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Morphological Seclusion Among three Isolated River Stocks of Tank Goby (Gobiidae: *Glossogobius giuris* Hamilton, 1822) Based on Truss Network Analysis

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Abstract: A total of 91 sexually mature individuals of tank goby *Glossogobius giuris*, from three different rivers namely *Atrai*, *Padma* and *Brahmaputra* of Bangladesh, were investigated from August 2014 to January 2015 based on eleven meristic, nine morphometric and twenty eight truss measurements analysis to find out morphological variations. Pectoral fin rays ($p<0.01$), caudal fin rays ($p<0.05$) and scales on lateral line ($p<0.05$) out of 11 meristic; peduncle length ($p<0.05$) and first pre-dorsal fin length ($p<0.05$) out of 9 morphometric and 1 to 2 ($p<0.05$), 3 to 4 ($p<0.05$), 6 to 7 ($p<0.01$), 9 to 10 ($p<0.05$) and 3 to 11 ($p<0.01$) out of 28 truss network measurements showed significant differences from each o ther among the individuals of the populations. For morphometric and truss characteristics, the 1st discriminant function (DF_1) accounted for 81.6% and 78.4% whereas the 2nd DF accounted for 18.4% and 21.6%, separately of the among-group variability and together they elucidated 100% of the total amongst group variability. In case of morphometric and truss network positions, scheming discriminant functions demonstrate the modest alienated clusters among the stocks. A UPGMA dendrogram through the hierarchical cluster analysis based on morphometric and landmark characters of tank goby formed one cluster as the *Atrai* River stock while another cluster united two stocks of the *Padma* and the *Brahmaputra* River.

Key words: Landmark · Morphological Dissimilarity · Riverine Stocks · *Glossogobius giuris*

INTRODUCTION

The freshwater tank goby *Glossogobius giuris,* under the spacious family Gobiidae with more than 2000 legal species belonging to more than 200 genera, locally known as *baila* or *bele* is a complex and disparate species of gobiid fishes predominantly available in the rivers, ponds and lakes [1] having a unique taste, low-fat and high protein content [2] with minor commercial importance for capture fishery [3]. In Bangladesh, a total of 54 species out of 260 freshwater fishes have been declared as threatened [4] but most of the wild populations have seriously declined in rivers and streams of Bangladesh. Although, *G. giuris* is not considered as threatened by IUCN, but abundance of the species is gradually decreased in nature due to over exploitation, habitat degradation, aquatic pollution, siltration, climate changes and other ecological reasons. In order to expand the management and conservation approaches, knowledge on the biology, morphology and population structure of any species is a requirement [5] applicable for learning short-term and ecologically persuaded variations.

However, body size disparity is a typical fact for *G. giuris* ranged from 3-40 cm in the assorted area of Bangladesh [6]. Divergences in morphological measurements among the populations of fish species are

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functional to assess the morphological plasticity [7]. So, the aspect creating it a matter of unique concentration is its peripheral morphological variability. Morphological scrutiny of fish populations have for a time been a physically powerful attention of ichthyologist [8, 9] to discover the functional morphology or make a distinction for practical uses in taxonomy and ecology [10]. Moreover, a relationship between different morphometric characters of fish is able to judge the physical condition of them and to find out potential health dissimilarity from unlike stocks of a species [11]. Truss network system is a series of dimensions measured between markers that outline a normal blueprint of joined squares or units from corner to corner of the fish body [12]. It can be successfully used to investigate stock structure separation within a species [13] and to assess the evolution of fish stocks with the highest opportunity of extracting physical discrepancy within and between species [14]. So, the references to different health dissimilarities are more academic while there are very practical and more cost-effective, immediate measures to judge the health status of a population. Thus far, information is to be had on length-weight relationship [15, 16], some aspects of biology and ecobiology [2, 17], reproductive biology [18], induced breeding [19, 20], morphology [19-23], taxonomy [24] and body shape variation [25, 26] of *G. giuris* both national and international territories. But, scarcity of scientific works is prevailing on the structural variations of tank goby population using morphological and landmark-based analysis in Bangladesh and no attempts had yet been taken to assess the stock variability of different riparian populations in this region except Mollah *et al.* [27]. So, it is urgent to figure out the structure of riverine fish stocks and can be the unswerving tools to spotlight the situation of existing population in this research area. The main sight of this study is to search out information about the morphological variations of *G. giuris* using size adjusted morphometric and truss network measurements with meristic counts from three major rivers in the northwest region of Bangladesh.

