



## INTRA-SPECIFIC DIVERSITY OF THE SILVER GRUNT (*Pomadasys Hasta*) IN THREE LOCATIONS OF BANGLADESH BASED ON MORPHOMETRIC ANALYSIS

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### Abstract

Morphometric variation is a useful tool for studying a species' population structure. The present study was performed to assess the intra-specific diversity between three stocks of the Silver grunt *Pomadasys hasta* (Khulna, Satkhira and Patuakhali of Bangladesh). Length-weight relationship, condition factor and few other morphometrics were analyzed using both univariate and multivariate approaches. A total of 105 samples were subjected to the analysis (weight  $95.05 \pm 44.22$  g) and length ( $16.18 \pm 2.57$  cm). A total of eleven morphometric traits including standard length (SL), head length (HL), pre dorsal length (Pre DL), dorsal length (DL), pre-anal length (Pre AL), pre-pelvic length (PreVL), pre pectoral length (PrePL), pre-orbital length (PrOL), body depth (BD), eye diameter (ED) and pre orbital length (PreOL) were measured. Significant differences were found in four morphometric measurements including head length (HL % of total length), eye diameter (ED % of HL), dorsal length (DL %) and pre dorsal length (PreDL%). A negative allometric growth was observed, as the slope  $b$  was far below 3. The highest value of  $b$  was found in Satkhira (2.7) and the lowest value of  $b$  was found in Khulna (2.07). Three separate stocks of *P. hasta* exhibited morphological variations in their attributes. The divergence among the stocks could have resulted from both environmental and genetic variances. The outcomes of the study will be helpful for management and conservation of natural population of *Pomadasys hasta* in Bangladesh.

**Keywords:** Morphometric variation, Intra-specific diversity, Length-weight relationship

### Introduction

Grunters are typically small to medium-sized fish that inhabit shallow coastal habitats. In Bangladesh, several species belonging to this particular family exhibit a high level of prevalence. The genus *Pomadasys* contains 25 species. *Pomadasys hasta* (Bloch, 1790) or *Pomadasys argenteus* (Forsskl, 1775) (Jahan et al., 2016) which is popularly known as "Datina" throughout Bangladesh and locally known as "Sada Datina" of the family Haemulidae, caught in coastal brackish and saline waters of Bangladesh. They can be marketed fresh or in salted form (Tareque et al., 2002). This species exhibits a vast dispersal in the Indo-West Pacific region, ranging from the Red Sea to the Philippines, extending northwards to southern Japan, and southwards to northern Australia. It has also been documented in New Caledonia (Thollot, 1996). Among the biological studies of fish, the size-frequency distributions are of paramount importance in fisheries management, culture, and regulation and also for ascertaining the environmental suitability of a particular fish in a particular area.

The capacity to discern and categorize different populations of a certain fish species is a fundamental necessity for the purposes of conservation, management, and utilization. There are numerous approaches for distinguishing a fish stock; geometric morphometric method is relatively a new method with several benefits, including cost-effectiveness, speed, and utility, and have been successfully employed in many research (Begg & Waldman, 1999). Consequently, morphometric characteristics are essential in fisheries research, as they are used to compare stock life histories and morphological trends across environments. In addition, morphometric traits exhibit greater resilience to environmental stressors and remain consistent across generations. However, when environmental pressure and other influences such as hybridization, inbreeding, and bottleneck effects significantly

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affect a population, morphometric traits display noticeable variations (Schaeffer et al., 2019). Environmental influences are the primary cause of morphological variation within species (Smartt & Lemen, 2015). For stock discrimination, a variety of techniques have been applied, including morphological traits, traditional tags, otolith properties, and molecular genetics, with morphometric characters being one of the most widely used (Begg et al., 1999).

*Pomadasys basta* (Silver Grunt) is an important fish species for its high market value and rich in protein supply. However, there has been no study conducted thus far about the morphometric analysis and length-weight relationship of the species. A research study was conducted to assess the potential changes in morphometric characteristics of *P. basta* across three distinct locations (Patuakhali, Khulna, and Satkhira) along the coastal part of Bangladesh.

