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MORPHOLOGICAL OBSERVATION AND PG-INDUCED BREEDING OF *Glossogobius giuris* (HAMILTON 1822)

M. R. Islam* and M. F. A. Mollah

Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

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ABSTRACT

The body characters of *Glossogobius giuris* were correlated with total length (L_T) whereas eye length (L_E), snout length (L_{SN}) and gape of mouth (M_G) were correlated with head length (L_H) at 1% level (p<0.01). Few differences were observed in meristic traits. L_T-W_B relationship was found as Ln W_B = - 4.493 + 2.887 Ln L_T (male, r = 0.976) and Ln W_B = - 5.327 + 3.291 Ln L_T (female, r = 0.999). The value of 'b' was 2.887 for male and 3.291 for female. The value of F_R was 1.028±0.21 for male and 1.004±0.28 for female. In growth trail, silver carp flesh (T_2) showed the highest (10.46±0.06) growth performance while perch feed (T_3) showed the lowest (2.63±0.05 g) in terms of weight gain. The highest I_G value (6.09±0.83) was observed on 15 April and the lowest (0.85±0.91) on 15 January. Mean fecundity varied from 3,339.89±261.53 to 15,012±4862.41. Preliminary success achieved in the breeding of *G. giuris* using PG extract at the rate of 20 mg (T_1), 40 mg (T_2) and 50 mg (T_3) PG kg$^{-1}W_B$ for female and 20 mg PG kg$^{-1}W_B$ for male. The highest ovulation (83.33±28.86%) and fertilization rate (98.67±2.31%) observed at the dose of 40 mg PG kg$^{-1}W_B$ in April which was significantly higher than that of 50 mg PG kg$^{-1}W_B$ (p<0.05). A dose of 20 mg PG kg$^{-1}W_B$ was not sufficient to ovulate the broodfish. Hatchling (45.00±5.29%) was observed only at the middle dose of 40 mg PG kg$^{-1}W_B$.

Key words: Morphology, I_G, Growth, PG-Induced breeding, Glossogobius giuris

INTRODUCTION

Glossogobius giuris, under the family of Gobiidae, is a 'low fat-high protein' fish and the proximate composition of moisture, protein, ash and lipid are about 85%, 15.6%, 2.94% and 1.54%, respectively (Islam and Joadder, 2005). The morphometric relationships can be used to assess the possible differences of the same species (King, 2007) and the comparative growth performances of fishes (Moutopoulos and Stergiou, 2002). However, it is still scarce for fishes (Martin-Smith, 1996; Hossain *et al*., 2009 and Hossain, 2010). Gonado-somatic index (I_G) determines the state of maturity and onset of spawning season used to follow the reproductive cycle of a species over the year at monthly or less intervals. The size of ovary and eggs is used to characterize the relative sexual maturity of the fish (Islam and Das, 2006). *G. giuris* is a suitable candidate for aquaculture for its high nutritive value (Joadder, 2009). The highest availability of *G. giuris* is generally seen in the rainy season all over the country. Although, it's abundance in nature is decreasing day by day due to various human interferences. Growth study of *G. giuris* was initiated in a wet laboratory using fiberglass tanks that have practical value and would be a basis for the development of culture technique in ponds or any kinds of waterbody. It was felt important to know the number of eggs, fry and young that could be produced from an individual broodfish for the purpose of better management and production. The proposed investigation was planned to denote the morphological traits and to develop an induced breeding technique of *G. giuris* using carp pituitary gland (PG) extract.

METERIALS AND METHODS

A total of 40 male and 40 female *G. giuris* was collected from wild source (Figure 1) separated by observing their genital papilla described by Islam (2004) and kept at 10% formalin. Various body parts and body weight were measured (Figure 2) to the nearest centimeter (cm) and gram (g), respectively. For L_T-W_B relationship, the mid value of four class intervals and the corresponding average weight (g) were converted to base log 10 to obtain straight line relationship between them expressed as $W_B = a\ L_T^b$ or Ln W_B = Ln a + b Ln L_T; W_B = body weight (g); L_T = total length (cm); a = intercept; and b = exponent. The condition factors were calculated as $F_C = (W_B.10^4.L_T^{-3})$; W_B = observed body weight (g) and L_T = observed length (cm). The relative condition factor was estimated as $F_R = W_O.W_C^{-1}$; W_O = observed body weight (g) and W_C = calculated body weight (g). A total of 10 wild gravid females were monthly taken (Figure 1) to know some aspects

*Corresponding author: M. R. Islam, Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bang;ladesh, rashed_26@yanoo.com; Cell: + 880-01717 289 715