MATERIALS AND METHODS

Sampling: A total of 91 adults of *G. giuris* were directly collected from the fisherman's catch at three sampling sites of three major rivers namely the *Padma*, the *Brahmaputra* and the *Atrai* in northwest region of Bangladesh. In order to examine the morphological structures from these populations, body weight (g) of accumulated fishes were recorded immediately using electronic balance (HD-602ND, MEGA, Japan) to avoid shrinkage. Then, weighted fishes were kept separately into zipper plastic bags before placing in transported ice box until brought to the laboratory of Department of Fisheries Biology and Genetics of Hajee Mohammad Danesh Science and Technology University (HSTU) in Bangladesh. The descriptive data for the source, place of collection, altitude, size, average total length, average body weight and date of collection of tank goby are presented in the Table 1.

Laboratory Works and Measurements

For Meristic Characteristics: A number of 11 meristic variables, based on the conventional technique illustrated by Hubbs and Lagler [28] were count in each specimen from the isolated river stocks by direct observation. Number of branchiostegal rays (BR), 1st dorsal fin rays (DFR_1), 2nd dorsal fin rays (DFR_2), pectoral fin rays (PcFR), pelvic fin rays (PvFR), anal fin rays (AFR), caudal fin rays (CFR), scales on lateral line (SOLL), scales above lateral line (SALL), scales below lateral line (SBLL) and number of vertebrae (NOV) were considered as the meristic characters. During meristic reckoning, a magnifying glass was used to count up the fin rays along with the principal ray was considered as separate ray. To avoid human error, all morphological measurements were performed by the same investigator. The number of vertebrae was counted by removing the muscle upon water boiling of fish sample for 15 minutes at 100°C temperature.

For Morphometric Characteristics: Ten morphometric characters i.e. total length (TL), standard length (SL), head length (HL), body depth (BD), eye length (EL), pre-orbital length (PROL), post-orbital length (POOL), peduncle length (PL), 1st pre-dorsal f in length ($PRDL_1$) and 2nd pre-dorsal fin length ($PRDL_2$) of each fish from these different stocks were measured to an accuracy of 0.05 mm with Vernier calipers and metallic ruler with minor modifications for this species following the conformist method expressed by Mousavi-Sabet and AnvariFAR [29].

For Truss Network Analysis: The truss protocol used to examine the morphological differences among the wild stocks of *G. giuris* based on thirteen landmarks creating "trusses" around fish body which layout maximize the number of dimensions and increase the sensitivity of analysis. Moreover, the truss network was constructed by interconnecting landmarks to form a total of 28 truss

Table 1: Descriptive data (mean ± SD) of *G. giuris* from three major rivers, northwest region, Bangladesh

Source of sample	Site of sample	Coordinate of sample	Size of sample	TL Mean ± SD	BW Mean ± SD	Date of collection
AR	Dinajpur	25° 55' N 88° 43' E	31	9.63 ± 0.88	8.75 ± 1.85	05.08.14
PR	Rajshahi	24° 21' N 88° 33' E	30	11.52 ± 1.59	14.38 ± 5.34	05.08.14
BR	Kurigram	25° 42' N 89° 44' E	30	11.07 ± 1.09	12.78 ± 3.54	08.08.14

AR = *Atrai River,* PR = *Padma River,* BR = *Brahmaputra River,*
TL = *Total length,* BW = *Body weight and* SD = *Standard deviation.*

