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RESEARCH PAPER

Reproductive Biology of the Female Asian Striped Dwarf Catfish *Mystus tengara* (Hamilton, 1822) (Siluriformes: Bagridae) in the Ganges River of Rajshahi, Northwestern Bangladesh

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Abstract

The present study was the detailed investigation to identify maturity of female *Mystus tengara* in the Ganges River of Rajshahi (24°22´N; 88°35´ E), northwestern Bangladesh. Specimens (n = 921) were collected monthly from January to December 2015, using cast nets (mesh size = 17 mm) for adults and purse-seine and trap nets (mesh size = 4 mm) for juveniles. Histological analyses of 171 females were performed in which oocyte development was divided into five stages, with the oocyte size range from 33 to 1609 µm in diameter. The ovarian cycle of *Mystus tengara* was divided into three periods: a long period of early oogenesis (emerging from December but expands to April as the initiation time of early oogenesis for all the oocytes were not similar), a short period of vitellogenesis (February to April) and a spawning period from May through July with peak activity in June. Both gonadosomatic (I_G) (up to 16.2%) and hepatosomatic indices (I_H) (up to 3.7%) can be used together to predict the spawning period where the females were observed to spawn in June and July. Total lengths at minimal observed maturity/50% maturity (L_{T50})/95% maturity (L_{T95}) values were 7.9/8.9/11.1 cm for females. *Mystus tengara* is likely an asynchronous multiple spawner with indeterminate fecundity.

Keywords: Oocyte, sexual maturity, vitellogenesis, asynchronous, indeterminate fecundity.

Introduction

Mystus tengara (Hamilton, 1822), the Asian stripped dwarf catfish belongs to the family bagridae is a native and commercially important small indigenous fish species of Bangladesh (Mitu and Alam, 2016). This species occurs widely throughout the Indian subcontinent including Bangladesh, India, Pakistan, Sri Lanka, Nepal and Bhutan, but it has also been reported from Myanmar, Malaysia, Laos, Vietnam and Combodia (Froese and Pauly, 2006). The maximum total length of this species is recorded 6.2 cm (Rahman, 1989), 7.0 cm (Bhuiyan, 1964) and 11.4 cm (in the present study). It is previously abundant in the rivers, creeks, canals, reservoirs, lakes, swamplands and ponds of Bangladesh (IUCN Bangladesh, 2000). But recently the populations have seriously declined to the lower risk near threatened due to over exploitation and various ecological changes in its natural habitats (Hossain, Jasmine, Ibrahim, Ahmed, Rahman, & Ohtomi, 2009). On the other hand, despite its economic importance, information about reproduction is often rare thus warranting the study of reproductive biology of this species. In depth, knowledge of several components of a stock's reproductive biology, such as spawning season, maturity size and spawning-stock biomass are essential for fisheries management (Kokokiris, Stamoulis, Monokrousos, & Doulgeraki, 2014). Determination of maturity stages and estimation of gonadal development are based either on a macroscopic (visual) examination or on a more accurate histological analysis of the gonad (Kokokiris *et al*., 2014). However, classifying individuals based on the method of visual examination of gonads has important limitations (Kokokiris *et al*., 2014). The stage of oocyte development cannot be examined (needed to distinguish sexually active from sexually inactive females), the number of oocytes ready to be released remains unknown, and the presence of postovulatory follicles or atretic stages cannot be assessed (Costa, 2009; Nunez & Duponchelle, 2009). These limitations could hinder development of an effective management scheme, especially for multiple-spawning species, because the incorrect classification of maturity can lead to crucial over or underestimations of fundamental reproductive parameters (Costa, 2009; Nunez and Duponchelle, 2009). However, there are many studies on the reproductive guilds for the genus *Mystus* (Qasim &

Qayyum, 1961; Bhatt, 1971a, 1971b; Rao & Sharma, 1984; Roy & Hossain, 2006; Musa & Bhuiyan, 2007). Rastogi and Saxena (1968), Gupta and Banerjee (2013) and Guraya, Kaur and Saxena (1975) have studied on *Mystus tengara* ovary. But to date, comprehensive studies are limited on microscopic observation of the oocyte development of *Mystus tengara*. To this end, the specific objectives of the current study were to provide a precise maturation scale based on histological evaluation of ovarian maturity of this economically important species in the Ganges River of Rajshahi, northwestern Bangladesh.

