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Fecundity of Wild Freshwater Spiny Eel *Mastacembelus armatus* Lacepede from Mymensingh Region of Bangladesh

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Abstract

The fecundity for 40 wild freshwater spiny eel *Mastacembelus armatus* estimated from Mymensingh region, Bangladesh during the breeding period from March to July 2004. The estimation of fecundity (mature ova) ranged from 3,155 to 24,684 eggs, the maximum fecundity was observed from a fish measuring 535 mm in length and 350 g in weight and the minimum from a fish of 260 mm in length and 51 g in weight. The maximum ova diameter was 2.75 mm in the month of April and minimum was 1.45 mm in May with a median of 2.08 mm in the month of March and then a sudden decrease in July (1.84 mm). The average number of ova present per gm body weight was 70.19 while the average number of ova present per gm ovary weight was 888.04. Fecundity increased with the increase in length and weight of the fish. Maximum GSI value for female spiny eel was 21.67% in the month of March and the minimum GSI value for the same gender was 3.30% in April and the median GSI value for the same was 8.06% in the month of May. The regressions of fecundity on body length, body weight and gonad weight of female spiny eels were $\text{Log F} = 2.59 - 2.72 \times \text{Log L}$ ($r = 0.86$), $\text{Log F} = 1.00 + 1.84 \times \text{Log BW}$ ($r = 0.88$) and $\text{Log F} = 0.69 + 3.25 \times \text{Log GW}$ ($r = 0.75$) respectively, where F is fecundity, L is total length (mm), BW is body weight (g) and GW is gonad weight (g). Fecundity-total length and fecundity-body weight gave a better relationship in comparison with fecundity-gonad weight relationship.

Introduction

Among the available freshwater eel species, *Mastacembelus armatus* has a good taste, high market value, lucrative size, important production potentials and high protein contents. The caloric value of eel flesh is as high as 303 cal/100 g compared to 110 cal/100 g in other average fishes (Nasar 1997). The freshwater spiny eel belongs to a family Mastacembelidae of order Perciformes is also known as Bam or Baim. It commonly occurs in the freshwater of

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this sub-continent (Jhingran and Talwar 1991). It is very common in rivers, canals, and ponds and inundated fields of Bangladesh (Rahman 1989). *M. armatus* is a very popular fish with high market demand, having about double the market value other than the carp fishes within the country. Instead of a delicious and widely accepted fish in this sub-continent, unfortunately no progress has been made to culture the species economically in Bangladesh. Very little systematic attempts have yet been made to study the biology and culture potential of this fish (Narejo 2003). Fecundity is one of the most important aspects of fish biology that must be understood to explain variations in the level of production, induced breeding success and amount of harvest. Fecundity may be expressed in terms of the number of eggs produced per brood fish in a breeding season (Lagler 1949).

Knowledge on reproductive biology of fish is essential for evaluating the commercial potentialities of its stock, life history, culture practice and management of its fishery (Doha and Hye 1970). 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). In order to achieve success in fish culture, it is important to asses the breeding cycle with fecundity of cultivable fishes. Knowledge on the fecundity of a fish species is important for determining: (a) spawning potential and its success (Qasim 1973), (b) fluctuations in the egg production potential of individual stock related to life processes such as age and growth (Ludwig and Lange 1975), (c) effects of environmental factors (DeVlaming 1971) and (d) formulating the commercial management of fishery (Lagler 1956). Reddy (1979) also mentioned the determination of breeding season is an essential part of biologic investigations of fishes.

Narejo (2003) worked on the reproductive biology of a freshwater spiny eel (*M. armatus*) and mud eel (*Monopterus cuchia*) of Mymensingh region, whereas, Taslim et al. (2002) carried out research on the fecundity of a freshwater eel (*Macrognathus aculeatus*) of Mymensingh basin. A serious shortage of some basic scientific information on the biology, especially fecundity of this spiny eel. In view of the above, present investigation was aimed to study the reproductive biology based on fecundity, ova diameter and gonadosomatic index of *M. armatus* from the wild freshwater spiny eel of Mymensingh region. The objective of this study also was to establish the empirical relationship between the fecundity with length, body weight and ovary weight of this species from an area.

Materials and Methods

Collection of fish samples

The study was conducted for a period of five months from March to July 2004. 40 females spiny eels were collected from different places of Mymensingh region, Bangladesh.