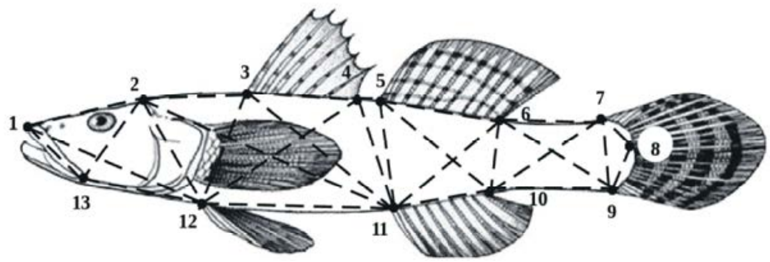

Fig. 1: Location of the 13 landmarks as black dots and associated box trusses as distance lines on fish body used to infer morphological differences among the populations of *G. giuris*. Truss network measurements refer to: *1) anterior tip of snout at upper jaw, 2) most posterior aspect of neurocranium (Forehead), 3) origin of 1st dorsal fin, 4) termination of 1st dorsal fin, 5) origin of 2nd dorsal fin, 6) termination of 2 nd dorsal fin, 7) dorsal attachment of caudal fin, 8) termination of vertebrae column, 9) ventral attachment of caudal fin, 10) termination of anal fin, 11) origin of anal fin, 12) origin of pelvic fin and 13) posterior most point of maxillary*

measurements (Fig. 1) according to Turan [12] and Mollah *et al.* [27]. Each landmark was measured by placing a fish on graph paper and then the landmarks were tipped with tinted indicators so as to get more precise and reliable measurements. Finally, the distances on the graph paper were measured using Vernier calipers.

Statistical Analysis: Analysis of morphological characters, continuous variables which depend on body size, was carried out separately since meristic and morphometric variables are different both statistically and biologically [30]. Dissimilarities were attributed to body shape differences but not be to the relative size of fish. Before going to univariate analysis, any size effect in the data set of morphometric and truss network variables of *G. giuris* individuals were eliminated by eradicating size dependent variations through an allometirc method depicted by Elliott *et al.* [31] with some minor modifications as:

$$Madj = M\,(TLs/TL_0)^b$$

where, *Madj* is the size adjusted measurement; *M* is the original measurement; *TLs* is the overall mean of total length for all fish from all samples in each analysis; TL_0 is the total length of fish; and *b* was estimated for each character from the detected data as the slope of regression of *log M* on *log* TL_0 using all fish in any group.

For both morphometric and landmark-based data, a univariate discriminant analysis was used to recognize the combination of variables that separate *G. giuris* species best. There were significant linear correlations among all measured characters and the total length of this species. The effectiveness of size-attuned conversions was assessed by testing the significance of correlation between transformed variable and total length. To discern the significant differences among the populations of *G. giuris*, a univariate analysis of variance (ANOVA) was carried out for both morphometric and landmark-based data sets while the non-parametric Kruskal Wallis test was also applied for meristic characters, correspondingly. Furthermore, size-adjusted records were standardized and submitted to a discriminant function analysis (DFA). Wilks' lambda was exercised to contrast the variations among all individuals of the river stocks. Both morphometric and truss measurements among the fish from these riverine groups, accompaniment with DFA were conjectured to cluster analysis for a dendrogram by implementing the Squared Euclidean Dissimilarity Distance Method as a measure of distinctions and the UPGMA (Unweighted Pair Group Method Analysis) as the clustering algorithm. Statistical analysis for all morphological and truss measurements were completed through SPSS software version 19.0 (SPSS, Chicago, IL, USA).

RESULTS

Meristic Counts: Eleven meristic counts from all fishes secured on 5 for branchiostegal rays, 6 for 1st dorsal fin rays, 9-11 for 2nd dorsal fin rays, 15-22 for pectoral fin rays, 8-12 for pelvic fin rays, 8-10 for anal fin rays, 12-26 for caudal fin rays, 23-32 for scales on lateral line, 4 for scales above lateral line, 4-5 for scales below lateral line and 26 for number of vertebrae were compared to assess the morphological divergences of *G. giuris*. From all meristic measurements, only difference occurred in pectoral fin rays (Kruskal Wallis, H-test: $df = 2$, $H = 24.114$, $p<0.05$) but rest of the characteristics were not significantly ($p<0.05$) different among the fish of these isolated stocks. Univariate analysis of variance (ANOVA) revealed that pelvic fin rays ($p<0.01$), caudal fin rays ($p<0.05$) and scales on lateral line ($p<0.05$) were significantly dissimilar from each other but rest of them were not ($p<0.01$ and $p<0.05$). First dorsal fin rays, branchiostegal rays and number of vertebrae cannot be computed to analyze because the variables were constant (Table 2).