### Materials and Method

Specimens of *P. basta* were gathered from three separate areas within the coastal zone of Bangladesh. These locations include the Rupsha River in Khulna (22°48'08.7"N 89°34'52.9"E), Kuyakata in Potuyakhali (21°48'49.1"N 90°07'22.6"E), and the Kholpetua River in Satkhira (22°33'35.4"N 89°11'04.2"E). A total of 105 samples were gathered during the years 2020 and 2021. The samples collected by the fisherman were promptly kept in ice and sent to the Biology laboratory at Fisheries and Marine Resource Technology Discipline of Khulna University. They were placed in an air-tight Styrofoam container to ensure accurate morphological examination.



Figure 1. Red solid circles on map show sampling locations (Khulna, Satkhira and Patuakhali)

### Measurements of morphometric traits

Prior to morphometric assessment, the sample weight was obtained using an electronic weighing machine. Initially, the fish specimen was positioned on a grid paper beside its unique identifier, and then, a digital photograph was captured using a Canon DS2000 camera. A total of 11 morphometric characters, including total length (TL), standard length (SL), Trunk Length (TrL), pre-dorsal length (PrDL), dorsal length (DL), pre-anal length (PreAL), pre-pelvic length (PreVL), eye diameter (ED), pre-orbital length (PrOL), highest body depth (HBD), head length (HL), pre pectoral length (PrePL) were measured using ImageJ software.

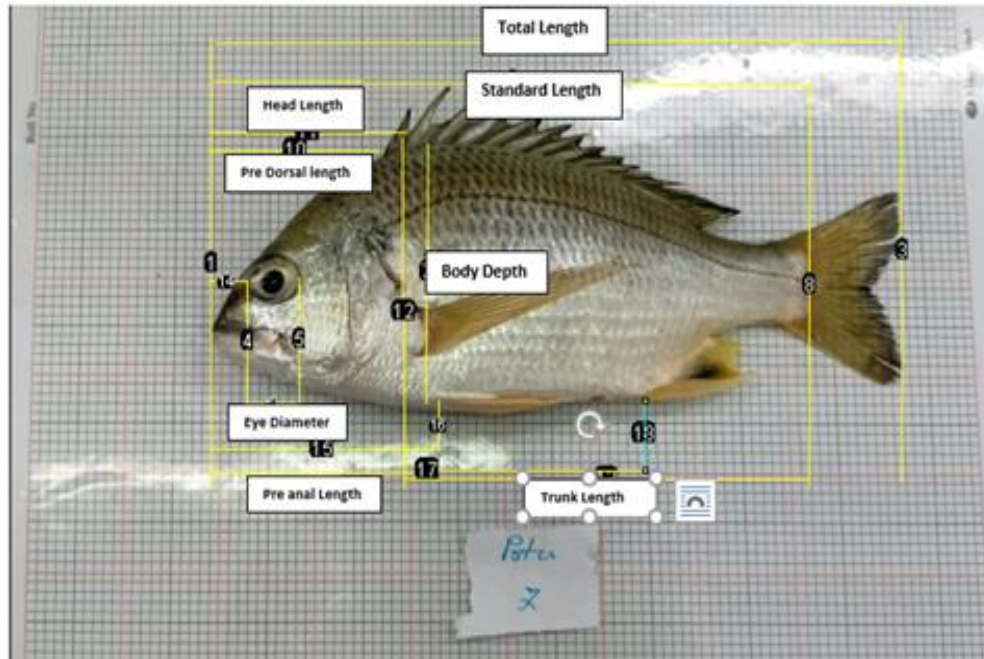


Figure 2. Morphometric measurement of *P. basta*.

### Standardization of data

Before analysis, the size impacts in the data set were eradicated. The inequities were ascribed to discrepancies in body morphology, rather than disparities in fish sizes. All of the measured features and the total length (TL) had substantial linear associations in the current study. As a result, all of the characters needed to be stripped of their size-dependent variations. The size impact was diminished from the data set using an allometric formula described by (Elliott et al., 1995) with minor modifications:

$$M_{adj} = M (L_s/L_o)^b$$

Where  $M$  is the initial measurement,  $M_{adj}$  is the size-adjusted measurement,  $L_o$  denotes the fish's TL, and  $L_s$  is the overall mean of the TL. The parameter  $b$  was determined for all feature by calculating the slope of the regression of the logarithm of  $M$  on the logarithm of  $L_o$ , employing all fish stocks. The efficacy of the size correction changes was evaluated by examining the statistical significance of the correlation amongst a transformed parameter and the TL.

