STUDY OF REPRODUCTIVE AND FEEDING BEHAVIOR OF *MASTACEMBELUS ARMATUS*

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ABSTRACT

The spiny eel, *Mastacembelus armatus* is a commercially important freshwater teleostean fish. Monthly samples of fish were collected from NCR, New Delhi region from January, 2016 to December, 2016. Fecundity estimation was carried out using gravimetric method as suggested by Lagler, 1956. The spawning period was determined by using the gonadosomatic index (GSI). Male showed a slight numerical superiority over female. Paired Gonads elongate with ripening and extend towards the posterior half of the abdomen. Gonads developed during March and entered the ripening stage and subsequently got predominant during May-June. The size of ova ranged between 0.4 to 1.45 mm in the ripe stage. Ova sampled from different parts of the ovary were of the same size indicated single spawning in a year. Fecundity increased with size and weight of fish. Absolute fecundity varied between 927-7409 egg cm^{-1} in the specimens of *M.armatus* ranging from 12.0-48.2 cm in size. Length-wise the fecundity varied between 53-146 egg cm^{-1} with 63 egg cm-1 and weight wise it varied between 13-88egg $g^{-1}$with an average of 29 egg g^{-1} of the body weight of the fish. Regression analysis indicated that the total length and weight could be used to predict fecundity of this spiny eel, but weight proved to be the best predictor of fecundity (r=0.9151). Although in both cases significant correlation was noted ($p<0.001$).Ova per gram of ovary weight varied between 177-1108, with an average of 64egg g^{-1}. The condition of all the ova in an ovary being at the same stage of development is indicative of the fact that spawning in this fish take place only once in a year.

Well developed dentition, absence of gill rakers , strongly built stomach and short intestine together with the dominance of animal matter in the gut contents ,suggested the carnivorous and active predatory habits of *M. armatus*. Body width in all life stages of *M .armatus* was about 5.56/of total body length, resulting in a slender body .This also pointed towards an active mobile lifestyle suited to its predatory nature. The fish fed on varieties of food items viz. fish, aquatic insects, crustaceans, molluscs, annelids, debris and mud that respectively obtained as 16.60, 14.75, 10.78, 8.50, 8.28, and 13.52 percent on average.

Key words: spiny eel, gastrosomatic index gonadosomatic index, fecundity, sex-ratio

Introduction

The spiny eel, *Mastacembelus armatus* is one of the most common species of teleosts found in Asia. It is an economically important large size (attains a length of 65 cm) inland water fish. It is also known as zig zag eel, locally known as "Baam or Baami, " *M. armatus* is nocturnal fish usually found in streams and rivers with sand, pebble, or boulder substrate. They seldom leave the bottom except when disturbed. Also occur in still waters, both in coastal marshes and dry zone tanks (Roberts, 1993). Sometimes stays partially buried in fine substrate. The fish is very popular as food and occupies an important commercial status. The food and feeding habits of fishes is variable throughout the year due to seasonal changes in temperature and water quality which are responsible for food production in a water body. Economic important species, both food and aquarium trades (Rainboth, 1996) having about double the market value compared to the carp fishes in the country. In spite of its delicious taste, flavor and market demand, very scanty systematic attempt has been made to study the biology and culture potential of this fish (Narejo,2002) Despite its abundance, palatability and consumer appeal, no published information is available on the feeding biology of *M.armatus*, except in the studies of Dutta (1989 and 1990), Serajuddin & Mustafa (1994) and Serajuddin *et. al.* (1998) on the feeding specialization and food and feeding habits of the species respectively, Sikder & Das (1980) on the skin structure of *M. armatus.* A number of workers reported that the reproductive traits such as fecundity and size of egg can be influenced by food quantity, fishing pressure and the environmental conditions .Serajuddin (2004) reported the intraspecific diversity of *M. armatus. Uthaykumar et.al.(*2013) studied impact of seasonal variation on feeding and reproductive behavior of *M.armatus.* Gupta and Banerjee (2016) studied food and feeding habit and reproductive biology of *M. armatus* Keeping in mind the paucity of information on the biology of this species, the present study focusing on the food and feeding habits and reproductive biology of *M. armatus* was undertaken, which would be useful for the artificial propagation of this fish in aquaculture. Studies of reproductive potential of fish are essential in formulating the degree of rearing facilities needed and to assess the aquacultural success.

