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Studies on the reproductive biology of spiny eel, *Macrognathus aral* from upper Assam

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Abstract

The one-stripe spiny eel, *Macrognathus aral* (Bloch and Schneider), has been gaining importance not only as a food fish but also as an aquarium fish for its body shape and behaviour. The overall M:F ratio recorded 1:0.27, both the males and females were mostly mature in May-August. The peak values of gonado somatic ratio (GSR) attained during May for males (1.3) and August for females (12.4) indicating that the fish have only one breeding season during summer. The range of ova diameter was found to vary from 0.3 to 1.4 mm, the absolute fecundity ranged from 250 (21.6 cm / 27.4 g) to 5220.1 (27.2 cm / 66.3 g) while relative fecundity ranged from 9.1 to 128.9. The 50% maturity is attained in length group of 10.1-14 cm for males and 14.1-18 cm for females. The species is a moderately fecund, isochronal spawner and having a restricted breeding season. The relationship between fecundity and body weight and length has also been discussed.

Key words

Reproductive biology, *Macrognathus aral*, Stripe spiny eel, Assam

Introduction

The *Macrognathus aral* (Bloch and Schneider) inhabits slow and shallow water of plains and estuaries and also found in canals, streams, *beels*, ponds and inundated fields and the species is distributed to India, Pakistan, Bangladesh (Talwar and Jhingran, 1991). In the north-east, particularly in upper Assam, the species has very high demand especially when sold alive, fetching a price between Rs. 180 and 250 kg^{-1}. The species popularly known as peacock eel in the international market also having an excellent ornamental value. The population of this species is fast declining in this region, as perceived from dwindling market arrivals, due to habitat modification and over exploitation. Unregulated exploitation might endanger their wild population. As per Conservation Assessment and Management Plan (CAMP) Report (1998) it is included under "Lower Risk near threatened" (LRnt-category) in India. However, Lakra and Sarkar (2006) reported the species distributed in the Eastern Ghat region of India have found place in the World Conservation Union Red List (2006).

There has been very little work carried out on the reproductive biology of *Macrognathus species*. Swarup *et al.* (1972) studied on sexual dimorphism of *M. pancalus*. Karim and Hossain (1972) have been worked on the general biology of *M. pancalus (Ham.)* in artificial ponds and also studied the sexual maturity and fecundity. Kocetov (1992) reported on few aspects of breeding of spiny eels. Narejo *et al.* (2002) studied on the ova diameter, gonadosomatic index, and fecundity of *Mastacembalus armatus* in Bangladesh. Chavan *et al*. (2006) made an attempt on the conservation for spiny eel, *Mastacembalus armatus*. Suresh *et al*. (2006) described some aspects of biology and fisheries of *M. pancalus* from Ganga river system. Extensive works have been carried out on food and feeding habit, cytological, redescription, morphometry and length-weight relationship of the mastacembelid fishes in India and abroad in last few decades. Of these, the most notable works were those of Saxena *et al.* (1979), Serajuddin and Mustafa (1994), Serajuddin *et al.* (1998), Froese and Binohlam (2000), Serajuddin (2004), Serajuddin and Ali (2005), Ahirrao (2008), Emmanuel and Melanie (2009), and Cakmak and Alp (2010). But no detailed work has so far been done on the reproductive biology of *M. aral*. Therefore, an in-depth study on the maturity and spawning biology of spiny eels was taken up in order to have baseline information for future captive breeding program of the species.

Materials and Methods

Altogether 197 specimens of *M. aral* were collected from different landing stations of lentic and lotic water systems in Dibrugarh and Tinsukia Districts of Assam between November 2007 and October 2008. The total length, weight, sex and maturity of gonad of the collected fish were recorded. The specimens (*M. aral*) were then preserved in 10% formalin for subsequent analysis.

Sex ratio of the fish was compared through Chi-square test (x^2), following Fisher (1970). Gonado-somatic ratio (GSR) of the male and female was estimated separately by using the following method of June (1953), GSR = weight of gonad (g) x 100/ total body weight (g). The ova diameter progression was recorded monthly 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. On the other hand, the absolute fecundity was calculated as suggested by Grimes and Huntsmen (1980). It was obtained by using the following formula: $F = N \times G\ g^{-1}$. Where, F = fecundity, N= no. of eggs in sub sample, G= total weight (g) of ovary and g= weight (g) of the sub-sample. Similarly, relative fecundity was estimated by simply dividing the absolute fecundity with total body weight (g). Length at first maturity and determination of M_{50} was also calculated following Hodgkiss and Mann (1978).