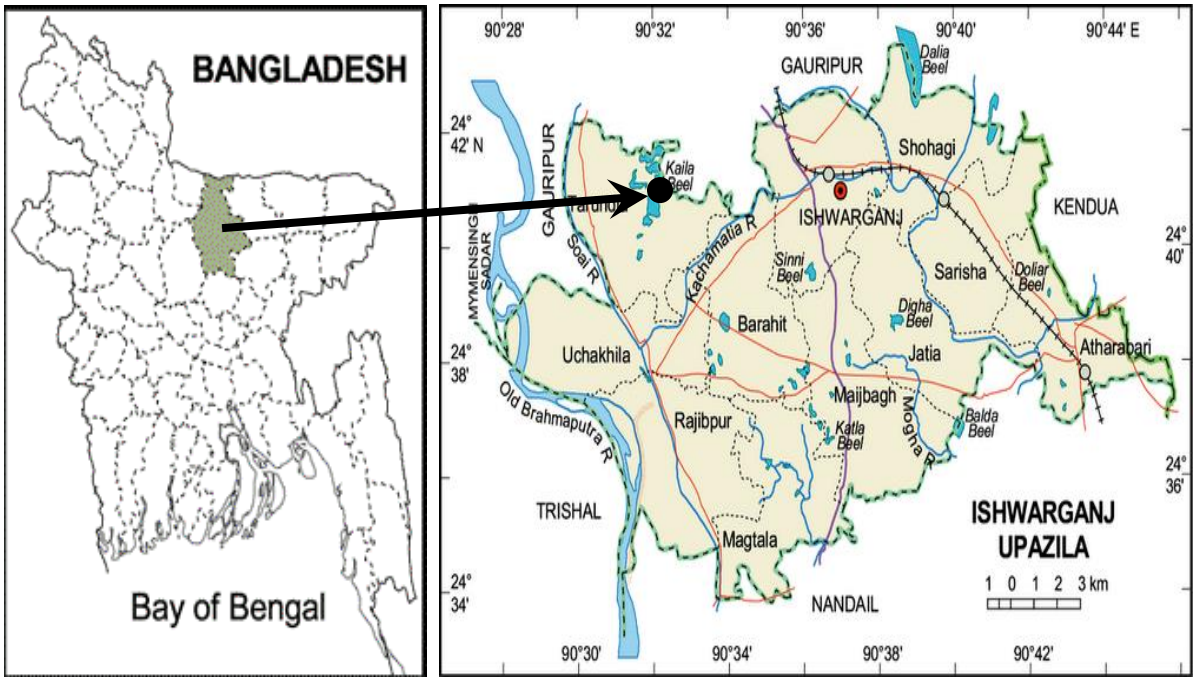

Figure 1. Geographical location of sample collection (•indicates sample collection site; Kaila beel, Ishwarganj, Mymensigh) of *G. giuris*.

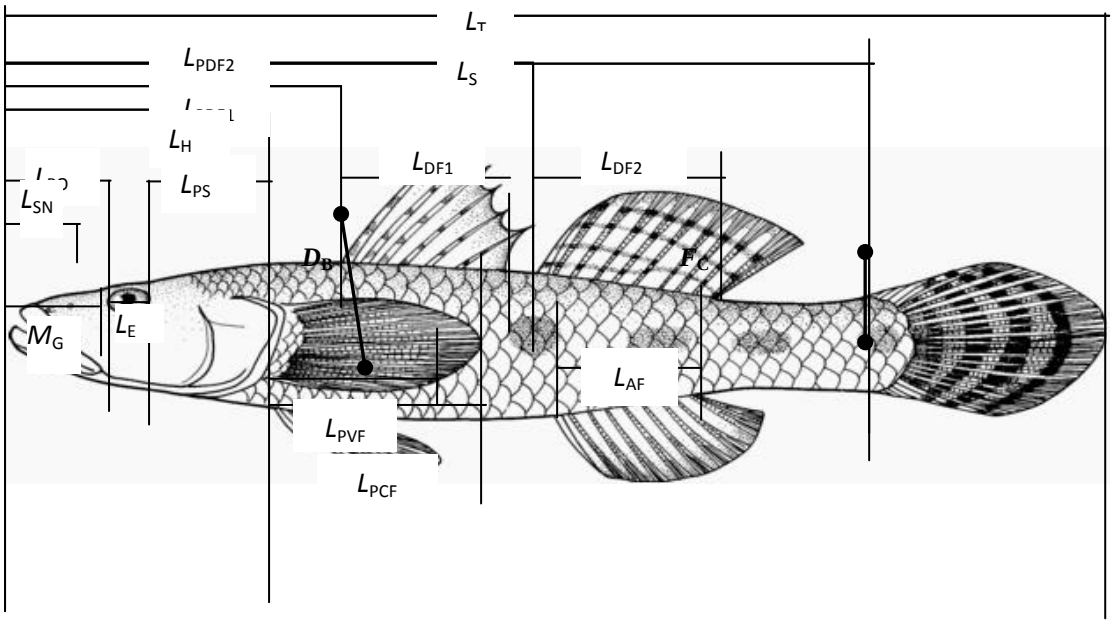

Figure 2. Showing the measurements of different body parts (see Table 1) of *G. giuris*.

