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RESEARCH PAPER

Delineating some of the reproductive aspects of *Macrognathus pancalus* from the river Sessa, Assam, India

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ABSTRACT

Macrognathus pancalus is the common Mastacembelidae species having good nutritional as well as ornamental value. Reproductive biology of the species was studied from June 2016 to June 2017 from Sessa river, Assam. The sex ratio of different month showed wide variation from 1:0.21 (April) to 1:4 (Oct) and overall M: F sex ratio was recorded 1:0.76, indicating a highly skewed distribution of sexes from the expected 1:1 ratio favoured by females in most of the months, ($P<0.0079$, $\chi^{2=}14.00$). The gonado-somatic index (GSI) sequence revealed prolonged spawning with its peak in August both in female (9.84±0.35) and male (3.29± 0.18).The ova diameter progressively increased from 0.4±0.10 (March) to 1.6±0.048 mm (September) having peak in August. The absolute fecundity of the fish ranged from 275 (fish: 9.5cm; 7.20gm) to 4518 (fish: 17.0cm; 12.80gm) and was high during May-August which falls within the breeding period. Fecundity increases with increase in weight of the fishes which indicate a linear relationship between absolute fecundity and fish weight ($r^2=0.824$, $P < 0.01$).

KEYWORDS: *Macrognathus pancalus*, Mastacembelidae, spawning, gonad, fecundity.

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Introduction

Macrognathus pancalus (Hamilton, 1822), commonly known as the striped spiny eel or barred spiny eel, mainly inhabits rivers, streams, lakes, canals, beels, ponds and inundated fields (Vettah *et al.*, 2006). It has a good nutritional value and demands a high price in markets when sold alive particularly in north-eastern parts of India where people delight alive and less bony fish (Serajuddin, 2005). Because of its beautiful colour pattern and fantabulous outlook it is popular as an aquarium fish and has been reported to be exported from India to America, Europe and other Asian countries. Its presence has also been reported from estuaries. Besides due to various anthropogenic factors the population of this species is declining in the Indian sub-continent, as perceived from dwindling market arrival (Lakra & Sarkar, 2006). Unregulated exploitation might endanger their wild population in near future. So far, there has been very little work on the reproductive biology of *M. pancalus* in worldwide. Suresh *et al.* (2006) studied some aspects of biology and fisheries of *M. pancalus* from Ganga river system. Abujam & Biswas (2011) also described on the certain reproductive biology of *Macrognathus aral* from upper Assam. Swarup *et al.* (1972) studied on sexual dimorphism of *M. pancalus* while, Karim & Hossain (1972) have worked on the general biology of *M. pancalus* in artificial ponds and also studied the sexual maturity and fecundity. But no detailed work has so far been done on the reproductive biology of *M. pancalus* from the Sessa River of Assam, India. In that context the present endeavour aims at unearthing the reproductive strategies of this particular species and generating baseline information to build up a scope for its artificial propagation as well as conservation of the species in future.

Materials and methodology

Samples of *M. pancalus* were collected from Sessa river of Dibrugarh district, Assam, India on monthly basis from June 2016 to June 2017. Altogether 480 (199 males, 281 females) specimens were collected for study of sex, gonadal development, spawning activity, ova diameter and fecundity and then preserved the specimens in 10% formalin for subsequent analysis. Sex was determined by examination of gonads either by visual assessment or under a binocular microscope. Spawning season was

estimated based on the observation of gonad maturation during the study period and the monthly gonado-somatic index (GSI). The monthly gonado somatic index was calculated according to formula GSI= (gonad weight/ total body weight) X 100 (June, 1953). Sex ratio of the fish was studied by chi-square test following the equation of Fisher (1970), assuming that the proportion of male to female ratio is 1:1. To determine the spawning season and breeding periodicity, maturity stages were classified as: stage I (Immature virgin), stage II (maturing or recovering spent), stage III (Ripening), stage IV (mature or ripe), and stage V (spent) (Pathak *et al.*, 2012). The ova diameter progression was studied on monthly basis as described by Hickling and Rutenberg (1936). It was calculated for each ovary as OD=1 ncm^{-1}, whereas OD=ova diameter, n= number of eggs in 1 cm.

