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Reproductive Biology Study of Big-Head Pennah Croaker (*Pennahia macrophthalmus* (Bleeker, 1850) from off Ganjam Coast, Odisha, India

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ABSTRACT: This study is based on the weekly collection of fishes from commercial bottom trawlers landed at Aryapally and Gopalpur fishing harbour, Ganjam Orissa. A total sample of 405 nos. of mature fishes with a size range between 121– 260 mm in length were collected during August-2017 to July-2018. The length at first maturity (50%) for *is* 176.5 mm in *P. macrophthalmus.* The diameter of fully ripe ova was found as 0.76 mm. It was revealed from the qualitative and quantitative gonadal study that for *P. macrophthalmus is a* asynchronous spawner in October and February to May. Annual male and female sex ratio of population was 1: 1.88 throughout the year. Females dominated males throughout the year except March *i.e.* after spawning. *Seven gonadal development stages were identified.* The absolute fecundity ranged from 85,124 - 3,21,564 eggs, with ovary weighing between 3.516 - 19.52 gm. The linear relationship between length and fecundity of *was* Log F = - 3.9299 + 3.9070 Log L (r^2 = 0.8960) showing good relationship between length and fecundity. it is apparent that in *P. macrophthalmus* when one batch of mature eggs is about to be shed another batch is getting ready immediately. The results of the study will help in the management options for a sustainable yield future generation.

Keywords: Length at first maturity, asynchronous Fecundity, spawning.

INTRODUCTION

In general, sciaenids are divided into two groups, the bigger sciaenids and lesser sciaenids. The later having a number of species of various sizes. The group Sciaenidae being abundant and rather cheap has received a good deal of attention from many parts of the world including India. In the recent year with modernization of boat the exploitation of Sciaenid fishery resources has significantly increased. Sciaenids are normally caught throughout the year. Peak landing period is during 4th and 1st quarter viz. September to March. The main contributing states in India to the sciaenid catch are Gujarat, Maharashtra, West Bengal, Tamil Nadu, Orissa, Andhra Pradesh, and Kerala etc. Orissa is bestowed with a good abundance of demersal fishery resources with a coastline of 480 kms and 2400 sq. km of continental shelf, which includes sciaenids, catfishes, pomfrets, ribbon fishes, eels, seer fishes, etc. (John and Sudarsan, 1990). Sciaenids contributes on an average 11% to the marine fish catch of Orissa in the last decades (Anon., 2015). About 16 species of sciaenids are exploited off Orissa coast**. S**ome are found in estuary, mangroves and Chilika lagoon too. Dutt and Thankam (1968) reported that along the east coast of India *Otolithus argenteus, Nibea maculata* and *O. ruber* are common in the seas and estuaries of Orissa and West Bengal. From the literature, it is ascertained that there has been no study on sciaenids from the North-East of India on biology, age, growth etc, after the work done on *Pseudosciaena coibor* from Chilika Lake by (Rajan, 1964). The current study aims to assess the study included the presence of lengths according to months, the various mature fish percentages with length, monthly changes in sexual maturity and their ratio, gonad morphology.

MATERIALS AND METHODS

To study the reproductive biology, a total sample of 405 nos. of mature fishes with a size range between 121–260 mm in length were collected during August-2018 to July-2019 samples were collected once in a week at random from Aryapally and Gopalpur fishing harbour, Ganjam Orissa. Fresh specimens were brought to laboratory. The identification of the species was done as per the FAO identification sheets (Fischer and Bianchi 1984). Gonads were weighed to the nearest 0.001g. Samples of ovary were preserved in 10 % formalin for ova diameter studies. A total of 250 numbers of ovaries of different maturity stages of *P. macrophthalamus* respectively, were examined for maturity studies. The distributions of ova of different

sizes were found to be same in the anterior, middle and posterior regions. According to Prabhu (1956) measurement of at least 500 eggs was necessary to mitigate the probable errors in the representation of various groups of eggs in different stages of maturity. The diameters of ova were measured in straight line under a compound microscope magnified 100 times with eyepiece fitted with an ocular micrometer. In the present study, ova samples from the middle part of both the ovary lobes were measured to the nearest micrometer (1µm division = 0.016mm) ova measuring above 5 µm division and above were considered for evaluating percentage of frequencies. The measured ova were grouped into 5 micrometer division class intervals and their frequency polygons drawn as followed by Clark (1934); Palekar and Karandikar (1952); Prabhu (1956). In order to study the maturity and spawning season, 164 males and 250 females of *P. macropthalmus* were observed.

