TEMPORAL VARIATIONS OF CONDITION FACTOR AND RELATIVE WEIGHT FOR *MYSTUS GULIO* (HAMILTON, 1822) FROM THE COASTAL WATER IN BANGLADESH

O Rahman[1], MY Hossain[1]*, M Ashekur Rahman[1], MA Islam[1], M Ataur Rahman[1], MF Parvin[1], MS Sarmin[1], BK Sarker[1], W Sabbir[2] and KA Habib[3]

[1]Department of Fisheries, University of Rajshahi, Rajshahi-6205, Bangladesh
[2]Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna-9208, Bangladesh
[3]Department of Fisheries Biology and Genetics, Faculty of Fisheries, Aquaculture and Marine Science, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh

Abstract

The long whiskers catfish, *Mystus gulio* (Hamilton, 1822), is a valuable, delicious food fish in coastal areas of Bangladesh. It is found in fresh and brackish water of South Asian region. The present study illustrates the temporal variation of condition factor (K_F) and prey-predator through relative weight (W_R) along with length-weight relation (LWR) of *M. gulio* in the Maloncho River at southern Bangladesh. There were a total of 1200 individuals collected between January-December 2017 and October 2019 to June 2020. Different traditional gears (such as cast net, seine net, square lift net) were used for collecting the fish samples. There were 35% males and 65% females. The total length of fish ranged 7.8-18.3 cm for males and 9.3-22.1 cm for females. The body weight ranged 8.80–72.34 g for males and 8.09-128.82 g for females. LWR was significant with r^2 value >0.950. The calculated co-efficient (*b*) were negative allometric growth in male and female (*b*<3.0, *p*<0.001). The K_F indicated the best condition of this species. W_R revealed no significant difference from 100 for both sex (*p* = 0.441) and females (*p* = 0.221), indicating a suitable habitat for growth. From conservation point of view, the findings of this present study on *M. gulio* will be helpful in Bangladesh (Maloncho River) and neighboring countries.

Key words: Coastal waters, Condition factor, Maloncho River, *Mystus gulio*, Relative weight

Introduction

The long whisker catfish *M. gulio* found in fresh and brackishwater, and is a demersal anadromous species (Riede 2004). It is generally recognized as the 'river catfish'. It is known as Nona tengra in Bangladesh, Nga-zin in Mayanmar and long whisker catfish in India and Sri Lanka. There are other names of *M. gulio* in India such as Kala tenguah, shingati, kontia and katta-keluthi (Froese and Pauly 2018). The species is generally used as a food fish and exported occasionally (Ng 2010). Geographically, *M. gulio* is distributed in Bangladesh, India, Indonesia, Pakistan, Nepal, Myanmar and Viet Nam (Talwar and Jhingran 1991, Menon 1999, Riede 2004).

Both in local and commercial perspective, the species are valuable for coastal fisheries in Bangladesh. Though, the fish harvested naturally, it is gradually decreasing as a result of destructive fishing, over-exploitation, ecological modifications and loss of habitat (Alam et al. 2006). The condition factor is an important biological parameter in the assessment of stock health of fish population (Bagenal and Tesch 1978). Essentially, conditions of aquatic animal reveal environmental (abiotic and biotic) status, fluctuation of

feeding condition in which they interact, physiological factors and infections of parasites (Le Cren 1951). The relative weight (W_R) makes it possible to recognize environmental changes as well as physiological components of the life history of fish (lipid storage and growth) and to evaluate the overall health and ecosystem disturbance (Rypel and Richter 2008).

There is no available literature on the condition factor of *M. gulio*. Previous studies on *M. gulio* included age and growth (Pantulu 1961), growth and survival (Islam et al. 2007), biometry and length-weight relationship (Dasgupta 1997), morphology and growth pattern (Gupta 2014), length-weight and length-length relationships (Hossain et al. 2016a). Details statistics on life-history traits of *M. gulio* is necessary for its management and to instigate protection strategies in the Maloncho River, southern Bangladesh and neighboring countries. This study deals with the temporal variation of condition factor, relative weight, prey-predator status of *M. gulio* in the Maloncho River. The purposes of this study are to realize fisheries data for formulating management policies for *M. gulio*.