Laboratory studies

Eels were anaesthetized with 0.02% clove oil (Keene et al. 1998). Individual eel was then measured for total length to the nearest mm and total mass to the nearest g. Gonad regions sectioned. Paired ovaries from each fish were carefully removed, washed, cleaned with distilled water, dried with the help of blotting paper and then weight and length were measured to the nearest mm and nearest 0.1g respectively. Small pieces, from the anterior, middle and posterior regions of gonads were fixed at 5% buffered formalin with the ratio between gonad and fixative was 1:10 for subsequent studies. The ovaries of female were heavily swollen, their membrane becomes transparent and mature eggs were observed by naked eyes. Weight of anterior, middle and posterior regions of gonads was also recorded.

Fecundity estimation

Gravimetric method was used for fecundity estimation. The gravimetric method used in the experiment followed by Blay (1981), Dewan and Doha (1979), Shafi et al. (1978) and Narejo et al. (2002). First external connective tissue and ovarian membrane of preserved ovary was removed and from the surface moisture was blotted. Samples taken from the anterior, middle, and posterior region of both ovaries were weighed separately and the number of ova present with in each sample was counted. Fecundity was estimated on the basis of total weight of the ovaries. The fecundity of the fish was obtained by using the formula given by LeCren (1951):

$$F = \frac{N \times \text{Gonad weight}}{\text{Sample weight}}$$

Where F is the fecundity and N is the number of eggs in the sample.

Measurement of ova diameter

A total of 100 fresh ova were taken randomly from anterior, middle and posterior region of each ovary separated from the tissue by a fine needle and brush. The ova diameter was measured under microscope fitted with ocular micrometer according to recommended method given by LeCren (1951).

Calculation of Gonado-Somatic Index (GSI)

The Gonado-Somatic Index were calculated for each female fish separately by the following formula:

$$GSI = \frac{\text{Weight of ovary}}{\text{Weight of fish}} x 100$$

Analysis of data

The values of body length, body weight, gonad weight and number of eggs were transformed to common logarithms. The number of eggs were regressed on body length, body weight and gonad weight by the simple linear, least squares technique (model 1), yielding equations of the form log Y = log a + b log X. Because both independent variables and the dependent variable are subject to random variation and measurement error, model II regression might be chosen more properly as suggested by Ricker (1973) and Sokal and Rohlf (1995). Todd (1981) applied a functional or geometric mean model II regression to fecundity of the two New Zealand species of *Anguilla*. However, as inevitably the regressions are going to be used here and by others for predicting fecundity at a given length, model I was used in this paper (Sokal and Rohlf 1995). This seems to be the recent general practice for fecundity-size relations in fishes (Fleming and Gross 1990; Horwood 1993; Elliott 1995; Koslow et al. 1995).

Results

Fecundity

Fourty specimens of mature female spiny eel sampled during March to July 2004 ranged from 260 to 535 mm in total length (TL) and 51 to 350 g in weight. The number of ova ranged from 3,155 to 24,684. Maximum fecundity was recorded from a fish measuring 535 mm in TL and 350 g in weight and the minimum, from a fish measuring 260 mm in TL and 51g in weight (Table 1). The average number of ova present per g of body weight was 70.19 while the average number of ova present per g of ovary was 888.04. It was also noted that the fecundity increased with the increase in total length and body weight of the fish. The equations of regression co-efficient between total length (TL), body weight (BW) and gonad weight (GW) versus fecundity (F) are given below. All these relationships have been shown graphically in Figs 1, 2 & 3. Fecundity of the 40 freshwater spiny eels increased symmetrically with body length, body weight and gonad weight as characterized by the relations:

$$\text{Log } F = 2.59 - 2.72 \times \text{Log } L \text{ (Fecundity - Total length) } (r = 0.86)$$

$$\text{Log } F = 1.00 + 1.84 \times \text{Log } BW \text{ (Fecundity - Body weight) } (r = 0.88) \text{ and}$$

$$\text{Log } F = 0.69 + 3.25 \times \text{Log } GW \text{ (Fecundity - Gonad weight) } (r = 0.75),$$

respectively, where F = total number of eggs in an individual, L = total length (mm), BW = Body weight (g) and GW = gonad weight (g).

