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Some aspects of reproductive biology of the Bartail Flathead *Platycephalus indicus* in Bardawil lagoon, North Sinai, Egypt

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ABSTRACT

The study was carried out to investigate some biological aspects as length-weight, sex ratio, Gonado-Somatic Index (GSI) and fecundity of the Bartail Flathead (*Platycephalus indicus*) in Bardawill lagoon, North Sinai, Egypt. Monthly samples of *Platycephalus indicus* collected from the commercial catch in different landing sites of the lagoon during two fishing seasons 2019-2020. In the present study the total length of combined sexes of the investigated specimens of *P. indicus* varied from 17.9 to 52.1 cm with weights ranging between 27.6 and 1003.7 g. Monthly, average gonad somatic index increased noticeably in both females and males in October and reached the highest value in November. With peaks in November Where spawning season. The Hepatosomatic Index increased noticeably in females and males from October to December. The overall sex ratio indicated that the females are dominant during most of the year, except in October, which show the lowest number and the sex ratio was 1.0:2.01 around the year. The length at first mature (L_{50}) was determined as at 35 cm, 38.8 cm and 37.5 cm for males, females and combined sexes respectively. The absolute fecundity (F) was increased with a total length and described by power equation $F = a L^b$ as $F = 8.2863 L^{2.7892}$. The number of eggs gradually increased from 81657 to 476291eggs eggs per cm.

Key words: Gonado somatic index (GSI), sex ratio, and length at first mature, Fecundity*, Platycephalus indicus*, Bardawill lagoon.

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INTRODUCTION

Bardawil lagoon fishes is considered the most Egyptian marine fish required for export because the lagoon is the cleanest marine water body in Egypt, as well as in the entire Mediterranean region **(Noor-El Deen *et al*., 2016)**.

Bartail Flathead *Platycephalus indicus* belongs to Family: Platycephalidae. *P. indicus* is an immigrant fish species to the Mediterranean Sea, **(Ben-Tuvia, 1953; El-Mor *et al*., 2002)**; as recorded in Egyptian Mediterranean waters **(Mouneimné 1977)** and **(Bariche, 2012**) in Lebanon; **(Saad, 2005)** in Syrian waters; **(Oral, 2010)** in Black Sea and Messina Strait in Italy **(Castriota *et al*., 2009; Sperone *et al*., 2015)** and in Kuwait **(Bawazeer, 1989; Richards, 2008)**.

(King, 2007; Knapp, 2008; Hashemi *et al*., 2012; Mohammadikia *et al*., 2013; Hashemi *et al*., 2014; Adeleh *et al*., 2015; Samir and El Sayed, 2016; Akita and Tachihara , 2019; Hajializadeh *et al*., 2019) but there is no research on the reproductive biology of Bardawill lagoon.

Understanding the reproductive biology of a species is a central aspect of providing sound scientific advice for fisheries management **(Morgan, 2008)**.

Reproductive biology has an important role in determining productivity and thus a population's resistance to overfishing or other human activities **(Al-Kiyuni *et al*., 2014; and Mehanna *et al*., 2019)**.

Knowledge of the sex ratio and the state of maturity of individuals in a population are very important in studies of productivity and population dynamic **(Cailliet *et al*., 1996 and Bariche *et al*., 2009)**. Sex ratio also constitutes basic information necessary for the assessment of the potential of fish reproduction and stock size estimation in fish population **(Vicentini and Araujo, 2003)**.

The size at sexual maturity of fish may be important to assess the optimum size of first capture of a species. Gonadosomatic index (GSI) is often used to follow the reproductive cycle of a species **(King, 1995)**.

The aim of the present research is to shed light on Reproductive biology of the Bar-tail Flathead (*Platycephalus indicus*) in Bardawill lagoon, North Sinai, Egypt using such information is essential for the management and accuracy of the fishing to determine the catch only for individuals which have reached maturity as it is one of the basic rules that should be followed to ensure sustainability.

