Article

Morphometry and meristic counts of Bombay duck, *Harpodon nehereus* (Hamilton, 1822) along Sunderban region of West Bengal, India

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Abstract

Fisheries sector have been gaining importance globally due to their role in national economy, foreign exchange earnings and employment generation besides providing nutritious food and cheap protein not only to the fisher folk but also to the rapidly growing population. Bombay duck fishery supported by single species, *Harpodon nehereus*, contributes about 4-5 % of the estimated average annual marine landings of India. With a peculiar discontinuous distribution fishery is utmost importance in two maritime states of India i.e. Gujarat and Maharashtra contributing 92% of the total landings and the remaining 8% landings were from West Bengal and Orissa coasts. *H. nehereus* forms a commercial fishery along Hooghly estuarine systems. The present study aims on the morphometric and meristic counts of *H. nehereus*. During the period of investigation, 373 fish samples with length range (145 to 302 mm) and weight range (28 to 212 gm) were examined. Highest significant correlation ($P<0.01$) was observed between reference length and other morphometric parameters of both sexes. Percentage range difference in male's morphometric characters like post orbital length (15.24) and snout length (15.04) are environmentally controlled and others like standard length (11.09), pre-dorsal length (12.18), height of pelvic fin (13.39) and height of pectoral fin (12.10) are intermediate controlled (genetic and environmental factors). But in case of females, none of the characters are controlled by environmental factors and parameters like pre-dorsal length (10.37) and post orbital length (12.37) are intermediate controlled, remaining parameters in both sexes are genetically controlled (hereditary). Meristic counts includes dorsal fin with 10-13 soft rays, pelvic fin with 9 soft rays, pectoral fin with 10-12 soft rays and anal fin with 13-15 soft rays.

Keywords Bombay duck; *Harpodon nehereus*; morphometry; meristic counts; Sunderban region.

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1 Introduction

As we are proceeding in this millennium, finfish and other aquatic products will be in acute short supply as domestic and International demand for both high and low valued species increasing due to raising populations, living standards and disposable incomes. Bombay duck, *Harpodon nehereus* is a key contributor in Indian marine fish landings ranging from 4-5% commonly along North-West and North-East coast (Fig. 1). Bombay duck production was 1, 15,296 tonnes in 2012, contributing nearly 3-4% of the total marine landings of India (CMFRI Annual Report, 2013). Though well relished and considered a delicacy in Western India, its culinary qualities have not been recognized in West Bengal. *H. nehereus* forms a lucrative fishery along Sunderban region of North-East coast of India. Bombay duck is a very soft and highly perishable due to high moisture content in its muscle. It is having good importance and relished by different sections of people as table fish and also valuable as laminated or dried from (Kumar et al., 2012a).