Morphometric Measurements: Univariate analysis of variance (ANOVA) demonstrated that only two size adjusted morphometric measurements i.e. peduncle length and first predorsal fin length were significantly different ($p<0.05$ with $df = 2.0$) from each other (Table 3). Among the 9 morphometric characteristics (Table 3), only peduncle length and first pre-dorsal fin length were significantly different ($p<0.05$) from each other may be transpired due to their separate ecological position, existing environmental differences of these rivers or come up from separate predecessors.

Landmark Measurements: Among 28 size adjusted landmark-based morphometric measurements, only 5 truss distances were significantly different ($p<0.01$ and $p<0.05$ with $df = 2.0$) from each other (Table 4). Prior to Canonical Discriminant Function analysis (DFA), discriminant function scores (DFs) 1 and 2 were determined on the basis of software process using both size adjusted morphometric and landmark distances and plotted in the discriminant space. In discriminant function analysis,

Table 2: Results of univariate analysis (ANOVA) of meristics characters of *G. giuris* collected from three rivers, northwest region, Bangladesh

S.L.	Characters	Wilks' Lambda	F	df_1	df_2	Sig.
1.	BR	-	-	-	-	-
2.	DFR_1	-	-	-	-	-
3.	DFR_2	0.961	1.784	2	88	0.174
4.	PcFR	0.729	16.369	2	88	0.000**
5.	PvFR	0.881	5.933	2	88	0.004
6.	CFR	0.902	4.776	2	88	0.011*
7.	AFR	0.976	1.098	2	88	0.338
8.	SOLL	0.922	3.722	2	88	0.028*
9.	SALL	0.903	4.717	2	88	0.011
10.	SBLL	-	-	-	-	-
11.	NOV	-	-	-	-	-

BR = *branchiostegal rays*, DFR_1 = *1st dorsal fin rays*, DFR_2 = *2nd dorsal fin rays*, PcFR = *pectoral fin rays*, PvFR = *pelvic fin rays*, AFR = *anal fin rays*, CFR = *caudal fin rays*, SOLL = *scales on lateral line*, SALL = *scales above lateral line*, SBLL = *scales below lateral line* and NV = *number of vertebrae*. *From 11 meristic counts, 3 were significantly different at 5% (*$p<0.05$) and 1% (** $p<0.01$) levels of significance with 2 degree of freedom from each other collected from three isolated river stocks.*

Table 3: Results of univariate analysis (ANOVA) of size adjusted morphometric characters of *G. giuris* collected from three rivers, northwest region, Bangladesh

S.L.	Characters	Wilks' Lambda	F	df_1	df_2	Sig.
1.	SL	0.986	0.632	2	88	0.534
2.	HL	0.994	0.250	2	88	0.780
3.	BD	0.987	0.596	2	88	0.553
4.	EL	0.976	1.085	2	88	0.342
5.	PROL	0.979	0.963	2	88	0.386
6.	POOL	0.949	2.363	2	88	0.100
7.	PL	0.903	4.745	2	88	0.011*
8.	$PRDL_1$	0.949	2.369	2	88	0.099*
9.	$PRDL_2$	0.985	0.664	2	88	0.517

TL = *total length*, SL = *standard length*, HL = *head length*, BD = *body depth*, EL = *eye length*, PROL = *pre-orbital length*, POOL = *post-orbital length*, PL = *peduncle length*, $PRDL_1$ = 1st *pre-dorsal fin length* and $PRDL_2$ = *2nd pre-dorsal fin length*. *From 9 morphometric counts, 2 were significantly different at 5% (*$p<0.05$) level of significance with 2 degree of freedom from each other collected from three isolated river stocks*

Table 4: Results of univariate analysis (ANOVA) of size adjusted truss distances of *G. giuris* collected from three rivers, northwest region, Bangladesh