The absolute fecundity was estimated as per Lagler, 1956; Doha and Hye, 1970.

Absolute fecundity = n G/g

n= No. of eggs in subsample, G= Weight of gonad, g= Weight of the subsample

Result

The present study is based on 480 fish samples of *Macrognathus pancalus* with length group of 9.0- 17 cm TL (199 males, 281 females). There were no observed ripe males or females smaller than 9.5 cm through all the collected samples.

Sex ratio: Sex ratio of different month has showed wide variation from 1:0.21 (April) to 1:4 (Oct). In the present study, out of 480 fish specimens examined, 199 were males and 281 females. The overall M: F sex ratio was recorded 1:0.76, indicating a highly skewed distribution of sexes. Sex ratio of different months has shown (Table 1) that there was significant variation from the expected 1:1 ratio favoured by females in most of the months, ($P<0.0079$, $X^2=14.00$). Monthly sex ratio confirmed the expected 1:1 during January. In respect to the length distribution females were predominant and bigger in size than males. Length group 9cm-12cm dominated the male population whereas in female population 13cm-16.9 cm length group showed its dominance (Figure.1).

Maturity stages: In both male and female the seasonal changes were grouped into 5 distinct stages viz. immature (stage I) and maturing (stage II) in February-March, Mature (stage III) and ripe (stage IV) specimens were recorded from April onwards till September and spent stages (V) appeared from October onwards (till December) whereas in males the developing stages were recorded during Feb-April, mature and ripe stages were available between May and September (Table 3). The spent and recovering stages of males were encountered between October and February.

Table 1. Monthly variation in sex ratio of *Macrognathus pancalus*.

Month	Total no. of fish	Male		Female		Sex ratio M/F	Chi square
		No. of fish	%	No. of fish	%		
June	41	12	29.27	29	70.73	1:0.4	7.05*
July	35	14	40.00	21	60.00	1:0.6	1.40
August	42	16	38.09	26	61.90	1:0.6	2.38
September	38	9	44.74	29	76.32	1:0.8	10.50*
October	40	32	80.00	8	20.00	1:4	14.40*
November	42	18	42.86	24	57.14	1:0.75	0.86
December	36	15	41.67	21	58.33	1:0.71	1.00
January	40	20	50.00	20	50.00	1:1	0
February	45	25	55.56	20	44.44	1:3.5	13.90*
March	40	19	47.50	21	52.50	1:0.90	0.10
April	46	8	17.13	38	82.61	1:0.21	19.60*
May	35	11	31.43	24	68.58	1:0.46	4.83*
Total	480	199	43.13	281	58.54	1:0.76	14.00*

$P< 0.01$

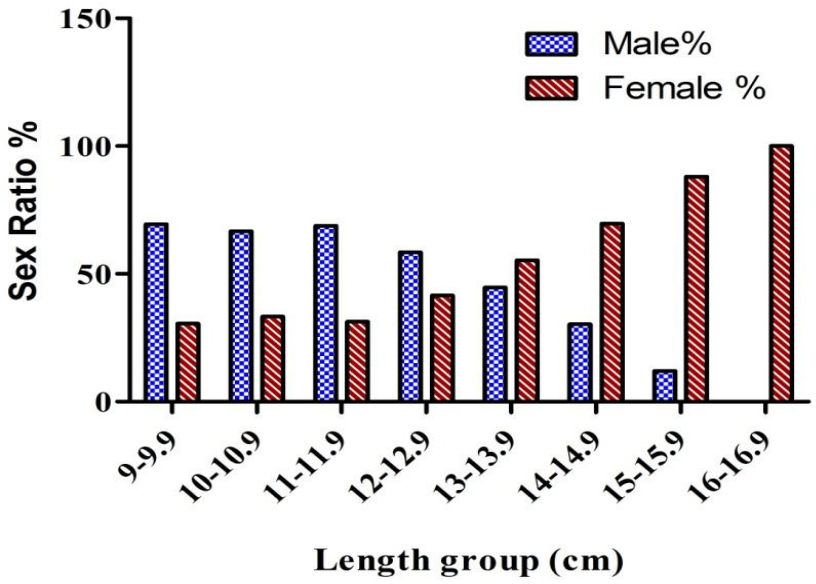

Figure 1. Sex ratio in different length groups (cm) of *Macrognathus pancalus*.