Table 1. Fecundity estimates for female *M. armatus* of minimum, median, and maximum lengths and weights from counting aliquots and from regression equations

	Length (mm)	Number of eggs		Weight (g)	Number of eggs		Ova diameter (mm)	GSI (Female)
		Aliquots	Regression		Aliquots	Regression		
Minimum	260	3155	2897	51	3155	4013	1.45	3.30
Median	352	8020	8335	118	8020	8312	2.08	8.06
Maximum	535	24684	19065	350	24684	23197	2.75	21.67

Ova diameter

Measurements of ova diameters were made to determine the relative sexual maturity of *M. armatus* (Table 1). The maximum ova diameter was obtained 2.75 mm in the month of April and minimum was1.45 mm in May with a median of 2.08 mm in the month of March and then a sudden decrease in July (1.84 mm). All the ova (100 from anterior, middle and posterior region of each ovary) were measured and found to be spherical and uniform in diameter.

Gonado-Somatic Index (GSI)

The GSI of the fish tends to increase as the fish approach maturity and declines with start of the spawning activities. The maximum GSI value for female spiny eel was 21.67 in the month of March and the minimum GSI value for the same gender was 3.30 in the month of April and the median GSI value for the same was 8.06 in the month of May (Table 1). A sharp increase of GSI was found in April (15.66) with sudden decrease in May (6.15), which was followed by July (7.00).

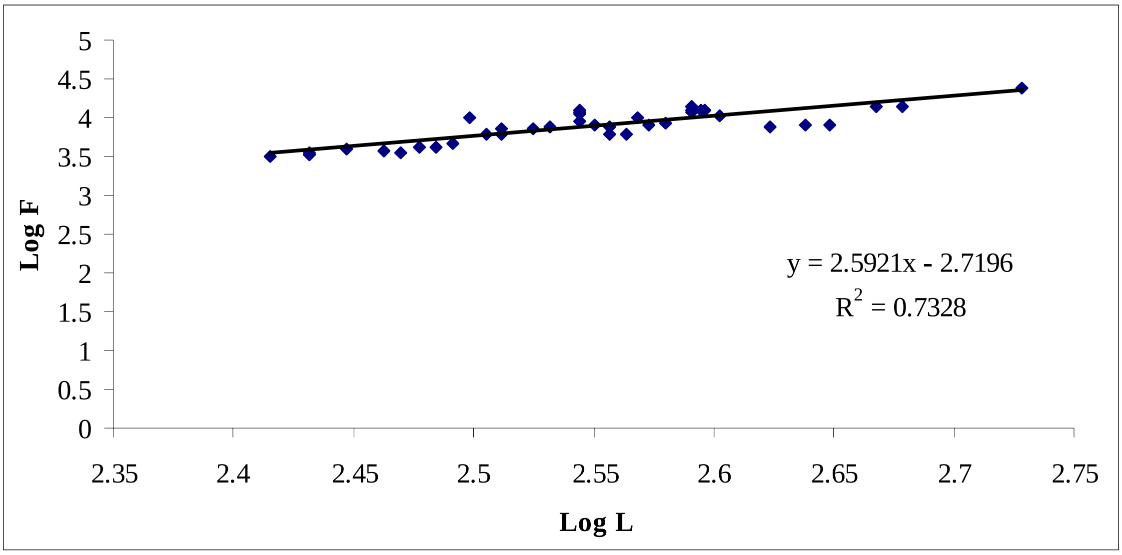

Fig 1. Logarithmic relationship between fecundity and body length of female spiny eel (*Mastacembelus armatus*) from Mymensingh region, Bangladesh