Materials and Methods

Fish Sampling, Physico-Chemical Properties and Histological Analysis

The lower Ganges River (known as the Padma River in Bangladesh) entered Bangladesh from India through the Rajshahi district (24°22′ N; 88°35′ E) (Figure 1). Water samples were collected once in a month over a one year period from this river from January to December, 2015 between 10:^{00} am and 11:^{00} am for analysis of various physico-chemical parameters using dark bottles. The physico-chemical parameters determined were temperature, transparency, dissolved oxygen, carbon-di-oxide and pH. Water temperature was determined using a centigrade mercury-in-glass thermometer of range 10-110°C and the results were expressed in degrees Celsius (°C). The hydrogen ion concentration (pH) was determined in the laboratory using Buffered Electronic pH meter. Using a Secchi disc at two depths (disappearing, reappearing) with a black and white standard color coded disc water transparency was measured. Dissolved oxygen and carbon-dioxide concentration were determined using a portable aquaculture kit (HACCH Kit, model FF-2, USA). The results were expressed as mg L^{-1}. In all, 921 female *Mystus tengara* were randomly sampled on a monthly basis from January to December 2015 from both commercial vessels and artisanal fishery, using cast nets with a 17 mm mesh size. In addition, juvenile specimens were collected with a 4 mm mesh size purse-seine and with trap nets (Figure 2). For each specimen, total length (L_T) (±1 mm) and whole body weight (W_T) (±1 g) were determined using a digital slide caliper and a digital balance, respectively. A semi-circle incision was used to open the body cavity and sex was assessed. The organs were dissected out and carefully separated. Gutted weight (Total body weight – gonad and liver weight) (W_G, g) was recorded. Ovaries (W_O) and liver weights (W_L) were measured (±0.01g) using a digital balance.

Determination of Oocyte Development Phases

To examine oocyte development a subsample of 171 ovaries were fixed in 10% buffered formalin for histological analyses. Once fixed, a 4-mm thick transverse section was taken from the middle of each gonad, dehydrated through a series of alcohol and solvent solutions and infiltrated with paraffin wax on an automatic tissue processor. A rotary microtome was used to cut 4-mm thick sections, which were stained with haematoxylin and eosin, cover-slipped with a mounting medium and examined under an Optika™ Vision Pro light microscope (×10–100 magnification) with an Optikam3 digital camera.

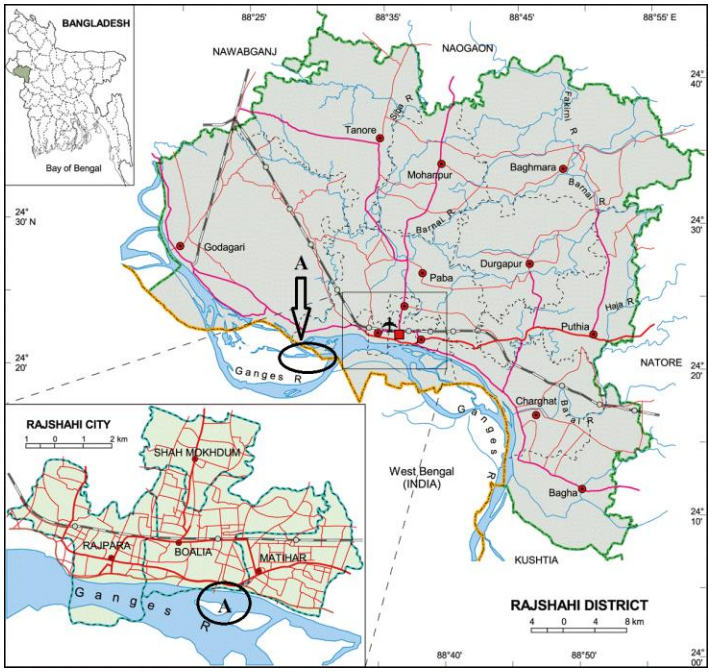

Figure 1. Map of research area, indicating the Ganges River (circled area) of Rajshahi city, northwestern Bangladesh from where fish samples were collected.

Figure 2. Lateral view of *Mystus tengara* (11.4 cm total length) (Source: Google; Accessed on: 25 November, 2016).

Development of the oocytes and maturity stages determined from microscopic observations of the ovarian histological slides. The oocyte development classification of Grier, Carmen Uribe, Aranz_abal, and Patino (2009) and Carmen Uribe, Grier, and Parenti, (2012) was used to define stages of oogenesis. Due to the necessity of using previously frozen samples, histological processing, and natural variation, oocytes were not perfectly spherical in shape; therefore, maximal and minimal oocyte diameters were averaged to decrease variance and avoid artificially increasing the overlap between different groups of oocytes (West, 1990). Hydrated oocytes rarely survived histological processing intact and were observed to be highly crenulated, which made accurate measurements difficult. Therefore, additional measurements were made of the largest oocytes extracted directly from the ovaries of spawning females, preserved in 10% buffered formalin, and rinsed in deionized water before taking measurements. Eight ripe ovaries (April = 2, May n = 2, June n = 2, July = 2) were assessed for oocyte size frequency distribution. In total, 242 oocytes were measured from eight ripe and three ovaries. The percentage frequency was plotted against oocyte diameter.

