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Fecundity and gonado-somatic index of wild freshwater spiny eel *Mastacembelus armatus* (Lacepede) from Kishoreganj region of Bangladesh

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Abstract

Fecundity and gonado-somatic index (GSI) of wild freshwater spiny eel *Mastacembelus armatus* were estimated from *haor* region of Kishoreganj district of Bangladesh. Estimated fecundity ranged from 2,235 to 19,493 for the fish measuring from 25 to 54 cm and weighing from 79 to 345 g. The minimum, median and maximum ova diameter was 0.20, 1.90 and 2.20 mm, respectively. The average numbers of ova present per g body weight were 45.41±8.85, 46.93±15.00 and 47.52±8.32 while the average numbers of ova present per g ovary were 369.64±40.66, 351.29±30.90 and 328.36±33.00 in the months of April, May and June, respectively. Maximum GSI for female spiny eel was 14.40±1.48 in the month of June and the minimum GSI for the same sex was 0.44±0.06 in September. The regression of fecundity on total length, body weight and gonad weight of female spiny eels were Log F = -0.875 + 2.957 × Log TL (r = 0.874), Log F = 0.630 + 1.461 × Log BW (r = 0.917) and Log F = 2.425 + 1.087 × Log GW (r = 0.977), respectively. Fecundity-gonad weight gave a better relationship when compared to fecundity-body weight and fecundity-total length relationship.

Keywords: *Mastacembelus armatus*, GSI, Fecundity

Introduction

Baim (*Mastacembelus armatus*) is one of the most sought after fishes. People like its flesh for special flavour and characteristic texture. Among the available freshwater eel species, *M. armatus* has 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 Synbranchiformes is also known as *Bam* or *Baim*. It commonly occurs in the freshwater of this sub-continent (Talwar and Jhingran, 1991). *Baim* is the inhabitant of rivers, canals, *beels*, ponds and inundated fields (Rahman, 1989). Its production from *beels*, floodplain and Kaptai lake was 234 ton in the year 2006-07 (FRSS, 2006-2007), 206 ton in the year 2005-2006 (FRSS, 2005-2006) and 283 ton in the year 2004-2005 (FRSS, 2004-2005).

Mastacembelus armatus is a very popular fish with high market demand, having about double the market value compared to the carp fishes in the country. In spite of its delicious taste, flavour and market demand, very scanty systematic attempt has been made to study the biology and culture potential of this fish (Narejo, 2003).

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 (Islam *et al*., 2012). Reproductive potential of a population is one of the basic exigencies to designate the individuals of that population in respect to their gonadal conditions (Akter *et al*., 2012). In order to achieve success in fish culture, it is important to assess 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 (Das *et al.*, 1989; Karim and Hossain, 1992); (b) fluctuations in the egg production potential of individual stock related to life processes such as age and growth (Shaheena, 2012); (c) effects of environmental factors (Bromage *et al.*, 1992); and (d) formulating the commercial management of fishery (Lagler, 1956). Reddy (1979) mentioned that determination of breeding season is an essential part of biological investigations of fishes. Narejo (2003) and Taslim *et al.* (2002) worked on the reproductive biology of some freshwater eels of Mymensingh region. But there is a serious shortage of some basic scientific information on the biology, especially fecundity of the spiny eel (*M. armatus*). In view of the above, present investigation was aimed to study the reproductive biology based on fecundity, ova diameter and gonado-somatic index of wild freshwater spiny eel, *M. armatus,* of *haor* region of Kishoreganj district of Bangladesh. The objective also included the study to establish the empirical relationship between the fecundity with total length, body weight and ovary weight of this species.

Materials and Methods

Collection of fish samples

The experiment was conducted for a period of 12 months from January to December 2012. 114 female spiny eels were collected from natural habitat of *haor* region in Kishoreganj district through the fishermen in order to determine gonado-somatic index (GSI) and 42 wild fish of the same species for fecundity study.