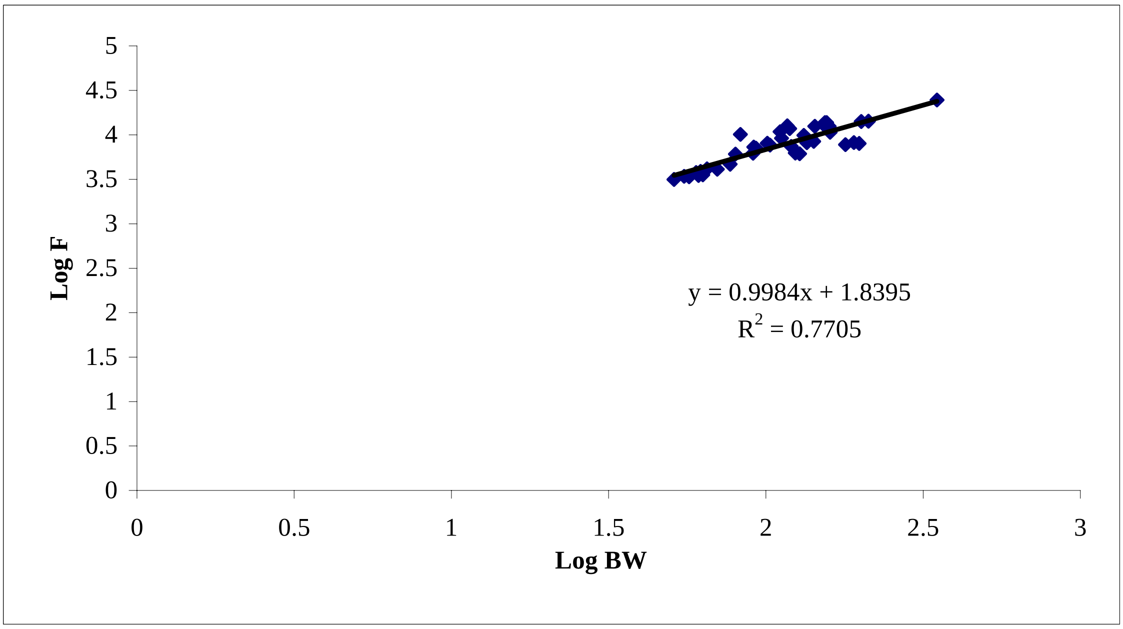

Fig 2. Logarithmic relationship between fecundity and body weight of female spiny eel (*Mastacembelus armatus*) from Mymensingh region, Bangladesh.

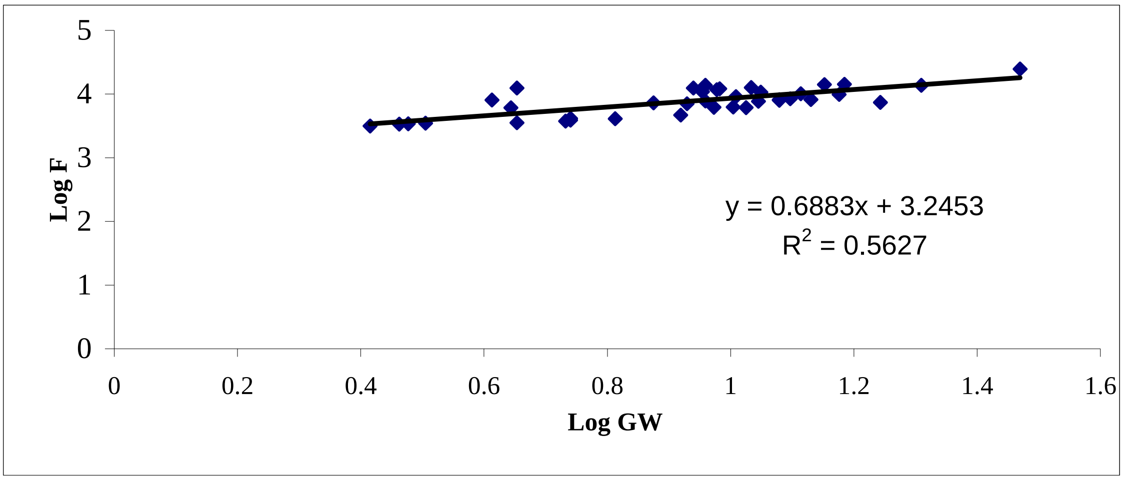

Fig 3. Logarithmic relationship between fecundity and gonad weight of female spiny eel (*Mastacembelus armatus*) from Mymensingh region, Bangladesh.