Materials and Methods

Study site and sampling

In the Maloncho River, samples were collected from Satkhira (Latitude 21°40' N; Longitude 89°35' E) from January-December 2017 and October 2019 to June 2020. A total of 1200 specimens (male = 420, female = 780) of *M. gulio* were collected from commercial fishermen, who caught *M. gulio* using gill net, cast net and seine net (mesh size 1.5 - 2.5, 1.0 - 2.0 and ~1.0 cm). The samples were immediately preserved on the spot with ice and then fixed on arrival at the workplace with a 10% formalin solution.

Fish measurement

Microscopic observation of gonads, and morphometric and meristic characters, and identification of sex were carried out. The total length (TL), standard length (SL) and fork length (FL) and body weight (BW) were measured via digital balance and with digital slide calipers.

Length-weight relationship (LWR)

The relation between length and weight (LWR) was measured using $W = a*L^b$, where W is the total body weight (BW, g), L is the total length (TL, cm), *a* & *b* are regression parameters. LWR parameters *a* and *b* were determined by $ln\ (W) = ln\ (a) + b\ ln\ ln(L)$. T-test was used for substantial deviation from the isometric value of b = 3 to validate the growth trend, either isometric or (+/-) allometric (Sokal and Rohlf 1987).

Condition factor

Monthly condition factor for *M. gulio* was calculated using samples with small to bigger body sizes. Fulton's condition factor (Fulton 1904) was obtained by $K_F = 100 \times (W/L^3)$, where 100 for scaling factor, the total body weight (BW, g) is W and the total length L is (TL, cm).

Relative weight (W_R)

The relative weight was measured by $W_R = (W / W_S) \times 100$ (Froese 2006), where $W_S = aL^b$, W_S is the estimated standard weight for the particular individual (where *a* and *b* values were deliberated from TL and BW relationships).

Statistical analyses

GraphPad Prism 6.5 software was used for statistical analysis. Homogeneity and data normality were tested. To check the difference of growth type between the sexes, ANCOVA was used. Wilcoxon sign ranked test was performed to know prey-predator status. Statistical significance was tested at 5% level ($p<0.05$).

Results

During the study, a total of 1200 (males = 420 and females = 780) individuals of *M. gulio* were collected from the Maloncho River, comprising 35% males and 65% females. Table 1 shows the specimen size (7.80-18.3 cm TL for male; 9.30-22.1 cm TL for females) and body weight (8.80-72.3 4 g for males; 8.09-128.82 g for females).

Table 1. Descriptive statistics for the length (cm) and weight (g) of *Mystus gulio* (Hamilton, 1822) in the Maloncho River, southern Bangladesh

Parameter	Sex	*n*	Min.	Max.	Mean± SD	95% CL
TL			7.80	18.30	11.54 ± 1.18	11.36 - 11.71
FL			7.20	15.80	10.14 ± 1.97	10.00 - 10.28
SL	Male	420	6.70	15.00	9.54 ± 1.41	9.410 - 9.610
BW			8.80	72.34	24.73 ± 10.53	23.72 - 25.74
TL			9.30	22.10	13.29 ± 2.61	13.11 - 13.48
FL			7.20	18.70	11.58 ± 2.09	11.43 - 11.73
SL	Female	780	6.80	17.50	10.95 ± 1.99	10.81 - 11.09
BW			8.09	128.8	36.59 ± 19.03	35.26 - 37.93

TL = total length, FL = fork length, SL = standard length, BW = body weight, *n* = sample size, Min. = minimum, Max. = maximum, SD = standard deviation, CL = confidence limit for mean values.

Length-weight relationship

Sample sizes (n), regression parameters and confidence intervals of 95% for a and b of LWRs, determination coefficient (r^2) and growth of *M. gulio* are shown in Table 2 and Figs. 1, 2, respectively. The *b* values for TL-BW relationships showed negative allometric growth in males mostly for the 12 months. LWR was highly significant with all r^2 values ≥0.951. ANCOVA revealed that there was no significant difference between males and females for the intercepts (ln *a*), (F = 0.613, *df* =1196, *p*<0.4337) and also for slopes (*b*), (F = 2.924, *df* = 1197, *p* = 0.0874).