Fecundity estimation

There are several methods for the estimation of fecundity of fish of which the actual counting method was found to be the most accurate one. Among the methods as outlined by Lagler (1956), gravimetric method is considered to be more efficient and gives fairly accurate result. This method has also been successfully used by Shafi and Quddus (1978); Dewan and Doha (1979); Mustafa *et al*. (1980) and Blay-Jr (1981). In this method, eels were anaesthetized with 0.02% clove oil (Keene *et al.*, 1998). Individual eel was then measured for total length to the nearest cm and body weight to the nearest g. The ovaries were dissected out by a pair of scissors. The external connective tissues were removed from the surface of each pair of ovaries. The moisture of the ovaries was removed with the help of a blotting paper. The weight of the ovaries of each fish was recorded with the help of an electronic balance. Then 1.00 g of ovarian part was taken separately from anterior, middle and posterior portions of each ovarian lobe accurately and gonad samples were fixed at 10% buffered formalin (gonad and fixative ratio being 1:10) for subsequent studies. The gonad samples were swollen heavily, their membrane became transparent and the number of mature and maturing eggs from each portion was found out separately by actual counting. The mean number of eggs in 1.00 g was determined and then multiplied by the total weight of the ovary, which gave the total number of eggs i.e. the fecundity of respective fish. This was done by the following formula:

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

Where, F = Fecundity of fish; and
N = Number of eggs in sample

Measurement of ova diameter

When an ovary of a fish was dissected out, a small representative part from anterior, posterior and middle portion of the same was taken separately. The ova of the samples were separated keeping in a physiological saline solution (0.85% NaCl) and spread on a glass slide to measure the diameter of ova under a microscope with an ocular micrometer. However, at least 100 ova of a single sample were measured and observed values for ova diameter were expressed in the unit value of the ocular micrometer according to recommended method given by LeCren (1951).

Ganado-somatic index (GSI)

Gonado-somatic index (GSI) is frequently applied to determine the spawning frequency of fishes. The GSI was calculated according to the following formula:

$$GSI = \frac{\text{Gonad weight}}{\text{Body weight}} \times 100$$

Statistical analysis

Several morphological characters were analyzed by Microsoft Excel (MS Excel) computer package as descriptive values such as mean and percentage. Determination of linear relationship and correlation coefficient (r) between total length and fecundity, body weight and fecundity, gonad weight and fecundity was performed using MS Excel. The statistical data analysis was carried out with the aid of the computer software SPSS version 11.5 (Statistical Package for Social Science).

Results

Fecundity

One hundred fourteen specimens of mature female spiny eel sampled during January to December 2012 ranged from 25.40 to 54.20 cm in total length (TL) and 78.50 to 345.00 g in weight. The number of ova ranged from 2,235 to 19,493. Maximum fecundity was recorded from a fish measuring 54.20 cm in TL and 345.00 g in weight and the minimum, from a fish measuring 25.40 cm in TL and 78.50 g in weight (Table 1). The average numbers of ova present per g of body weight were 45.41±8.85, 46.93±15.00 and 47.52±8.32 while the average numbers of ova present per g ovary were 369.64±40.66, 351.29±30.90 and 328.36±33.00 in the months of April, May and June, respectively (Table 2). It was also noted that the fecundity increased with the increase in total length and body weight of the fish. The equations of regression coefficient 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.

Table 1. Fecundity estimates for female *M. armatus* of minimum, median, maximum lengths, weights, no. of eggs, ova diameters and GSI (%)

	Length (cm)	Weight (g)	No. of eggs	Ova diameter (mm)	GSI (%)
Minimum	25.40	78.50	2235.00	0.20	8.29
Median	40.80	167.20	8390.40	1.90	13.60
Maximum	54.20	345.00	19493.00	2.20	17.69

Table 2. Values (Mean ± SD) of total length, body weight, ovary weight, GSI, fecundity, ova per g body weight and ova per g ovary weight of female *M. armatus* during January to December 2012