Seasonality of Gonad Development and Spawning Season

The maturation stages of ovary were divided into six stages including ImReg, reproductively inactive ovaries; eDev, early developing ovaries; lDev, late developing ovaries; SpC, spawning capable ovaries; SpA, spawning active ovaries; Reg, regressing phase ovaries. The spawning season of the *Mystus tengara* was determined by monthly changes in the: (i) percent frequency of the maturity stages, (ii) gonadosomatic index (I_G), I_G = 100 × gonad weight/gutted weight), (iii) hepatosomatic index (I_H), I_H = 100 × liver weight/gutted weight, and (iv) condition factor ($C_F = (W_T / L_T^b) \times 1000$, b (3.198) being the exponential of the regression $W_T = aL_T^b$. Changes of I_G, I_H and C_F in maturity stages were also analyzed to determine changes of body indices with respect to various phases of ovarian development.

Length at Sexual Maturity

A total of 765 females sampled during the period of late gametogenesis and maximum gonad activity (from March to October) were used to estimate size at first sexual maturity. These are defined as the sizes (L_T) at which 50% (L_{T50}) and 95% (L_{T95}) of all fish sampled are at the relevant maturity phase (developing, spawning capable, regressing ovarian phase). Binomial maturity data (0, immature; 1, mature) (Mollet, Cliff, Pratt Jr. & Stevens, 2000) were used to fit a logistic regression model of the form $p = [1+e^{-(a+bL)}]^{-1}$ (using maximum likelihood approach), where p is the proportion of mature individuals and a and b are model parameters. Estimates of the L_T at 50% maturity (L_{T50}) and L_T at 95% maturity (L_{T95}), with bootstrap confidence intervals, were calculated based on maturity stage of females.

Statistics

The significance of difference (at the 5% level) in I_G, I_H and C_F between monthly samplings and maturity stages was tested by analysis of variance (ANOVA) with a *post-hoc* Tukey test using the statistical package STATISTICA 9 (StatSoft® Incorporation). To meet the assumptions of ANOVA, the data were logarithmically transformed when deemed necessary.

Results

Table 1 shows the physic-chemical properties include water temperature, transparency, dissolved oxygen, free CO_2, pH. Total length of all analyzed female individuals (n=921) ranging from 6.2 to 11.4 cm, with the smallest and the largest individuals captured in October and July respectively (Table 2). Seven stages (stage 1 to stage 7) of oocyte development (Table 3) observed with the oocyte diameter ranging from 33µm to 1629 µm (Table 4).

Table 1. Physico-chemical properties (Mean±SD) of the Ganges River of Rajshahi, northwestern Bangladesh from January to December, 2015

Months	Water temperature	Transparency	Dissolved oxygen (mg/L)	Free Carbon-di-oxide (mg/L)	pH
January	22.3±2.12	32.4±12.12	6.67±1.12	3.6±0.5	7.8±0.1
February	24.4±1.01	31±8.89	6.98±0.89	3.2±0.8	7.6±0.4
March	25.9±4.12	32±10.56	7.89±0.90	3.0±1.1	7.9±0.3
April	25.8±3.08	34±12.23	7.34±0.56	3.0±0.3	8.0±0.6
May	26.1±1.67	32±10.12	6.19±0.76	3.2±1.4	8.2±0.3
June	23.9±1.12	36±7.77	8.16±0.88	3.8±1.0	8.0±0.3
July	23.4±2.78	36±10.20	6.45±1.67	3.1±0.7	8.1±0.5
August	25.2±3.12	33±5.56	7.45±1.16	3.5±0.4	7.8±0.5
September	25.1±2.98	31±14.98	7.19±1.58	3.6±0.6	7.6±0.2
October	24.9±3.12	34±11.54	6.49±1.65	3.2±0.4	7.7±0.6
November	22.6±2.45	32±13.45	6.41±1.06	3.6±0.6	7.7±0.5
December	22.9±1.12	34±5.87	6.59±1.11	3.2±0.2	7.9±0.3
Bangladesh standard for Fisheries (EQS, 1997)	25 (°C)	10	4.0-6.0	<2	6.5-8.5

Table 2. Collected female specimens of *Mystus tengara* per length range from January to December, 2015 in the Ganges River of Rajshahi, Northwestern Bangladesh

