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Breeding performance of green back grey mullet *Liza subviridis* (Valenciennes 1836) from coastal water of the Bay of Bengal

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Abstract
Berried females of *Liza subviridis* (Valenciennes 1836) were collected from the fish landing centers of Cox's Bazar (Bay of Bengal) to estimate the maturity stages, gonado somatic index (GSI), ova diameter, fecundity, breeding time and both the macroscopic and microscopic appearance. Data were collected for consecutive 6 months following seasonal patterns. Study revealed that the breeding period of *Liza subviridis* (Valenciennes 1836) was found to occur from last December to January with January as peak. The GSI ranges from 0.83 to 25.71. The ova diameter was found ranging from 0.07 mm to 0.60 mm and highly related with mean GSI. Fecundity was calculated to be 32,010 to 1,86,662, which showed high fecundity compared to other marine fish. There was found no significant correlation between fish weight and body length of *Liza subviridis*.

Keywords: Breeding performance, *Liza subviridis*, GSI, Fecundity.

1. Introduction
The green back grey mullet *Liza subviridis* (Valenciennes 1836) is cultured in many developing nations. It is a brackish water fish commonly available in shallow coastal waters, estuary and mangrove swamps of Bangladesh. Locally called "JatiBata'' in Bengali and belongs to the family Mugilidae of order Mugiliformes. In Bangladesh *Liza subviridis* occurs along the coastal regions of the Bay of Bengal. The adults and juveniles of this species are hardy, euryhaline, eurythermal and not competitor of food. School occurs in shallow coastal waters, enters lagoons and estuaries to feed. Juveniles often occur in shrimp culture farms as wild species and often forage in mangrove swamps. As an international group of fish, in the family mugilidae, grey mullet group is widely distributed in the coastal waters of tropical and subtropical regions extending from 42 ºN to 42 ºS [1]. This species is important and meeting the subsistence protein requirements of the people of the Pacific basin, South East Asia, India, Bangladesh, the Mediterranean and Eastern European countries and in many parts of Central and South America. Mullet is omnivorous species and can be stocked in both brackish and freshwater pond, and therefore the grey mullet is expected to play an important role in future productivity as a result of efficient utilization of water area [2]. Though this fish is very familiar with the local consumption in Bangladesh, still it is not properly exploited but it can play an important role to fulfill the demand of the local consumption. Moreover, the surplus can be exported to the foreign countries. *Liza subviridis* with her tasty and rich flesh is valued commercially, presents 70-80% of total mullet found in the coastal regions of the Bay of Bengal. It is adapted for cultivation in brackish water ponds and gives good result in poly-culture with shrimps, which is preferred by people as food fish. Knowledge on fish breeding performance is important to evaluate the commercial potentiality of its stock, life cycle, culture and management [3, 4]. Several studies on pelagic and demersal fish breeding biology had been conducted so far worldwide [5, 6]. However, though *L. subviridis* is one of the highly esteemed table fish both at home and abroad, yet very little work has so far been reported on its breeding performance from the Bay of Bengal. Hence, this study was conducted to investigate the breeding performance considering the economic importance of this species.

2. Materials and Methods
A total of 30-berried females of *L. subviridis* were collected in different seasons (monsoon and post-monsoon) from the fish landing centers of Cox's Bazar, Bangladesh for this study. The collected fishes were immediately brought to the Laboratory of the Institute of Marine

Sciences and Fisheries, University of Chittagong for future analysis. All specimens were washed thoroughly with tap water. Total length and standard length of each fish were measured in nearest centimeter (cm). Body weight of each fish was measured by means of a pan balance in nearest gram (g). Before weighing the fishes, excess water was removed with blotting paper. Ovary from the each fish was removed by dissecting out the abdomen. The two lobes of each ovary were dried off by removing excess fluid with blotting paper. They were then weighed on a pan balance to the nearest 0.01g. Ovary of the fish was categorized as immature, maturing, mature and spent. Fecundity was determined following the standard method [7]. Five cross sectional samples were taken randomly from anterior, middle and posterior regions of the two lobes of each ovary. The eggs in each sample of five sections were counted and mean value was then calculated. The diameter of eggs was determined with the help of an ocular micrometer. Gonado Somatic Index (GSI) was computed by following Kader [8]. The value of correlation co-efficient (r) between fecundity and total length, standard length, body weight and gonad weight were calculated. The regression line of fecundity on the aforesaid parameters was established. All of the statistical analyses were carried out following Spiegel [9] and the mathematical relationships between fecundity and that of the other parameters were determined by following Lagler *et al.* [3].