Table 2. Maturity stages of *M. pancalus*.

Maturity stages	Testes	Ovary
StageI (Immature)	Testes very thin, thread like, translucent.	Ovaries are small, thin and semi-transparent.
StageII (Maturing)	Testes are slightly elongated, white in colour.	Ovaries elongated, swollen, light yellow in colour.
StageIII (Mature)	Testes are creamy white occupying half of the stomach cavity.	Ovaries voluminous. Ova are with distinct yolk and are visible with naked eye.
StageIV (Ripe)	Testes are massive in size, creamy white in colour.	Ovaries massive in size and occupy major portion of the stomach cavity.
StageV (Spent)	Testes shrinking, flaccid, whitish to translucent and very thin.	Ovaries flaccid, shrinking, left with only a few residual eggs under ova.

Table 3. Monthly variation in maturity stages of *M. pancalus*

Months	No of females examined	Maturity stages (%)					No of males examined	Maturity stages (%)				
		I	II	III	IV	V		I	II	III	IV	V
June	29	--	--	25.4	45.33	--	12	--	--	10.12	19.15	--
July	21	--	--	4.50	55.50	--	14	--	--	2.00	38.00	--
August	26	--	--	--	61.90	--	16	--	--	--	38.1	--
September	29	--	--	--	76.32	--	9	--	--	--	44.74	--
October	8	--	--	--	--	20.0	32	--	--	--	--	80.0
November	24	--	--	--	--	57.14	18	--	--	--	--	42.86
December	21	9.50	--	--	--	48.83	15	12.50	--	--	--	29.19
January	20	38.9	11.1	--	--	--	20	40.50	9.50	--	--	--
February	20	29.9	14.5	--	--	--	25	28.06	27.50	--	--	--
March	21	--	20.7	31.8	--	--	19	--	20.20	27.30	--	--
April	38	--	9.90	72.7	--	--	8	--	6.29	11.10	--	--
May	24	--	--	40.77	27.80	--	11	--	--	18.20	13.23	--

Gonado-Somatic Index (GSI): Samples analysed for the study covered twelve months (June to May), GSI and sequence of maturity stages for males and females of *M. pancalus* revealed that GSI increased considerably from March until May reaching its peak value in August. The highest mean GSI value for males (3.29± 0.18) and females (9.84±0.35) were demonstrated during August, while the minimum values were seen in November- January. The appearance of gradual increases in GSI reveals that spawning activity takes place during summer months in *M. pancalus*.

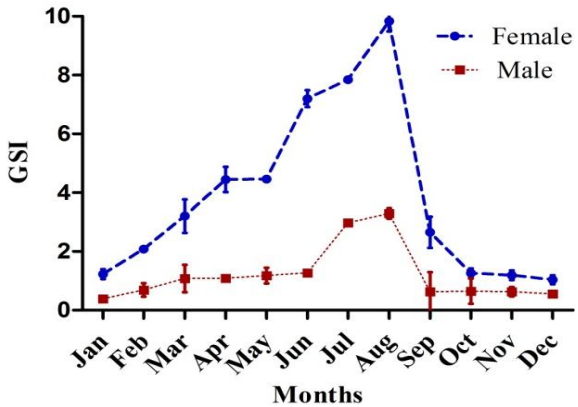

Figure 2. Monthly variation of Gonado- Somatic Index (GSI) of *M. pancalus*.

Ova diameter: The ova diameter progressively increased from 0.4±0.10 (March) to 1.6±0.048 mm (September). Immature ova (0.4-0.6 mm) were found in the ovaries during March- April. Maturing and mature ova (0.61-0.8 mm) were encountered during April to June while ripe ova (0.81-1.6 mm) during June to September (Figure. 3) with the peak in August (1.6±0.048 mm). The eggs were spherical and uniform in diameter. The frequency of maturing and mature ova gradually fall down from October onwards and these were completely absent during November-January, indicating that the spawning was over and their frequency began to rise from March onwards.