Month (2012)	No. of fish examined	Total length (cm)	Body weight (g)	Ovary weight (g)	GSI (%)	Fecundity (Nos.)	Ova per g body weight	Ova per g ovary weight
January	8	42.79±7.10	199.75±75.23	1.83±0.95	0.88±0.30	Not done	-	-
February	8	43.16±7.85	203.25±74.88	2.61±1.26	1.24±0.40	Not done	-	-
March	8	42.99±6.32	208.25±73.09	6.56±2.71	3.13±1.09	Not done	-	-
April	14	35.12±3.92	129.06±30.95	15.94±4.84	12.21±1.48	6058.41±2333.86	45.41±8.85	369.64±40.66
May	14	40.29±2.59	166.91±27.70	22.64±8.69	13.11±3.22	8191.16±3704.92	46.93±15.00	351.29±30.90
June	14	46.95±3.76	226.07±53.22	32.79±9.15	14.40±1.48	11040.76±4191.70	47.52±8.32	328.36±33.00
July	8	40.05±1.85	159.33±16.23	1.39±0.60	0.85±0.30	Not done	-	-
August	8	41.18±2.77	166.39±18.66	1.25±0.63	0.75±0.38	Not done	-	-
September	8	30.90±5.59	78.49±23.22	0.35±0.12	0.44±0.06	Not done	-	-
October	8	47.31±11.17	305.08±217.82	1.34±0.73	0.48±0.14	Not done	-	-
November	8	45.15±6.34	236.13±95.43	1.75±0.86	0.73±0.17	Not done	-	-
December	8	48.00±2.68	264.50±10.01	2.18±1.04	0.81±0.36	Not done	-	-

Fecundity of the 42 freshwater spiny eels increased symmetrically with total length, body weight and gonad weight as characterized by the relations:

$$\text{Log } F = -0.875 + 2.957 \times \text{Log TL (Fecundity - Total length) } (r = 0.874)$$
$$\text{Log } F = 0.630 + 1.461 \times \text{Log BW (Fecundity - Body weight) } (r = 0.917) \text{ and}$$
$$\text{Log } F = 2.425 + 1.087 \times \text{Log GW (Fecundity - Gonad weight) } (r = 0.977),$$

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

Ova diameter

Measurements of ova diameters were made to determine the relative sexual maturity of *M. armatus*. The minimum, median and maximum ova diameter was 0.20, 1.90 and 2.20 mm, respectively (Table 1). 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 of *M. armatus* (female) increased as the fish reached toward maturity and declined with the start of spawning activities. It was calculated during January to December 2012. Month wise changes in mean GSI values are presented in Table 2 and Fig. 4. The values of GSI ranged from 0.44±0.06 to 14.40±1.48 in female *M. armatus* during January to December 2012. The higher values of GSI were observed during April to June ranging from 12.21±1.48 to 14.40±1.48. The GSI increased in every month from March to June. After spawning activities, GSI declined suddenly in the month of July and the lowest GSI (0.44±0.06) was recorded in the month of September.

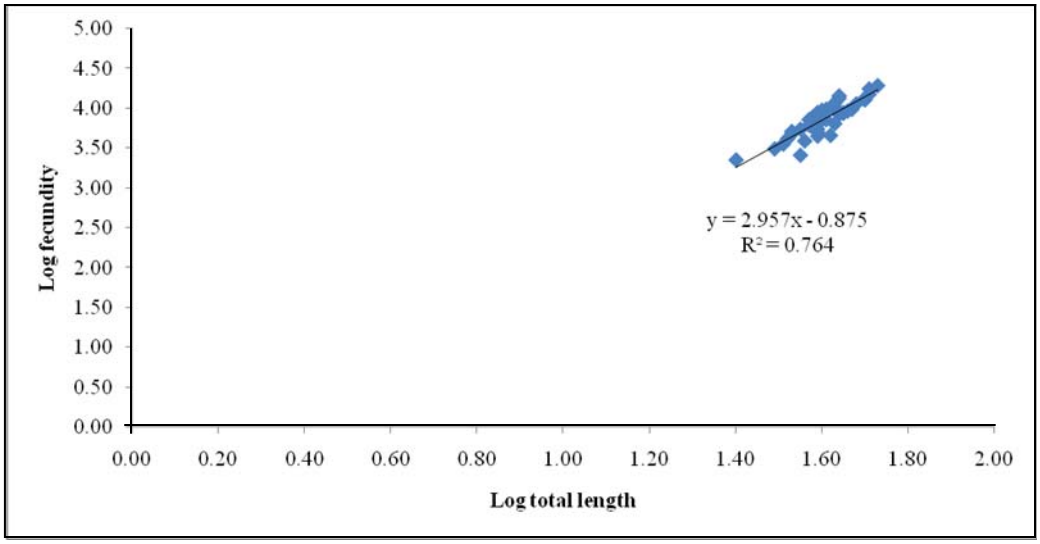

Fig. 1. Logarithmic relationship between fecundity and total length of female spiny eel (*Mastacembelus armatus*) from Kishoreganj region, Bangladesh