S.L.	Characters	Wilks' Lambda	F	df1	df2	Sig.
1.	1 to 2	0.901	4.820	2	88	0.010*
2.	2 to 3	0.982	0.808	2	88	0.449
3.	3 to 4	0.951	2.276	2	88	0.109*
4.	4 to 5	0.929	3.358	2	88	0.039
5.	5 to 6	0.915	4.078	2	88	0.020
6.	6 to 7	0.904	4.697	2	88	0.012**
7.	7 to 8	0.979	0.925	2	88	0.400
8.	8 to 9	0.961	1.790	2	88	0.173
9.	9 to 10	0.952	2.237	2	88	0.113*
10.	10 to 11	0.960	1.856	2	88	0.162
11.	11 to 12	0.992	0.371	2	88	0.691
12.	12 to 13	0.992	0.376	2	88	0.688
13.	1 to 12	0.984	0.710	2	88	0.494
14.	1 to 13	0.989	0.468	2	88	0.628
15.	2 to 11	0.958	1.912	2	88	0.154
16.	2 to 12	0.994	0.247	2	88	0.782
17.	2 to 13	0.976	1.069	2	88	0.348
18.	3 to 11	0.888	5.539	2	88	0.005**
19.	3 to 12	0.990	0.458	2	88	0.634
20.	4 to 11	0.946	2.504	2	88	0.088
21.	4 to 12	0.968	1.475	2	88	0.234
22	5 to 10	0.959	1.889	2	88	0.157
23	5 to 11	0.973	1.243	2	88	0.294
24	6 to 9	0.999	0.025	2	88	0.976
25	6 to 10	0.988	0.521	2	88	0.596
26	6 to 11	0.999	0.058	2	88	0.944
27	7 to 9	0.943	2.635	2	88	0.077
28	7 to 10	0.996	0.159	2	88	0.854

*From 28 size adjusted truss measurements, 5 distances were significantly different at 1% (**p<0.01) and 5% (*p<0.05) levels of significance with 2 degree of freedom from each other collected from three isolated river stocks*

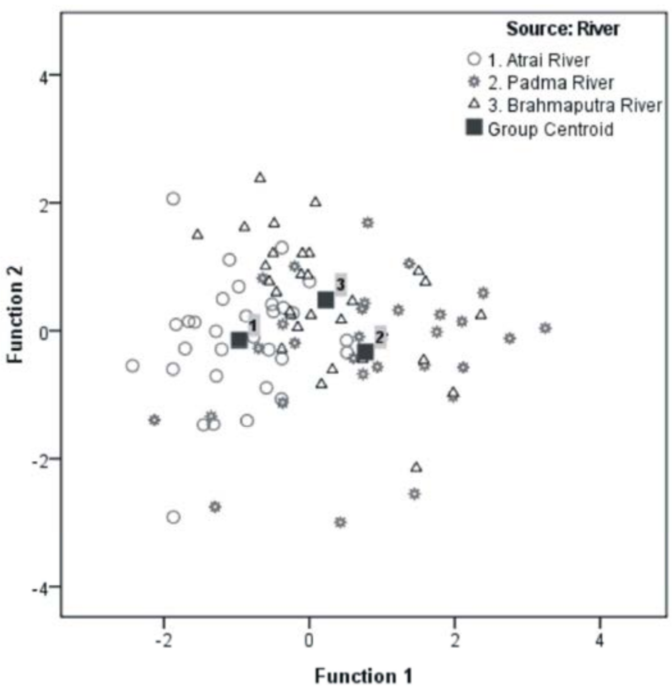

Fig. 2: Sample centroids of discriminant function scores using size adjusted morphometric characters of *G. giuris* collected from three rivers, northwest region, Bangladesh