Fecundity: The absolute fecundity of *M. pancalus* was estimated based on 281 gravid females, which were taken during the spawning months. The absolute fecundity of the fish ranged from 275 (fish: 9.5cm; 7.20gm) to 4518 (fish: 17.0cm; 12.80gm). Monthly variation in mean fecundity is shown in figure3 and fecundity was high during May-August which falls within the breeding period. Fecundity increases with increase in length and weight of the fishes which indicate a linear relationship between absolute fecundity and fish weight with high correlation (r^2=0.824, P < 0.0001). It was evident that fecundity increased as fish grows in weight (Figure.4.) The body weight and fecundity exhibited a linear relationship according to the following equation in *M. pancalus*.

F=1043.5 Wt+416.59

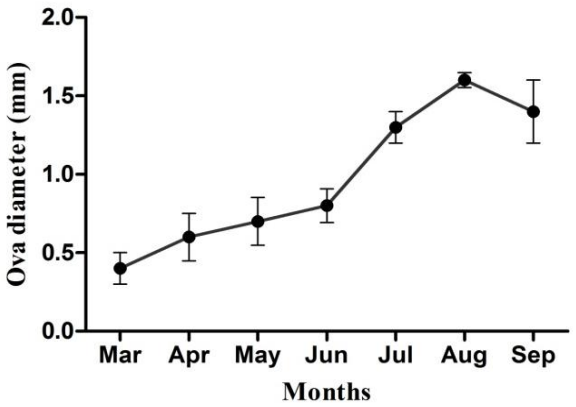

Figure 3. Monthly variation of mean ova diameter of *M. pancalus*.

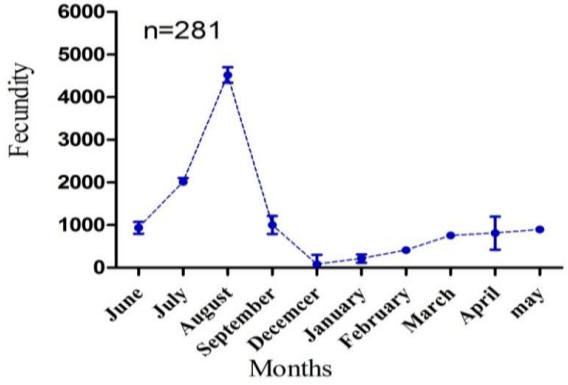

Figure 4. Mean monthly variations in absolute fecundity of *M. pancalus*.

Discussion

Sex ratio, maturity, gonado-somatic index and fecundity are some of the conventional and vital tools for effectively analyzing the reproductive potential of a population (Sabrah *et. al.*, 2016). In the present investigation it was found that females dominated the population during most of the study periods and in all the length groups compared to males and these difference in the sex ratio was significance (P <.001) from the expected ratio (1:1).

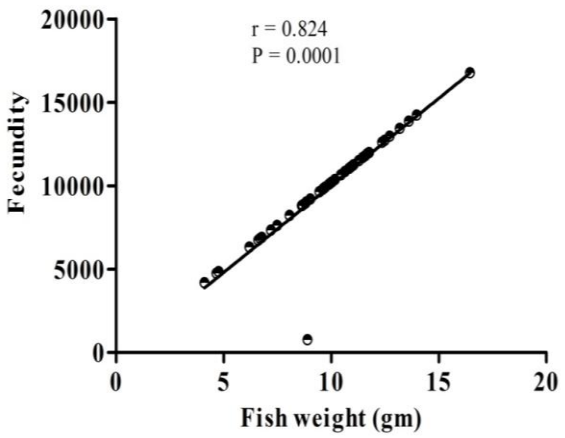

Figure 5. Relationship between fecundity in relation to body weight of *Macrognathus pancalus*.