of reproductive biology of *G. giuris*. The ovary was removed carefully and preserved in 10% formalin for further study. Gonado-somatic index was calculated as $I_G = (O_W.F_W.^{-1}) \times 100$; O_W = weight of ovary (g) and F_W = weight of fish (g). Fecundity was estimated as $F = (E_N \times W_G).W_S^{-1}$; E_N = the number of eggs, W_G = gonad weight and W_S = sample weight. Growth performances were conducted for 90 days in nine fiberglass tanks (70 × 42 × 40 cm^3) having inlet and outlet facilities disinfected with $KMnO_4$ (0.01 $g.l^{-1}$) and dried in the sun. Deep tubewell water was supplied through porous PVC pipe into each tank where 200 $ml.h^{-1}$ water was passed through "L" shaped outlet PVC pipe. A total of 150 fry collected from wild source (Figure 1) was brought to "Mini Hatchery and Breeding Complex" disinfected with $KMnO_4$ (0.01 $g.l^{-1}$) for 30 sec and stocked in the cisterns. From cisterns, 72 healthy fry of same size were selected and transferred into fiberglass tank for stocking and rearing. Homogeneity for each replication was maintained by the initial total length (cm) and body weight (g). The stocked fry (8 fish.replicate^{-1}) were reared with three feeds *i.e.* poultry viscera (T_1), silver carp fish flesh (T_2) and perch feed (T_3) containing 7.95%, 13.68% and 22.41% protein (Wet basis) respectively supplying twice in a day (900 and 1500 hours). The quantities of feed were adjusted by their satiation level. Readings were noted at monthly for growth and at fortnightly for water quality parameters between 900 and 1000 hours.

$$\text{i) } L_{PG} = \frac{L_{AF} - L_{AI}}{L_{AI}} \times 100$$

$$\text{ii) } W_{PG} = \frac{W_{AF} - W_{AI}}{W_{AI}} \times 100$$

$$\text{iii) } R_{sG} = \frac{\text{Ln } W_{B2} - \text{Ln } W_{B1}}{T_2 - T_1} \times 100$$

$$\text{iv) } R_{FC} = \frac{\text{Feed fed (Dry matter)}}{\text{Live weight gain}}$$

Where
L_{PG}= percent gain in length
Wpg= percent gain in weight
$L_{AF=}$= average final length
L_{AI} =average initial length
$W_{AF=}$ average final weight
$W_{AI=}$ average initial weight
$R_{SG=}$ specific growth rate
$R_{FC=}$ food conversion ratio

For PG-induced breeding, the gravid male and female were fed with fish flesh (silver carp) for 3 months in cisterns which were previously collected from wild source. A total of 46 healthy and same size gravid broodfish was caught from cisterns randomly and stocked in 3 fiberglass tanks for conditioning to 6-8 h. Acetone dried carp pituitary gland (PG) extract was used to induce the broodfish. Amount of PG was calculated as *Weight of required amount of PG* (mg) = $(W_{TB} \times X)\ 10^{-3}$; W_{TB} = total body weight (g) of all the fish to be injected and X = the rate in mg of PG to be injected. Total volume of the extract to be prepared was calculated as *Volume of extract* (ml) = $(W_{TB} \times 1.0)\ 10^{-3}$, homogenized at 3000 rpm for 10 min and kept at 4 ºC prior to injection. A total of 36 broodfish per trial was transferred into 3 separate fiberglass tanks from conditioning tanks to administer PG extract using 1.0 ml graduated hypodermic syringe. Female were injected with PG dose of 20 (T_1), 40 (T_2) and 50 (T_3) $mg.kg^{-1}W_B$ respectively while male were treated with PG dose of 20 $mg.kg^{-1}W_B$ intramuscularly near the first dorsal fin above the lateral line inserting the needle at 45º angle. Then, both male and female were kept together (1:1 sex ratio) treatment-wise in another 3 fiberglass tanks for ovulation. The treated female were taken out 16-18 h post-injection for stripping applying smooth and gentle pressure to collect ovulated eggs. The male were sacrificed to collect their milt to fertilize the ovulated eggs. The stripped eggs were taken in a small clean plastic bowl and then milt was added to it, mixed properly with the help of a soft chicken feather treatment-wise to fertilize the collected eggs. Few drops of water were added to increase the movement and activity of sperm for better egg fertilization. Eggs after fertilization were washed several times with clean water before placing in trays (101.6 × 40.6 × 12.7 cm^3) treatment-wise for incubation with gentle shower for proper oxygenation. To calculate the fertilization and hatching rate, a portion of eggs was taken and incubated in 12 bowls (40 cm diameter) corresponding to the treatment. The remaining eggs were incubated in separate 3 trays treatment-wise. Within 6-10 h of incubation, the number of fertilized eggs from each bowl for respective treatment was counted based on their color. After completion of hatching, the number of larvae was counted by siphoning them out. However, the breeding parameters were calculated as *% ovulation* = $(F_{NO}.F_{NI}^{-1}) \times 100$; F_{NO} = no. of ovulated fish, F_{NI} = no. of injected fish, *% fertilization* = $(E_{NF}.E_{TN}^{-1}) \times 100$; E_{NF} = no. of fertilized eggs, E_{TN} = total no. of eggs and *% hatching* = $(E_{NH}.E_{TI}^{-1}) \times 100$; E_{NH} = no. of hatched eggs and E_{TI} = total no. of incubated eggs. The hatching was completed within 46-56 h at 25-27º C. The larvae were fed with hard-boiled chicken egg yolk from the third day of hatching. The relationship of different morphological parameters were determined both as simple linear relationship and logarithmic relationship with the help of "Excel", "MSTATC" and "SPSS" computer based software. One way analysis of variance (ANOVA) was used for statistical analysis of the experimental data followed by "Duncan's Multiple