Table 2. Descriptive statistics and estimated parameters of the length-weight relationship ($BW = a \times TL^b$) of *Mystus gulio* (Hamilton, 1822) in the Maloncho River, southern Bangladesh

Month	Sex	*n*	*a*	*b*	95% CL of *a*	95% CL of *b*	*r²*	GT
	M	34	0.0474	2.61	0.0337– 0.0668	2.47 – 2.76	0.978	-A
January	F	66	0.0511	2.53	0.0430 – 0.0608	2.46 – 2.60	0.988	-A
	M	34	0.0467	2.52	0.0318 – 0.0686	2.36 – 2.67	0.972	-A
February	F	66	0.0441	2.54	0.0318 – 0.0611	2.41 – 2.66	0.962	-A
	M	29	0.0524	2.52	0.0392 – 0.0700	2.40 – 2.64	0.986	-A
March	F	71	0.0513	2.51	0.0430 – 0.0611	2.44 – 2.57	0.988	-A
	M	30	0.0445	2.54	0.0295 – 0.0670	2.38 – 2.70	0.974	-A
April	F	70	0.0457	2.53	0.0365 – 0.0572	2.45 – 2.61	0.982	-A
	M	44	0.0168	2.84	0.0114 – 0.0247	2.69 – 2.99	0.972	-A
May	F	56	0.0195	2.85	0.0126 – 0.0301	2.69 – 3.01	0.960	-A
	M	37	0.0446	2.58	0.0272 – 0.0729	2.37 – 2.78	0.951	-A
June	F	63	0.0511	2.50	0.0387 – 0.0674	2.40 – 2.60	0.975	-A
	M	27	0.0540	2.50	0.0336 – 0.0867	2.30 – 2.71	0.964	-A
July	F	73	0.0401	2.58	0.0309 – 0.0522	2.47 – 2.68	0.970	-A
	M	38	0.0520	2.53	0.0377 – 0.0718	2.40 – 2.67	0.977	-A
August	F	62	0.0583	2.50	0.0448 – 0.0758	2.40 – 2.60	0.976	-A
	M	32	0.0207	2.92	0.0114 – 0.0373	2.67 – 3.17	0.957	-A
September	F	68	0.0233	2.89	0.0159 – 0.0340	2.74 – 3.05	0.956	-A
	M	43	0.0454	2.52	0.0329 – 0.0627	2.39 – 2.66	0.973	-A
October	F	57	0.0506	2.52	0.0359 – 0.0714	2.39 – 2.65	0.963	-A
	M	35	0.0299	2.77	0.0193– 0.0465	2.58 – 2.96	0.965	-A
November	F	65	0.0488	2.52	0.0356 – 0.0670	2.40 – 2.65	0.964	-A
	M	36	0.0421	2.63	0.0293 – 0.0604	2.48– 2.78	0.974	-A
December	F	64	0.0490	2.54	0.0387 – 0.0621	2.44– 2.63	0.977	-A