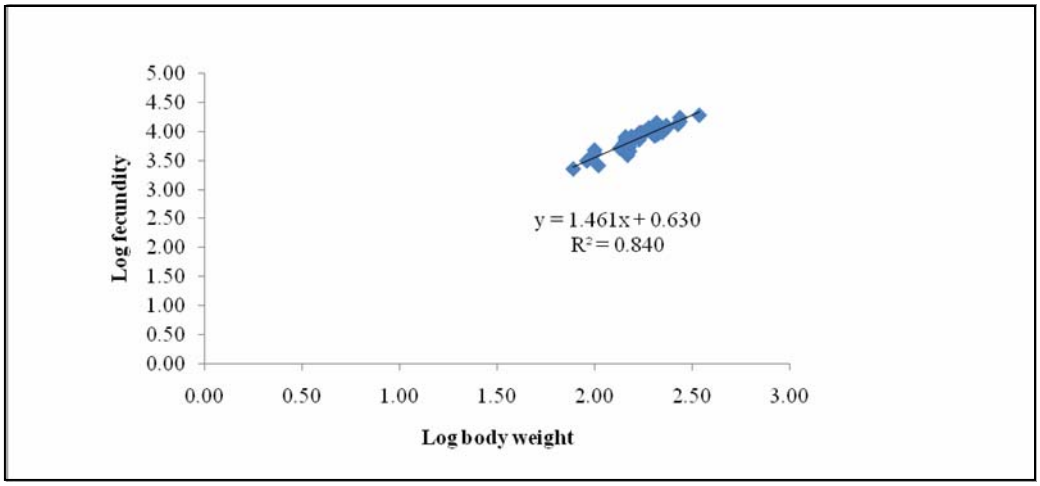

Fig. 2. Logarithmic relationship between fecundity and body weight of female spiny eel (*Mastacembelus armatus*) from Kishoreganj region, Bangladesh

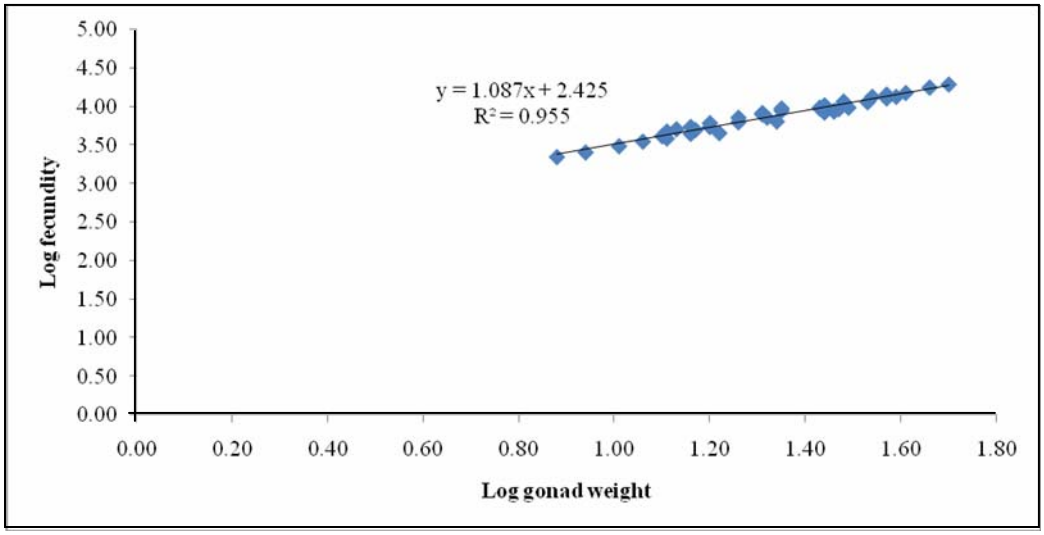

Fig. 3. Logarithmic relationship between fecundity and gonad weight of female spiny eel (*Mastacembelus armatus*) from Kishoreganj region, Bangladesh