It was also noticed that the percentage of females was higher than males by about 2/3 during the study periods and the ratio of males to that of females decrease as the fish length increases. Sex ratio studies have been considered important in fisheries science, generally a sex ratio of bisexual species is close to 1:1 (Swarup *et al*., 1972) while Suresh *et al*. (2006) have documented female dominance in their study. The concept of 1:1 sex ratio was confirmed by Pathani (1978) in *Tor tor* and Jhingran & Khan (1979) in *Cirrhinus mrigala*. Conover and Voorhees (1990) indicated that high temperature observed during the late spawning may cause most of the recruited small fish produced to become males. Wahbeh (1992); Yousif and Sabrah (2004) and Cherif *et al*. (2007) reported that the predominance of females may be connected with the high catch ability for females than in males, or as they are more vulnerable to the fishery, also in some species males migrate, disappear or to guard their eggs and juveniles in deep waters. According to Chakroun and Ktari (2006) an unbalanced sex-ratio in favour of females in some species, revealing that the natural mortality may be higher for males while the females are more prone or highly vulnerable to the fishing gears. Suresh *et al*., (2006) also reported female dominance in their study. Pathak *et al*., (2013) too observed male dominance in lentic habitat while female dominance in lotic habitat for this fish species.

Monthly distribution of the developing stages revealed that maturing period (stage II) to be between February-March; mature (stage III) and ripe (stage IV) to be from April onwards till September. Similar pattern of development in the gonads of spiny eel has also been reported by Abujam and Biswas (2010). A marked increase in gonado-somatic index (GSI) pattern for the species in males and females from March to September synchronized with those of high percentage of matured fishes reflects good gonadal cycle. These sequences probably suggest that *M .pancalus* species are characterized by prolonged spawning activity extending from June onwards to early September (monsoon spawner fish). These results are in agreement with the previous studies on *M. pancalus* that recorded the same spawning periodicity (Suresh *et al*., 2006). Suresh *et al*. (2006) reported early maturation of male fishes. However, paradoxical to that report Pathak *et al*. (2013) observed both the sexes to get matured at the same length. Successive changes observed in the intra-ovarian diameter for a period not less than a year can give an idea of the spawning periodicity of the fish studies (Al-Mukhtar *et al*., 2006). The ova diameter studied showed maturing and mature egg (0.61-0.8 mm) during April to June while ripe egg (0.81-1.6 mm) were encountered from June till September with the peak in August (1.6 mm). Nabi and Hussain (1996) in *Macrognathus aculeatus* and Suresh *et al*. (2006) in *Macrognathus pancalus* also documented similar findings. The occurrence of maturing and mature ova gradually decreased from October onwards and these stages were completely absent during November-February, indicating culmination of the spawning season (June – September) and the advent the spent stage. This indicated that the fish has probably a long spawning period, extending from June to September.

Fecundity is one of the most common traits for reproductive potential of a particular fish species whereby it is enumerated by the number of ripe eggs in the ovaries of a female fish (Hyndes *et al*. 1992). Estimation of fecundity of fish is a prerequisite not only in successful breeding programme but also in its stock, life history etc. (Pankhurst 1998). According to Abujam and Biswas (2011), the low fecundity of the species also might be due to prolonged breeding season or parental care and high fecundity might be the result of environmental conditions in *Macrognathus aral*. The fecundity of a species is also dependent availability of body cavity keep mature ovaries, on egg size and high fecundity is often correlated with small egg size and vice versa (Rath 2000). However, in the present study, higher fecundity was found in larger specimens in the species. Furthermore, the fecundity increases with the increase weight of *M.pancalus*. The results of the present study are similar to those obtained by Narejo *et al*. (2002) in *M. armatus* and Suresh *et al*. (2006) in *M. pancalus*. Fecundity was moderately high during May- August in the species. The variations of fecundity are very common in fishes and the number of eggs produced by an individual

female is dependent on various factors, like size, age, types of species of the samples and their ecological habitats including food availability (Moyle and Cech, 2000; Annappaswamy *et al.* 2008). The present enumeration revealed a linear relationship of fecundity with body weight, this relationship was in cohert with that of Das *et al.* (1989) in *Heteropneustes fossilis*. Similar observation had also been reported in *Labeo calbasu* (Pathak and Jhingran, 1977); *Gudusia chapra* (Kabir *et al.,* 1998). Hence, from the above observation it is revealed that the spawning season of *M. pancalus* extends from June to September with peaks in August. Closed or less intense fishing during the spawning period and selective catch of only 11.5 cm (say 12 cm) and above length would help conservation of the natural stock of the fish, by allowing the fish to breed at the spawning season. Also, the baseline data generated will be expedient to biologist aims at standardizing the captive breeding technique in view of its artificial propagation and for further conservation.

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