### Length-weight relationship measurement

To estimate the length-weight relationship the following formula was used.

$$W = a L^b \quad (\text{Cren, 1951})$$

Where,

W = weight in g, L = length in cm, a = intercept, and b = exponent

The regression of total length and body weight yielded the following equation in the arithmetic scale:

$$W = a + b TL$$

Where, X represented total length and Y represented body weight. Here a and b are parameters of the power equation. The equation was log transformed to evaluate the parameters a and b.

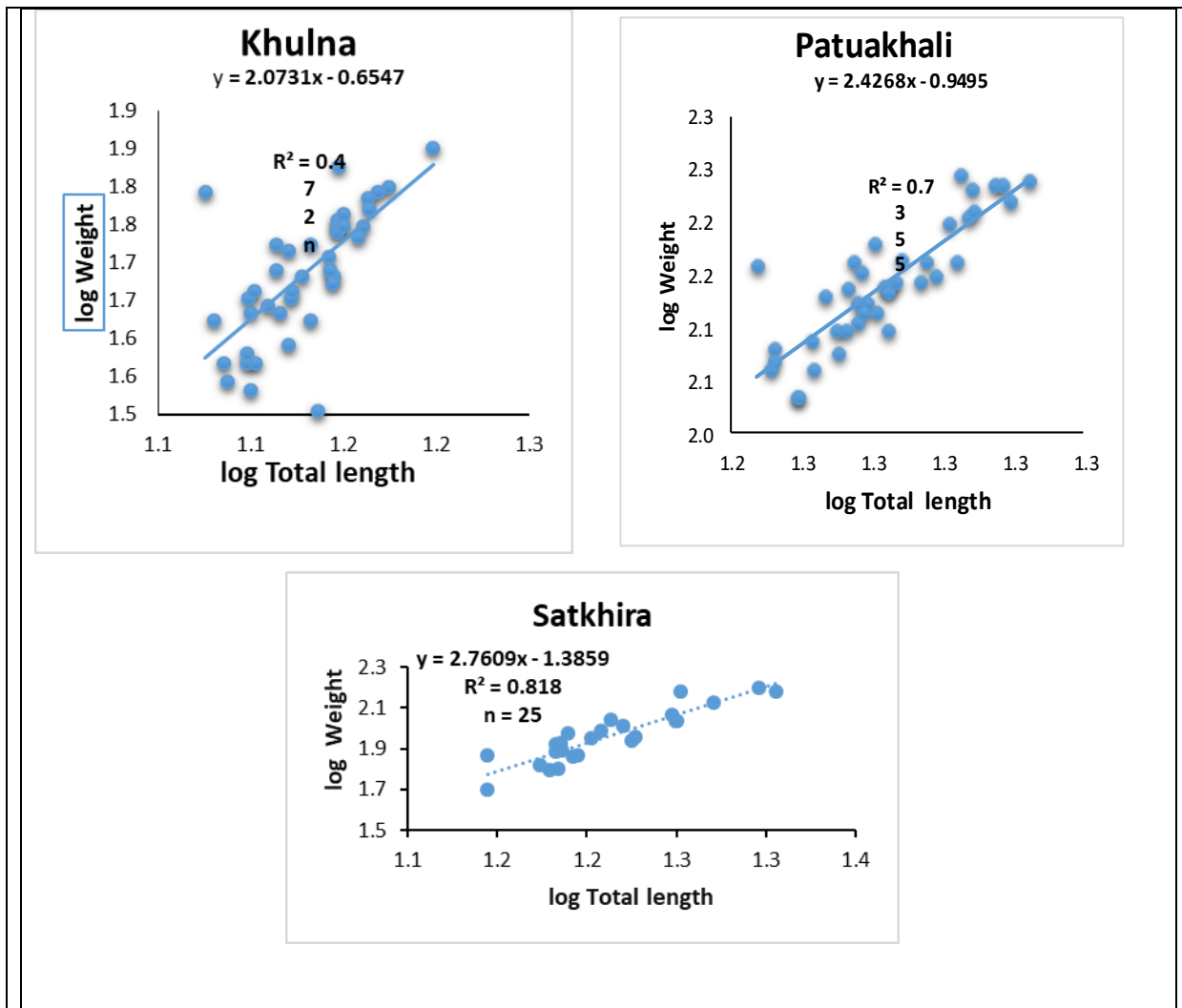
The value of b' represents the value of condition factor.