Very little work has been carried out on reproductive biology of spiny eels, however Karim and Hossain (1972), worked on sexual maturity and fecundity of *Mastacembelus pancalus*, Saxena *et al*. (1979) observed the cytological details of oocytes of this fish. Qaayum and Qasim (1961) studied the spawning frequencies and breeding season of *Rhynchobdella aculeata (Macrognathus aculeatus)* and Serajuddin *et al*. (2002) studied the reproductive cycle and fecundity of spiny eel. *M. armatus.* Serajuddin (2004) reported the intraspecific diversity of *M. armatus*. The karyotype of *M.armatus* was studied by Das & Khuda Bukhsh (2007). Narejo *et al* (2002) studied the reproductive biology of *M.armatus* from Bangladesh. Pathak *et al* (2012) reported a comparative analysis of reproductive traits in a closely related species,*Macrognathus pancalus* from lentic and lotic ecosystems of Gangetic basin. Serajuddin and Pathak (2012) studied reproductive traits *of M.armatus.*

Keeping in mind the paucity of information on this aspect of *M.armatus* present study is undertaken to gather the data on various aspects of breeding of *M.armatus* such as sex ratio, gonad maturation, fecundity and spawning season of this fish.

Methodology

Monthly samples of fish were collected from NCR region from January to December from Delhi NCR with each sample of about 20-30 .The fish were caught using cast and drag nets and brought to laboratory packed in ice.The time of collection was fixed during the early hours of the morning to minimize the possible effects of diet on feeding and differential digestion of food items.Total length of each fish was measured from the tip of the snout to the longest caudal fin ray to the nearest 0.1 mm.Their weight (g) was recorded on an electric balance sensitive up to 0.001 g. The fish (size range 5-50 cm) were sexed and divided into five length groups on the basis of their sizes. Except for group one ,where it was 5 cm.,length range of each group was 10 cm.,then we dissected all the samples. Gonadal condition was examined and the stage of maturation of the samples was determined following the scheme of classification used by Qayyum and Qasim (1964a) for *Ophiocephalus punctatus*.

The intensity of feeding was studied by determining the gastrosomatic index (gut weight expressed as percentage of body weight) using the method suggested by Khan *et* .al.(1988). For the analysis of gut contents, methods like the frequency of occurrence, numerical counts and gravimetric method were applied as summarized by Lagler (1956). Qualitative analysis (identification of prey items in the gut contents) formed an important part of the gut content analysis; and it was on the basis of qualitative analysis that the above mentioned all relative quantitative assessments were made. For this purpose, the prey items were identified and categorized according to their systematic status.

Fecundity estimation was carried out by using gravimetric method (Lagler 1956)

F=N x Gonad weight/Sample weight

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

To determine the stages of maturity, the gonads were extracted from the fish, the intra ovarian eggs were taken out and their diameter was measured with the help of an ocular micrometer using 8x12.5 magnification of binocular dissecting microscope. Timing of spawning will be determined by using the gonadosomatic index.(GSI)

GSI=GWx100/BW

Where GW is the Gonad Weight to the nearest 0.01g and BW is the Body Weight of fish (g) nearest to 1.0 g.

Results & Discussion

Food and feeding

Well developed dentition, absence of gill rakers ,strongly built stomach and short intestine ,together with the dominance of animal matter in the gut contents ,suggestd the carnivorous and active predatory habits of *M.armatus*. Body width in all life stages of *M.armatus* was about 5.56/of total body length ,resulting in a slender body .This also pointed towards an active mobile lifestyle suited to its predatory nature.

Food Composition

Freshwater shrimps (Macrobrachium species) were the preferred prey organisms **(Table- 1)** other organisms consumed were dipteran larvae, brine shrimps (branchipus species), earthworms and minor carps (cyprinids), depending on the frequencies of their occurrence. Food categories of lesser importance include aquatic vegetation fish eggs and barbells which may have been accidentally swallowed by the fish while it was voraciously feeding on other organisms. Following the criteria proposed by Nikolosky (1963), food eaten by *M.armatus* could be divided into three categories;

Crustaceans and forage fish are as basic food for the adults and annelids and aquatic insects as basic food for the juveniles. Aquatic annelids and insect larvae could be considered as the secondary food for adults, while forage fish and crustacean together represented the secondary food of juveniles. Molluscs and aquatic vegetation could be regarded as incidental item for both juvenile and adults. Khan (1934) reported *M.armatus* as carnivorous and emphasized that it is detrimental to eggs and fry of other fishes. Das and Moitra (1953) pointed out that this fish mainly feeds on crustacean. Jhingran (1982) described it as piscivorous. Dutta (1989-90) carried out stomach content analysis of *M.armatus* collected from Gadigarh stream (Jammu) and reported it as selective insectivorous fish (Serajuddin *et. al.*1998) reported it as a carnivorous. However, Mookerjee *et. al.* (1947) reported this species to be herbivorous.