n = sample size, *a* = intercept, *b* = slope, CL = confidence limit for mean values, *r²* = co-efficient of determination, GT = growth type, M = male, F = female, A = negative allometric.
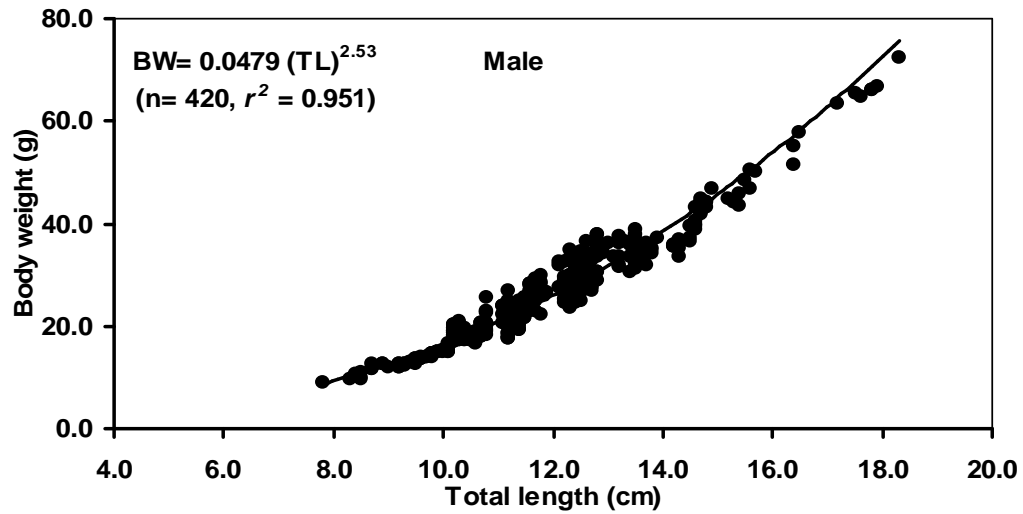
Fig. 1: Length-weight relationship of male *Mystus gulio* in the Maloncho River, southern Bangladesh.
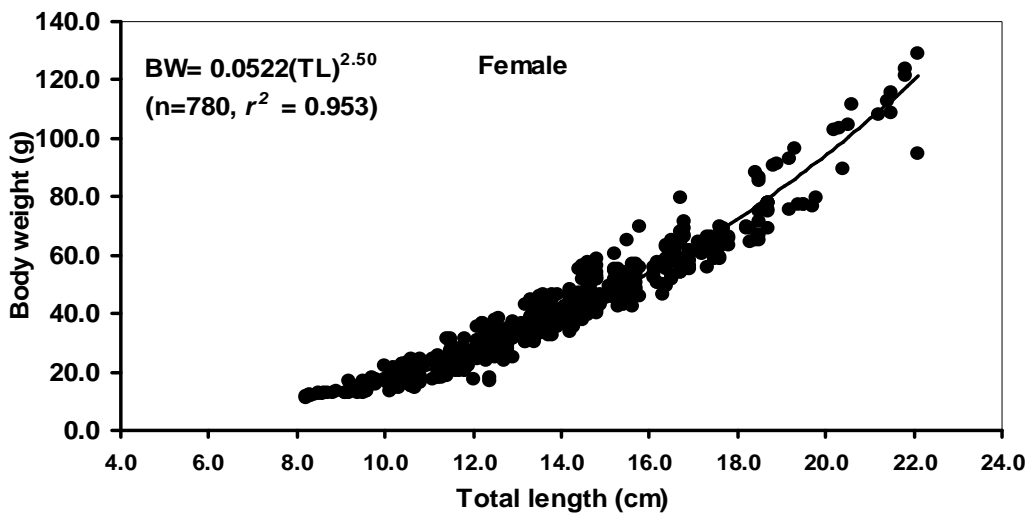

Fig. 2: Length-weight relationship of female *Mystus gulio* in the Maloncho River, southern Bangladesh.

Condition factor

Fulton's condition factor (K_F)

K_F ranged 0.890-2.217 (Mean±SD = 1.549±0.169, 95% CL = 1.533-1.566) for males and 0.995-2.187 (Mean±SD = 1.473 ± 0.211, 95% CL = 1.458–1.488) for females (Table 3, Figs. 3, 4). There was important

relationship between BW vs. K_F according to the spearmen rank correlation test (r_s = -0.4801, p<0.0001) and TL *vs.* K_F (r_s = -0.6423, *p*<0.0001) for both sexes.

Table 3. Fulton's condition factor (K_F) of *Mystus gulio* (Hamilton, 1822) in the Maloncho River, southern Bangladesh