### Data analysis

The statistical analysis was conducted using the MINITAB software, specifically Version 17 (Minitab, 2014). Graphs were generated using the software programs MINITAB and Microsoft Excel. ANOVA and MANOVA were conducted to assess the statistical significance of the observed morphological variations.

### Results

Length-weight relationship of *P. hasta* from different stocks



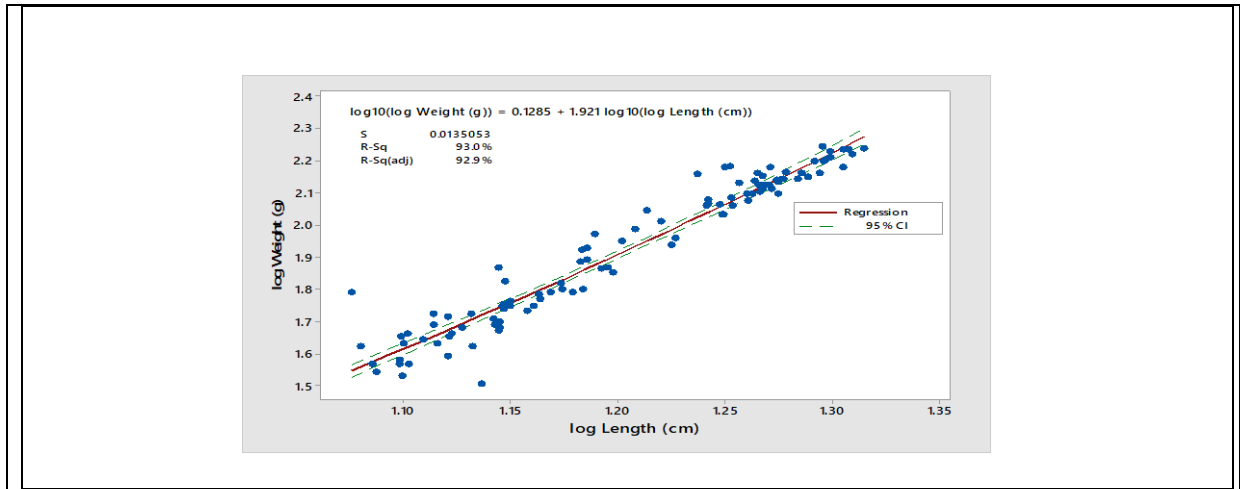


Figure 3. Length-weight relationship of *P. basta*

The fitness of the linear regression equations were determined based on coefficient of determination ( $R^2$ ). Here all the positive value of  $R^2$  of Satkhira and Patuakhali showed strong relationship except the  $R^2$  of Khulna showed a weak relationship. The regression line of total length-body weight relationships are shown in figure 3.

Here the uppermost value of  $b$  was found in Satkhira (2.76) and the lowest value of  $b$  was found in Khulna (2.07). On the other hand more value of  $R^2$  was found in Satkhira (0.8) and the lowest value in Khulna (0.47). The value of  $a$ ,  $b$  and  $R^2$  was shown in the table 1.

Table 1. Total Length-Body Weight relationship, regression coefficient and equations in several stocks

Population	a	b	Equation	$R^2$
Khulna	-0.65	2.07	$y = 2.07x - 0.65$	0.47
Satkhira	-1.38	2.76	$y = 2.76x - 1.38$	0.81
Patuakhali	-0.94	2.42	$y = 2.42x - 0.94$	0.73
All Habitat	-1.73	3.04	$y = 3.04x - 1.73$	0.93

### Measurements of morphometric traits

In this study, 11 morphometric measures were counted which were TL, SL, TrL, PrDL, DL, PreAL, PreVL, ED, PrOL, HBD, HL, PrePL.

Table 2. ANOVA result of all the morphometric measurement of *P. basta* from three regions.