Intensity of feeding in relation to seasons

The values of gastrosomatic index (GSI) for different months are given in Table 2. It was found that the individuals in the size range 21-50 cm consumed more food during summer (March-June) than during the rainy season and winter (July-February). The younger specimens (5-20 cm) were found feeding voraciously during post monsoon and autumn periods (September-November). Like adults they too consumed a lesser quantity of food during winter. Pronounced feeding activity in the younger individuals of both sexes was observed in the month of October, and it was extremely low in December. In adult female specimens, a higher GSI was recorded for all sizes in April. In these cases, low GSI

varied with size. The lowest values for the size groups 31-40 cm and 41-50 cm were observed in August and October respectively. Maximum numbers of empty guts were found during spawning and during the winter season.

Feeding Intensity in Relation to Maturity Stages

In both the sexes (male & female) the most active feeding period was found in the gonad ripening stage ,which is the third stage of sexual cycle. This suggests that, at this stage the fish feed more voraciously because of a higher energy demand associated with gonad development. Fish with medium gut fullness in almost all the months suggest that feeding was never discontinued and even during the breeding season, there was no cessation of feeding. Khan *et al* (1988)also reported the same type of feeding intensity in relation to the stages of maturity in freshwater catfish ,*Mystus nemurus*

Maturity Stages

Five maturity stages have been recognized in both males and females *M. armatus.* Details about these stages are mentioned below:

Male

Stage I (Immature Virgin): Testes are small, paired, slender, thread like, distinguished microscopically from the ovaries. Vasadeffrentia not very distinct and difficult to locate.

Stage II (Maturing Virgin or Recovering Spent): Testes slightly elongated, opaque and white in colour. Vasa diferentia distinct and easy to locate.

Stage III (Ripening): Testes ivory in colour, more prominent than Stage II. Viscous fluid oozes out if slight pressure is brought to bear on the abdomen.

Stage IV (Ripe or Full Mature): Testes flabby, massive, creamy white in colour, grown to maximum in size, occupying substantial part of the body cavity and discharge white milt on gentle pressure.

Stage V (Spent): Testes shrunken, their weight drastically reduced in this stage. No milting while pressure on abdomen.

Female

Stage I (Immature Virgin): Ovaries short, translucent, paired, silver in colour thread like structures extending one third of the body cavity. Eggs of circular shape, semitransparent.

Stage II (Maturing Virgin or Recovering Spent): Ovaries thin, slightly elongated. Ova spherical opaque.

Stage III (Ripening): Ovaries yellowish, elongated, slightly lobulated, ovarian blood vessels visible extending almost the entire length of the body cavity. Eggs visible to naked eye.

Stage IV (Ripe or Full Mature): Ovaries yellow white in colour ovarian membrane are very thin. Eggs opaque and very distinct, almost round and easily ejected if slight pressure is applied on the abdomen.

Stage V (Spent): Ovaries flabby, shrunken and left with only a few residual ova in recently spawned fish . Majority of ova were small, transparent, invisible to naked eye, resembles stage II, but differs from it in the relatively smaller sizes and loosely packed mature ova. Weight considerably reduced.

In both of the sexes gonads show a regular seasonal development with little overlap in different phases of maturation.

Sex ratio, Gonad Development, Ova Diameter and Fecundity

Male shows a slight numerical superiority over female. Paired Gonads elongate with ripening and extend towards the posterior half of the abdomen. Gonads developed in March and entered the ripening stage and subsequently got predominant thereafter.

Size of ova ranged between 0.4 to 1.45 mm in the ripening stage. Ova sampled from different parts of the ovary were of the same size. The reproductive potential of the fish was measured in terms of fecundity .Fecundity increased with size and weight of fish. Absolute fecundity varied between 927-7409 egg cm-1 in the specimens of *M.armatus* ranging from 12.0-48.2 cm in size. Length-wise the fecundity varied between 53-146 egg cm-1.with an average of 63 egg cm-1 and weight wise it varied between 13-88egg g- 1with an average of 29 egg g-1 of the body weight of the fish. Regression analysis indicated that the total length and weight could be used to predict fecundity of this spiny eel, but weight proved to be the best predictor of fecundity (r=0.9151). Although in both cases significant correlation was noted ($p<0.001$).Ova per gm of ovary weight varied between 177-1108, with an average of 64egg g-1. Results of the relationship of fecundity with both ovary length and ovary weight are presented in Table 3.The condition of all the ova in an ovary being at the same stage of development is indicative of the fact that spawning in this fish take place only once in a year. Breeding season synchronous with onset of monsoon i.e. from late June to early September. The male : female ratio remains near constant throughout the year.