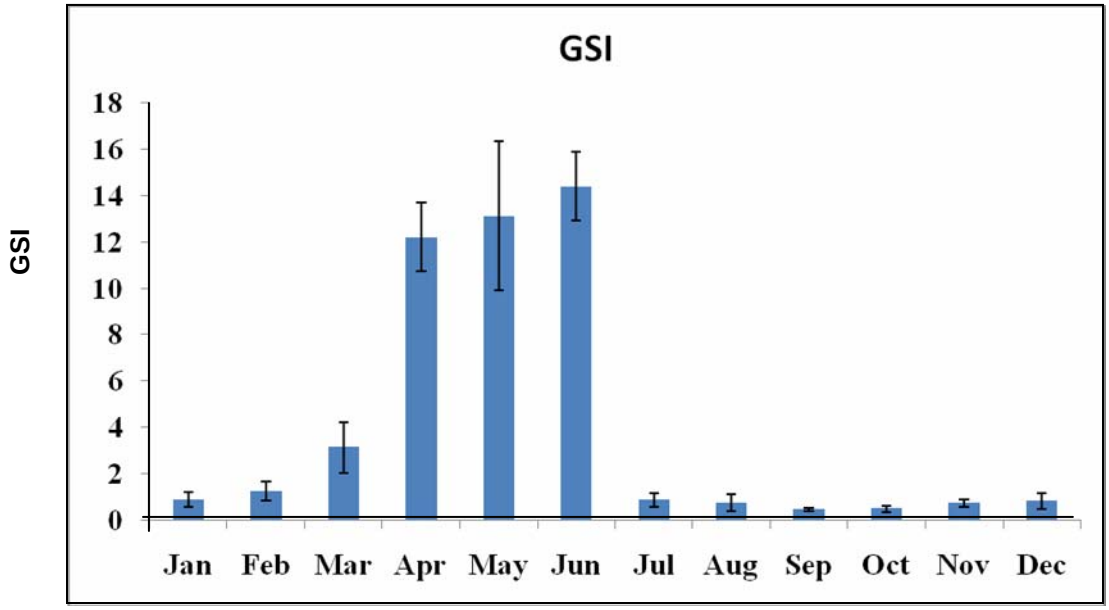

Fig. 4. Month wise changes in mean GSI values of female spiny eel (*Mastacembelus armatus*) from Kishoreganj region, Bangladesh

Discussion

The fecundity of freshwater spiny eel, *M. armatus* was estimated from samples of 3 months i.e. April to June 2012. The fecundity estimates during the present study ranged from 2235 to 19493 eggs and the size of fish varied from 25.40 to 54.20 cm (TL). The average numbers of ova present per g of body weight were 45.41±8.85, 46.93±15.00 and 47.52±8.32 while the average numbers of ova present per g ovary were 369.64±40.66, 351.29±30.90 and 328.36±33.00 in the months of April, May and June, respectively. Nasar (1989) calculated the fecundity of *Monopterus cuchia* to range from 118 to 687. Narejo (2003) reported the fecundity of *M. cuchia* to range from 260 to 5890 and *M. armatus* to range from 580-10980 respectively. The authors also reported that average number of ova present 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 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 in the length range 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 the estimate given by Barbin and McCleave (1997). The difference in the fecundity estimation could be due to different environmental conditions in which the populations live. The fecundity also varied with the seasons, climatic conditions and environmental habitat, nutritional status and genetic potential (Bromage *et al.*, 1992).

During the present investigation, the fecundity was plotted against the total length, body weight and gonad weight. Correlation coefficient (r) between fecundity and total length was 0.874; fecundity and body weight was 0.917; and fecundity and gonad weight was 0.977 for *M. armatus*. The relationship with fecundity was stronger (r=0.917) in case of body weight than total length (r=0.874) where as the strongest correlation was found between fecundity and gonad weight (r=0.977). Similar observations were reported by many authors like Khan *et al.* (2002) for the canine catfish, *Plotosus canius*; Rehman *et al.* (2002) for grey mullet, *Liza parsia*; and Nabi *et al*. (2007) for *Glossogobius giuris*.

In the present experiment, the minimum, median and maximum ova diameters were 0.20, 1.90 and 2.20 mm, respectively. 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. The results of the present study are closed to those obtained by Narejo *et al*. (2002) who worked on fish that were reared in the cemented cisterns.

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). 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).