Serial No.	Characters	Df1	Df2	F	Sig
1	Dressing % or Trunk length %	2	102	1.83	0.166
2	Head length (HL %)	2	102	12.46	0.000*
3	Highest Body depth (BD %)	2	102	1.11	0.334
4	Eye Diameter (ED % of HL)	2	102	20.59	0.000*
5	Condition factor	2	102	2.03	0.137
6	Dorsal length (DL%)	2	102	5.73	0.004*
7	Pre dorsal length (PreDL%)	2	102	5.34	0.006*
8	Pre Orbital length (PreOL%)	2	102	0.82	0.444
9	Pre Pectoral length (PrePL%)	2	102	2.47	0.090
10	Pre Pelvic length (PreVL%)	2	102	1.27	0.284
11	Pre Anal length (Pre AL%)	2	102	1.77	0.176

\* Indicates significant difference at  $p < 0.05$

Table 3. Morphometric value (Mean±SD) of Datina from three locations

Trait	Location	Average	SD
Dressing %	Khulna	59.5	1.9
	Patuakhali	58.7	2.2
	Satkhira	59.5	1.0
HL%	Khulna	25.1	1.7
	Patuakhali	26.6	1.1
	Satkhira	26.7	1.7
BD%	Khulna	34.4	1.6
	Patuakhali	34.7	2.1
	Satkhira	35.1	1.4
ED%	Khulna	28.1	2.6
	Patuakhali	24.9	1.8
	Satkhira	25.9	2.4
CF%	Khulna	2.0	0.4
	Patuakhali	2.1	0.2
	Satkhira	2.2	0.3
DL%	Khulna	43.8	2.5
	Patuakhali	44.6	1.5
	Satkhira	45.6	1.9
PreDL%	Khulna	26.0	2.7
	Patuakhali	27.0	1.7
	Satkhira	25.3	1.5
PreOL%	Khulna	16.0	2.7
	Patuakhali	16.6	1.9
	Satkhira	16.1	1.8
PrePL%	Khulna	28.6	1.7
	Patuakhali	29.1	1.8
	Satkhira	29.6	2.3
PreVL%	Khulna	33.2	2.5
	Patuakhali	32.7	2.3
	Satkhira	34.0	2.9
PreAL%	Khulna	62.2	2.9
	Patuakhali	62.8	2.9
	Satkhira	63.7	4.0

### Variation in different traits

#### Dressing percentage (DP)

The ANOVA analysis indicated no statistically significant differences (Table 2) seen among the various stocks for Dressing percentage ( $F_{(2,102)} = 1.83, p < 0.05$ ). The highest DP was observed in Satkhira ( $59.5 \pm 2.35$ ) while the lowermost was found in Patuakhali ( $58.7 \pm 1.07$ ) (Table 3).

#### Head length

Table 2 revealed a significant difference in head length among various stocks ( $F_{(2,102)} = 12.46, p < 0.05$ ). The highest head length was found in Satkhira stock ( $26.7 \pm 1.74$ ) while the lowest head length was found in Khulna ( $25.14 \pm 1.6$ ) (Table 3).

#### Body depth (BD %)

The results showed that, for maximum body height, there was no significant difference between the stocks (Table 2) ( $F_{(2,102)} = 1.11, p < 0.05$ ). The Satkhira stock had the greatest body height ( $35.06 \pm 1.39$ ), whilst the Khulna stock displayed the lowest body height (Table 3).

### Eye Diameter (ED % of HL)

The Eye diameter was significantly differed (Table 2) among various stocks for eye diameter ( $F_{(2, 102)} = 20.59, p < 0.05$ ). The Khulna stock had the longest eye length ( $28.13 \pm 2.59$ ) while Patuakhali had the shortest ( $24.9 \pm 1.7$ ) (Table 3).

### Condition factor

There were no statistically significant variations (Table 2) between the various equities regarding the Condition factor ( $F_{(2, 102)} = 2.03, p < 0.05$ ). The Satkhira stock exhibited the highest Condition factor ( $2.15 \pm 0.29$ ), whilst the lowest Condition factor was observed in Khulna ( $2.01 \pm 0.35$ ) (Table 3).

### Dorsal length (DL%)

The ANOVA analysis indicated statistically significant variations (Table 2) among several stocks in terms of dorsal length ( $F_{(2, 102)} = 5.73, p < 0.05$ ). The highest DL% was found in Satkhira stock ( $45.5 \pm 1.8$ ) while the lowest was found in Khulna ( $43.8 \pm 2.5$ ) (Table 3).

### Pre dorsal length (Pre DL%)

Table 2 shows the significant variations in dorsal length between the stocks as assessed by the ANOVA analysis ( $F_{(2, 102)} = 5.34, p < 0.05$ ). The highest pre dorsal length was found in Patuakhali stock ( $27.03 \pm 1.6$ ) while the lowest was found in Satkhira ( $25.34 \pm 1.5$ ) (Table 3).