Table- 1.
Gut contents of the spiny eel. *M.armatus*

Food Items	Numerical content (%)	Frequency of occurrence (%)	Gravimetric index (%)
Crustacea			
Macrobrachium	82	55.7	97.52
Eubranchipus	25	28.8	0.97
Daphnia	18	11.5	
Teleostomi			
Puntius	14	23.0	27.52
Esomus	08	07.6	09.57
Osteochilus	04	05.7	12.32

Unidentified	25	48.0	62.20
Scale	40	38.4	0.98
Aquatic insects (larval stage)	Numerous	19.2	06.80
Ephemeroptera	Numerous	30.7	08.52
Diptera	02	05.7	0.43
Hemiptera	30	11.5	02.32
Unidentified			
Annelids			
Aquatic earthworm	Numerous	26.9	15.00
Mollusca			
Gastropods	05	03.8	0.21
Digested matter		36.5	35.00
Aquatic vegetation		03.8	04.32
Fish eggs	Numerous	07.6	02.35
Barbels	40	17.3	0.53

Table-2
Gastrosomatic index of *M.armatus* in different seasons
Size range according to sex

Month	5-10cm			11-20 cm			21-30cm			31-40 cm			41-50 cm		
	M	F	Combined	M	F	Combined	M	F	Combined	M	F	Combined	M	F	Combined
Jan.	1.8	1.2	1.3	2.2	1.8	2.1	3.2	3.2	3.4	3.6	2.9	2.6	1.6	1.7	1.6
Feb.	1.8	1	1.4	2.2	1.6	2.2	3.1	3.2	3.5	3.2	2.9	3.4	2.8	2.5	2.6
March	1.5	1.5	1.6	2.5	2.0	2.2	3.5	3.4	3.4	3.6	3.7	3.4	2.9	2.8	2.8
April	1.3	1.6	1.8	2.3	2.5	2.4	3.6	3.5	3.5	3.3	3.8	3.4	3.5	3.5	2.1
May	1.6	1.8	1.7	2.6	1.9	2.5	3.7	3.5	3.6	3.8	3.1	3.5	3.6	3.4	3.4
June	--	1.8	1.8	2.5	2.5	2.4	3.8	3.2	3.5	3.6	2.7	3.4	3.8	2.6	3.7
July	--	--	--	2.3	2.6	2.4	2.9	2.8	2.9	1.4	1.8	1.9	3.6	2.6	3.2
Aug	--	--	--	2.6	2.3	2.5	2.1	2.6	2.5	1.9	1.6	1.8	2.1	1.8	2.1
Sept.	--	--	--	2.5	2.6	2.6	3.5	2.9	3.2	1.8	1.8	1.7	1.9	1.7	1.8

Oct.	3.1	1	2.6	2.7	1.9	2.6	3.6	3.2	3.1	1.9	2.3	2.0	2.0	1.6	2.0
Nov.	2.1	0.9	2.1	1.9	1.7	2	3.7	2.8	2.9	2.6	3.0	2.9	1.7	3.0	1.8
Dec.	--	0.8	0.8	1.7	1.7	1.8	3.6	2.5	2.9	2.4	2.7	2.6	1.5	1.7	1.6
Mean # SE	1.7 # 0.20	1.6 #0.11	1.6 # 0.14	2.3 # 0.08	2.1 # 0.08	2.3 # 0.07	3.4 # 0.14	3.1 # 0.12	3.2 # 0.10	2.7 # 0.23	2.7 # 0.20	2.7 # 0.20	2.6 # 0..24	2.3 # 0.19	324 # 0.20

Male-M ; Female=F; Combined=C

Table-3

Regression analyses of fecundity relations in *M.armatus*

Parameters	Regression equation		Correlation Coefficient	significance
	Logarithmic	Parabolic		
Body Length 'L' Vs Fecundity 'F'	Log F= 1.83 + 0.99 Log L	$F= 6.7 \times 10^{1} L^{0.99}$	0.86	0.001
Body Weight 'W' Vs Fecundity 'F'	Log F= 2.50 + 0.41 Log W	$F= 3.1 \times 10^{2} W^{0.41}$	0.91	0.001
Ovary Length 'OL' Vs Fecundity 'F'	Log F= 1.74 +1.88Log OL	$F= 5.4 \times 10^{1} L^{1.88}$	0.93	0.001
Ovary Weight 'OW' Vs Fecundity 'F'	Log F= 3.21 + 0.14Log OW	$F= 1.6 \times 10^{3} OW^{0.14}$	0.87	0.001

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