MATERIALS AND METHODS

1. Study area:

The study was carried out in the Bardwell Lagoon **(Fig. 1)**. The lagoon is located in north Sinai Peninsula, bordered northerly by the Mediterranean Sea and southerly by Sinai desert. It is covers an estimated area of 136,318 Feddan with a maximum length of 95 Km and a maximum width of 22 Km, the water depth ranges from 0.5 to 3 m **(GAFRD, 2015)**.Three openings connect the lagoon with the sea; two artificial openings at the West side (Boughaz I and Boughaz II) and one natural opening at the East (El-Zaranik). The fishing in the lagoon is seasonal starting in April and extends to the end of December.

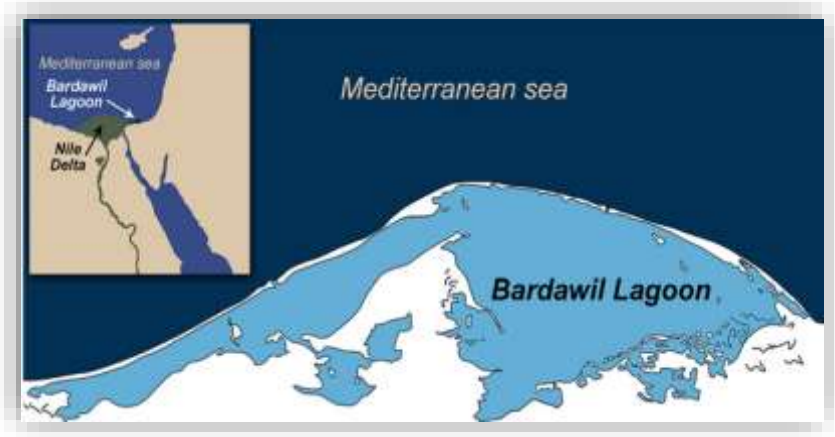

Fig. 1. Map of the study area Bardawill lagoon, North Sinai, Egypt.

2. Sampling

Monthly, random samples of Bartail Flathead (*Platycephalus indicus*) were collected from the mixed catch of three landing sites at the Bardawil lagoon. The sampling period lasted during two fishing seasons 2019-2020 from August to December during period study. The fish were kept in a tightly closed ice box, and then transported to laboratory. Total of 904 individuals were collected.

3. Data analysis:

In the laboratory, the total length (TL) from the tip of snout to longest ray of the caudal fin by using a measuring board at the laboratory was measured. Total weight (TW) in grams was measured to the nearest 0.1 g using electronic weighing balance. Fish specimens were dissected to determine its sex and maturity stages. The gonads were weighed to the nearest 0.01 g and the ovaries were preserved in 10% formalin for subsequent examinations.

Spawning season was determined by examination of gonads to determine the sex and the stage of maturity, the Gonad somatic indices (GSI) were calculated by equation of **Bariche *et al.* (2003)** as follows: **GSI**= [Gonad Weight / Body Weight] ×100, sex ratio for different length groups and monthly were calculated. A t-test was used to determine whether differences between measured male and female parameters were significantly different or not.

The Hepatosomatic index (HSI) was calculate by liver weight and body weight ratio using following formulae **HSI**= (Liver Weight (g.) / Body Weight (g.)) ×100 **(Sulistyo *et al.*, 2000)**.

For estimation of the length at first maturity, the total body length was plotted against the frequency percentage of mature individuals during the spawning season, and then the length at 50% considered as the length at first maturity **(Sendecor, 1956)**.

The absolute fecundity ($F_{abs.}$) is defined as the number of mature eggs in the ovaries during the spawning season.Numbers of 82 mature ovaries were used to determine fish fecundity. Mature

ovaries were taken, washed, dried and weighted. Then the ovarian tissue was removed and the net eggs weight was obtained. Eggs were well mixed, and three subsamples were weighted and counted under the microscope. Total fecundity was calculated according to **(Yeldan and Avsar, 2000)** as:

$\mathbf{F_{abs.}}$ = [(Gonad weight* Egg number in the subsample)/ Weight of subsample]

The relative fecundity ($\mathbf{F_{rel.}}$) was calculated as: $\mathbf{F_{rel.}} = \mathbf{F_{abs.}}$ / (Total length or Bodyweight)

RESULTS AND DISCUSSION

A total of 904 (300 males and 604 females) specimens of *P. indicus* were used in this study. In the present study the total length of Males was ranged from 18.2 to 38.5 cm with weights ranging between 29.3 and 358.5g.While, the total length of Females was ranged from 17.9 to 52.1 cm with weights ranging between 27.6 and 1003.7g.