Month	Sex	n	Fulton's condition factor (K_F)			
			Min.	Max.	Mean ± SD	95% CL
	M	34	1.651	2.096	1.882± 0.113	1.843 –1.922
January	F	66	1.370	1.844	1.599 ± 0.148	1.562–1.635
	M	34	1.204	1.619	1.412 ± 0.131	1.366 – 1.458
February	F	66	1.032	1.579	1.328 ± 0.147	1.292 – 1.364
	M	29	1.412	1.840	1.648 ± 0.113	1.605 – 1.691
March	F	71	1.188	1.828	1.435 ± 0.140	1.402 – 1.468
	M	30	1.148	1.668	1.398 ± 0.141	1.346 – 1.452
April	F	70	0.995	1.553	1.292 ± 0.162	1.254 – 1.331
	M	44	0.890	1.504	1.130 ± 0.122	1.068 – 1.142
May	F	56	0.898	1.819	1.303 ± 0.181	1.254 – 1.351
	M	37	1.348	1.859	1.581 ± 0.142	1.534 – 1.629
June	F	63	1.124	1.521	1.342 ± 0.123	1.311 – 1.375
	M	27	1.479	1.942	1.675 ± 0.111	1.631 – 1.719
July	F	73	1.210	1.730	1.470 ± 0.116	1.390 – 1.445
	M	38	1.436	2.217	1.694 ± 0.189	1.632 – 1.757
August	F	62	1.258	2.155	1.625 ± 0.173	1.581 – 1.669
	M	32	1.543	1.897	1.705 ± 0.105	1.667 – 1.743
September	F	68	1.461	2.187	1.798 ± 0.159	1.759 – 1.836
	M	43	1.265	1.742	1.430 ± 0.110	1.396 – 1.464
October	F	57	1.272	1.748	1.483 ± 0.132	1.448 – 1.518
	M	35	1.597	1.867	1.750 ± 0.072	1.725 – 1.774
November	F	65	1.187	1.811	1.434 ± 0.148	1.397 – 1.470
	M	36	1.493	2.097	1.736 ± 0.150	1.685 – 1.787
December	F	64	1.357	2.158	1.611 ± 0.177	1.567 – 1.655

n = sample size, Min. = minimum, Max. = maximum, SD = standard deviation, CL = confidence limit for mean values.
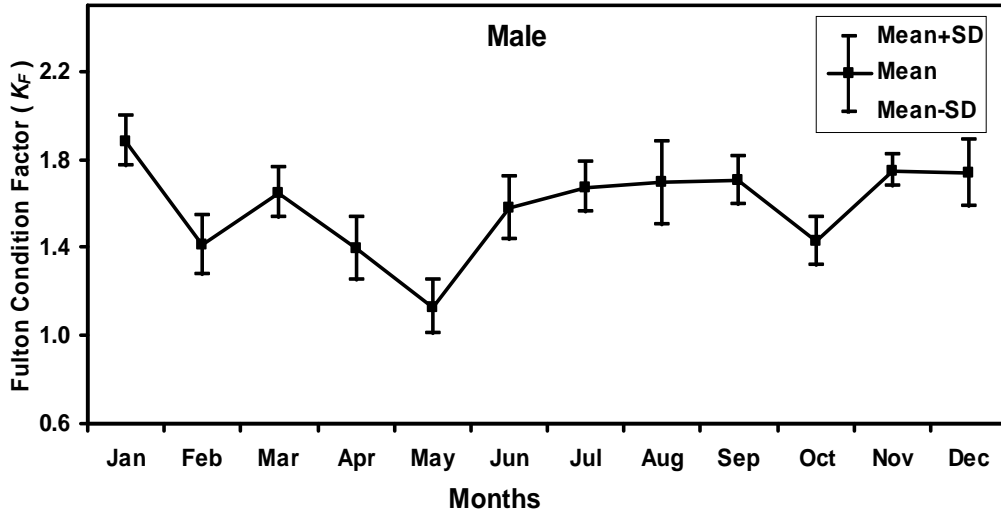
Fig. 3: Monthly variation of Fulton's condition factor (K_F) for male *Mystus gulio* (Hamilton, 1822) in the Maloncho River, southern Bangladesh.
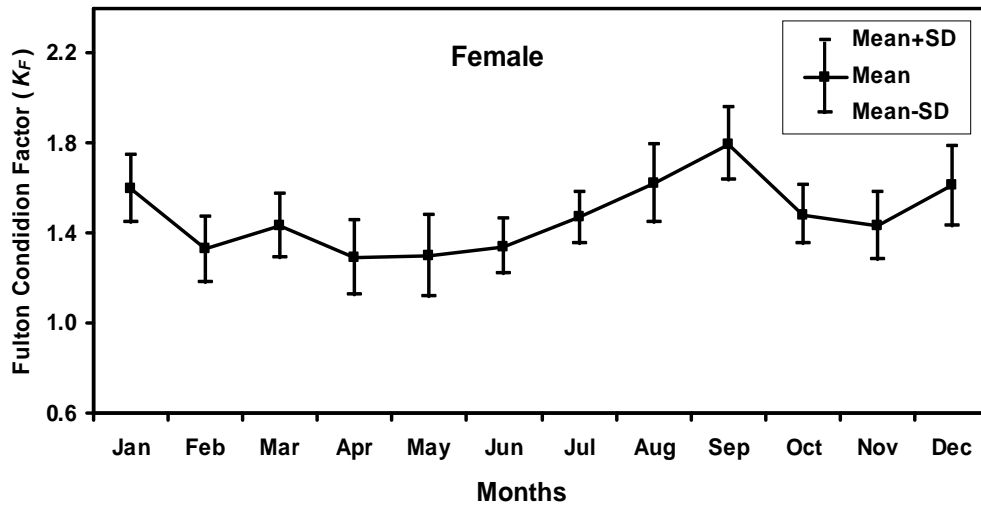