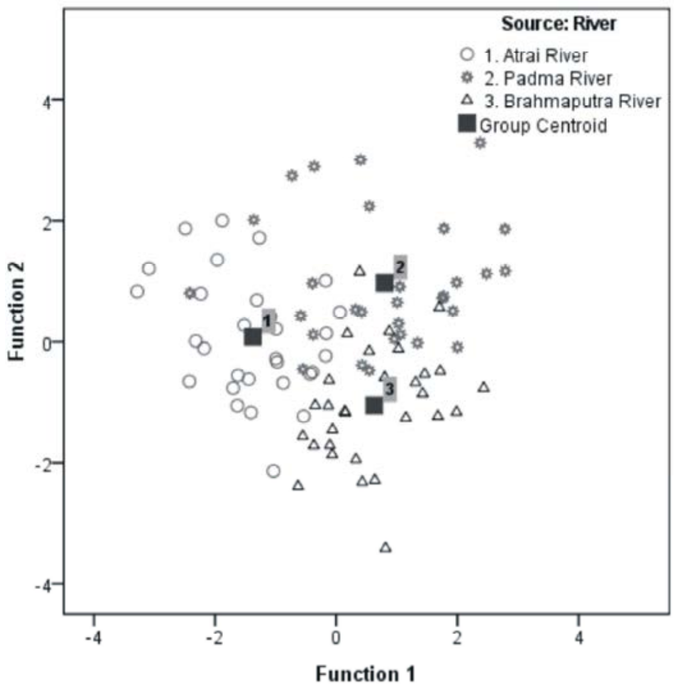

Fig. 3: Sample centroids of discriminant function scores using size adjusted truss distances of *G. giuris* collected from three rivers, northwest region, Bangladesh

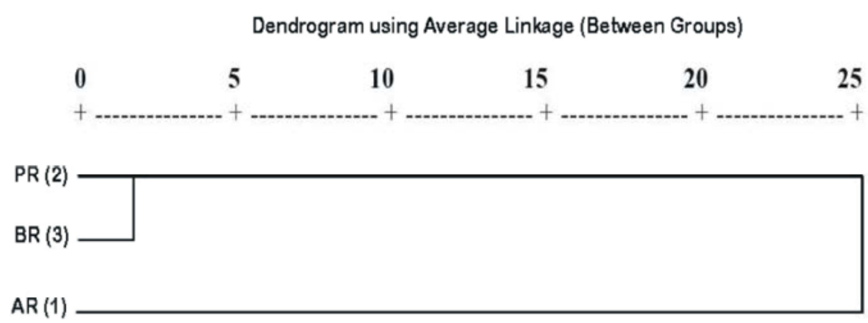

Fig. 4: Dendrogram using the cluster analysis based on both morphometic and truss network measurements of *G. giuris* collected from three rivers, northwest region, Bangladesh

Table 5: Pooled within-groups correlations between discriminating variables and canonical discriminant functions in case of morphometric characteristics of *G. giuris*

		Functions	
S.L.	Morphometric characteristics	DF_1	DF_2
1.	SL	-0.129*	0.012
2.	HL	0.168*	-0.159
3.	BD	0.106	0.142*
4.	EL	-0.061	0.111*
5.	PROL	0.010	-0.070*
6.	POOL	-0.020	0.025*
7.	PL	-0.038	0.924*
8.	$PRDL_1$	0.258	-0.371*
9.	$PRDL_2$	0.095*	0.000

TL = *total length*, SL = *standard length*, HL = *head length*, BD = *body depth*, EL = *eye length*, PROL = *pre-orbital length*, POOL = *post-orbital length*, PL = *peduncle length*, $PRDL_1$ = 1st *pre-dorsal fin length* and $PRDL_2$ = *2nd pre-dorsal fin length*. **Largest absolute correlation between each variable and any discriminant function where variables ordered by absolute size of correlation within function.*

Table 6: Pooled within-groups correlations between discriminating variables and canonical discriminant functions in case of truss distances of *G. giuris*

S.L.	Characteristics	Discriminate Functions (DF) DF_1	DF_2
1.	1 to 2	-0.513*	0.204
2.	2 to 3	0.156*	0.110
3.	3 to 4	0.360*	0.089
4.	4 to 5	0.114	-0.139*
5.	5 to 6	0.017*	0.001
6.	6 to 7	0.519*	0.110
7.	7 to 8	-0.093*	0.091
8.	8 to 9	-0.111*	-0.053
9.	9 to 10	-0.324*	0.240
10.	10 to 11	-0.180*	-0.071
11.	11 to 12	0.294*	0.102
12.	12 to 13	0.063	-0.168*
13.	1 to 12	0.123	0.228*
14.	1 to 13	-0.013	-0.090*
15.	2 to 11	0.166*	-0.032
16.	2 to 12	0.049	-0.075*
17.	2 to 13	-0.142*	-0.040
18.	3 to 11	-0.018	-0.842*
19.	3 to 12	0.276*	-0.029
20.	4 to 11	.069	-.229*
21.	5 to 10	-0.020	-0.020*
22.	5 to 11	0.015	0.121*
23.	6 to 9	0.177*	0.088
24.	6 to 10	0.022	-0.121*
25	6 to 11	-0.090	-0.153*
26.	7 to 9	0.115*	0.022
27	7 to 10	0.232*	-0.021
28	4 to 12	-0.063*	0.017