Monthly average gonads somatic index (GSI) for both males and females of *p. indicus* are given in **Table (1)**. These results were graphically represented in **figure (2)**. The gonad somatic index increased noticeably in both females and males in October and reached the highest value in November, this means that the reproduction season of *p. indicus* Bardawil Lagoon is from October to December with peaks in November. By using a t-test found that, differences between measured male and female parameters were significantly different ($P<0.05$).

Table 1. Monthly average gonads somatic index for males and females of *p. indicus*

Month	Males		Females		Total
	No. of fish	G.S. I.	No. of fish	G.S. I.	
Aug.	12	0.31	48	0.23	60
Sep.	55	0.54	206	1.11	261
Oct.	159	0.83	156	2.67	315
Nov.	59	0.85	122	2.86	181
Dec	15	0.37	72	1.58	87
SUM	300		604		904

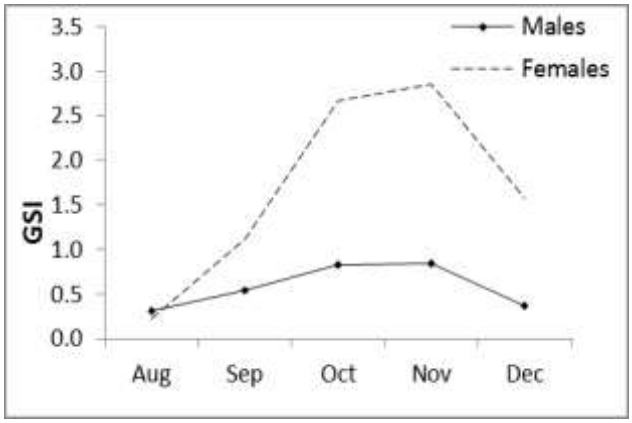

Fig. 2. GSI for (♂) and (♀) of *p. indicus* in Bardawil lagoon during two fishing season, 2019-2020

The analysis of Gonadosomatic index values provides important information regarding to the measure of gonad size relative to body weight **(Wootton, 1990)**. And also the studying of the spawning season **(Ahirrao, 2002)**. In the present study, the gonad somatic index of *p. indicus* was recorded in different months to confirm the spawning period. It was found that, the lower values of GSI were recorded in August, September. The higher values were recorded in October, November. Mean GSI value and maturity stages indicated that spawning time were occurred during October to November,

The present results disagree with resulted by **Van Der Elst and Adkin (1991)** in southern African waters, the GSI of *p. indicus* showing a protracting spawning period beginning from July to November , **Masuda *et al.* (2000)** recorded that, *p. indicus* spawns from April to August with peaks in June for both sexes in the coastal waters of Japan, **Hashemi *et al.* (2012)**, as the spawning season of *p. indicus* in Northwest of Persian Gulf, from April to May and **Akita and Tachihara (2019)** recorded that, The main spawning season was estimated between February and May and continues into September. The factors controlling the reproductive cycle are both extrinsic and intrinsic. Beside the intrinsic factor (endocrine system), the external factors include temperature, photoperiod, density of food supply and that of fish population **(De Vlaming, 1982 and You and You, 1987)**.

Table (2) shows the monthly average Hepatosomatic Index (HIS) for both males and females of *p. indicus*. These results were graphically represented in the **figure (3)**. The Hepatosomatic Index increased noticeably in females and males from October to December. The present results disagree with resulted by **Mohammadikia *et al*. (2014)** recorded that, the mean values of the HSI were 0.89 for males and 1.28 for females. The highest HSI values were observed in January, and the lowest were in April. The mean values of Hepatosomatic Index (HIS) were 1.23 in male specimens and 1.32 for female specimens **(Hashemi *et al*., 2012)**.