Discussion

The fecundity of freshwater spiny eel, *M. armatus* were described for five months from March to July 2004. The fecundity estimates during the present study were ranged from 3155 to 24684 eggs and the size was from 260 to 535 mm (TL). The average number of ova present per g of body weight was 70.19 while the average number of ova present per g of ovary was 888.04. Nasar (1989) calculated the fecundity of *Monopterus cuchia* ranging 118-687 eggs. Narejo (2003) calculated the fecundity of *M. cuchia* ranging 260-5890 and *M. armatus* ranging 580-10980 respectively. The author's also reported that average number of ova present in per g of body weight was 4.61 and per g of ovary weight was 74.27 in case of *M. cuchia* and average number of ova present in per g of body weight was 29.38 and per g of ovary weight was 407.57 in case of *M. armatus* respectively. Estimates of fecundity from mean counts of aliquots for an individual American eel (*Anguilla rostrata*) ranged from 1.84 million to 19.92 million eggs ranging in length from 45.2 to 113.3 cm (Barbin and McCleave, 1997). It was suggested that perhaps the variation was due to different temperature and feeding regimes, producing variation in fat metabolism (Svedang et al. 1996), although fat content was not measured. The productivity of local waters may thus produce variation in size at maturity and it may also produce variation in size-fecundity relation. The estimate of fecundity in the present study was much higher than the estimate given by Nasar (1989) and Narejo (2003) and was much lower than estimate given by Barbin and McCleave (1997). The change in the fecundity estimation could be due to different environmental conditions in which the two populations live. The fecundity also varied with the seasons, climatic conditions and environmental habitat, nutritional status and genetic potential (Bromage et al. 1992).

The fecundity increased with the increasing length and weight of the fish. The results of the present study are very similar to those obtained by Kabir et al. (1998) in *Gadusia chapra*, Narejo (2003) in *Monopterus cuchia* and *M. armatus*. During the present investigations, the fecundity was plotted against the body length, body weight and gonad weight. It was observed that the fecundity- body length and fecundity-body weight relationships gave a better relationship when compared with fecundity-gonad weight relationship. It may be noted from the above equations as well as from the Figs 1, 2 and 3 that the logarithmic relationship of the fecundity-total length and fecundity-body weight were found to be more correlated than the fecundity-gonad weight relationship. The results of the present study were very similar to those observed by various authors like Kabir et al. (1998) in *Gudusia chapra*, Faruq et al. (1996) in *Clarias batrachus*, Azadi and Siddique (1986) and Das et al. (1989) *in Heteropneustes fossilis*, Danwattana and Nakorn (1985) in *Channa striatus* and Azadi et al. (1987) in *Mystus vittatus*. All the ova (100 from each ovary) were found to be spherical and uniform in diameter, indicating that the eggs were shed in a single batch. Thus the eggs shed in a season developed simultaneously. Nabi and Hossain (1996) reported similar results in freshwater spiny eel *Macrognathus aculeatus*. Narejo (2003) also observed similar results in freshwater spiny eel *M. armatus.*

In the present experiment, the maximum ova diameter was 2.75 mm in the month of April and minimum was1.45 mm in the month of May with a median of 2.08 mm in the month of March. Narejo et al. (2002) observed that *M. armatus* has only one breeding season during May to July with a peak in July and the maximum size of the mature ova was 1.00 mm progressively increasing in the ova diameter during December to July. It might be due to the fact that Narejo et al. (2002) worked on fish that was reared in the cemented cisterns. The present experiment was carried out with the fishes that were collected from open water fishery resources.

The fecundity of the fish was inversely proportional to the ova diameter (fecundity increases with the decrease of ova diameter). Various workers in different fish species have reported higher fecundity with small ova diameter (Pathak and Jhingran 1977; Nabi and Hossain 1996; Narejo et al. 1998; Afroz et al. 1990). Most eggs of migrating female eels were less than 0.25 mm diameter (Wenner and Musick 1974; Todd 1981). Similarly fecundity decreases with the increase in ova diameter that was reported by Das et al. (1989), Shaima et al. (1992) and Faruq et al. (1996, 1998).

In the present experiment, the maximum GSI value for female spiny eel was 21.67 recorded in March and the minimum GSI value for the same gender was 3.30 recorded in April and the median GSI value for the same was 8.06 recorded in May. The present experiment indicated that the fish also spawned once in a year during March to July with a peak in March and GSI value had a sudden decrease (21.67 to 15.66) during April in comparison with the previous month. It might be due to the environmental variations. The GSI value of *M. armatus* indicates that the breeding period of this fish spread from March to July with a peak in March, it might be due to age and stock variation.

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