Range Test" to determine the significance of variation among the treatment mean.

RESULTS AND DISCUSSION

The comparative data relating to various body measurements were calculated to compare the various morphometric relations of *G. giuris*. The relationship between dependent variable *i.e.* L_S, L_H, D_B, F_{DC}, L_{DF1}, L_{DF2}, L_{PCF}, L_{PVF}, L_{AF}, L_{PDF1}, L_{PDF2}, L_{PA}, L_{PR} and L_{PO} were found to be highly correlated with an independent variable (L_T) while the L_E, L_{SN} and M_G (dependent variables) with L_H (independent variable) showed a higher degree of correlation at 1% level of significance (p<0.01) by a straight line equation as Y = a + b X showed in Table 1. The meristic counts of both male and female were more or less similar. Scale on lateral line 29-35, above lateral line 4-5, below lateral line 4-5 and around caudal peduncle were 11-14. Gill rakers 4±0, branchio-stegeal rays 5±0, first dorsal fin rays 6±0, second dorsal fin rays 10-11, pectoral fin rays 15-19, pelvic fin rays 10-12, anal fin ray 8-9 and caudal fin rays were 21-28. The overall fin formula was D_1. VI, D_2. 10-11, P_1. 15-19, P_2. 10-12, A. 8-9. The total length (L_T) was plotted against their body weight (W_B) on logarithmic scale which showed the regression to be positive and highly correlated (p<0.01, Table 2). The L_T-W_B relationship were expressed as Ln W_B = - 4.493 + 2.887 Ln L_T (male) and Ln W_B = - 5.327 + 3.291 Ln L_T (female). There are no available literatures on *G. giuris* except the L_T-W_B relationship and some aspects of reproductive biology. The morphological traits of *G. giuris* are more or less similar to Rahman (2005), Hoese and Allen (2009) and Reza *et al.* (2009). The growth rates (%) of various morphometric traits are also more or less similar to *Puntius sarana* reported by Hossain *et al.* (2009). The dependent variables found to be correlated with the independent variables significantly at 0.1% to *Gudusia chapra* (Narejo *et al.*, 2000). They found Log W_B = - 1.8419 + 2.768 Log L_T and Log W_B = -1.708 + 2.667 Log L_T with F_R value of 1.0555 and 1.00465 for male and female *G. giuris*, respectively (Joadder, 2009). The value of 'b' was 2.42 to 3.03 and 2.49 to 2.92 fitted by $W_B = 0.000038\ L_S^{2.82}$ and $W_B = 0.000053\ L_S^{2.74}$ with F_R value varied from 0.84 to 1.42 and 0.96 to 1.54 for male and female *G. giuris*, respectively (Rashid, 2009). The L_T-W_B relationship was expressed as $W_B = 0.00004\ L_T^{2.57}$ and $W_B = 0.000007\ L_T^{3.05}$ for male and female, respectively (Ferdous, 2009).