The GSI, which is indicative of the breeding season of the fish, was calculated from January to December. There was a spectacular rise in the values in April to June (12.21±1.48 to 14.40±1.48). The highest gonado-somatic index of female *M. armatus* was 14.40±1.48 in June and the lowest was 0.44±0.06 in September. The present experiment indicated that the fish spawn once in a year during April to June with a peak in June. The results of the present study closely relate to those obtained by Narejo *et al*. (2002). Similar observations were reported by Nabi and Hossain (1996) in freshwater spiny eel, *Macrognathus aculeatus*.

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References

Afroz, T., Nabi, M.R., Mustafa, G. 1990. Fecundity of chapila, *Gudusia chapra* (Hamilton) from Jahangirnagar University ponds. *Bangladesh Journal of Life Science* **11(1-2)** 45-51.

Akter, H., Islam, M.R., Belal Hossain, M. 2012. Fecundity and gonado-somatic index (GSI) of Corsula, *Rhinomugil corsula* Hamilton, 1822 (Family: Mugilidae) from the Lower Meghna River Estuary, Bangladesh. *Global Veterinaria* **9(2)** 129-132.

Barbin, G.P., McCleave, J.D. 1997. Fecundity of the American eel *Anguilla rostrata* at 45^0 N in Maine, USA. *Journal of Fish Biology* **51** 840-847.

Blay-Jr, J. 1981. Fecundity and spawning observation of *Sarotherodon galiaeus* in a concrete pond. *Aquaculture* **25** 95-99.

Bromage, N., Jones, J., Randal, C., Thrush, M., Davies, B., Springate, J., Duston, J., Baker, G. 1992. Brood stock management, fecundity, egg quality and the timing of egg production in the rainbow trout (*Oncorhynchus mykiss*). *Aquaculture* **100** 141-166.

Das, M., Dewan, S., Debnath, S.C. 1989. Studies on fecundity of *Heteropneustes fossilis* (Bloch) in a mini pond of Bangladesh Agricultural University, Mymensingh. *Bangladesh Journal of Agricultural Science* **16(1)** 1-6.

Dewan, S., Doha, S. 1979. Spawning and fecundity of certain pond fishes. *Bangladesh Journal of Agriculture* **4** 1-8.

Faruq, M.A., Saha, J.K., Mian, M.I., Rahmatullah, S.M. 1996. The fecundity of *Clarias batrachus* (Liennaeus) and the relationship of fecundity with length and weight. *Bangladesh Journal of Fisheries* **19(1-2)** 67-70.

Faruq, M.A., Saha, J.K., Mian, M.I., Rahmatullah, S.M. 1998. Fecundity, length and weight relationship and condition factor in *Heteropneustes fossilis* (Bloch). *Bangladesh Journal of Fisheries* **21(1)** 77-81.

FRSS. 2004-2005. Fisheries Resources Survey System, Department of Fisheries, Bangladesh. pp. 48.

FRSS. 2005-2006. Fisheries Resources Survey System, Department of Fisheries, Bangladesh. pp. 47.

FRSS. 2006-2007. Fisheries Resources Survey System, Department of Fisheries, Bangladesh. pp. 48.

Islam, M.R., Sultana, N., Hossain, M.B., Mondal, S. 2012. Estimation of Fecundity and Gonadosomatic Index (GSI) of Gangetic Whiting, *Sillaginopsis panijus* (Hamilton, 1822) from the Meghna River Estuary, Bangladesh. *World Appllied Science Journal* **17(10)** 1253-1260.

Karim, M.A., Hossain, A. 1992. Studies on the biology of spiny eel, *Mastacembelus pancalus* in artificial ponds. Part II. Sexual maturity and fecundity. *Bangladesh Journal of Agricultural Science* **1** 15-18.

Keene, J.I., Noakes, D.L.G., Moccia, R.D., Soto, C.G. 1998. The efficacy of clove oil as an anaesthetic for rainbow trout, *Oncorhynchus mykiss* (Walbaum). *Aquaculture Research* **29** 89-101.

Khan, M.S.A., Alam, M.J., Rehman, S., Mondal, S., Rahman, M.M. 2002. Study on the fecundity and GSI of brackish water catfish *Plotosus canius* (Ham.-Bucch.). *Online Journal of Biological Science* **2** 232-234.

Lagler, K.F. 1956. *Freshwater Fishery Biology*. Second Ed. WMC Brown Company, Dubuque, lowa. pp. 421.