Fig. 4: Monthly variation of Fulton's condition factor (K_F) for female *Mystus gulio* (Hamilton, 1822) in the Maloncho River, southern Bangladesh.

Relative weight (W_R)

The calculated W_R for the males were 77.034-129.490 (Mean±SD = 100.414 ± 8.851, 95% CL= 99.570-101.260) and for females were 68.944-137.574 (Mean±SD = 100.654 ± 10.828, 95% CL = 99.890-101.420)

(Table 4, Figs. 5, 6). According to spearmen rank correlation test, there was significant relationship between BW *vs.* W_R (r_s = 0.2080 p<0.001), but not TL *vs.* W_R (r_s = 0222 p<0.4415) for both. According to Shapiro-Wilk normality test, W_R between sexes did not show normality (p<0.0001) and for both males and females, the graded Wilkoxon sign test showed no major differences from 100.

Table 4. Relative weight (W_R) of *Mystus gulio* (Hamilton, 1822) in the Maloncho River, southern Bangladesh

Month	Sex	n	Relative weight (W_R)			
			Min.	Max.	Mean ± SD	95% CL
January	M	34	94.024	112.410	102.039 ± 4.445	100.489 – 103.590
	F	66	91.706	114.002	101.093 ± 4.851	99.900 – 102.285
February	M	34	88.722	112.116	98.499 ± 6.112	96.366 – 100.632
	F	66	84.064	114.241	99.647 ± 8.324	97.601 – 101.693
March	M	29	93.767	107.736	100.487 ± 3.749	99.061 – 101.914
	F	71	83.889	110.566	99.447 ± 4.671	98.341 – 100.553
April	M	30	83.330	110.285	98.881 ± 6.595	96.418 – 101.344
	F	70	84.152	112.196	98.927 ± 7.346	97.176 – 100.679
May	M	44	77.034	129.490	100.07 ± 10.069	97.170 – 103.293
	F	56	68.944	137.574	103.322 ± 13.548	99.694 – 106.950
June	M	37	87.163	111.139	98.114 ± 7.160	95.726 – 100.501
	F	63	90.307	114.337	100.282 ± 6.039	98.761 – 101.803
July	M	27	89.145	109.727	100.038 ± 4.597	98.220 – 101.857
	F	73	88.376	113.602	100.611 ± 5.919	99.230 – 101.992
August	M	38	82.921	113.210	100.282 ± 6.718	98.073 – 102.489
	F	62	87.109	114.074	100.185 ± 6.710	98.481 – 101.889
September	M	32	90.705	110.843	99.996 ± 6.103	97.797 – 102.197
	F	68	80.128	119.727	100.281 ± 8.681	98.180 – 102.381
October	M	43	89.554	109.902	100.118 ± 4.958	98.592 – 101.644
	F	57	84.670	111.533	100.216 ± 6.246	98.558 – 101.873
November	M	35	94.858	106.895	100.145 ± 3.799	98.840 – 101.450
	F	65	86.258	118.117	100.274 ±7.411	98.437 – 102.110
December	M	36	85.906	110.073	100.107 ± 6.339	97.962 – 102.251
	F	64	86.183	112.173	98.007 ± 6.328	96.427 – 99.588