Length Range	January	February	March	April	May	June	July	August	September	October	November	December
6.0 – 6.4	17	20	10	00	00	00	00	02	05	08	10	09
6.5 – 6.9	13	15	12	00	00	00	00	04	08	11	08	06
7.0- 7.4	07	27	17	12	04	00	00	01	06	12	13	07
7.5- 7.9	10	13	12	14	09	12	04	09	14	16	14	06
8.0- 8.4	00	00	13	17	07	09	06	08	07	08	11	12
8.5- 8.9	00	00	07	07	06	16	09	12	09	06	09	15
9.0 - 9.4	00	00	09	15	09	09	07	09	05	03	10	17
9.5 - 9.9	00	00	07	13	12	17	10	08	11	02	07	08
10.0-10.4	00	00	02	09	16	14	12	14	03	03	06	07
10.5-10.9	00	00	00	10	10	15	14	11	04	05	05	04
11.0-11.4	00	00	00	00	14	07	07	07	02	04	03	02

Table 3. Collected female specimens of *Mystus tengara* per length range and maturity stage used in histological analyses from January to December, 2015 in the Ganges River of Rajshahi, Northwestern Bangladesh

Maturity stage	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
Length range							
6.0 – 6.4	00	00	00	00	00	00	00
6.5 – 6.9	00	00	00	00	00	00	00
7.0- 7.4	01	00	00	00	00	00	00
7.5- 7.9	07	11	01	00	00	00	00
8.0- 8.4	06	07	01	07	03	01	03
8.5- 8.9	05	09	06	05	04	02	06
9.0 - 9.4	08	07	08	06	05	02	09
9.5 - 9.9	01	07	07	07	09	04	04
10.0-10.4	02	02	02	03	08	03	05
10.5-10.9	00	01	01	04	09	09	03
11.0- 11.4	00	01	01	02	09	07	01

Values in parentheses are the 11 specimens measured for oocyte diameter.

Physico-Chemical Parameters

Maximum water temperature was found in May (26.1±1.67) while it was minimum in January (22.3±2.12). Transparency reached the highest in July and the lowest in February. Similarly, the dissolved O_2 and free CO_2 were the highest 8.16±0.88 and 3.8±1.0 respectively in June and the lowest in May and April, 6.19±0.76 and 3.0±0.3 respectively. pH observed the peak at May and touched the lowest

Table 4. The stages of oocyte development, average oocyte and nuclear development of *Mystus tengara* from January to December, 2015 in the Ganges River of Rajshahi, Northwestern Bangladesh

Stages	Oocyte stages	Number measured	Average oocyte diameter (µm)	Average nucleus diameter (µm)
Early perinucleus	Stage 1	30	67 (33-102)	30 (15-55)
Late perinucleus	Stage 2	45	124 (85-164)	52 (35-70)
Primary growth yolk vesicle	Stage 3	27	283 (169-397)	86 (42-131)
Early vitellogenesis	Stage 4	34	810 (598-1023)	167 (97-237)
Late vitellogenesis	Stage 5	47	1062 (856-1269)	209(143-275)
Maturation	Stage 6	28	1175 (927-1424)	222(157-288)
Hydration	Stage 7	31	1407 (1206-1629)	Oil drop 180 (105-256)