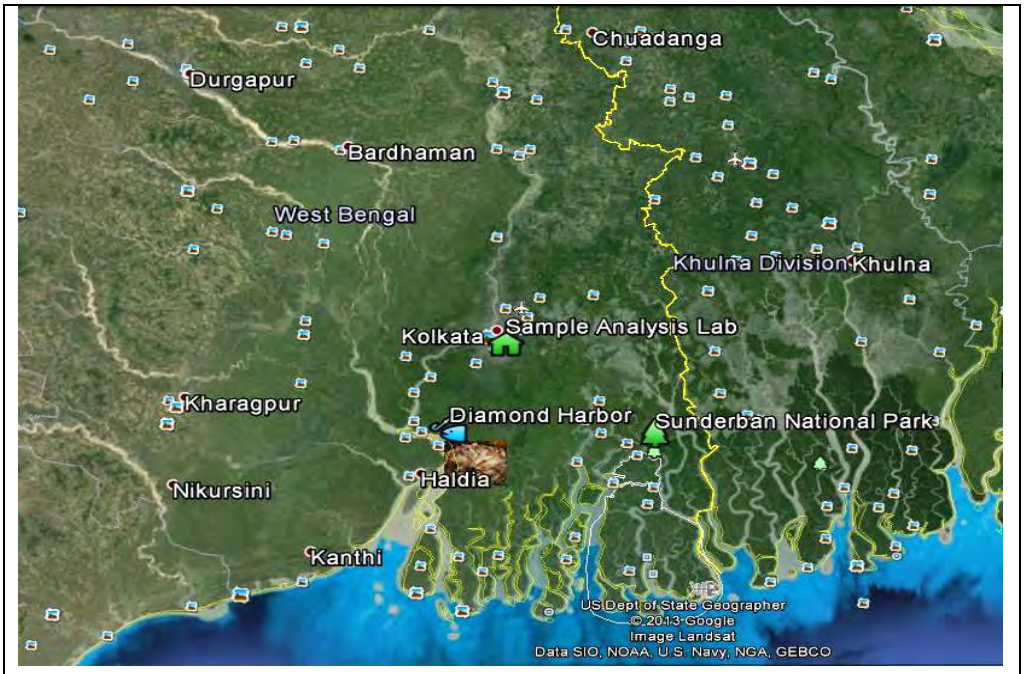


Fig. 1 Sampling site i.e. Diamond harbor (22^{o} 12’53.92’’ N & 88^{o} 12’22.74’’ E)

Fig. 2 A view of *Harpodon nehereus* during measuring of morphometric & meristic parameters.

The fishery, biology and population characteristics of the *H. nehereus* from the Saurashtra coast were extensively studies (Balli et al., 2011; Ghosh et al., 2009; Bapat, 1970; Khan, 1985, 1986a, 1986b, 1987 and 1989). Along Hooghly matlah estuarine region of North-East cast of India, food and feeding habits was studied (Pillay, 1951, 1953; Kumar et al., 2012b)and population dynamics was also estimated (Krishnayya, 1968). Studies on the morphometry and meristic counts are vital for the differentiation of taxonomic units. Studies on variation in morphological characters are critical in order to elucidate patterns observed in phenotypic and genotypic variations among coastal fish populations (Beheregaray and Levy, 2000). There were no studies related with morphometry and meristic counts of Bombay duck, *H. nehereus* stocks along North-East coast of India. The present work aims to full fill the research gap, upgrade the biological information of species and also study the factors which influence the stock dynamics.

2 Materials and Methods

2.1 Sampling site and size

The present work aims on some aspects of morphometric and meristic characters of *H. nehereus* for the period of one year (August, 2008 to July, 2009). The samples were collected from the Daimond harbour area (22^{o} 12'53.92'' N & 88^{o} 12'22.74'' E), Sagar Islands, Bokkhali, 8-Jetighat and local fish markets, which were mainly procured from different areas of Sundarban region of South 24 – Paraganas district (Fig. 1). Samples were captured mostly by stationary bag-net, locally called *Beenjal*, *Behundijal* which are non-selective multispecies small meshed nets.

Current experiment, total of 373 specimens of *H. nehereus* was sampled for the 12 months period (August, 2008 to July, 2009). More than 30 specimens were examined in the laboratory during each month. Samples were collected twice in a month and examined usually at fortnightly intervals. Total length and standard length were measured in market itself by using the millimeter scale (Fig. 2). Total weight was measured with a monopan balance for individual fish in grams.

2.2 Sampling method

For study of the morphometric and meristic characters the standard procedure (Lowe-McConnel, 1971) was followed. All linear measurements were rounded to the nearest mm. Among different morphometric characters, standard length, head length, pre-dorsal length, length base of dorsal fin, length base of anal fin, pectoral fin length, dorsal height, pectoral fin height, least depth of caudal peduncle, post orbital length, snout length, eye diameter were measured. Four meristic characters such as dorsal fin rays, pectoral fin rays, pelvic fin rays and anal fin rays were estimated. Total length and head length were used as reference length. Total length was measured from tip of the snout to the tip of the caudal fin. The diameter of the eye was measured in horizontal axis. The regression of various morphometric characters on standard length was obtained by least square method with the formula $Y = a + bX$, where, 'Y' is different morphometric measurements and 'X' is the reference length; 'a' is the constant value; 'b' is the exponent.