n = sample size, Min. = minimum, Max. = maximum, SD = standard deviation, CL = confidence limit for mean values, M = male, F = female.
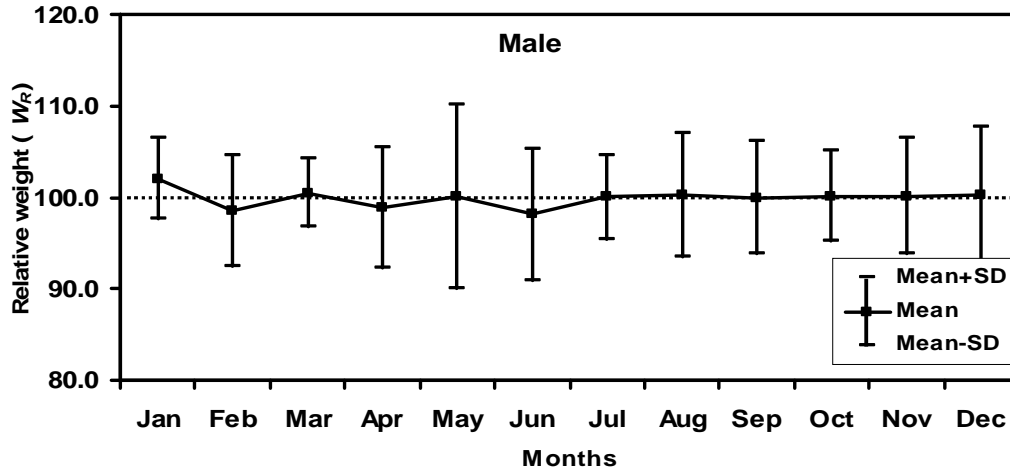
Fig. 5: Monthly changes of relative weight (W_R) for male *Mystus gulio* in the Maloncho River, southern Bangladesh.
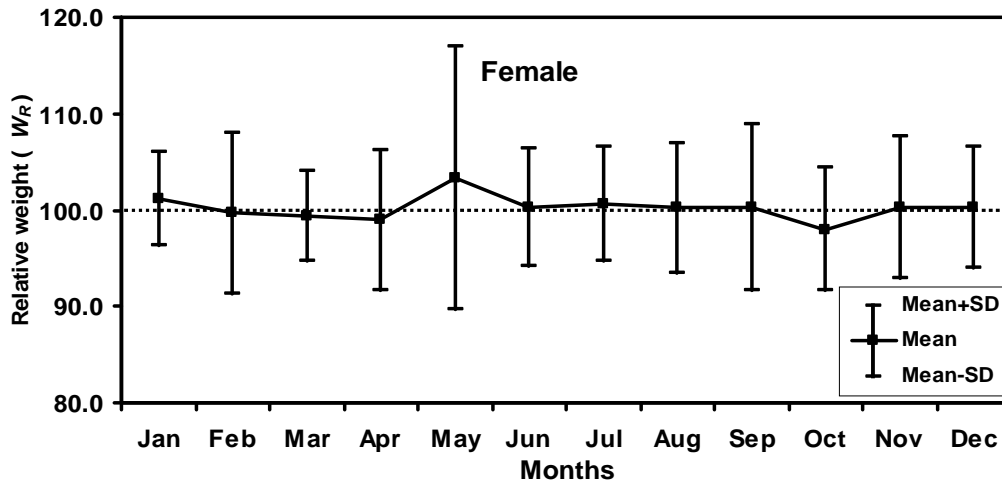

Fig. 6: Monthly changes of relative weight (W_R) for female *Mystus gulio* in the Maloncho River, southern Bangladesh.

Discussion

Information on temporal variation of *M. gulio* is scare in the literature. As it is a commercial food fish in the Asian countries and the practice of aquaculture is yet to realize, consequently, the demand of this fish is high in the domestic market. Therefore, effective assessment of wild stocks of *M. gulio* is essential. The present study determines the temporal variation of condition factor and prey-predator status of *M. gulio* in the Maloncho River.