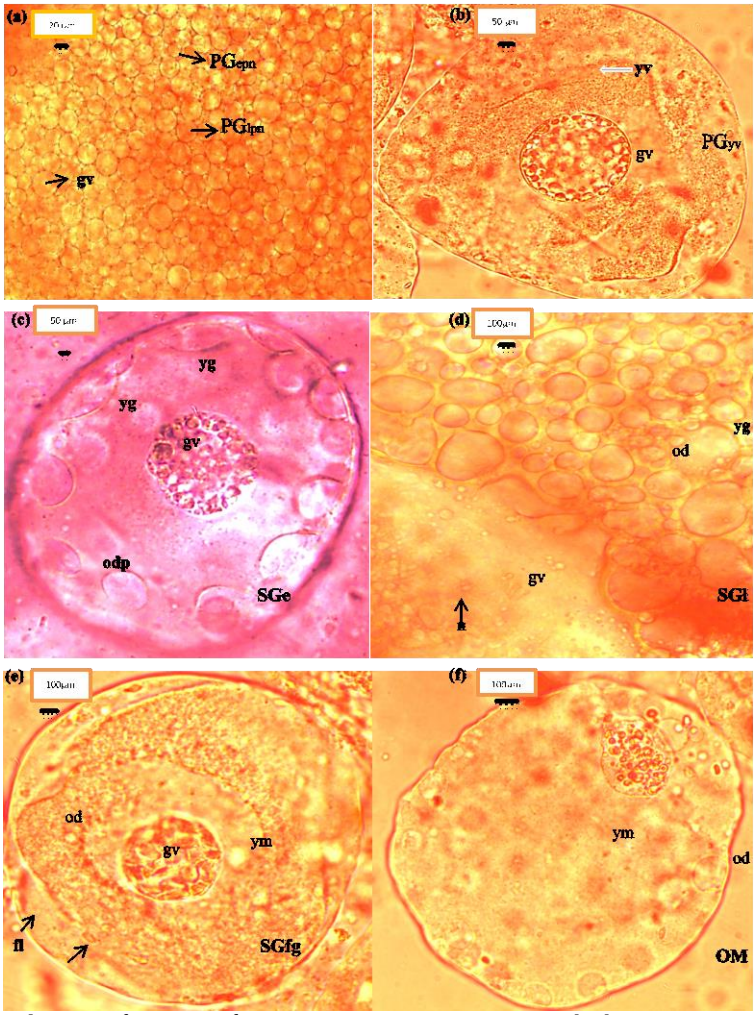

Figure 3. Developmental stages of oocytes of *Mystus tengara*. a: Primary growth phase oocyte at the early perinucleolus step (PGepn) and late perinucleolus step (PGlpn) possessing an ovoid germinal vesicle (gv). b: Primary growth yolk vesicles phase (PGyv) oocyte with dispersed yolk vesicles (yv). c, d: Secondary growth stage oocytes (SG) with yolk granules (yg) and oil droplets (odp) at early (SGe) or late vitellogenesis (SGl) phase. e: Full-grown vitellogenic oocyte (SGfg) with fluid yolk (ym) and oil drops (od). f: Oocyte at the final maturation phase (OM) with yolk material and oil droplets. fl, follicular layer; n, nucleolus; ym, yolk mass; zp, zona pellucida.

value at February (Table 1).

Oocyte Development Stages

Oogonia and primary growth phase (PG) oocytes (mainly at the early perinucleolus step, PGepn and late perinucleolus step, PGlpn) possessing a spherical or ovoid germinal vesicle (Figure 3a). The diameter of PGepn and PGlpn oocytes reached 33 to 102 µm (n = 30) and 85 to 164 µm (n = 45) respectively. Primary growth phase oocyte at yolk vesicles phase (PGyv) oocytes reached a diameter of 169 to 397 µm (n=27) (Figure 3b). Secondary growth stage oocytes (SG) enclosed within the oocyte periphery, spherical

acidophilic yolk granules (yg) that progressively increased in number and dispersed within the ooplasm (Figure 3c, d). The diameter of SGe oocytes can be up to 598-1023 µm (n=34), whilst SGl oocytes reached 856-1269 µm (n=47). SGfg oocytes reached 927-1424 µm (n=28) in size, close to maximum size (Figure 3e). During the final maturation phase (OM) hydrated oocytes were found (Figure 3f).

Maturity Classification

In ripe ovaries oocytes of all developmental stages were observed (Figure 4), indicating asynchronous oocyte development. 78% of measured oocytes were pre-vitellogenic oocytes (oocyte stages early perinucleus to primary growth yolk vesicle), while vitellogenic oocytes (from early vitellogenesis to hydration) accounted for just 22%. There was no apparent hiatus between pre-vitellogenic and vitellogenic oocytes (Figure 4) and a generalized atresia and resorption of mature oocytes at the end of the spawning season, indicating indeterminate fecundity of this species.

Seasonal Ovarian Cycle and Variation of Body Indices

Reproductively inactive ovaries (immature or regenerating phase ovaries) were decreasing from February to July but were found all the year round (Figure 5). The initiation of ovarian growth were initially seen from December onwards but extended to July (Figure 5). Late developing phase (vitellogenesis) ovaries were observed from February onwards. The ovaries entered into spawning active phase from March to June (Figure 5). Spawning-capable females were reported between May, June and July, peaking in June (100% spawning capable) (Figure 5). As none capable of spawning and many fish with regressing phase ovaries were observed in July, it seems females probably finished spawning in August (Figure 5). The mean gonadosomatic index (I_G) value increased significantly from April to July in comparison to other months, peaking in June (16.2%, Figure 6, $P<0.001$). The mean hepatosomatic index (I_H) was significantly an upward trend from March to May, culminating in April (3.7%) during vitellogenesis (Figure 6, $P<0.001$). The mean C_F values varied slightly from 1.07 (March) to 1.24% (December, Figure 6) tending to be lower from March to June during vitellogenesis and spawning.