2.3 Statistical analysis

Correlation co-efficient between variables were calculated and regression equations were found out following standard methods. Isometric growth was tested by employing Fisher's t test. Significant difference among mean of different biological parameters were tested employing standard statistical tools like Student's't' test, and ANOVA (Snedecor and Cochran, 1967), etc.

3 Results and Discussion

Studies on the morphometric and meristic characters of fishes provide substantial information with regard to the exact nature of stocks and their geographical distributions. Morphometric differences are seen with in the

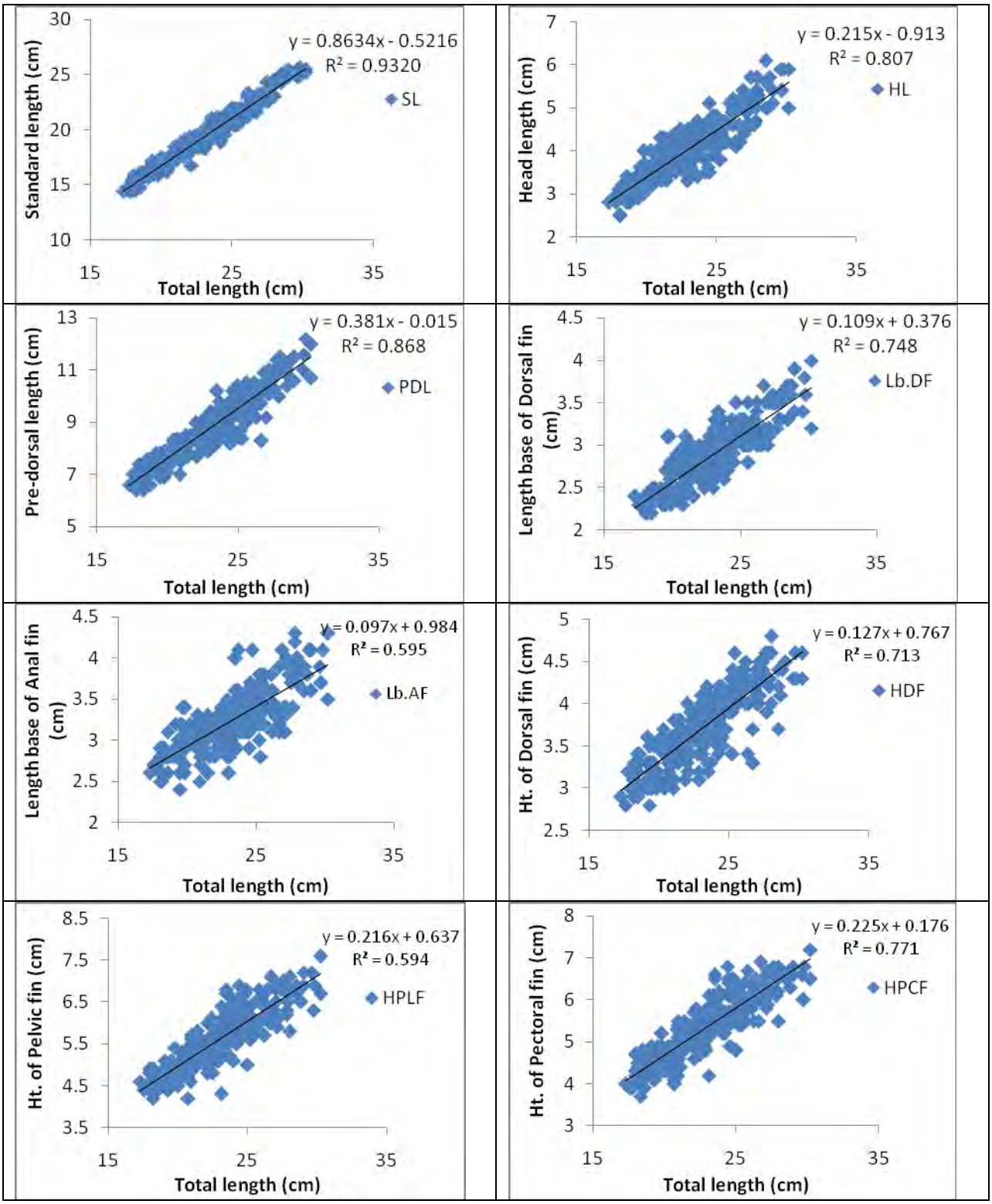
species and even within different sexes of species due to interactive genetic and environmental effects. The knowledge of exact genetically and environmental controlling characters are essential for the identification of species of a genus and the populations with in a species. Current study reveals that the biometry values *H. nehereus* showed a proportional positive increase with total length of fish. The mean, percentage range, percentage difference and standard error values of different morphological characters of *H. nehereus* are presented in Fig. 3, 4 and Table 1, 2.

