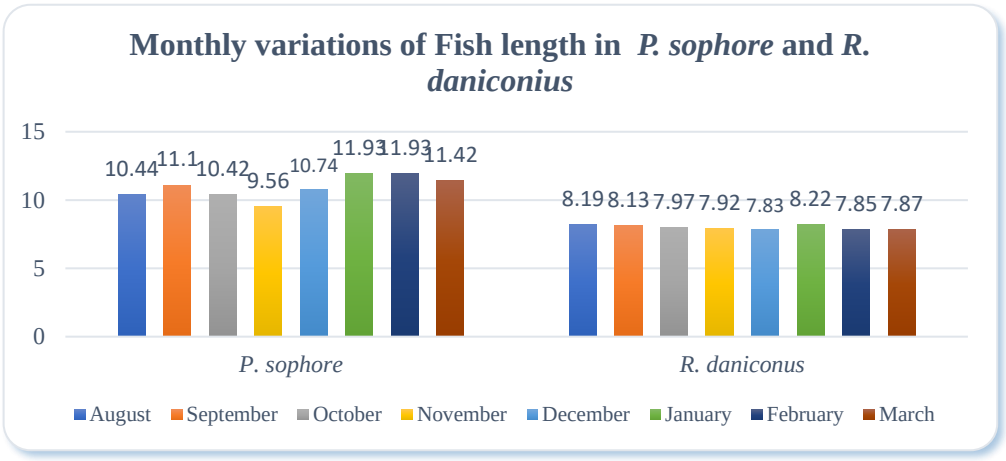

Fig.1*Monthly variations of Fish length in P. sophoreand R. daniconius*

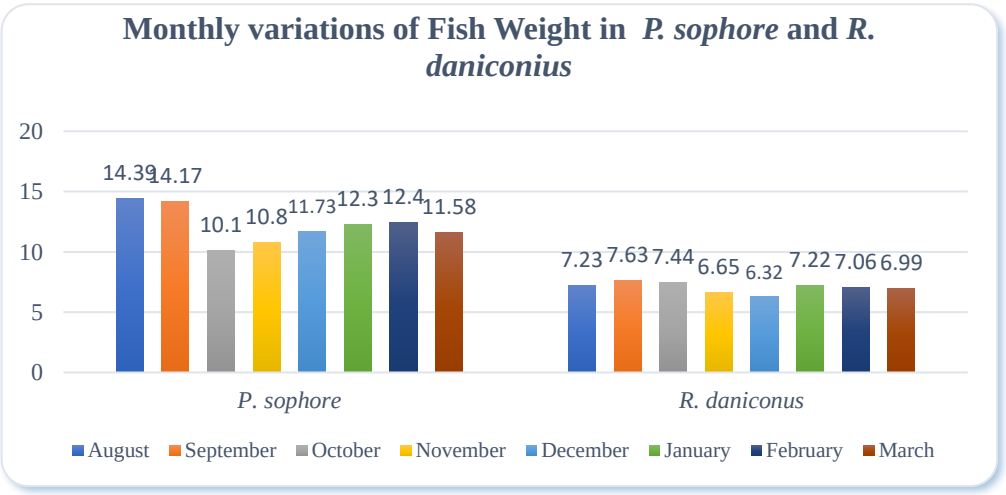

Fig.2*Monthly variations of Fish Weight in P. sophoreand R. daniconius*

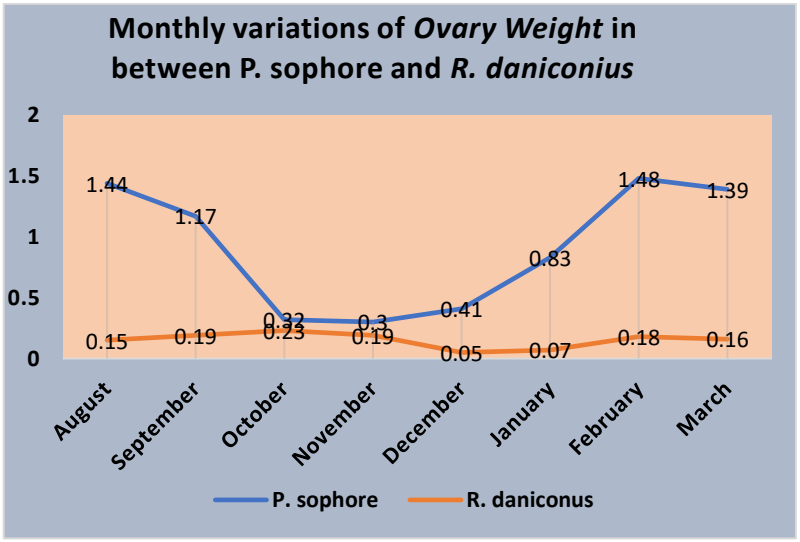

Fig.3*Monthly variations of Fish Ovary Weight in P. sophoreand R. daniconius*

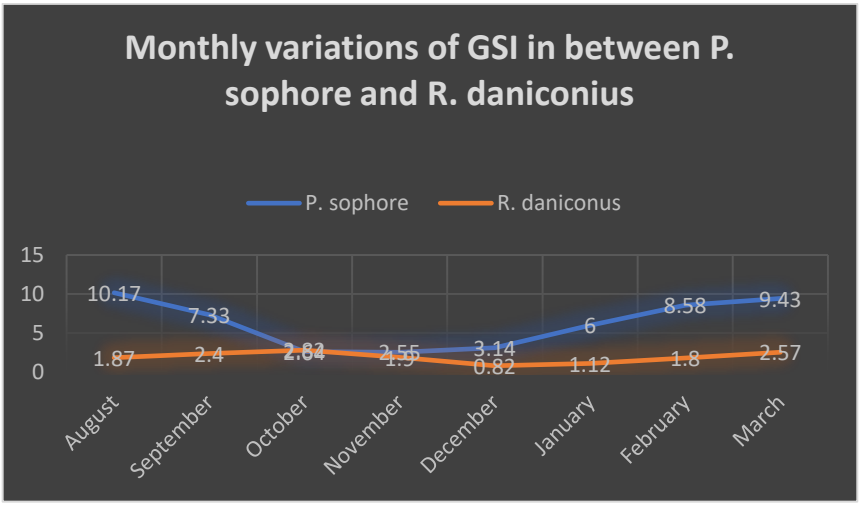

Fig.4*Monthly variations of GSI in P. sophoreand R. daniconius*

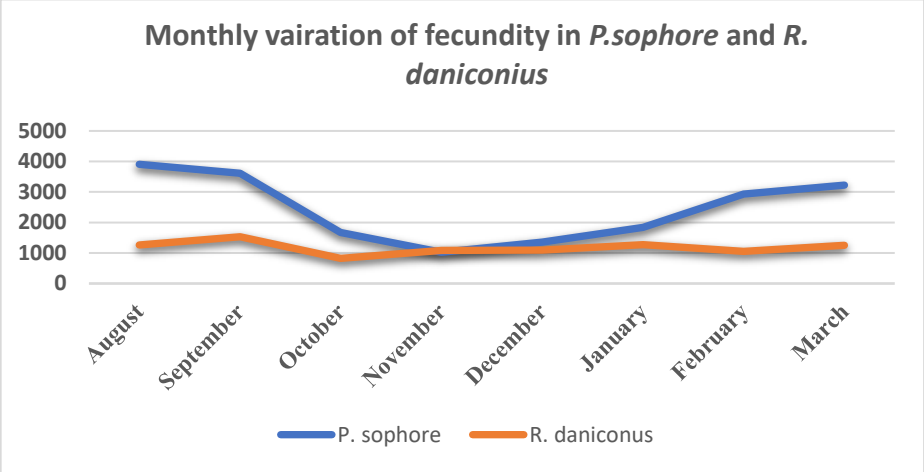

Fig.5*Monthly variations of Fecundity in P. sophoreand R. daniconius*

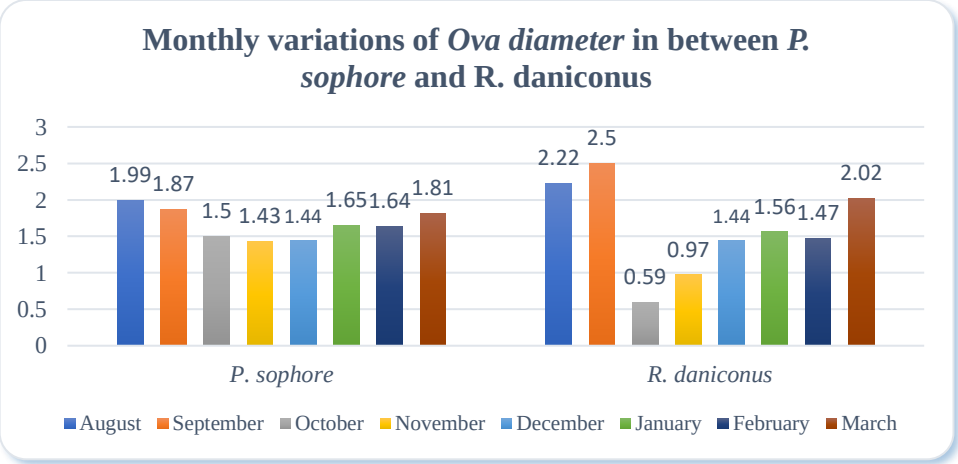

Fig.6*Monthly variations of Fecundity in P. sophoreand R. daniconius*

Gonadal Stages	***P. shophore***	***R. daniconius***
Immature-Ovaries thin, flat, ribbon-like, whitish-yellow in colour, almost transparent, ova are not visible to naked eyes but under microscope ova are irregular in shape with a clear nucleus.	October, December January,February	October, November December, January, February
Maturing- Ovaries became thicker, occupy about half of the body cavity, yellowish in colour, eggs are visible to naked eyes.	August, September, January, March	February, and March
Mature -Ovaries increase in volume and weight, occupy three fourth of the body cavity. Eggs are visible with naked eye, pinkish yellow in colour.	August September, and March	August andMarch
Ripening -Ovaries increase in lemgth and weight, occupy almost whole of the body cavity, eggs distinctly visible with naked eyes, dark yellowish in colour.	Augustand September	August, September, October
Spent-Ovaries become flaccied, show reduction in weight, pale whitish in colour. Fully ovary with bloodshots in fresh condition appear empty.	September, October, December	September, October, November, December