The mean value of I_G ranged from 0.85±0.91 to 6.09±0.83 while the highest mean value was recorded as 6.09±0.83 on 15 April and the lowest value was recorded as 0.85±0.91 on 15 January 2010 (Figure 3). Mean fecundity ranged from 3,339.89±261.53 to 15012.38±4862.41. L_T-F (r = 0.625) and W_B-F (r = 0.681) relationship were found to be linear (Figure 4 and 5) indicating a high correlation (p<0.01). The breeding period estimated from the I_G value was presented from the second half of January to July with a peak in May (Ferdous, 2009) and January to June (Islam, 2009) which are more or less similar to present study where the peak breeding period ranged from 15 April to 15 May. Rao and Rao (2007) reported breeding season of *G. giuris* to prolong from August to January with a peak in September. The fecundity varied from 9,380 to 293,664 with the mean value of 113,030. Hossain *et al.* (2010) found that L_S-F and W_B-F relationships of *G. chapra* were ln F = 2.659 ln L_S + 3.496 (r = 0.938) and ln F = 0.769 ln W_B + 7.408 (r = 0.827), respectively.

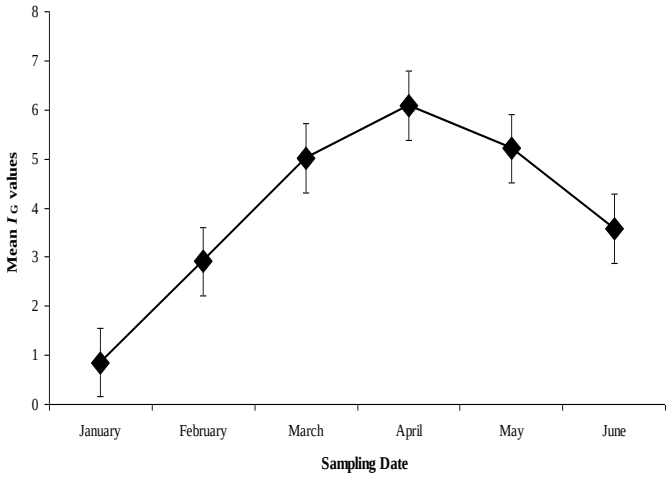

Figure 3. Monthly variation of gonado-somatic index (GSI) of *G giuris* (Female) with peak in April.

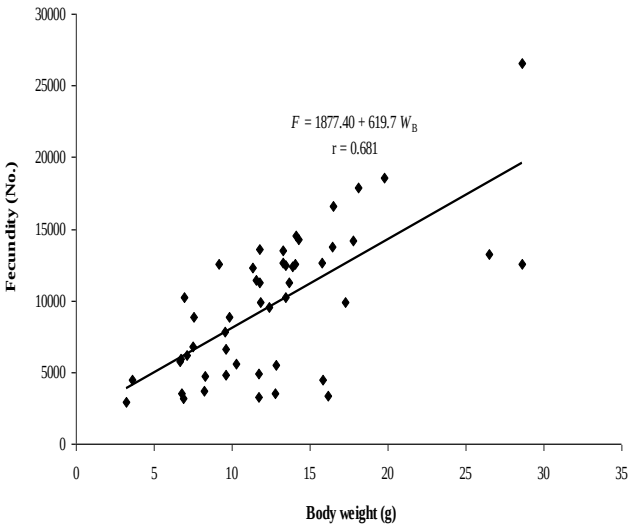

Figure 4. Relationship between total length and fecundity of *G. giuris*.

Table 1. Showing the rate of growth on a percentage basis (Mean±SD) and correlation of different body parts of *G. giuris* in relation to the total length (L_T) and head length (L_H)

Measurements (cm) on the basis of L_T	Mean±SD		Mean L_T (%)		Correlation (r)	
	Male	Female	Male	Female	Male	Female
Total length (L_T)	9.15±1.25	10.02±0.99				
Body weight (W_B)	6.85±3.47	9.88±3.42	71.94±25.77	96.48±23.08	0.892	0.973
Standard length (L_S)	7.17±0.90	7.91±0.78	78.47±1.66	78.96±0.96	0.993	0.992
Head length (L_H)	2.23±0.37	2.44±0.26	24.56±1.62	24.41±1.07	0.939	0.904
Body depth (D_B)	1.53±0.22	1.74±0.25	16.76±1.13	17.32±1.26	0.864	0.895
Dorsal fin length$_1$ (L_{DF1})	1.06±0.23	1.26±0.25	11.45±1.11	12.59±2.11	0.959	0.635
Dorsal fin length$_2$ (L_{DF2})	1.49±0.24	1.60±0.21	16.29±1.43	15.95±1.26	0.863	0.818
Pectoral fin length (L_{PCF})	1.80±0.25	1.79±0.18	19.72±1.32	17.93±0.82	0.890	0.889
Pelvic fin length (L_{PVF})	1.47±0.18	1.57±0.12	16.12±0.70	15.79±0.97	0.951	0.767
Anal fin length (L_{AF})	1.20±0.22	1.32±0.14	13.07±0.92	13.20±0.73	0.935	0.872
Pre-dorsal fin length$_1$ (L_{PDF1})	2.83±0.40	3.06±0.31	30.94±1.26	30.59±0.89	0.961	0.955
Pre-dorsal fin length$_2$ (L_{PDF2})	4.16±0.56	4.64±0.47	45.46±1.31	46.09±0.83	0.981	0.928
Pre-anal fin length (L_{PAF})	4.58±0.58	5.01±0.50	50.19±4.08	50.07±0.94	0.847	0.983
Pre-orbital length (L_{PO})	0.76±0.12	0.80±0.10	8.31±0.83	8.00±0.36	0.735	0.947
Post-orbital length (L_{PS})	1.21±0.18	1.30±0.14	13.18±0.80	13.04±0.36	0.912	0.976
Eye length (L_E)	0.49±0.05	0.52±0.04	5.41±0.48	5.23±0.52		
Snout length (L_{SN})	0.46±0.04	0.47±0.06	5.03±0.54	4.74±0.49		
Gape of mouth (M_G)	0.80±0.13	0.80±0.10	8.73±0.67	8.01±0.61		
Depth of caudal fin base (F_C)	0.78±0.12	0.78±0.10	8.49±0.43	7.83±0.52	0.936	0.876