Table 2. Monthly average Hepatosomatic Index (HIS) for males and females of *p. indicus*

Month	Males		Females		Total
	No. of fish	H.S. I.	No. of fish	H.S. I.	
Aug.	12	1.13	48	1.81	60
Sep.	55	1.07	206	1.76	261
Oct.	159	1.40	156	2.31	315
Nov.	59	1.55	122	2.70	181
Dec.	15	1.36	72	1.90	87
SUM	300		604		904

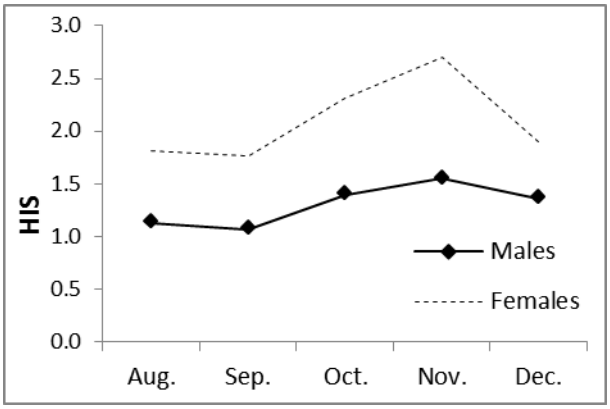

Fig. 3. HIS for males and females of *p. indicus* in Bardawil lagoon during two fishing season, 2019-2020

The first sexual maturity for *p. indicus* in Bardawil lagoon during the study period was determined by examination of gonads to determine the sex and the stage of maturity. The length at first maturity was estimated at 35 cm, 38.8 cm and 37.5 cm for males, females and combined sexes respectively Figure (4).

The present results disagree with resulted by **Akita and Tachihara (2019)** recorded that, Lm_{50} were estimated at 43.5-cm for females, and 23.2-cm for the males. Also disagree with **Hashemi *et al.* (2012**) resulted that, the mean size at first sexual maturity (Lm) of *P. indicus* in Northwest of Persian Gulf was 28.3cm for males and 31cm for females.