Table-4. *Showing month wise maturation in P.sophore and R.daniconius*

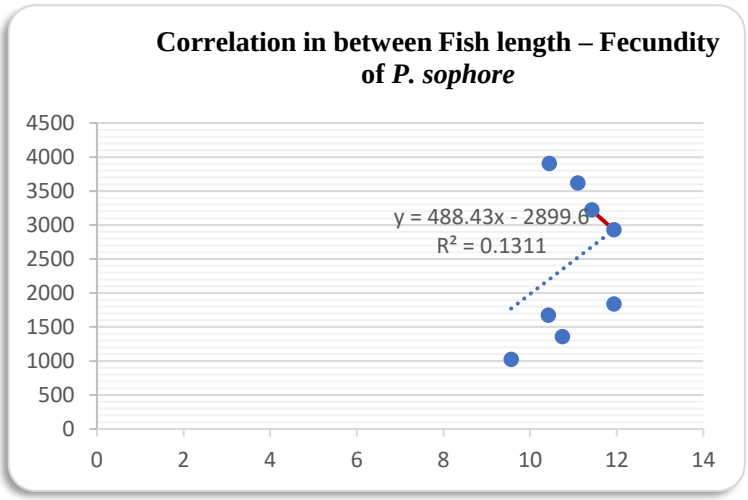

Fig.7*Correlation in between Fish length – Fecundity of P. sophore*

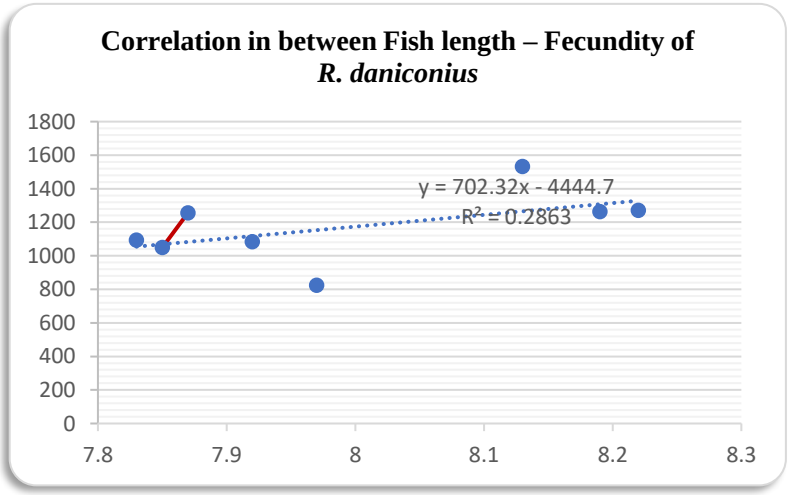

Fig.8*Correlation in between Fish length – Fecundity of R.daniconius*

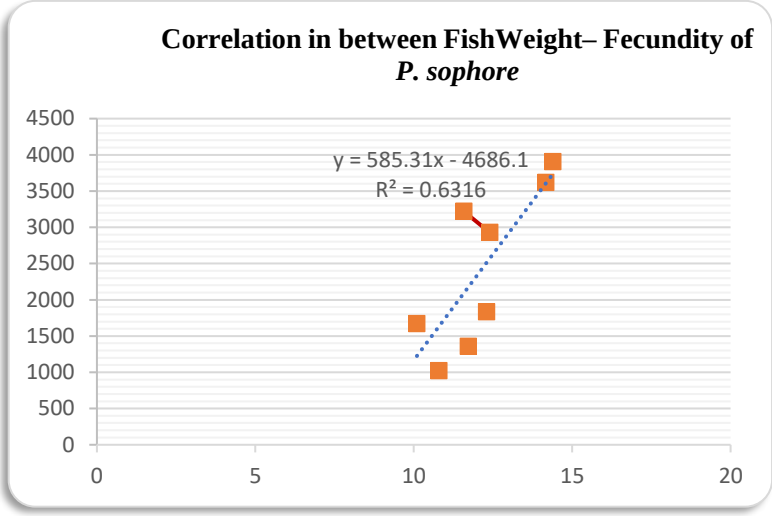

Fig.9*Correlation in between Fish weight – Fecundity of P.sophore*

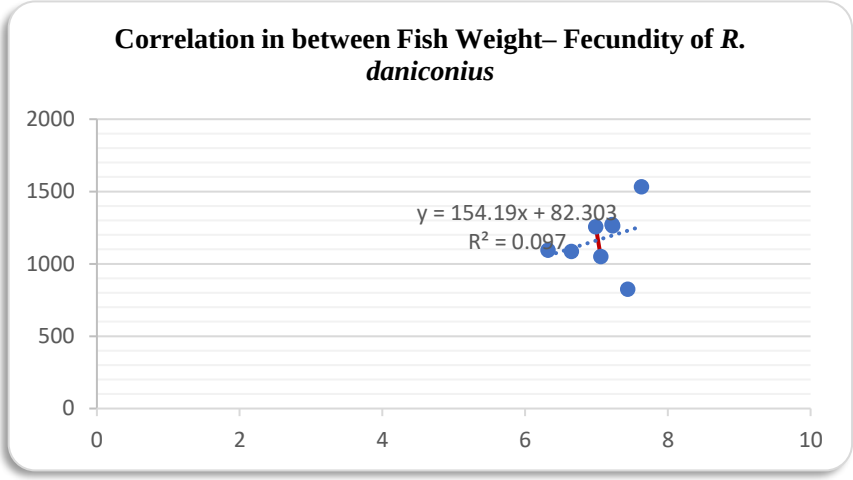

Fig.10*Correlation in between Fish weight – Fecundity of R.daniconius*

In *P. sophore* the relationship between fecundity with the body length is expressed by an equation Y=488.43X-2899.6BL.(Fig-7) which shows that there is no effect of length on fecundity and the coefficient of correlation is very weak, as the value of r=0.1311, Similarly in *R. daniconius* which is expressed by an equation Y=702.32X-4444.7BL also the coefficient of correlation is very weak, observed that length and fecundity is not related and the value of r=0.2863.(Fig-7 &8)