Results and Discussion

Sex ratio (male: female): The sex ratio studies have been considered important in fisheries. Generally, a sex ratio of bisexual species is close to 1:1 (Swarup *et al*., 1972). The concept of 1:1 sex ratio was confirmed by Pathani (1978) in *Tor tor* and Jhingran and Khan (1979) in *Cirrhinus mrigala*. However, the sex ratio of different month has showed wide variation from 1:0.12 (Oct) to 1:0.91 (Mar). In the present study, out of 197 fish specimens examined, 155 were males and 42 females. The overall M:F ratio was recorded 1:0.27, indicating a highly skewed distribution of sexes. Sex ratio of different months has shown (Table 1) that there was highly significant variation from the expected 1:1 ratio favoured by males in most of the months. Females attain larger in size (28.5 cm and 88.23 g) than males (20.8 cm and 27.53 g). Probably due to their differential size and niche they occupy, the female evades the fishing gear more often than not and hence the females were less encountered in the catch. The present observation confirms an

Table - 1: Monthly variation in sex ratio (male: female) of spiny eel *M. aral*

Months	Male	Female	Total sample	Sex ratio	Chi-square
November	11	2	13	1:0.18	6.23**
December	11	3	14	1:0.27	4.57*
January	7	-	7	-	7.00**
February	11	-	11	-	11.00**
March	11	10	21	1:0.91	0.05*
April	17	4	21	1:0.24	8.05**
May	13	5	18	1:0.38	3.56*
June	18	4	22	1:0.22	8.91**
July	13	4	17	1:0.31	4.76*
August	14	4	18	1:0.29	5.56**
September	12	4	16	1:0.33	4.00*
October	17	2	19	1:0.12	11.84**
Overall	155	42	197	1:0.27	64.82

* = Non significant, ** = significant at 5% level

Table - 2: Percentage occurrence of spiny eel *M. aral* in different stages of maturity

Months	No. of females examined	Maturity stages (%)					No. of males examined	Maturity stages (%)				
		I	II	III	IV	V		I	II	III	IV	V
November	2	- - -	- - -	- - -	- - -	15.4	11	15.4	- - -	- - -	- - -	69.2
December	3	- - -	- - -	- - -	- - -	21.4	11	- - -	- - -	- - -	- - -	78.6
January	-	- - -	- - -	- - -	- - -	- - -	7	- - -	- - -	- - -	- - -	100
February	-	-	- - -	- - -	- - -	- - -	11	- - -	27.3	- - -	- - -	72.7
March	10	23.8	14.3	9.5	- - -	- - -	11	9.5	23.8	- - -	- - -	19.1
April	4	- - -	9.5	9.5	- - -	- - -	17	9.5	52.4	19.1	- - -	- - -
May	5	- - -	- - -	5.6	22.2	- - -	13	- - -	27.8	44.4	- - -	- - -
June	4	- - -	- - -	9.1	9.1	- - -	18	31.8	31.8	18.2	- - -	- - -
July	4	- - -	5.9	17.6	- - -	- - -	13	- - -	11.8	35.3	29.4	- - -
August	4	- - -	- - -	11.1	11.1	- - -	14	22.2	27.8	11.1	5.6	11.1
September	4	- - -	- - -	6.3	6.3	12.5	12	- - -	25.0	- - -	- - -	50.0
October	2	- - -	- - -	- - -	- - -	10.5	17	10.5	5.3	- - -	- - -	73.7