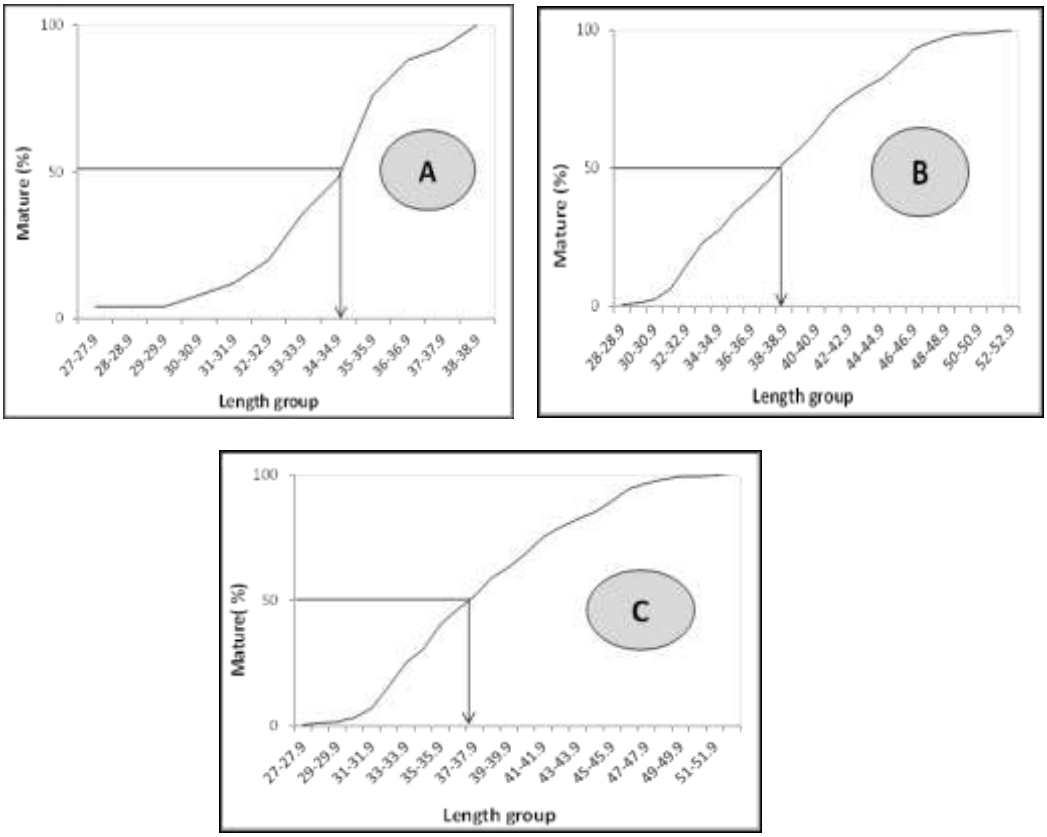

Fig. 4. Length at first maturity of male ♂ (A) female♀ (B) and combined sexes♀♂ (C) of *p. indicus* in Bardawil lagoon during two fishing season, 2019-2020

The variations of sex ratio in *T. puta* were studied monthly and according to the different length groups. **Table (3)** and **Figure (5)** show

the monthly variation in the sex ratio of males to females in Bardawil lagoon. **Table (4) and figure (6)** show the Sex ratio of *T. puta* in relation to various Length groups in Bardawil lagoon during the study period.

Table 3. Monthly variation in the sex ratio of *p. indicus* in Bardawil lagoon during the period of study

Month	Total	Males		Females		M/F ratio	M:F
		no. fish	M%	no. fish	F%		
Aug.	60	12	20.0	48	80.0	0.25	1.0: 4.0
Sep.	261	55	21.1	206	78.9	0.27	1.0: 3.7
Oct.	315	159	50.5	156	49.5	1.02	1.02:1.0
Nov.	181	59	32.6	122	67.4	0.48	1.0: 2.1
Dec.	87	15	17.2	72	82.8	0.21	1.0: 4.8
Total	904	300	33.2%	604	66.8%		1.0: 2.01

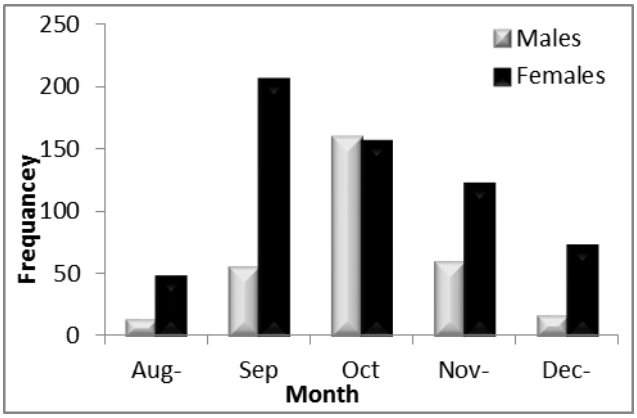

Fig. 5. Monthly variation of male and female number (Sex ratio) of *p. indicus* in Bardawil lagoon during two fishing season, 2019-2020