The regression coefficient 'b' of different variable characters (Yi) on the total length (X) was highest in case of standard length. The 'b' values for standard length on total length are 0.5747 for male and 0.9067 for females respectively. Least depth of caudal peduncle (Y) on total length (X), showing lowest 'b' value i.e. 0.0281 for males and 0.0389 for females. While considering the post orbital length, snout length and eye diameter in terms of percentage of head length, post orbital length shows highest 'b' values, which were 0.7744 for males and 0.8015 for females.

The present study revealed the highest correlation of standard length on total length in case of both male (r =0.965) and female (r =0.961) and also observed the highest correlation of post orbital length on head length in case of both male (r =0.948) and female (r =0.957). The lowest value of the correlation for the male was noticed in the case of height of pelvic fin (r =0.771) on total length and snout length (r =0.642) on percentage of head length. In female lowest correlation value was observed in case of length base of anal fin (r =0.597) on total length and snout length (r =0.572) on percentage of head length. Morphometric analysis of the present study revealed that the correlation values were greater in male than female when calculating the percentage on total length and head length. Only the post orbital length giving the more value in case of female (r =0.957) when compare to male (r =0.948). All the regression coefficient 'b' values, correlation differentiation 'R^2' and coefficient of correlation 'r' values are represented in Table 3.

Nikolsky (1963) stated that the males and females often differ in the length and shapes of fins. Phenotypic plasticity during present investigation occurred due to the environmental factors because fishes were procured from different water bodies of Sunderban areas of Hooghly-Matlah estuarine system. Johal et al. (1994), classified three categories of morphometric characters based on percentage range difference i.e. genetically controlled characters (<10% range difference), intermediate (10.1% to 14-99% range difference) and environmentally controlled characters (>15% percentage difference). In current study, in male parameters like post orbital length (15.24%) and snout length (15.04%) are environmentally controlled and the other parameters like standard length (10.09%), pre-dorsal length (12.18%), height of pelvic fin (13.39%) and height of pectoral fin (12.10%) were controlled by intermediate factors, but in case of female pre-dorsal length (10.37%) and post orbital length (12.37%)were controlled by intermediate factors. Other than these parameters, all the remaining parameters in both male and female were controlled by genetic factors (hereditary).

Meristic characters of *H. nehereus* (Table 4) in the current study includes dorsal fin with 10-13 soft rays, pelvic fin with 9 soft rays, pectoral fin with 10-12 soft rays and the anal fin with 13-15 soft rays. The variations in the number of meristic characters have been documented by many workers (Abdurahiman et al., 2004), who opined that the environmental factors particularly that the temperature influences meristic characters in the process of their growth in fishes. The variations can also be exhibited by various stocks found in different geographical areas (Sarker et al., 2004).The present study agreed with the previous work (Bapatet al., 1970). The meristic counts in both of the sexes were found to be quite similar resembling the earlier work.


y = 0.8634x - 0.5216
R² = 0.9320
SL
Standard length (cm)
Total length (cm)
y = 0.215x - 0.913
R² = 0.807
HL
Head length (cm)
Total length (cm)
y = 0.381x - 0.015
R² = 0.868
PDL
Pre-dorsal length (cm)
Total length (cm)
y = 0.109x + 0.376
R² = 0.748
Lb.DF
Length base of Dorsal fin (cm)
Total length (cm)
y = 0.097x + 0.984
R² = 0.595
Lb.AF
Length base of Anal fin (cm)
Total length (cm)
y = 0.127x + 0.767
R² = 0.713
HDF
Ht. of Dorsal fin (cm)
Total length (cm)
y = 0.216x + 0.637
R² = 0.594
HPLF
Ht. of Pelvic fin (cm)
Total length (cm)
y = 0.225x + 0.176
R² = 0.771
HPCF
Ht. of Pectoral fin (cm)
Total length (cm)