3. Results and Discussion

The total length of the sampled fish ranged from 14 cm to 25 cm with the total body weight of the berried female ranged from 108 g to 140 g followed by gonad, ranged from 1.0 g to 36.0 g (Table 1). The female reproductive organs of *Liza subviridis* (Valenciennes 1836) consisted of bi-lobed gonads. The ovary was asymmetrical in respect to size, length and weight. Gonads of different stages of maturity differed in shape, size and color in different seasons. The lobes of each ovary were found elongated and flat. Left lobe was slightly lager in most cases. Central region of each lobe was broader. The two lobes, situated on the dorsal side of the body cavity, were connected by mesenteries on the dorsal surface. The two ducts, extending from the posterior end of each lobe, united to form a common gonoduct leading to urinogenital pore. Based on color changes, external morphology, transparency, ova size the ovary was divisible into four maturity stages i.e., immature, maturing, mature and spent, which showed the detail of the morphological changes taking place in different maturity stages of the ovary (Table 2). In immature stage ovaries found bi-lobed, almost symmetrical, thin, transparent extending more than half of the length of body cavity. Eggs were minutes, visible under high magnification. Egg diameter ranged from 0.08 mm to 0.18 mm. Gonado Somatic Index (GSI) ranged from 0.83 to 2.97. Maturing stage was characterized by more enlarged ovaries, granular appearance and almost symmetrical, extending more than half of the length of body cavity. Ova were visible to the eye. Egg diameter ranged from 0.20 mm to 0.46 mm and GSI ranged from 3.82 to 10. In mature stage, ovaries were found much more fattened in the middle portion and tips are slightly pointed. The eggs were separated from each other and visible through transparent thin layer. The color of ovaries was fade yellow. Egg diameter ranged from 0.47 mm to 0.60 mm with the GSI ranged from 15.25 to 25.71. Spent stage was characterized by irregular in shape eggs, eventually ruptured and the eggs became dark under microscope. Egg diameter ranged from 0.07 mm to 0.10 mm and GSI ranged from 0.91 to 2.27. Studies of above different stages described by number of researchers [8, 10, 1]. The GSI of *L. subviridis* ranged from 0.83 to 25.71. The highest of GSI was recorded for mature stage in January (25.71) and minimum GSI was found in September (0.83).The seasonal variation of GSI values is shown in Table 3. During the study period, relatively higher values of GSI were observed in the month of December (22.95) to January (25.71) which indicated one peak of the GSI in a year, meaning that this fish breeds one time annually within December to January. GSI values in female *L. subviridis* of the study agreed with Nash and Shehadeh [1] and Yashouv [11] who worked on female *Mugilcephalus.* The peak of GSI value in the month of December and January indicated their spawning season, which agreed with the species of Liza parsia, spawned between January and March [1]. Ova diameter of *L.subviridis* ranged from 0.07 mm to 0.60 mm. The highest value of ova diameter was recorded for mature stage. The minimum ova diameter was found in January (0.07mm) and the ova size reached its peak during the breeding month in December (0.56) to January (0.60 mm). The minimum and maximum ova diameter was found in post monsoon (Table 3).

Observation of fecundity revealed that berried females of *L. subviridis* carried about 32,010 to 1, 86,662 eggs (Table 1). The fecundity was found minimum when the fish was having 23cm of total length and body weight of 110 g, while maximum fecundity was found in a fish having total length of 23 cm and body weight of 120 g. There as found no significant relation between fecundity and body weight. The mean numbers of eggs were 82,335 for a fish with a mean of total length of 21.18 cm and mean weight of 120.17g. The variation of fecundity is very common in fish as stated by other studies elsewhere [12, 13, 14, 15, 8, 16, 17] and numerous factors including nutritional state [18, 19] time of sampling and maturity stage [13] and racial characteristics [20] have been suggested to explain variation in fecundity both within and between fish population. The fecundity of mullets generally increases with the increase of size of females, thus fecundity and quality of the sexual products seem to alter as the growth rate of the spawners changes [21]. According to El-Maghraby *et al.* [22] that fecundity increases at a rate of about three times the length of the fish, as in *Mugilcapito* from Lake Borullus. This study also stated that the variation in fecundity between fishes of the same age is greater than the variation between fishes of the same weight or length. Consequently, fecundity is important in fish breeding biology, as fecundity is the season's crop or number of eggs released by an individual fish during a spawning season. Moreover, the study of fecundity is important to have a full understanding about the periodicity of spawning [23].

Table 1: Observations of breeding performance of Green Back grey Mullet *L. subviridis* collected from coastal water of the Bay of Bengal, Indian Ocean.

Collection period	Total length (cm)	Standard length (cm)	Total body weight (g)	Gonad weight (g)	GSI	Fecundity	Egg diameter (mm)
Post Monsoon	18-25	14-20	108-140	01-36	0.91-25.71	32,010- 88,918	0.07-0.60
Monsoon	14-25	11-20	115-140	01-3.8	0.83-2.97	72,676-1, 86,662	0.08-0.20

Table 2: Color, size, gonadosomatic index and ova diameter in different maturity stages in the ovary of *L. subviridis*.

Maturity stages	Color	GSI	Ova diameter (mm)
Immature	Pinkish	0.83 - 2.97	0.08 - 0.18
Maturing	Yellowish	3.82 – 10	0.20 – 0.46
Mature	Fade yellow	15.25 -25.71	0.47 – 0.60
Spent	Reddish	0.91 – 2.27	0.07 – 0.10

Table 3: Seasonal variation of mean GSI and ova diameter of *L. subviridis.*

Collection period	No. of fish	Mean range of GSI	Egg diameter (mm)
Post Monsoon	20	0.91 – 24.45	0.09 – 0.18
Monsoon	10	0.91-2.70	0.07 – 0.59

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