The correlation between fecundity and weight in *P.sophore*is expressed by an equation Y= 585.31X-4686.1BW and the correlation was positive. i.e. as fecundity increases the weight of fish also increases and the value of r= 0. 6316. (Fig -9). In *R. daniconius*correlation between the fecundity with the weight of fish is expressed by an equation Y=154.19X+82.303, and a value of r= 0.097, This means the variation in fecundity could be not explained by the body weight of *R. daniconius.* (Fig-9 & 10)

Discussion-

Study on reproductive biology of any fish species is essential for assessing the commercial potentialities of its stock, life history, culture practice and actual management of its fishery. The significance of studying the maturity of a particular fish is to ascertain the sex- ratio, size, and age at first maturity, the number of matured fish in the stock at a particular time of the year and the gonadosomatic index of the fish. The ratio between gonad weight and fish weight is designated as gonadosomatic index or gonsomatic (GSI). This index is used as an indicator of a spawning period of fishes. GSI is also used to ascertain the period of development of gonads as well as the spawning season. (Mohua Dutta *et al* 2020)A similar investigation was found but there is fluctuation of temperature with season which directly affects the breeding biology of any fishes so, there were many studies results are the same but due to differences in seasonal variations from one region to another region monthly changes occur in ripening, mature, maturing and immature stages, similar (Se Un Ki *et al* 2018)the reproductive cycle of slender catfish was very similar to South torrent catfish while quite different from Black bullhead and bullhead. The slender catfish is a Korean endemic living in small tributaries make it very vulnerable to environmental change. Chakraborty *et al.* reported that the egg diameter of *Puntius sarana* was significantly higher in the month of June, where the diameter of the ova was decreased was in the month of October,

which indicates that the diameter of the ova was highest in the peak spawning season. In *Puntius sophore* maximum fecundity was in month of august and and minimum in month of November. In *Rasbora daniconius* Maximum fecundity wasin month of September and minimum was in month of October.Present investigation results observed that both fishes breed twice or thrice in a year and its depends on habitat and seasonal variations, similarly, Piska and Waghray (1986) observed that the breeding season of *A. mola* from Himayat sagar, Andhra Pradesh extended from February to July. But in Kaptai reservoir of Bangladesh *A. mola* was found as a multiple breeder and spawned during July, August, October and March (Azadi and Mamun, 2004). Kohinoor et al. (2003) obtained highest value of GSI during July and concluded that *A. mola* breeds twice in a year once during May-July and again during September, October from samples collected from the pond of Bangladesh Agricultural University.(Sarkar et al 2019) In Patna, fish breeds within a strict monsoon calendar i.e. May to September (5 months) with peak spawning during June-July. Interestingly, a second but minor burst of gonadal activity was observed during winter months i.e. November-January where few maturing-mature females were encountered in *P. sophore*. This has also never been reported before.

In this study for more accuracy fecundity was correlated with length and weight, according to Bhatt et al. (1977), fish fecundity is most accurately estimated by two morphometric variables taken together with less accuracy for length than weight variables (BW and OW). Study Shows four gonadal development stages i.e. Immature, Maturing, Mature, and Ripening of *P.sophore* and *R. daniconius*and In *Puntius sophore* and *Rasbora daniconius*maximum average ova diameter was, in month of August and in month of September respectively. The minimum ova diameter *Puntius sophore*and R*asbora daniconius*was found in month of November and October whereas,Alam *et al* (2014) investigated that the ovary of these species passes four major maturation stages viz. Immature, Maturing,Mature and Ripe. Oocytes of different sizes were found at the same time, which indicates *P. sophore* is an asynchronous spawner with a prolonged breeding season reported by Hasan *et al*(2018).

This study concluded that in *P. sophore* GSI was maximum in month of August and sudden decreases in month of October to December then again rise in march and in *R. daniconius* it rise in August, September and October and then again rise in month of March, so there is variation was found in GSI in different month, this may be due to changes in environment parameters.

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