Measurements (cm) on the basis of L_H	Mean±SD		Mean L_H (%)		Correlation (r)	
	Male	Female	Male	Female	Male	Female
Head length (L_H)	2.23±0.37	2.44±0.26				
Eye length (L_E)	0.49±0.05	0.52±0.04	22.27±2.14	21.49±2.38	0.856	0.343
Snout length (L_{SN})	0.46±0.04	0.47±0.06	20.87±3.83	19.43±1.98	0.435	0.662
Gape of mouth (M_G)	0.80±0.13	0.80±0.10	36.19±5.45	32.86±2.71	0.720	0.779

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Table 2. Length-weight relationship, condition factor (F_C) and relative condition factor (F_R) of *G. giuris* (Male)

Sex	Length group (cm)	Frequency (f)	Observed length (L_O)	Observed body weight (W_O)	Intercept (a)	Slope (b)	Calculated body weight (W_C)	Condition factor (F_C)	Relative condition factor (F_R)	Correlation (r)
Male	6.00 -7.99	8	7.55±0.37	4.08±0.72	0.0048	2.887	4.04±0.55	0.948±0.23	1.009±0.27	0.976
	8.00 -9.99	19	8.88±0.65	5.42±1.43			5.25±0.88	0.775±0.53	1.032±0.12	
	10.00 -11.99	13	10.54±0.69	10.65±3.44			10.29±1.46	0.909±0.37	1.035±0.08	
	12.00 -12.99	-	-	-	-	-	-	-	-	
	Mean	$\sum f = 40$	9.15±1.25	6.85±3.47	0.0048	2.887	6.65±1.65	0.853±0.48	1.028±0.21	
Female	6.00 -7.99	-	-	-	-	-	-	-	-	0.999
	8.00 -9.99	25	9.37±0.41	7.61±0.93	0.0112	3.291	7.57±0.76	0.925±0.33	1.005±0.08	
	10.00 -11.99	12	10.86±0.41	12.63±1.59			12.56±0.95	0.986±0.42	1.006±0.22	
	12.00 -12.99	3	12.13±0.06	17.81±0.02			17.82±0.49	0.998±0.32	0.999±0.17	
	Mean	$\sum f = 40$	10.02±0.99	9.88±3.42	0.0112	3.291	9.84±1.06	0.949±0.51	1.004±0.28	

Table 3. Growth and survival rate of *G. giuris* in fiber glass tank after 90 days experimentation (Mean±SD)

Treatment	G_L	L_{PG}	G_W	W_{PG}	R_{SG}	R_{FC}	R_S
T_1	1.60±0.03^a	21.21±0.39^a	6.10±0.40^a	161.37±11.06^a	1.06±0.01^a	8.50±0.06^a	62.50±12.50^a
T_2	2.14±0.01^b	28.35±0.03^b	10.46±0.06^b	277.54±3.12^b	1.47±0.01^b	4.70±0.01^b	70.83±7.21^a
T_3	0.41±0.02^c	5.43±0.21^c	2.63±0.05^c	69.62±1.65^c	0.59±0.03^c	18.90±0.03^c	45.83±2.20^b

Values of the parameter in each column with different superscripts (a, b and c) differs significantly ($p<0.05$)