LeCren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *Journal of Animal Ecology* **20** 201-219.

Mustafa, G., Ahmed, A.T.A., Islam, K.R. 1980. Food and feeding habits and fecundity of a freshwater perch, *Nandus nandus*. *Bangladesh Journal of Agricultural Science* **5** 205-210.

Nabi, M.R., Hossain, M.A. 1996. Reproductive biology of the freshwater Spiny Eel, *Macrognathus aculeatus* (Bloch). *Bangladesh Journal of Zoology* **24(2)** 115-120.

Nabi, M.R., Rahman, H.A., Mustafa, S., Kader, M.A. 2007. Population dynamics of estuarine set bag net fishery of Bangladesh. *Chiang Mai Journal of Science* **34(3)** 355-365.

Narejo, N.T. 2003. Comparative studies on the biology and culture of *Monopterus cuchia* and *Mastacembelus armatus* of Mymensingh region. PhD thesis, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh. pp. 205.

Narejo, N.T., Ali, S.S., Jafri, S.I.H., Hussain, S.M. 1998. Studies on the reproductive biology of Palla, *Tenualosa ilisha* from the river Indus. *Pakistan Journal of Zoology* **30(3)** 223-227.

Narejo, N.T., Rahmatullah, S.M., Mamnur, Rashid, M. 2002. Studies on the reproductive biology of freshwater Spiny Eel, *Mastacembalus armatus* (Lacepede) reared in the cemented cisterns of Bangladesh Agricultural University, Mymensingh, Bangladesh. *Pakistan Journal of Biological Science* **5(7)** 809-811.

Nasar, S.S.T. 1989. Parental care and fecundity in *Monopterus cuchia* (Ham.). *Journal of Freshwater Biology* **1(1)** 67-70.

Nasar, S.S.T. 1997. *Backyard eel culture*: International Institute of Rural Reconstruction, Silages, Cavity, Philippines. pp. 88.

Pathak, S.C., Jhingran, A.G. 1977. Maturity and fecundity of *Labeo calbasu* (Ham.) of Loni reservoir, Madhya Pradesh. *Journal of Inland Fisheries Society of India* **9** 72-83.

Rahman, A.K.A. 1989. *Freshwater Fishes of Bangladesh*. Zoological Society of Bangladesh. University of Dhaka. pp. 364.

Reddy, B.P. 1979. Maturity and spawning in the murrel, *Channa punctatus* (Bloch, 1973) (Pisces, Teleostei, Channidae) from Guntur, Andhra Pradesh. *Proceedings of Indian National Science Academy* **B 45(6)** 543-553.

Rehman, S., Islam, M.I., Shah, M.M.R., Mondal, S., Alam, M.J. 2002. Observation on the fecundity and gonadosomatic index (GSI) of *Liza parsia* (Ham.). *Online Journal of Biological Science* **2** 690-693.

Shafi, M., Quddus, M.M.A. 1978. Fecundity of Indian Halibut, *Psettodes erumei* (Bloch and Schneider) from the Bay of Bengal. *Bangladesh Journal of Zoology* **6(2)** 113-120.

Shaheena Shafi. 2012. Study on fecundity and GSI *Carassius carassius* (Linneaus, 1758-introduced) from Dal Lake Kashmir. *Journal of Biology, Agriculture and Healthcare* **2(3)** 68-75.

Shaima, K., Nashida, B., Isabella, B. 1992. Studies on some aspects of the biology and fecundity of *Mystus tengara* (Hamilton-Buchanan 1822). *Bangladesh Journal of Zoology* **20(2)** 333-340.

Svedang, H., Neumann, E., Wickstrom, H. 1996. Maturation patterns in female European eel: age and size at the silver eel stage. *Journal of Fish Biology* **48** 342-351.

Talwar, P.K., Jhingran, A.G. 1991. *Inland fishes of India and adjacent countries*. Vol.1 Oxford and IBH publishing Company Private Limited, New Delhi, India. pp. 541.

Taslim, R., Rashid, H., Sukhan, Z.P., Janat, M.S., Das, M. 2002. A study on the fecundity of a freshwater eel, *Macrognathus aculeatus* (Bloch) of Mymensingh basin. *Bangladesh Journal of Fisheries* **25(1-2)** 181-191.