### Pre-orbital length

The study findings revealed that there were no statistically significant disparities (as shown in Table 2) across different stocks in terms of Pre-orbital length ( $F_{(2, 102)} = 0.82, p < 0.05$ ). The highest pre dorsal length was found in Patuakhali stock ( $16.5 \pm 1.858$ ) while the lowest was found in Khulna ( $15.9 \pm 2.7$ ) (Table 3).

### Pre Pectoral length (Pre PL%)

There were no statistically significant variations (Table 2) between the lengths of the pre-pectoral fins of the various stocks ( $F_{(2, 102)} = 2.47, p < 0.05$ ). The Satkhira stock exhibited the greatest pre-dorsal length, measuring at  $29.6 \pm 2.2$ , whilst the Khulna stock displayed the lowest pre-dorsal length, measuring at ( $28 \pm 4.1$ ) (Table 3).

### Pre Pelvic length (Pre VL%)

No significant variations were found for dorsal length among the four stocks, according to the ANOVA analysis (Table 2) ( $F_{(2, 102)} = 1.27, p < 0.05$ ). The highest pre dorsal length was found in Satkhira stock ( $33.9 \pm 2.9$ ) while the lowest was found in Khulna ( $32.4 \pm 5.1$ ) (Table 3).

### Pre Anal length (Pre AL%)

The results indicated that there were no notable disparities (Table 2) among various stocks in terms of Pre anal length ( $F_{(2, 102)} = 1.77, p < 0.05$ ). The highest pre dorsal length was found in Satkhira stock ( $63.7 \pm 4$ ) while the lowest was found in Khulna ( $60.80 \pm 9.5$ ) (Table 3).