Growth performances of *G. giuris* in terms of length gain, weight gain, R_{SG} (%.day^{-1}), food conversion ratio (R_{FC}) and R_S (%) during 90 days experimentation were represented in the Table 3. The mean final length and body weight were 9.14±0.33, 9.69±0.41 and 7.95±0.38 g; and 9.88±0.37, 14.24±0.56 and 6.41±0.43 g in treatment T_1, T_2 and T_3, respectively. Gross production (kg.m^{-2}) was 0.81±0.07, 1.35±0.11 and 0.35±0.05 in treatment T_1, T_2 and T_3, respectively. The production of T_2 ($p<0.05$) was significantly higher than those of treatment T_1 and T_3. Water temperature (°C), dissolved oxygen (mg.l^{-1}) and pH were noted as 25.45±0.46, 25.49±0.37 and 25.48±0.46; 6.79±0.42, 6.81±0.53 and 6.07±0.28 and 7.92±0.16, 7.91±0.14, 7.92±0.15 in treatment T_1, T_2 and T_3, respectively and no significant differences were observed among them ($p<0.05$). Noor (2005) revealed that Thai koi (*A. testudineus*) obtained average length of 14.66±0.38 cm and weight of 57.22±2.93 g for 50 days experiment by applying hand made feed which contained 38% protein. The R_{SG} of *G. giuris* (%.day^{-1}) are much lower than 7.92 for *A. testudineus* when fed 24%, 28.45% and 35% protein containing feeds (Noor, 2005). Hossain *et al*. (1994) reported that R_{FC} of *Puntius gonionotus* varied from 1.74 to 2.29 for fish feed containing different levels of mustard oil cake and seasame meals. Lower growth performances of *G. giuris* may be associated with age and size of fish, species variations, protein supply and environmental conditions. Water quality parameters are more or less similar to Alim (2005).

Three breeding trials were conducted in April, May and June using 20 mg (T_1), 40 mg (T_2) and 50 mg (T_3) PG kg$^{-1}W_B$ of *G. giuris* as shown in Table 4. During induced breeding trails behaviors were exhibited by both male and female but the most common behaviors displayed by the male involved physical contact with the female (e.g. prodding, tail beating), whereas the female mostly reacted by performing behaviors related to body and/or fin oscillations. The highest mean ovulation (83.33±28.86%), fertilization (98.67±2.31%) and hatching rate (45.00±5.29%) were observed in the medium dose of 40 mg PG kg$^{-1}W_B$ (T_2) in April which was significantly higher ($p<0.05$) than the fish treated with 50 mg PG kg$^{-1}W_B$ (T_3). A dose of 20 mg PG kg$^{-1}W_B$ used in treatment T_1 was not sufficient to induce the broodfish to ovulate. There were no significant differences ($p<0.05$) on ovulation between the treatment T_2 and T_3. There was no hatchling under the treatment T_3 from April to June. Immediately after hatching, the larvae (Figure 6) moved horizontally (after hatching to 12 h old larvae) close to the bottom, then moved vertically (12-36 h old larvae) from bottom close to the water surface and back quickly to the bottom and again. Finally, they took about 72-96 h (between 3-4 days) before the larvae begin to swim freely on a horizontal position. Yolk sac absorption started after 68-72 h of hatching. After yolk sac absorption most of the larvae died within 1-2 days of hatching and only 35-40 larvae survived after 4-5 days out of few thousands hatched which preferred to feed on tubificid worm. Successful induced breeding using PG extract and its analogue has also been reported in several fish species viz. *Rita rita* (Mollah *et al*. 2008); *Puntius gonionotus* (Bhuiyan *et al*. 2006) and *Pangasius pangasius* (Khan and Mollah, 2004). Breeding behaviors occurred with the highest frequency during courtship after PG administration within 6-8 h and similar results were recorded for grass gobi (*Zosterisessor ophiocephalus*) by Marchesan *et al.* (2000) in nature without PG injection. Khan and Mollah (2004) conducted three breeding trials with *Pangasius pangasius* injecting PG extract at the rate of 9, 10, 11 and 12 mg.kg$^{-1}W_B$ which resulted ovulation in 100% female. A dose of 10 mg.kg$^{-1}W_B$ of PG demonstrated the best result in consideration to fertilization and hatching rate of eggs. Tan and Lam (2003) used HCG to ovulate marble gobi (*Oxyeleotris marmorata*) where over 90% of the eggs were fertilized, of which over 90% hatched subsequently and hatching time was extremely variable, ranging from 2 to 5 days after fertilization at a temperature of 27±1°C. However, the larvae did not survive for more than a few days. PG doses of 3 (D_1), 6 (D_2), 9 (D_3), 12 (D_4) and 15 (D_5) mg.kg$^{-1}W_B$ induced ovulation in 100% *P. gonionotus* (Bhuiyan *et al.*, 2006). The best outcomes were achieved under higher dose during early (D_4 in April) and later part (D_4 in July) of breeding season. Relatively lower dose was required in the middle part of the breeding season (D_2 in June). So, the peak month (June) and the dose D_2 were found to be most effective for induced spawning of *P. gonionotus*. Mollah *et al.* (2008) reported PG at a dose of 100 mg.kg$^{-1}W_B$ of female *Rita rita* to be effective for induction of ovulation from among 4 doses viz. 80, 100, 120 and 140 mg. Interestingly PG doses at 80 and 140 mg.kg$^{-1}W_B$ had no effect on breeding. This indicates that both lower and higher doses than the required one are unable to exercise their efficacy. The findings are similar to *G. giuris* where PG dose at 20 mg.kg$^{-1}W_B$ (T_1) was less and 50 mg.kg$^{-1}W_B$ (T_3) were more than 40 mg.kg^{-1} body weight (T_2). The amount of PG required for *G. giuris* is lower or higher may be due to species differences and physiological individuality.