**Largest absolute correlation between each variable and any discriminant function where variables ordered by absolute size of correlation within function*

stock of tank goby from the *Atrai* River was separated from other two stocks of the *Padma* and the *Brahmaputra* River (Fig. 2 and Fig. 3). This proposed that stock of *G. giuris* from the *Atrai* River was morphologically dissimilar to other stocks of the *Padma* and the *Brahmaputra* River but stocks from the *Padma* and the *Brahmaputra* River showed very close relationship among them. This advocated that the three isolated stocks are morphologically fragmented or divergent and more or less isolated from each other. Discriminant function analysis produced two discriminant functions (DF_1 and DF_2) for both morphometric and landmark measurements. For morphometric and landmark characters, the first DF accounted for 81.5% and 68.6% and the second DF accounted for 18.5% and 31.4% respectively of among group variability explaining 100 % of total among group variability. In pooled within groups correlation between discriminant variables and discriminant functions revealed that standard length, head length and first pre-dorsal fin length among the 9 morphometric measurements donated to the first DF and the rest six measurements i.e. body depth, eye length, preorbital length, post orbital length and pre-dorsal fin length contributed to the second DF (Table 5). For landmark-based characters, 17 truss measurements out of 28 were dominantly contributed to the first DF and the rest 11 dimensions contributed to the second DF (Table 6).

A dendrogram (UPGMA) anchored in the hierarchical cluster analysis based on standardized morphometric and truss network measurements of *G. giuris* are shown in Fig. 4. The dendrogram formed two main clusters in which *Atrai* River stock in one cluster while another two rivers *Padma* and *Brahmaputra* formed a new cluster point toward that *Atrai* River as a separate stock. The second cluster of dendrogram explained that individuals of tank goby from the *Padma* and the *Brahmaputra* River had very close relationship. This result recommends higher morphological plasticity in the populations of *Atrai* River compared to the *Padma* and the *Brahmaputra* River.

DISCUSSION

This study focused on identifying the morphological differences among the stocks of tank goby inhabiting three separate rivers of Bangladesh but not considered for ecological or heritable seclusion. However, significant differences come to mind in pectoral fin rays ($p<0.01$ and $p<0.05$), caudal fin rays ($p<0.05$) and scales on lateral line ($p<0.05$) were much different from each other but rest of them were not significant both $p<0.01$ and $p<0.05$ showing resemblance with the findings of Mollah *et al.* [27], Islam and Mollah [19]. Engin *et al.* [32] reported that pectoral fin rays ranged from 20-21 with 3-4 uppermost end rays scrutinized for red-mouthed goby *Gobius cruentatus* and 16-21 for *Glossogobius aureus* [33]. No significance differences ($p<0.01$ or $p<0.05$) were found in meristic characters among the populations of *Cirrhinus reba* [34]. But 3 of 6 differences ($p<0.05$) observed in meristic characters from stinging catfish *Heteropneustes fossilis* [35] and 1 of 7 from mullet *Rhinomugil corsula* populations [36] compared to *G. giuris* that may be due to taxonomic, environmental, geographical, spawning and feeding strategic variations. Besides, considerable differences ($p<0.01$) were observed in all morphometric characters among three populations of *G. giuris* [27], 13 of 30 measurements from Chinese minnow *Gobiocypris* *rarus* populations [37] and 15 of 31 ($p<0.05$) from endangered Caspian lamprey *Caspiomyzon wagneri* [38]. The factors that influence morphological differences are renowned [39], by an interface between genetic and environmental factors [40] and both within and between populations of fish are relatively hard to give details explanations [41]. Aquatic animals are extremely responsive to ecological alteration and rapidly modify their indispensable morphology that shows high plasticity in order to cope with new environmental changes [42]. They will demonstrate better morphological variations both within and between populations compared to other vertebrates and are highly susceptible to atmospheric morphological distinctions [43].