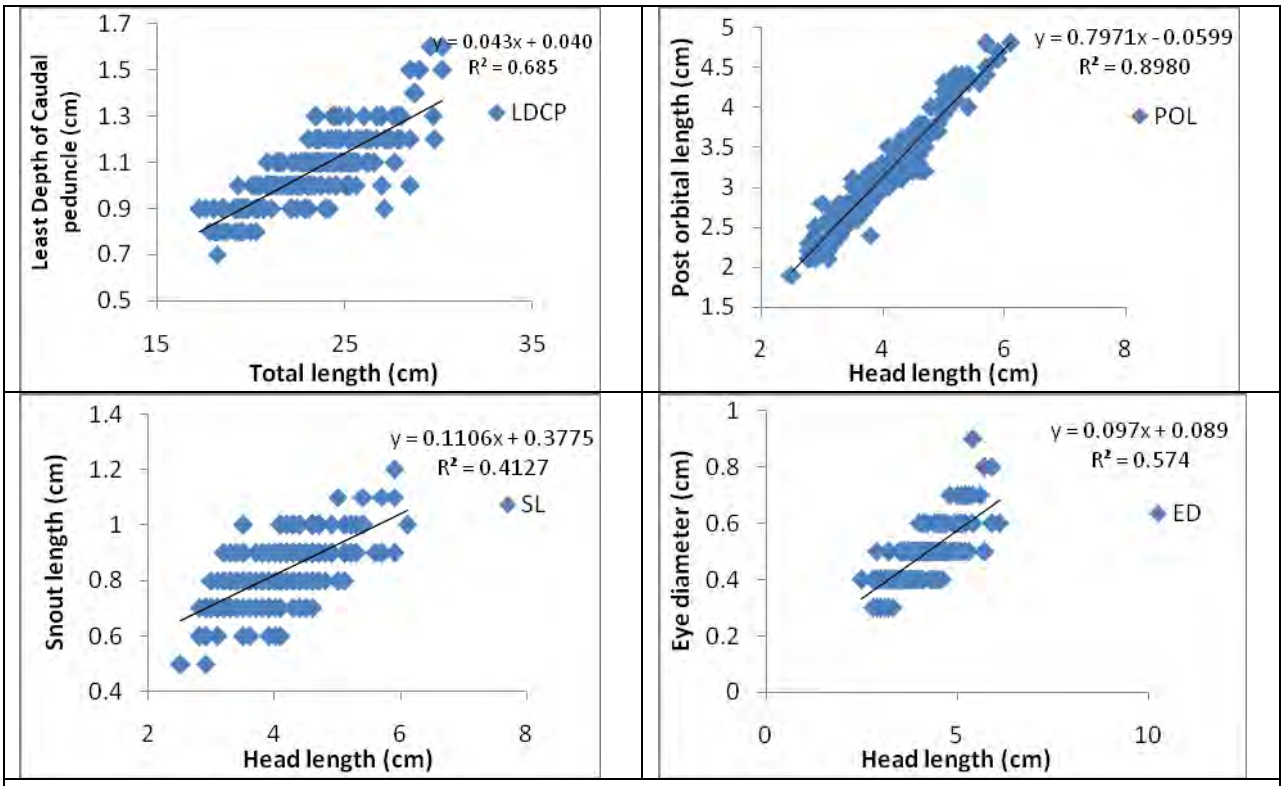