During present study, a total of 1200 specimens with different body sizes were captured using traditional fishing gear from the Maloncho River. However, it was not possible to catch fishes <7.8 cm TL and >22.1 cm TL that may be attributed to the selectivity of fishing gear. The maximum length of *M. gulio* was 22.1 cm which is higher than those recorded from the Chilika lagoon, India (TL = 21.5 cm; Panda et al. 2016), and from the Rupsha River, Bangladesh (TL = 17.2 cm; Hossain et al. 2016a). Knowledge on maximum length of fish is useful for the calculation of asymptotic length and growth coefficient as well as for the planning and management of fishery resources (Hossain et al. 2012, 2016b). The values of parameter b range from 2.5 to 3.5 (Froese 2006) and the value of b in the analysis was within this limit. When b is close to 3 (b ≈ 3.0), isometric growth is indicated, *b*>3.0 indicates positive allometric growth and b<3 indicates negative allometric growth (Tesch 1971). In most of the months, both sexes had negative allometric growth on the basis of b-values. In the existent study, the regression parameter *b* of LWR ranged 2.50–2.84 for males and 2.50–2.85 for females. The *b* values for TL-BW relationships indicate negative allometric growth in males. The overall b for the LWR suggested negative allometric growth (<3.0) in both males and females in the existent analysis. In addition, for both sexes, the overall growth trend was negative allometric. However, positive allometric was reported from Rupsha River, Bangladesh (*b* = 3.11) by Hossain et al. (2016a), isometric growth pattern was reported from Chilika lagoon, India (*b* = 3.03) by Panda et al. (2016) and negative allometric was reported from Narreri Lagoon, Pakistan (*b* = 2.20) by Haroun et al. (2017). However, the growth pattern may vary due to habitat condition, seasonal impact, stomach fullness level, maturation of gonads, health, method of preservation and variations in the observation of sample collection length groups (Tesch 1971, Weatherley and Gill 1987), all of which were not considered in the study.

The condition factor is one of the traditional fisheries procedures used as a measure of the variability due to the growth coefficient. It expresses the state of a fish in numerical terms, such as the degree of well-being in its natural environment, relative strength or fatness. The condition factor of Fulton (K_F) is an index that represents interactions in the physiological condition of fishes between biotic and abiotic factors. When the value of this condition factor is greater, it indicates that the fish have reached a better condition. In this study, the K_F ranged from 0.890-2.217 for males and 0.995- 2.187 for females. According to the spearmen rank correlation test, both BW and K_F were significantly linked (r_s = -0.480, p<0.0001) and TL vs. K_F (r_s= -0.642, p<0.0001). In general, a relationship with gonadal production was indicated by the seasonal cycle in fish conditions (Hossain et al. 2006). Monthly K_F values have increased and b values have decreased between June to September, suggesting the spawning season. A number of factors, such as stress, sex, season, feed availability, and other parameters of water quality, may affect the K_F of fish (Khallaf et al. 2003). Therefore, it can be assumed that, the Fulton's condition factor (K_F) is the best for determining the well-being of *M. gulio* in the Maloncho River and adjacent ecosystem.

Relative weight is the most popular index to assess the status of fish in a habitat (Froese 2006). Relative weight can be used to estimate the condition of fish health (Rypel and Richter 2008). According to Porath and Peters (1997) W_R influenced the prey availability in a population. There is a significant correlation between relative weight, prey and predator availability (Kohler and Kelly 1991). Prey-predator status of a water body affects the fisheries community and the recruitment pattern (Shulman and Ogden 1987). The values of W_R falling below 100 for an individual or population recommend problems such as low prey accessibility or high predator density; whereas values above 100 indicates a prey surplus or low predator density (Rypel and Richter 2008). In our study the mean W_R was not significantly different from 100 for both females and males populations of *M. gulio* indicating a balance habitat (Anderson and Neumann 1996) in the Maloncho River.

W_R was higher in the month of January for male and May for female populations of *M. gulio* that represent in these months the predator was in lower amount and prey was in higher amount in the Maloncho River

ecosystem. Also W_R was very low in the month of June for male and October for female population of *M. gulio* that indicates in the June the predator was in higher amount for male and October for female, it may be due to the spatial distribution of fishes and climatic condition. W_R of fishes may also be affected by physiological and behavioral aspects of fishes (Davis 2000).

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Disclosure statement

No possible conflict of interest identified by the authors was noted.

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