Variation of Body Indices According to Ovarian Maturity Phase

Mean I_G and I_H values were significantly higher in late developing (lDev), spawning capable and spawning active females (SpC, SpA), reached the peak values in spawning active females (Figure 7a, b, $P<0.001$). I_G and I_H declined to bottom most values in regressed (Reg) and reproductively inactive females (ImReg). In contrast, the C_F values were significantly lower for late developing and spawning capable females (Figure 7c, $P<0.001$), with the lowest values for spawning active females (1.02%).

Maturity Rates According to Size of Mature Fish

The smallest individual with mature ovaries was 7.9 cm L_T. The maturity curve showed a L_{T50} of 8.9 cm L_T (95% C.I.=8.00–10.1) and L_{T95} of 11.1 cm L_T (95% C.I.=10.2–12.1) (Figure 8).

Discussion

The current study presents the most comprehensive investigation of oocyte development and maturity classification of *Mystus tengara*. The results show that most of the measured physico-chemical parameters were not in the permissible limits of World Health Organization (EQS, 1997) standards. An acceptable limit of water-quality parameters affect the ability of aquatic organisms to grow and reproduce (Flura, Hossain, Rubel, Tanu, & Khan, 2016). The size of *Mystus tengara* in the Ganges River (11.4 cm LT) greatly exceeded the maximum size (10.2 cm L_T) recorded in earlier studies in the Tanore wetland of Rajshahi, northwestern Bangladesh (Mitu & Alam 2016) but was smaller compared to another study of wetland of Baruipur, West Bengal, India (Gupta & Banerjee 2013). It is probable that these differences are due to the water quality parameters, areas (shallow waters) and fishing gears used that limit the access to individuals of large size. In this study, the oocyte diameter ranging from 33µm to 1629 µm which was larger than the oocyte diameter in previous study of Rastogi and Saxena (1968). This may be attributed to the observation of oocytes from fresh ovary in this study. However, oocytes lost their original shapes due to frozen histological processing in the previous study. The period of early oogenesis is long (December to April) but the period of vitellogenesis is short, from February to April. Results of this study clearly indicate that spawning extends from April to July, with a peak in June. Guraya *et al*. (1975) also reported July as its spawning month, though Rastogi and Saxena (1968) reported June as the spawning month those support the present findings. The small duration of breeding season is very common in the genus *Mystus*. Qasim and Qayyum (1961) reported June to September as the breeding season for *Mystus vittatus*; while Bhatt (1971a, b) found *Mystus vittatus* and *Mystus cavasius* to breed during August-September in Aligarh. Similar to most Ganges river fish stocks the *Mystus tengara* is a late summer – early rainy season spawner. The existence of such strong seasonality across its distribution indicates that seasonality is an important factor for spawning. The spawning capable ovaries of females contained

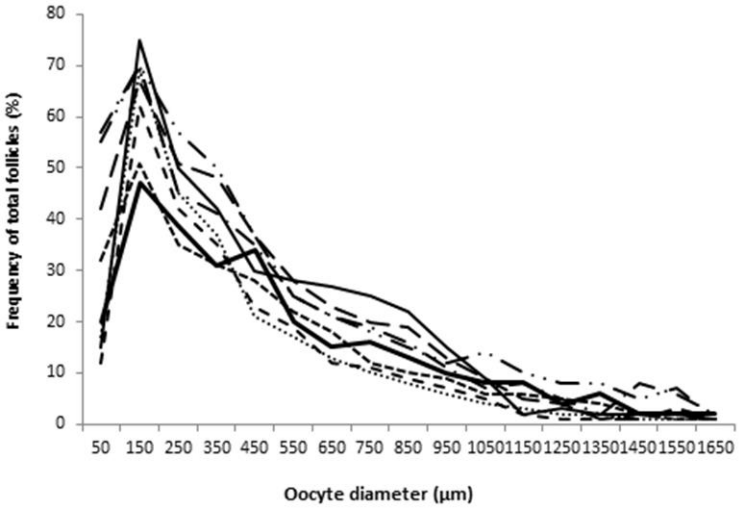

Figure 4. The oocyte size frequency distribution (percentage of total follicles) from ripe ovaries (n=8) of mature female *Mystus tengara* during April (——— , n = 1, — · · — , n = 1), May (····· , n = 1, — — — , n = 1), June (— · — n = , — — — ; n = 1) and July (——— n = 1, ------ n = 1), 2015 in the Ganges River of Rajshahi, northwestern Bangladesh.