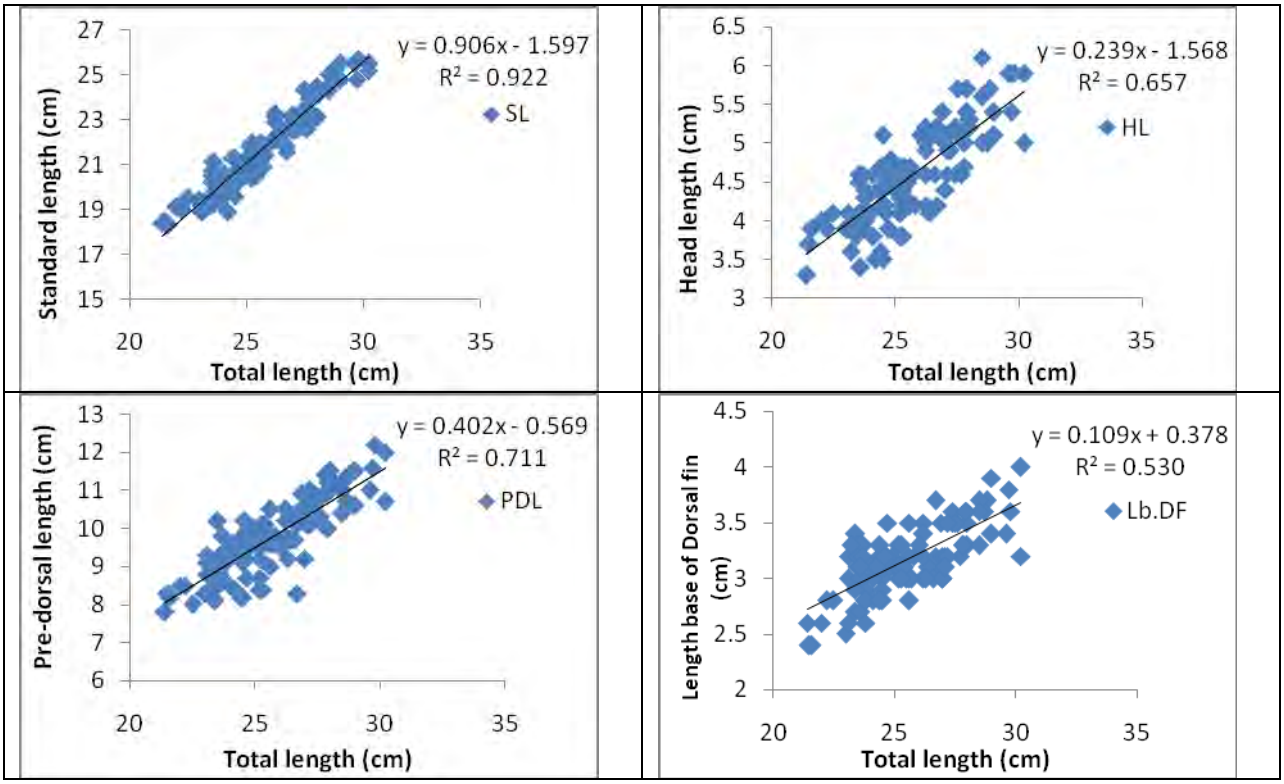