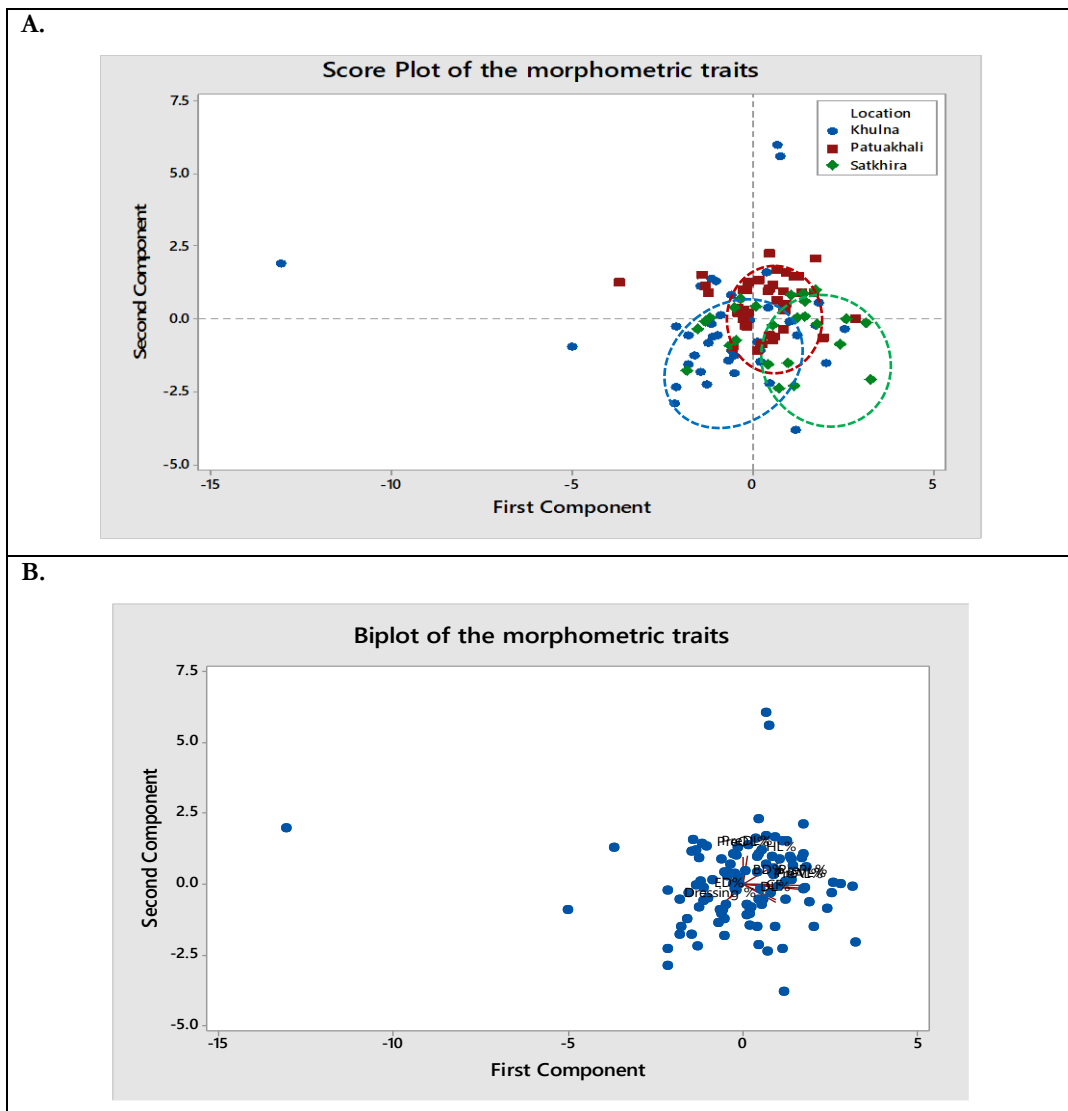
## Multivariate Analysis

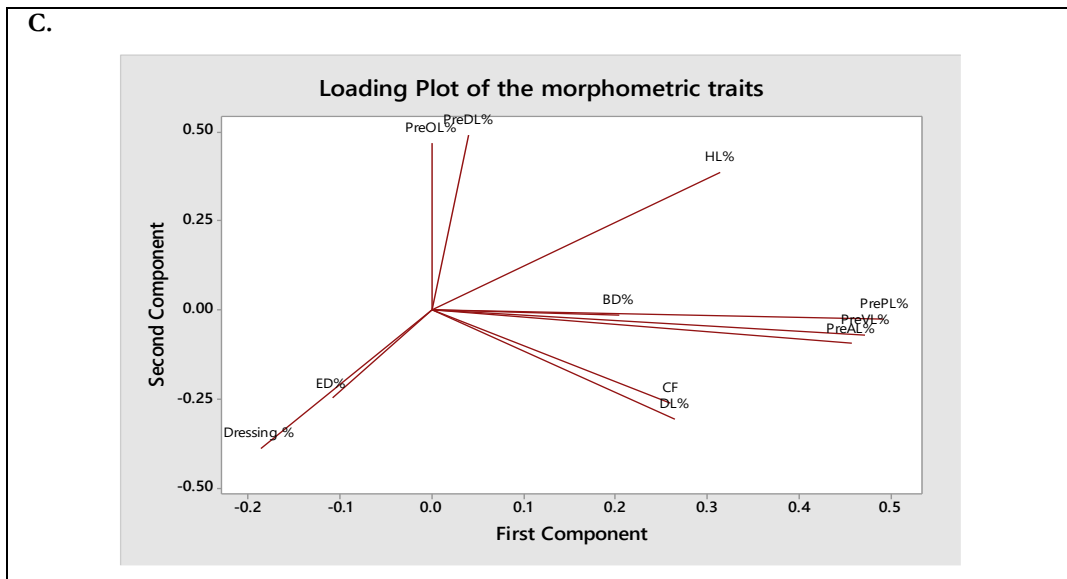
### Principal Component Analysis (PCA)

The multivariate analysis, utilizing eleven morphometric measurements, demonstrated that the stock of *P. basta* from Khulna exhibited greater diversity compared to the populations from Satkhira and Patuakhali. Conversely, the populations from Satkhira and Patuakhali displayed comparable patterns of morphometric variability (Figure 4 A-B). The loading plot of PCA highlights the most influential factors in the variability of morphometric measurements (Figure B). Only a few number of morphometric parameters exhibited substantial variation among the three Datina stocks (Table 2, and Figure 4 A-B). The variation in ecosystems and water properties may be attributed to local and geographical factors. Our study exposed that the population of *P. basta* from Khulna were comparatively more detached from that of Satkhira and Patuakhali. This phenomenon can be traced to the movement of individuals from the Bay of Bengal to coastal areas and vice versa.