The maturity stages were classified exclusively depending on the stages, size and other observations of the ovary. The percentage of occurrence of various stages of maturity in different months were calculated for one year and graphically represented. The spawning period was ascertained from the occurrence of ripe females. The length at first maturity was determined based on the examination of the ovaries for all three species. The females in stage III and above were considered as mature for the determining the length at first maturity. The percentage of cumulative frequency were plotted against the size to determine the size at which 50 % fish mature. The fecundity was estimated by examining a total of 23 specimen respectively. The ripe ovaries were preserved in 10 % formalin for a week before they were subjected to ova count. The fecundity was estimated by the gravimetric method (Mac Grigor, 1957), which involves counting the number of mature ova from a known weight of mature/ripe ovary. For determination of fecundity, 0.05g of ovary were sampled from the free segments of each ovary with accuracy of 0.001g. Each portion was teased out and the ovary samples were spread evenly on a counting slide with a few drops of water. The number of mature ova of each portion was counted and average number of ova from the three portions was determined. From these values, the fecundity was determined using the formula (Fecundity = (No. of ova in the sample/ weight of sample) × weight of paired ovaries). To find out the relation between fecundity (F) and total length (TL), fecundity and body weight (TW) and fecundity and ovary weight (OW), Correlation coefficient (r) was calculated (Snedecor and Cochran 1967). Least square method was used to calculate regression of fecundity (F) to total length, body weight and ovary weight of fish. Sex ratio was determined from the number of specimens of each sex sampled every month for all the three species excluding the indeterminate. The ratio of males and females was worked out month wise and size wise. The proportions thus obtained were tested against expected 1: 1 ratio by Chi square test (Snedecor and Cochran 1967) to find out the significant difference in the sex ratios. The formula used was Chi square = (O-E)2 / E Where O and E denote observed and expected values.

RESULTS AND DISCUSSION

Size at first maturity was calculated from percentage distribution of different maturity stages in length group 10 mm class interval. Fishes in the stage III and above were taken for study and cumulative percentage frequencies were plotted. This fish attains first maturity at a length of 176.5 mm (Fig. 1). Mature ovaries were found round the year, but running ovaries were observed in October and February to May. As spent specimens were also available in November, it was concluded that species also releases eggs in October and November, in addition to February to May.

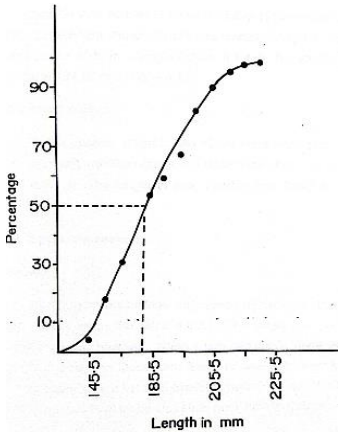


Fig. 1. Graphical representation of Length at first maturity.

Table 1: Month wise percentage distribution of maturity stages.

Months	No of examined	Maturity Stages						
		I	II	III	IV	V	VI	VII
January	17	5.58	5.58	5.89	29.41	17.34	-	5.58
February	23	8.7	4.35	34.79	21.64	17.39	8.69	4.35
March	25	4.00	-	17.4	43.47	22.08	13.05	-
April	31	12.9	15.13	9.69	12.9	22.58	22.58	4.21
May	33	21.21	19.35	24.25	-	12.12	15.15	9.12
June	26	34.62	38.46	15.38	-	-	-	11.54
July	15	56.66	46.67	6.67	-	-	-	-
August	18	44.46	27.78	27.78	-	-	-	-
September	21	23.8	9.53	23.8	9.53	33.34	-	-
October	17	5.88	5.88	35.29	23.53	23.53	5.88	
November	12	33.34	24.99	16.67	16.67	16.67	-	-
December	16	18.75	6.25	31.25	18.75	31.25	-	-

Mature ovaries were found round the year, but running ovaries were observed in October and February to May. As spent specimens were also available in November, it was concluded that species also releases eggs in October and November, in addition to February to May. In this species, stage III and above were seen in females above 151mm length. Running condition (stage VI) ovary was observed in size above 181mm (Table 1). A peculiar pattern of maturity was seen in this species. Ovary up to stage IV was available throughout the year except May-August. Running ovary (stage VI) was available in the months from February to May and also in October. Spent stage was observed continuously from January to June and except in March (Table 2). A total of 405 specimens were studied for the sex ratio during August-2017 to July-2018.

Table 2: Lengthwise sex ratio.