Present study was not designed to investigate the actual causes due to which morphological variations occur among the male and female and to determine whether the morphological variation are environmentally induced or due to genetic factors or both. Only a reliable artificial breeding and larvae rearing technique can ensure a steady supply of quality fish seeds. Towards this venture the very

Table 4. Effects of different doses of PG on ovulation response, fertilization and hatching of eggs of *G. giuris* (Mean±SD)

Trial and Date	Treatments	Weight of brood fish (g)		Dose of PG ($mg.kg^{-1}$ fish)		Time and mode of PG injection	Latency period (h)	Ovulation rate (%)	Incubation parameters		Fertilization rate (%) at 1:1 sex ratio	Incubation period (h)	Hatching rate (%)
		Female	Male	Female	Male				Tem.	DO			
1st trial 25.4.2010	T_1	30.00±2.00	22.33±1.57	20		At 5.30 pm and single	-	-	-	-	-	-	-
	T_2	27.00±2.65	23.67±2.52	40	20		16.33±0.57[a]	83.33±28.86[a]	26.1±0.0[a]	5.4±0.07[a]	98.67±2.31[a]	47.30±1.54[a]	45.00±5.29[a]
	T_3	27.00±3.56	23.33±2.51	50			17.16±0.28[b]	66.67±28.86[a]	26.1±0.0[a]	5.5±0.09[a]	23.00±7.00[b]	-	-
2nd trial 21.5.2010	T_1	29.33±2.31	23.33±1.53	20		At 5.30 pm and single	-	-	-	-	-	-	-
	T_2	30.00±1.00	24.00±1.73	40	20		16.83±1.04[a]	66.67±28.86[a]	25.6±0.0[a]	5.5±0.06[a]	97.00±2.65[a]	48.33±2.00[a]	41.67±6.11[a]
	T_3	29.33±1.53	23.66±0.58	50			17.5±0.50[b]	50.00±0.00[a]	25.6±0.0[a]	5.5±0.03[a]	18.00±1.00[b]	-	-
3rd trial 28.6.2010	T_1	29.66±0.57	23.333±1.52	20		At 5.30 pm and single	-	-	-	-	-	-	-
	T_2	30.33±0.58	22.67±1.53	40	20		17.16±0.28[a]	33.33±28.86[a]	26.5±0.0[a]	5.4±0.07[a]	72.23±2.31[a]	-	-
	T_3	29.33±2.89	24.00±2.00	50			17.83±0.28[b]	16.67±28.86[a]	26.5±0.0[a]	5.1±0.15[a]	-	-	-

Values of the parameter in each column with different superscripts (a, b and c) differs significantly ($p<0.05$

preliminary information generated on the breeding biology and subsequent success in induced breeding

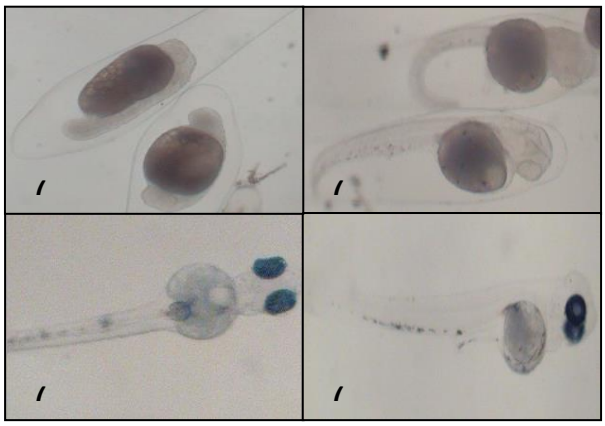

Figure 6. A view of developmental stages (*a* and *b*) and hatchings (*c-ventral view* and *d-lateral view*) of *G. giuris* under an electric microscope (Model no. Olympus-CX21).

trials can serve as the base for further research on *G. giuris* with an aim of establishing the package of induced breeding and stackable sized seed production. However, present findings can serve as the basis for further researches on *G. giuris*.

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