In the truss network system of *G. giuris*, a authoritative device to spot a stock of aquatic species [44], collected from separate rivers, where 5 (1 to 2, 3 to 4, 6 to 7, 9 to 10 and 3 to 11) of 28 truss distances (Table 4) were significantly different ($p<0.05$ or <0.01) from each other. Mollah *et al.* [27] found considerable differences ($p<0.01$) in 23 landmark-based distances from three stocks of *G. giuris* in Bangladesh and 1 of 22 ($p<0.001$) from *Eutropiichthys vacha* populations [45]. Exploitation of DNA markers to recognize genetics variations among fish populations are insufficient owing to high market price and require well equipped laboratory [34]. But stock structure analysis based on truss network measurements of fish body could be easily suitable caused by the normal connection between homologies and measurements and provides inclusive consideration on phenotypic agility [46]. Conversely, landmark-based distances can also be able to make a phenotypic distinction among the stocks of exploited fishes when genetic markers might not exist enough to sense obtainable genetic deviations among populations as well as a tiny quantity of DNA premeditated by DNA markers. Diverse habitats from identical aquatic environment encompass a variety of settings which can alter the food and feeding habits, growth models and reproductive plans of a species [47]. In Bangladesh, there is a very little rate of geographical and environmental alterations as a consequence of its small geographical area compared to others countries. But, present study in the rivers *Atrai*, *Padma* and *Brahmaputra* have a unlike ecological circumstances as a results of water quality parameter, food abundance, breeding strategy and rate of climate change from each other. Because of small environmental alterations, it is very hard to investigate small structural variations of this species using meristics or size standardized morphometric characters.

In this experimentation, dissimilarity among the river stocks of *G. giuris* was verified using DF analysis and significant relationships were also detected between size adjusted morphometric and truss network characters. Plotting DFs (Fig. 2 and Fig. 3) exposed advanced morphological remoteness among the stocks of tank goby. The stock of *Atrai* River presented intermediate distinctiveness between the stocks of this species from the *Padma* and the *Brahmaputra* River whereas the *Padma* and *Brahmaputra* stocks highly overlapped (Fig. 2). In the Figure 4, the *Padma* and the *Brahmaputra* stocks partially overlapped. In case of morphometric measurements (Fig. 2), the 1st DF accounted for much more (81.6%) of the among group changeability than did the 2nd DF (18.4%). For adjusted truss distances (Fig. 3), the 1st DF answered for a large extent (78.4%) of the among cluster discrepancy than did the 2nd DF (21.6%). From both morphological dimensions (Fig. 2 and Fig. 3), it was more apparent that 2nd DF explicated not as much of the variance than did the 1st DF. For that reason, the 2nd DF was with a reduction of instructive in enlightening morphological divergences among the stocks of running water bodies. Parallel outlines of group variability reported in *Labeo calbasu* [48] and *Alburnoides eichwaldii* [49].

Dendrogram based on meristic or morphometric or truss network systems noticed variation probably due to environmental circumstances, split environments as well as genetic differences for Japanese charr *Salvelinus leucomaenis* populations [50], owing to reproductive isolation, temperature, salinity, food availability or migration for anchovy populations *Engraulis engrasicolus* [44] and down to unusual hydrological surroundings for horse mackerel *Megalaspis cordyla* [51]. There is no discrete environmental differentiation of the river systems but unspecified variations would be the ecological pattern, foodstuff profusion, breeding ground or shelter competition. As a result of pitiable water flows with restricted range of migration day by day in the winter season from three major rivers the *Atrai*, the *Padma* and the *Brahmaputra* of Bangladesh where the anticipated morphological diversity of *G. giuris* populations have occurred by geographic partition as well as heritable variations.

The study focused on identifying the morphological differences among the stocks of tank goby inhabiting three separate rivers of Bangladesh but not considered for ecological or heritable seclusion. This is very preliminary information on the morphological isolations of *G. giuris* which would be the basis for potential advanced research from different regions in order to explain the morphological plasticity. For the purposes of protection, supervision strategies, superior broodstock and quality seed of this indigenous freshwater species for both inland and closed aquatic environments, knowledge on their biology, population structure, genetics studies and environmental factors are crucial to save them from their extinction in Bangladesh.

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