Length Group (mm)	No. of male	Nos. of female	% of male	% of female	Sex ratio	Chi square value
100 - 110	1	0	100	0	-	-
111 – 120	0	1	0	100	-	-
121 –130	1	5	16.67	83.33	1:5.29	2.67
131 – 140	8	14	36.36	63.64	1:1.75	1.09
141 – 150	5	11	31.25	68.75	1:2.2	2.25
151 – 160	23	33	41.07	58.93	1:1.43	1.79
161 – 170	19	27	41.3	58.7	1:1.42	1.39
171 – 180	17	31	35.42	64.58	1:1.82	4.08 *
181 – 190	13	25	34.21	65.79	1:1.92	3.79
191 – 200	9	15	37.50	62.50	1:1.67	4.17 *
201 - 210	8	20	28.57	71.43	1:2.5	5.14 *
211 - 220	20	34	37.04	62.96	1:1.7	3.63
221 – 230	11	19	36.67	63.33	1:1.73	2.13
231 - 240	5	13	27.78	72.22	1:2.6	3.56
241 – 250	1	5	16.67	83.33	1:1.5	2.67
251 – 260	3	2	60.00	40.00	1:0.67	0.2
261 – 270	4	1	80.00	20.00	1:0.25	1.8
271 - 280	2	0	100	0	-	-
Total	149	256			1:1.88	

Table 3: Monthwise sex ratio.

Months	No. of male	No. of female	% of male	% of female	Sex ratio	Chi square value
January	10	17	37.04	62.96	1:1.7	1.81
February	16	23	41.03	58.97	1:1.44	1.26
March	23	27	46.00	54.00	1:1.17	0.32
April	10	31	24.39	75.61	1:3.1	10.76 *
May	21	33	38.89	61.11	1:1.57	2.67
June	17	26	39.53	60.47	1:1.53	1.88
July	11	15	42.31	57.69	1:1.36	0.62
August	21	18	53.85	46.15	1:0.86	0.23
September	5	21	19.23	80.77	1:4.2	9.85 *
October	8	17	32.00	68.00	1:1.25	3.84
November	2	12	14.29	85.71	1:6	17.14 *
December	5	16	23.81	76.19	1:3.2	5.76 *
Total	149	256			1: 2.365	

Lengthwise percentage distribution of maturity stages of females shows a significant difference in sex ratio was observed in the length range of 171 – 180 mm, 191 – 200 mm, and 201 – 210 mm, where, females were significantly more in number than males. Annual sex ratio of population was 1: 1.88 throughout the year. Monthwise distribution of males and females is presented in Table 3. Significant difference in sex ratio was observed in the month of April, September, November and December. Females dominated males throughout the year except March *i.e.* after spawning. The overall sex ratio of population was 1: 2.365 throughout the year. From the samples collected it is observed that the males dominated over females in post spawning periods. The eggs in the maturing stage were also seen in all months and fully ripe oocytes were observed during May and November. Other observations followed the typical characteristics of asynchronous spawner/partial spawner, described earlier for *J. carutta.* Rao (1964) while working on *Psedosciaena aneus* (Syn: *P. macrophthalmus)* at Vishakhapatnam waters also reported similar spawning periodicity of this species.

Fecundity of this species was determined by studying 22 specimens ranging from 188 – 246 mm in total length and 115 gm to 214 gm in total weight. The absolute fecundity ranged from 85,124 - 3,21,564 eggs, with ovary weighing between 3.516 - 19.52 gm. The fecundity correspond to length and weight is shown (Fig. 2 and 3).

The linear relationship between total weight and fecundity of the species is given below and have shown good relationship between weight and fecundity (Fig. 3).