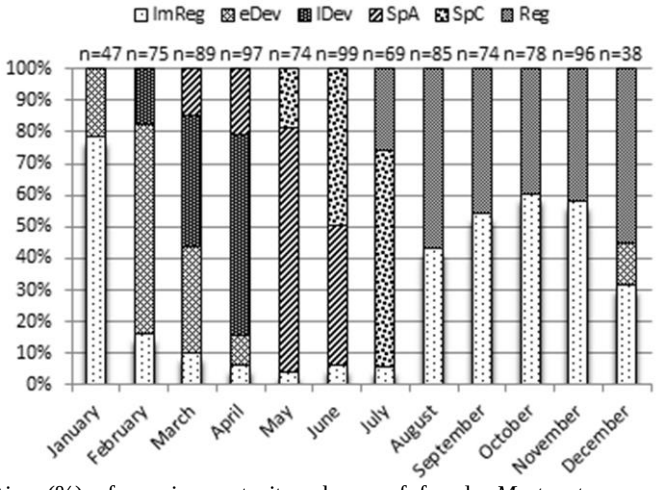

Figure 5. Monthly variation (%) of ovarian maturity phases of female *Mystus tengara* (n = 921), Ganges River (Northwestern Bangladesh) of Rajshahi from January to December, 2015. ImReg, reproductively inactive ovaries; eDev, early developing ovaries; lDev, late developing ovaries; SpC, spawning capable ovaries; SpA, spawning active ovaries; Reg, regressing phase ovaries.

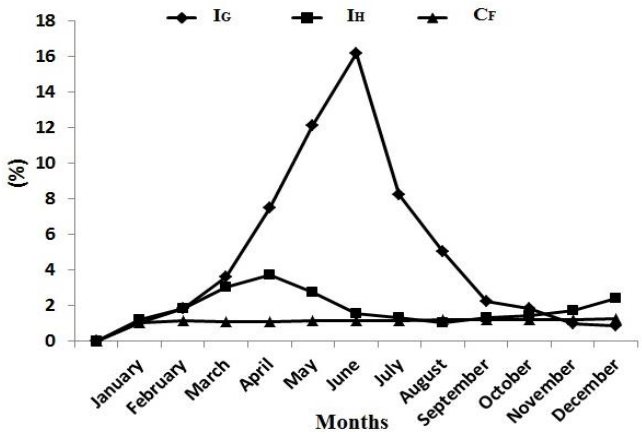

Figure 6. Monthly variation of mean gonadosomatic index (I_G), hepatosomatic index (I_H) and condition factor (C_F) of female *Mystus tengara* (n=526) in the Ganges River (Northwestern Bangladesh) of Rajshahi from January to December,