Fig. 3 Morphometric analysis of Bombayduck, *Harpodon nehereus* in Male.



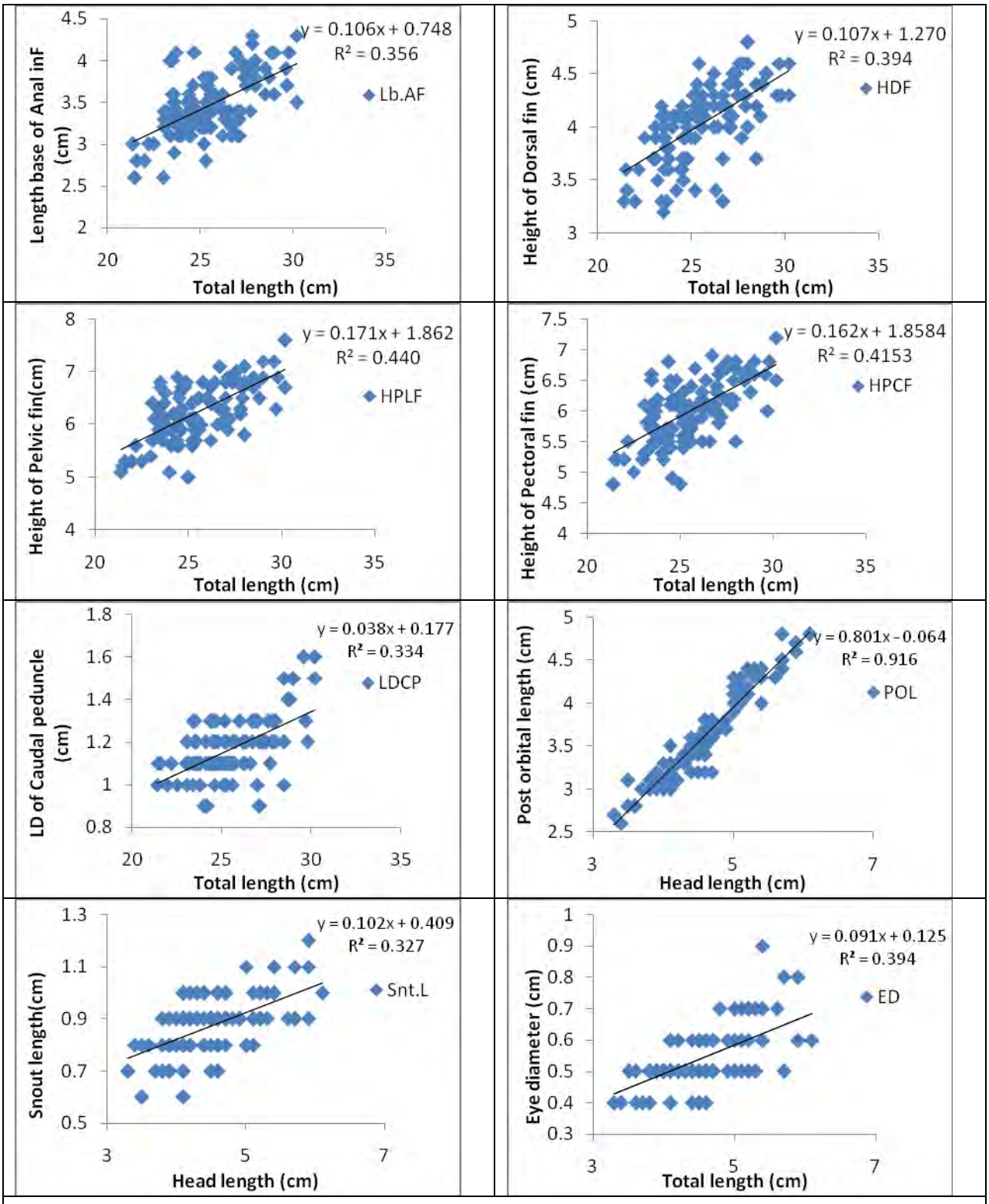


Fig. 4 Morphometric analysis of Bombayduck, *Harpodon nehereus* in Female.

Table 1 Morphometric analysis of *Harpodon nehereus* (Male).

Parameters	Mean	SE	Percentage Range (min-max)	Percentage range difference
% on Total length				
Standard length	83.685	0.146	78.07 - 89.16	11.09
Head length	17.390	0.083	20.94 - 13.6	7.34
Pre-dorsal length	37.796	0.128	30.26 - 42.44	12.18
Length base of Dorsal fin	12.766	0.057	10.96 - 16.06	5.13
Length base of Anal fin	14.250	0.065	11.83 - 17.25	5.42
Height of Dorsal fin	16.474	0.074	13.22 - 19.17	5.95
Height of Pelvic fin	25.510	0.125	18.61 – 32.00	13.39
Height of Pectoral fin	24.266	0.158	18.18 - 30.28	12.1
Least depth of Caudal fin	4.693	0.021	4.00 - 5.92	1.92
% on Head length				
Post-orbital length	79.575	0.210	73.33 - 88.57	15.24
Snout length	20.693	0.163	13.08 - 28.12	15.04
Eye diameter	12.487	0.090	10.00 - 18.52	8.52

Table 2 Morphometric analysis of *Harpodon nehereus* (Female).