Table 4. PCA-assisted factor loading of various morphometric tests among *Datina* populations obtained in three different locations in Bangladesh.

Variable	PC1	PC2	PC3	PC4
CF	0.260	0.261	0.232	0.084
Dressing %	0.188	0.389	0.149	0.316
HL%	0.313	0.387	0.325	0.107
BD%	0.204	0.013	0.425	0.603
ED%	0.110	0.249	0.329	0.548
DL%	0.264	0.307	0.459	0.223
PreDL%	0.039	0.491	0.220	0.337
PreOL%	0.000	0.468	0.220	0.220
PrePL%	0.493	0.026	0.255	0.043
PreVL%	0.472	0.070	0.292	0.071
PreAL%	0.457	0.095	0.269	0.002





## Discussion

Fish have a higher degree of morphological variation within and between populations than the other vertebrates, making them particularly vulnerable to environmentally driven morphological changes (Hossain & Saha, n.d.). Fish exhibit a remarkable degree of phenotypic plasticity, enabling them to swiftly adjust to environmental fluctuations by modifying their physiological and behavioral traits, hence leading to subsequent alterations in their morphology (Ljunggren et al., 1987). The current study identified notable morphological variations among three isolated stocks of the Satkhira, Khulna and Patuakhali of *P. basta*. Out of the eleven morphometric measurements, four exhibited statistically significant differences which include HL, ED, DL and Pre DL. Similar findings were observed in the stocks of Chinese three line grunt (*Parapristipoma trilineatum*), wherein significant morphological variations were identified in body depth, condition factor, caudal peduncle depth, and scales above the lateral line (Yokogawa, 2000). The observed phenotypic variances may be attributed to factors like as habitat conditions, food availability, feeding strategies, and distinct geographical locations. It was anticipated that there would be morphometric variations across the three populations due to their geographical isolation and potential divergence from distinct ancestral lineages. Therefore, it is plausible that significant environmental differences may be present among the three populations of *P. basta*. Fish exhibit a high degree of sensitivity to alterations in their surrounding environment. Fish have the ability to rapidly adapt by modifying their morphological characteristics as needed. The plasticity of morphological features in response to environmental factors, like variations in food quantity and temperature, is widely recognized (Shao et al., 2007). The final effect of these alterations is a change in their morphology (Ryman et al., 1987). Unbiased morphometric measures performed over a three-dimensional contour of a fish stock eliminate the need to determine the types of characters and the ideal quantity of characters for stock separation. Additionally, these measurements give information regarding the complete fish species (Turan et al., 2004).

In this experiment, the outcome established the disparity among the equities, and notable correlations were detected in the length and weight relationship among the three stocks of *P. basta*. All the stocks had negative allometric growth ( $b < 3$ ) and the highest and lowest value was found for Satkhira (2.76) and Khulna (2.07) stocks respectively. Almost same results were found for *Pomadasyus jubelini*, the species displayed negative allometric growth ( $b = 2.8177$ ), indicating that body length increased proportionally greater than body weight. The variations in the

length-weight relationship among the three stocks may be attributed to both environmental and genetic factors. Therefore, it may be inferred that the morphological variations across the three populations may be attributed to environmental factors, distinct habitats, and genetic variances.

## Conclusion

The examination of morphometric markers is a powerful tool that may be used to indicate phenotypic stocks. The current study revealed a distinct diversity among various stocks of *P. hasta* in Khulna, Satkhira, and Patuakhali. This study facilitated enhanced management of species subpopulations and guaranteed improved management of the fishing resources. A univariate analysis of eleven morphometrics were studied and found four significant difference including head length (HL %), eye diameter (ED % of HL), dorsal length (DL%) and pre dorsal length (PreDL%). Given the variations observed in the stocks, it is evident that there have been alterations in the environment or genetic diversity. The morphometric data variances revealed distinctions among three separate populations of the same species. Accurate and thorough data and research on the composition of stocks is crucial for achieving a sustainable approach to exploiting, selecting, and breeding species, subspecies, stocks, and races, as well as for restoring habitats and managing and conserving them. This analysis serves as an initial phase for a forthcoming investigation on the disparity of *Datina* across various equities. Additional study, particularly in the fields of genetics and the impact of environmental conditions, is necessary to preserve the gene pool and facilitate the large-scale development of the nutritionally significant species, *P. hasta*.

## Conflict of Interest

The authors declare no conflict of interest.

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