Table 4. Sex ratio of *p. indicus* in Bardawil lagoon during the period of study

Length group	Total	Males		Females	
		no. fish	%	no. fish	%
17-17.9	1	0	0.0	1	100.0
18-18.9	7	6	85.7	1	14.3
19-19.9	9	5	55.6	4	44.4
20-20.9	20	9	45.0	11	55.0
21-21.9	26	9	34.6	17	65.4
22-22.9	30	15	50.0	15	50.0
23-23.9	24	8	33.3	16	66.7
24-24.9	34	17	50.0	17	50.0
25-25.9	40	25	62.5	15	37.5
26-26.9	50	40	80.0	10	20.0
27-27.9	58	36	62.1	22	37.9
28-28.9	46	19	41.3	27	58.7
29-29.9	39	15	38.5	24	61.5
30-30.9	58	25	43.1	33	56.9
31-31.9	49	15	30.6	34	69.4
32-32.9	57	11	19.3	46	80.7
33-33.9	44	14	31.8	30	68.2
34-34.9	36	14	38.9	22	61.1
35-35.9	42	11	26.2	31	73.8
36-36.9	28	3	10.7	25	89.3
37-37.9	28	1	3.6	27	96.4
38-38.9	26	2	7.7	24	92.3
39-39.9	23	0	0.0	23	100.0
40-40.9	17	0	0.0	17	100.0
41-41.9	24	0	0.0	24	100.0
42-42.9	20	0	0.0	20	100.0
43-43.9	13	0	0.0	13	100.0
44-44.9	5	0	0.0	5	100.0
45-45.9	11	0	0.0	11	100.0
46-46.9	15	0	0.0	15	100.0
47-47.9	10	0	0.0	10	100.0
48-48.9	5	0	0.0	5	100.0
49-49.9	4	0	0.0	4	100.0
50-50.9	3	0	0.0	3	100.0
51-51.9	1	0	0.0	1	100.0
52-52.9	1	0	0.0	1	100.0
SUM	904	300		604	

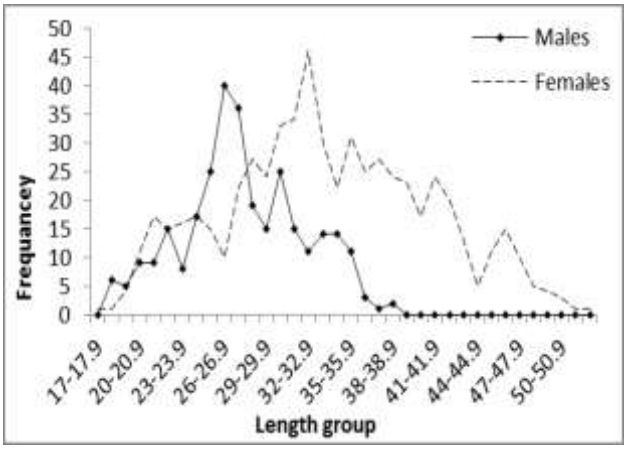

Fig. 6. Sex ratio of *p. indicus* in relation to various Length groups in Bardawil lagoon during two fishing season, 2019-2020

In the present study, the results show that the two sexes are not present in the same proportion throughout the different months of the year. The females are dominant during most of the year, except in October, which show the lowest number. Also, the overall of sex ratio of *p. indicus* was from male to female about (1.0: 2.01 in study period) as shown in previous results. The present results disagree with resulted by **Qin and Gao (2012)** in China the overall of sex ratio are female: male=1.25:1 in summer and female: male=1.78:1 in autumn.

Shafi and Quddus (1974) reported that the number of male and female varied considerable from month to month and the difference may largely be due the selective gear used. However, it is not clear which factors might be responsible in the fluctuation of male and female population distribution. According to **Beevi and Ramachandran (2005)** a rising temperature and moderate water velocity, vulnerability of female to their predators and other natural hazards, migratory phase in brooder population are some of the reasons for the change in the sex ratio in fishes. The presence of more female in most of the months may be due to vulnerability of female **(Bhatnagar, 1972)**.

Fecundity: the relation between body size (total length and body weight) and fecundity (absolute and relative) of *p. indicus* were calculated as illustrated in **Table (5)**. The number of eggs gradually increased with the increasing of fish length or weight as fish of 31.7 cm

(205.9 g.) to lay eggs about 81657 reaching maximum of about 476291eggs for a fish of 52.1 cm (1003.9 g.).The relative fecundity gradually increased from 396.6 to 735.9 eggs per g. with average of 547 g^{-1}. The relation between fecundity and size was illustrated in **Figures (7 and 8)**. The absolute fecundity was increased with a total length and described by power equation $F = a L^b$ as $F = 8.2863 L^{2.7892}$.While, **Al Mudhaffar (2017)** resulted that, Absolute Fecundity for *P.indicus* in Iraqi Marine Waters ranging from 55536 to 532480 eggs whereas Relative Fecundity was ranging from 0.098 to 0.022 egges /gm for indiviuals raning in length from 561 to 420mm and weighing 1688.5 to 1040 gm.