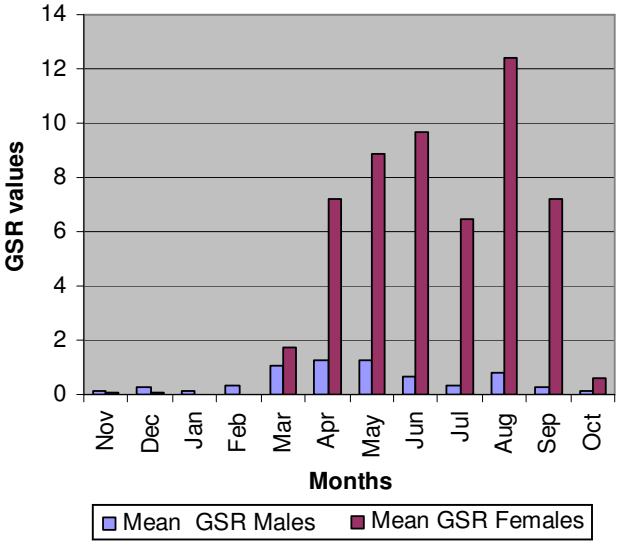

Fig. 1: Monthly variation in gonadosomatic ratio of spiny eel, *M. aral*

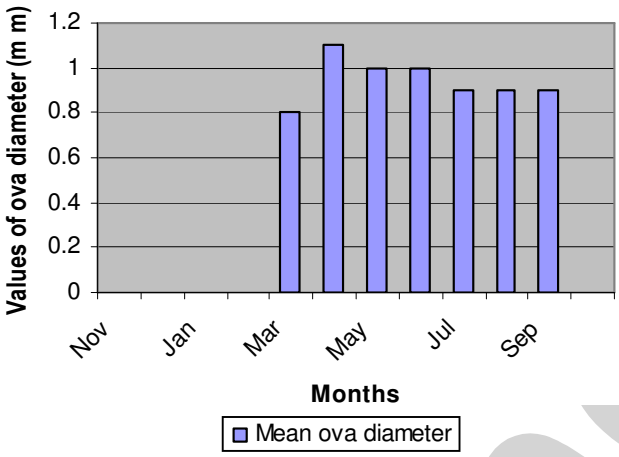

Fig. 2: Monthly progression of mean ova diameter of spiny eel, *M. aral*

earlier report on the differential sex of spiny eel by Suresh *et al.* (2006).

Maturity stages: It is observed that all stages of maturity occurred in most of the months of a year. The monthly percentage distribution of males and females at various maturity stages is given in Table 2. Females were mostly immature (stage I) and maturing (stage II) in March-April. Mature (stage III) and ripe (stage IV) specimens were recorded from May onwards till August and spent stages (V) appeared from September onwards (till December) whereas males were in developing stages during Feb-April, mature and ripe stages were available between May and August and similar trend was reported by Abujam and Biswas (2010) in spiny eel from upper Assam. The spent and recovering stages of males were encountered between September and February (Table 2).

Gonado-somatic ratio: The gonadosomatic ratio (GSR) is an indicator of the seasonal development of the gonads. The monthly variations in GSR of the males and females ranged from 0.11 (Nov) to 1.3 (May) and from 0.08 (Nov) to 12.4 (August) respectively. The mean gonadosomatic ratio for the male and female fish specimens was 0.57 and 5.43. The GSR values for males were observed higher during February-August (peak in May) and subsequently decreased from September onwards whereas GSR in females increased from March to September (peak in August) which started decreasing from October onwards (Fig. 1). This also indicated that the spawning was over by October and GSR declining abruptly thereafter, when the fish become spent. Therefore, it is concluded that the fish spawned once in a year with one spawning peak, and same has also been reported by Nabi and Hossain (1996) in freshwater spiny eel, *Macrognathus aculeatus* from Bangladesh.

Ova diameter: The ova diameter progressively increased from 0.3 (March) to 1.4 mm (May). Immature ova (0.3-0.6 mm) were found in the ovaries during March-April. Maturing and mature ova (0.61-0.9 mm) were encountered during March to September while ripe ova (0.91-1.4 mm) during March to September (Fig. 2) with the peak in May (1.4 mm). The eggs were spherical and uniform in diameter. Similar findings were also reported by Nabi and Hussain (1996) in *Macrognathus aculeatus* and Suresh *et al.* (2006) in *Macrognathus pancalus*. The frequency of maturing and mature ova gradually fall down from October onwards and these were completely absent during November-February, indicating that the spawning was over. Thereafter their frequency began to rise from March. This indicated that the fish has probably a long spawning period, extending from March to September. The progressive change 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 (Biswas, 1993).