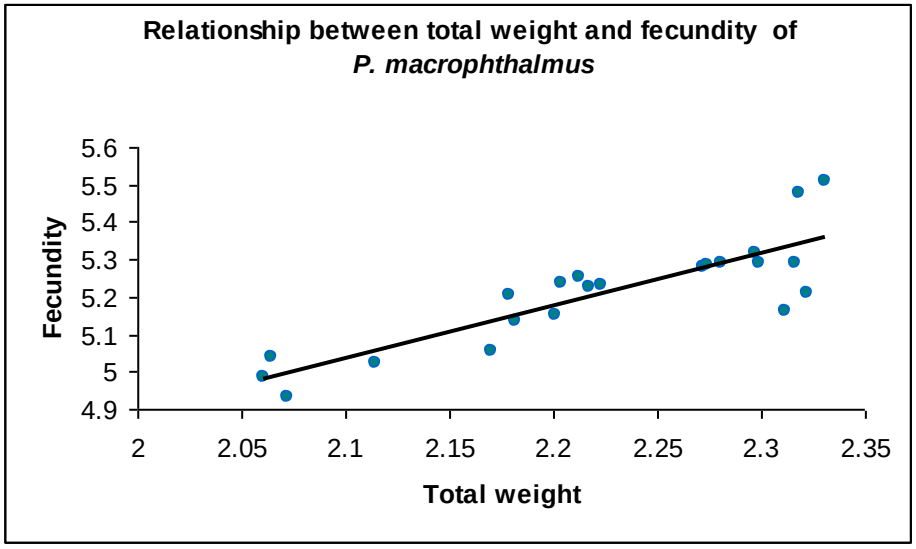
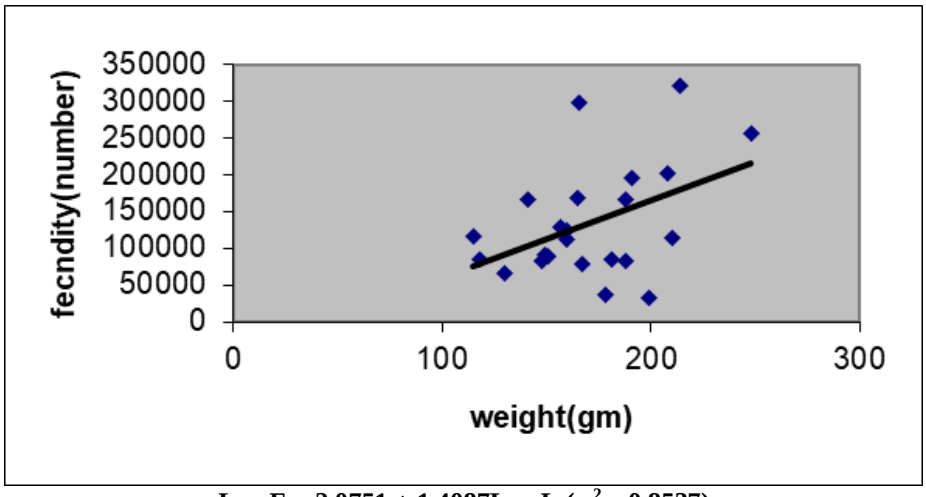
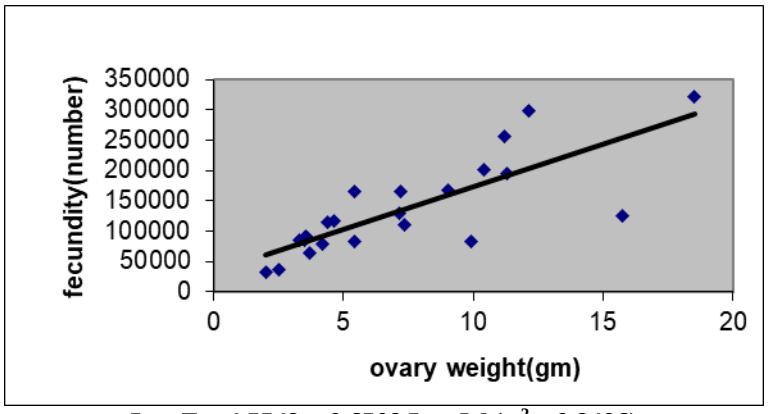


Fig. 2. The relationship between total weight and fecundity.



Log F = 2.0751 + 1.4087Log L (r^2 = 0.8537)

Fig. 3. The linear relationship between total weight and fecundity.



Log F = 4.5549 + 0.6509 Log W (r^2 = 0.9406)

Fig. 4. The linear relationship between total weight and fecundity.

The linear relationship between weight of ovary and fecundity of the species is given below and have shown good relationship between weight and fecundity (Fig. 4). The absolute fecundity ranged from 85,124 - 3,21,564 eggs, with ovary weighing between 3.516 gm – 19.520 gm. Rao (1967) reported that *Pseudosciaena aneus* (≈ *P. macrophthalmus)* spawns once in a year, from December to March. Murty and Ramalingam (1986) observed *P. macrophthalmus* from Andhra coast to spawn at least twice in a year. The present study also indicates this species spawns at least twice in a year while the time interval between the two is slightly longer.

From the above study it is concluded that *P. macrophthalmus* a asynchronous spawner breeds in two distinct batches *i.e.* in October and February to May. The average percentage composition of male and female indicates that females outnumbered the males. The length at first maturity (50%) is 176.5 mm and the fecundity reveals that the number of eggs produced was found to be increase with increase in total length; total weight and ovary weight and fecundity shared a good correlation with body weight and ovary weight for all the three species.

There is a need for management measures and awareness among the fishermen such as optimum mesh size regulation to protect the brooder *viz.* above 176 mm and protection of spawning ground and the season towards the sustainability of the big-head Pennah Croaker (*Pennahia macrophthalmus)* stock and its productivity on the Odisha coast.

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