Table 5. The relation between (total length and body weight) and fecundity of *p. indicus* in Bardawil lagoon during two fishing season, 2019-2020

Mean length (cm)	Mean weight (g.)	No. of Fish	Fecundity absolute	Fecundity Relative (eggs/cm)	Relative (eggs/g)
31.7	205.9	2	81657	2575.9	396.6
32.6	255.4	2	128837	3952.0	504.5
33.5	273.4	4	198036	5907.1	724.3
34.4	267.1	1	196563	5714.0	735.9
35.6	306.1	10	178770	5025.9	584.1
36.7	325.2	5	184222	5016.3	566.5
37.5	360.0	6	215423	5747.7	598.4
38.5	404.5	8	230231	5985.9	569.2
39.8	434.3	3	244352	6139.5	562.6
40.5	470.9	3	270170	6670.9	573.8
41.5	488.4	7	272242	6566.8	557.4
42.4	496.2	5	274628	6480.9	553.4
43.5	600.2	2	283824	6532.2	472.9
44.5	606.0	1	333273	7489.3	550.0
45.4	669.8	7	365827	8057.9	546.2
46.4	712.6	8	377053	8123.6	529.2
47.9	863.9	1	382542	7986.3	442.8
48.3	736.9	2	439744	9113.9	596.7
49.3	815.5	2	440575	8936.6	540.3
50.3	901.6	1	447000	8886.7	495.8
51.5	999.9	1	463932	9008.4	464.0
52.1	1003.9	1	476291	9141.9	474.4
Average			294311	6761	547

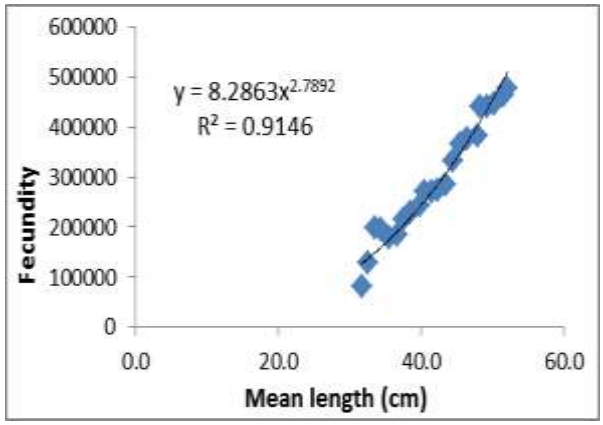

Fig. 7. Relationship between total length (cm) and Absolute fecundity of *p. indicus*

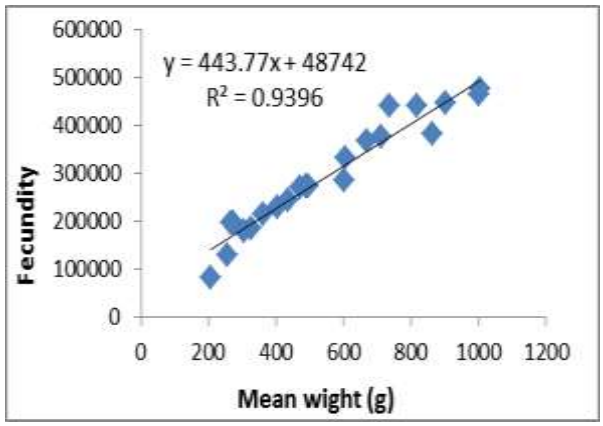

Fig. 8. Relationship between body weight (g) and Absolute fecundity of *p. indicus*

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