Fecundity: Estimation of fecundity of fish is a prerequisite in successful breeding programme as fecundity of a species is an indicator of reproductive potential of the species. Bagenal and Braum (1978) had reported that fecundity in fish species characteristically varied among individuals of the same size and age. Fagade *et al.* (1984) had also suggested that fecundity variation may be due to differential abundance of food. In the present study the individual fecundity recorded from 250 (21.6 cm / 27.4g) to 5220.1 (27.2 cm / 66.3g) while relative fecundity ranged from 9.1 to 128.9 (Table-3). The monthly variation in mean fecundity, calculated as mean of fecundities of monthly samples. The average monthly absolute fecundity for female *M. aral* was found to range from 833.43±248.26 to 3027.57±1689.66 while relative fecundity varied from 39.63±18.61 to 88.76±28.31. Fecundity was high during May-September. Jayasankar (1990) reported the fecundity in *Signanus canaliculatus* varied irrespective of the length or body weight of the fish and increased with ovary weight while Narejo *et al*. (2002) observed that fecundity of spiny eel was mainly dependent on their total length and body weight. Based on the above studies it may be concluded that the spiny eel is a moderately fecund species.

Length at first maturity and determination of M_{50}: For determining the size at first maturity of the gonads of *M. aral*, percentages of immature, maturing and mature/ripe were calculated

Table - 3: Monthly variations in body length, body weight and fecundity of spiny eel, *M. aral*

Months	Mean body length (cm)	Mean body weight (g)	Mean absolute fecundity	Mean relative fecundity
March	17.47±1.86	16.41±5.54	870.64±248.3	53.4±31.39
April	18.17±3.89	20.79±16.43	833.43±235.9	39.63±18.61
May	18.27±3.07	20.73±15.6	2191.45±978.32	61.01±20.85
June	17.2±5.85	21.56±19.67	3027.57±1689.66	70.38±28.68
July	18.96±3.99	25.58±14.38	2219.86±1473.66	64.18±31.95
August	16.82±3.92	17.02±12.32	1682±846.97	77.86±42.86
September	17.95±2.65	20.5±7.54	1663.16±281.37	88.76±28.31

Mean ± S.D.

Table - 4: Percentage (%) of maturity in different body length groups of spiny eel, *M. aral*

Body length (cm)	Sex	Immature %	Maturing %	Mature/Ripe %
6.0-10	Male	100	- - -	- - -
	Female	- - -	- - -	- - -
10.1-14	Male	28.6	53.6	17.8
	Female	66.7	33.3	- - -
14.1-18	Male	5.3	40.0	54.7
	Female	6.3	62.5	31.2
18.1-22	Male	2.4	33.3	64.3
	Female	- - -	23.5	76.5
22.1-26	Male	- - -	25	75
	Female	- - -	25	75
26.1-30	Male	- - -	- - -	- - -
	Female	- - -	- - -	100

separately (Table. 4). The result indicated that in the 6.0-10 cm length group, 100% males were immature while 53.6% of maturing males and 66.7% immature females were observed in the 10.1-14 cm length group. The 40% of maturing males and that of 62.5% females were observed in the length groups of 14.1-18 cm. Similarly, 75% of both males and females were found mature/ripe in the length group of 22.1-26 cm and 100% maturity (females) was observed in 26.1-30 cm length group. Again, 50% maturity (M_{50}) was calculated in length group of 10.1-14 and 14.1-18 cm for male and female respectively indicating that males mature at smaller size than their female counterparts. The calculated size at first maturity for male was an average of 12.05 cm and for female it was an average of 16.05 cm. Hence, this length groups may be considered as the length at which first maturity is attained. Incidentally, the smallest mature male and female was recorded in the present study as 12.6 and 15.7 cm respectively.

Although spiny eel is still available in both lotic and lentic systems, the exceedingly low availability of female is baffling, it may be due to high agility of females to escape fishing gear. From the available data it appears that the breeding season of spiny eel is between May and September indicating a prolonged breeding season. The values of GSR and ova diameter in different months corroborate the above studies. Therefore it is concluded that the fish spawns once in a year with single spawning peak. The fecundity study reveals that the species is moderately fecund.

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