Parameters	Mean	SE	Percentage Range (min-max)	Percentage range difference
% on Total length				
Standard length	84.304	0.191	80.00 - 89.41	9.41
Head length	17.751	0.129	14.28 - 20.82	6.54
Pre-dorsal length	37.986	0.176	31.09 - 41.46	10.37
Length base of Dorsal fin	12.436	0.079	10.60 - 14.53	3.93
Length base of Anal fin	13.634	0.105	11.06 - 17.09	6.03
Height of Dorsal fin	15.805	0.103	12.36 - 17.95	5.59
Height of Pelvic fin	24.447	0.153	20.00 - 28.51	8.51
Height of Pectoral fin	23.347	0.147	19.20 - 27.87	8.67
Least depth of Caudal fin	4.679	0.030	4.02 - 5.53	1.51
% on Head length				
Post-orbital length	79.453	0.229	75.51 - 87.88	12.37
Snout length	19.273	0.197	14.63 - 24.24	9.61
Eye diameter	12.227	0.112	9.75 - 15.15	5.4

Table 3 Regression equation of morphometric parameters of *Harpodon nehereus*.

Parameters	Male			Female		
	Regression equation	**R^2**	**r**	**Regression equation**	**R^2**	**r**
Standard length (Y) on Total length (X)	Y=5.6675+0.5747x	0.932	0.965	Y= -1.5976+0.9067x	0.922	0.961
Head length (Y) on Total length (X)	Y=0.7397+0.1406x	0.746	0.864	Y= -1.5685+0.2398x	0.657	0.811
Pre-dorsal length (Y) on Total length (X)	Y=2.2972+0.2728x	0.831	0.912	Y= -0.5698+0.4025x	0.711	0.844
Length base of Dorsal fin (Y) on Total length (X)	Y=1.0956+0.0765x	0.661	0.813	Y=0.3788+0.1093x	0.530	0.729
Length base of Anal fin (Y) on Total length (X)	Y=1.5891+0.068x	0.589	0.773	Y=0.7489+0.1066x	0.356	0.597
Height of Dorsal fin (Y) on Total length (X)	Y=1.5413+0.0927x	0.649	0.806	Y=1.2706+0.1079x	0.394	0.628
Height of Pelvic fin (Y) on Total length (X)	Y=2.4058+0.142x	0.594	0.771	Y=1.862+0.1714x	0.440	0.663
Height of Pectoral fin (Y) on Total length (X)	Y=1.9848+0.1501x	0.607	0.779	Y=1.8812+0.1611x	0.415	0.643
Least depth of Caudal fin (Y) on Total length (X)	Y=0.4004+0.0281x	0.628	0.793	Y=0.1777+0.0389x	0.334	0.578
Post-orbital length (Y) on Head length (X)	Y=0.0602+0.7744x	0.898	0.948	Y=0.064+0.8015x	0.916	0.957
Snout length (Y) on Head length (X)	Y=0.3194+0.1204x	0.412	0.642	Y= 0.4097+0.1028x	0.327	0.572
Eye diameter (Y) on Head length (X)	Y=0.149+0.0832x	0.436	0.661	Y=0.1258+0.0917x	0.394	0.628

Table 4 Meristic characters of *Harpodon nehereus*.

Parameter	**Meristic counts**
Number of Dorsal fin rays	11 – 13 soft rays
Number of Pectoral fin rays	10 – 12 soft rays
Number of Pelvic fin rays	9 soft rays
Number of Anal fin rays	13 – 15 soft rays

4 Conclusion

Current study, shows high significant correlation ($P<0.01$) between reference length and other morphometric features of the both sexes. On the percentage of range difference in case of male the morphometric characters like Post orbital length and Snout length are environmentally controlled and the other characters like standard length, pre-dorsal length, height of pelvic fin and height of pectoral fin are intermediate controlled. But, in case of female none of morphometric characters are controlled by environmental factors and the parameters like pre-dorsal length and post orbital length are intermediate controlled. However, the results clearly reveal that the biometry values of *H. nehereus* showed a proportional positive increase with total length of fish.

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