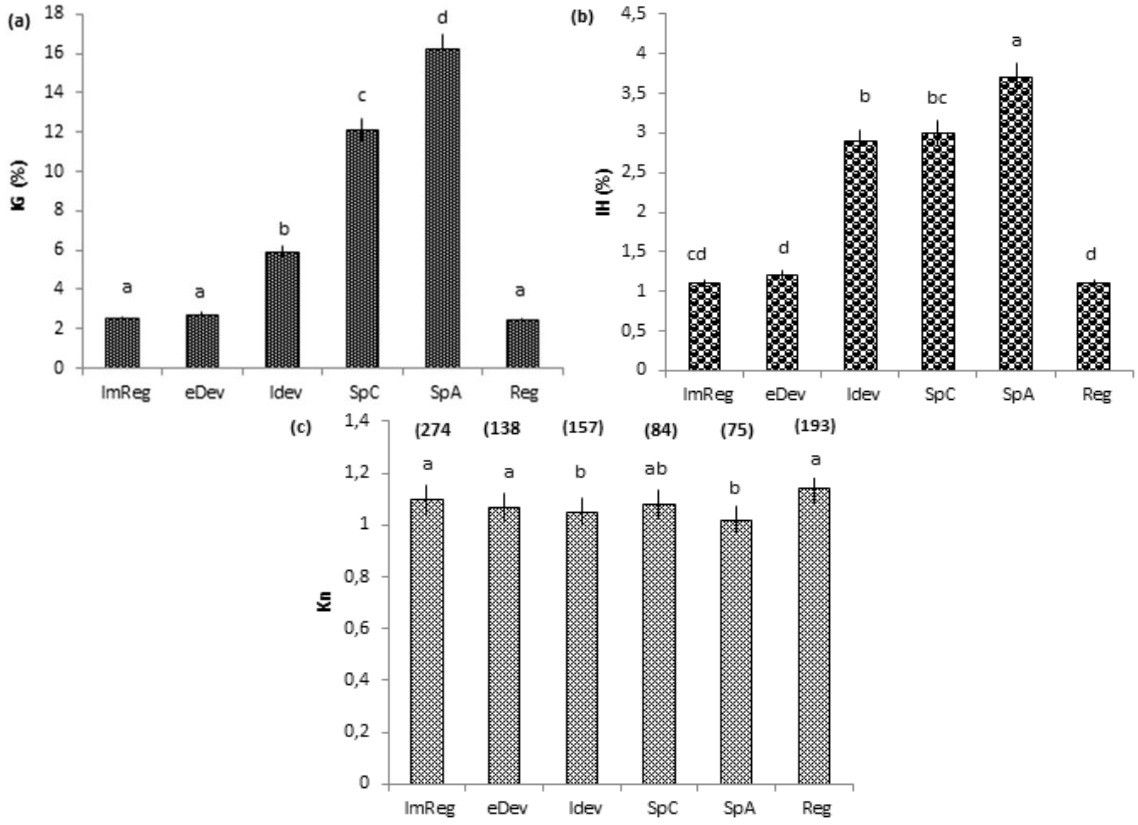

Figure 7. Monthly variation of mean gonadosomatic index (I_G) (a), hepatosomatic index (I_H) (b), and condition factor (C_F) (c) by ovarian phase of female *Mystus tengra* (n=921), Ganges River (Northwestern Bangladesh) of Rajshahi from January to December, 2015. ImReg, reproductively inactive ovaries; eDev, early developing ovaries; lDev, late developing ovaries; SpC, spawning capable ovaries; SpA, spawning active ovaries; Reg, regressing phase ovaries. In parentheses = size of samples. Different letters indicate statistical differences ($P<0.001$).

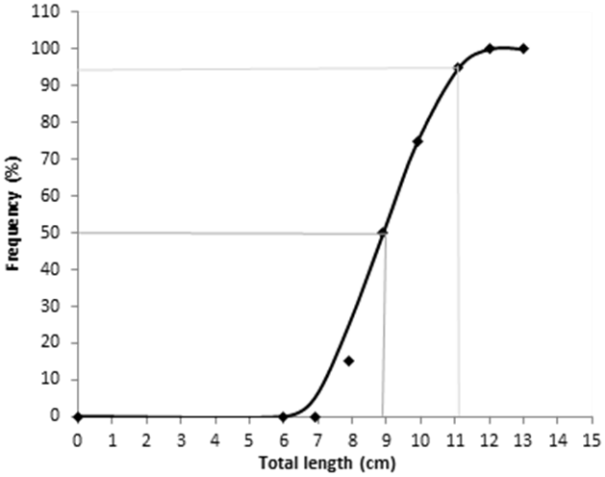

Figure 8. Sexual maturity curve for total length (L_T) of female *Mystus tengara* (n = 765) in the Ganges River of Rajshahi (Northwestern Bangladesh). The length at first maturity was 7.9 cm L_T and L_{50} was 8.9 cm L_T.

oocytes at different stages of development indicating asynchronous oocyte development of a multiple spawning species. According to Rastogi and Saxena (1968) *Mystus tengara* shows asynchronous oocyte development which is similar to our present observation. However, estimation of the fecundity pattern of a fish stock is of great importance for assessment of the spawning stock biomass (Ganias, 2013), which in turn is recognized as an essential parameter for fisheries assessment and management (Kokokiris *et al.* 2014). Coupled with the asynchronous oocyte development, the increase in I_H

during the spawning season and the extended spawning period indicate that this species has an indeterminate fecundity. During the spawning period, the I_H increases in mass in a manner positively associated with the $I_{G,}$ supporting the assumption that I_H variations are related to energy storage for reproduction. Increasing hepatocyte numbers and size are linked to vitellogenesis in liver, because the precursors of the yolk and proteins of the egg chorion are synthesised in that organ (Hoar, Randall, and Donaldson, 1983; N`Da & Deniel 1993). In contrast, the C_F index was not associated with the I_G may suggest that reproduction does not influence the condition of the fish (i.e. oocyte maturation is not reached at the expense of body muscle or lipids). Some species may compensate for inadequate energy deposits during gonadal development with the energy derived by feeding (Aristizabal, 2007). This is likely the case for *Mystus tengara*, which feed throughout their entire spawning period (Mitu & Alam, 2016). Using histological criteria in this study, length at first maturity has been determined for this species at the value of 7.9 cm L_T. Similarly, L_{T50} to be at the value of 8.9 cm L_T and L_{T95} at the value of 11.1 cm L_T, a value obviously lower than the values for *Mystus tengara* in wetland of West Bengal, India reported by Gupta and Banerjee (2013). This reflects the existence of natural variations in length at maturity (i.e. in growth rates), fishery induced changes or the differences in the methodologies used to estimate size at maturity (i.e. sample size, gear selectivity, methodology to define maturity). The *Mystus tengara* fishery is a relatively recent phenomenon, a sound basis for the development of management advice and for future research has now been established. This basic knowledge will enable routine sampling and further more specific biological studies to be initiated.

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