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ANALYSIS OF THE MORPHOMETRIC AND MERISTIC CHARACTERS OF THE FISH *NANDUS NANDUS* (HAMILTON) FROM THE NEW ALLUVIAL ZONE OF WEST BENGAL

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INTRODUCTION

Nandus nandus is also known as the Gangetic leaf fish. It inhabits fresh and brakish waters of India, Nepal, Pakistan, Bangladesh, Burma, Thailand and Malaysia. It occurs in ditches and inundated fields and is common in summer months when it is collected from dired-up beds of tanks, beels, bheries *etc.* and attains a length of 20 cm. It is a high-prized fish and had great demand in the market due to its taste and once used to fetch good price. But now it is rarely available in the market since its population has declined to an alarming extent in this region of West Bengal. This fish has been catergorised as critically endangered by Das and De, 2002.

Morphological variation in fish have been cited by various authors for different species of fishes but no report is available on the morphometric and meristic analysis of *Nandus nandus*. It is very much essential to record the morphological and meristic characters of different species of fishes for solving the race problem. With this aim the present work on the morphometric and meristic characters of *Nandus nandus* has been undertaken from the New Alluvial Zone of West Bengal.

MATERIALS AND METHODS

The materials of the present study pertains to the specimens of *Nandus nandus* collected from Mogra beel, situated at Birohi in the Nadia district of the New Alluvial Zone of West Bengal (Latitude 21.5–24.5° North and Longitude 86–89° East) during the period August 2001 to July 2003.

Collections were made mostly at fortnightly intervals. The study is based on the examination of 158 specimens of *Nandus nandus* in the size range of 20.0 mm to 160.0 mm.

Divider and measuring board, having graduation in millimeter have been used for various measurements. A total of 23 morphometric parameters have been undertaken according to Lowe Mc Connell (1971).

Biometric Index :

The number of times each character went into the reference length of the fish was considered as the Biometric Index (Tobor, 1974). Biometric study was done for 10 morphometric characters. For each character, a mean index for each 1 mm length group has been calculated to see whether it is constant or varying with the increase in total length and head length.

Meristic Characters :

Seven meristic characters were taken up for study following Lowe Mc Connell (1971).

All the measurements and counts were made on the left side of the fish. The specimens of *N. nandus* taken up for the present study were grouped into 1 mm length groups for convenience sake by pooling the data together, *viz.*, Group I : 20.0–30.0 mm, Group II : 30.0–40.0 mm and so on. In this way 14 groups of *N. nandus* could be made.

The regression method has been applied in various morphometric parameters with the formula :

$$Y = a + bX$$

where '*Y*' is the variable character such as total length, head length *etc.*, '*a*' is the constant value to be determined, '*b*' is the regression coefficient and '*X*' is the standard length or head length. The values of '*a*' and '*b*' were determined by the formula :

$$b = \frac{XY - N\,XY}{X - N\,X}, \qquad a = Y - bX$$

where, N = total number of length groups, X = mean of 'X' and Y = mean of 'Y'.

All linear measurements were made to the nearest 0.1 mm then converted to a percentage of the standard length and head length. Mean, range and '*b*' values were tabulated and compared.

RESULTS AND DISCUSSION

The morphometric characters showed a proportional positive increase with increase in length of the fish. The mean and range of these values have been presented in Table 1. Among the meristic characters the number of pectoral, ventral and caudal fin rays were constant. The number of dorsal, anal lateral line scales and lateral line transverse scales showed variations without any relation to length of the fish. The average values and the range of variations of the variable meristic characters are shown in Table 2.

The regression coefficient '*b*' (Table 3) of different variable characters (Y) on total length (X) indicates that the rate of growth in respect to total length is highest in case of anal length

Table 1. : Morphometric analysis of *Nandus nandus*.

Parameters	% Total length	
	Mean	**Range**
Head length	35.72	34.45 – 37.06
Predorsal length	37.71	35.73 – 40.80
Anal length	59.31	58.45 – 66.30
Girth length	68.24	65.78 – 74.64
Body depth	28.20	25.00 – 32.43
Head depth	22.54	20.68 – 23.63
Dorsal fin height	13.32	12.20 – 14.94
Dorsal fin base	40.85	38.79 – 42.99
Pectoral fin length	13.38	12.50 – 14.66
Pectoral fin base	05.17	04.82 – 05.74
Anal fin length	14.06	11.28 – 17.52
Anal fin base	11.52	10.74 – 13.21
Ventral fin length	14.60	13.53 – 16.66
Ventral fin base	04.75	03.95 – 06.32
Length of caudal peduncle	11.01	10.52 – 11.78
Least height of caudal peduncle	10.32	09.51 – 10.92
Parameters	**% Head length**	
	Mean	**Range**
Pre-orbital length	33.85	31.11 – 36.43
Inter-orbital length	18.86	17.66 – 21.70
Post-orbital length	47.41	40.31 – 50.77
Eye diameter	21.07	17.73 – 24.80
Upper jaw length	33.53	30.72 – 39.53
Lower jaw length	30.53	27.27 – 35.65
Gape width	31.97	28.57 – 35.32

Table 2. : Meristic characters of *Nandus nandus*.

Parameters	Mean	Range
No. of dorsal fin rays	13 / 12	12–14 / 11–13
No. of pectoral fin rays	–	16 (constant)
No. of ventral fin rays	–	1 / 5 (constant)
No. of anal fin rays	3 / 7	3 / 7–9
No. of caudal fin rays	–	15 (constant)
No. of lateral line scales	52.5	46–59
No. of lateral line transverse scales	5.75 / 13.5	5.5–6 / 7–20

Table 3. : Regression equation of morphometric parameters of *Nandus nandus*.

Parameters	Regression equation	Correlation coefficient 'r'
Predorsal length (Y) on total length (X)	Y = 2.5372 + 0.3417 X	0.9988
Head length (Y) on total length (X)	Y = 1.1074 + 0.3410 X	0.9986
Eye diameter (Y) on total length (X)	Y = 1.6951 + 0.0523 X	0.9942
Pre-orbital length (Y) on total length (X)	Y = 0.7635 + 0.1111 X	0.9824
Inter-orbital distance (Y) on total length (X)	Y = 0.2260 + 0.0635 X	0.9921
Post-orbital length (Y) on total length (X)	Y = –0.6348 + 0.1809 X	0.9971
Gape (Y) on total length (X)	Y = –0.1008 + 0.1141 X	0.9743
Length of upper jaw (Y) on total length (X)	Y = 1.9282 + 0.0918 X	0.9907
Length of lower jaw (Y) on total length (X)	Y = 1.6966 + 0.0839 X	0.9827
Head depth (Y) on total length (X)	Y = –0.6887 + 0.2348 X	0.9902
Body depth (Y) on total length (X)	Y = –3.9099 + 0.3354 X	0.9967
Anal length (Y) on total length (X)	Y = 0.2197 + 0.5961 X	0.9965
Girth (Y) on total length (X)	Y = –5.7919 + 0.7607 X	0.9945
Dorsal fin height (Y) on total length (X)	Y = 1.4615 + 0.9952 X	0.9952
Dorsal fin base (Y) on total length (X)	Y = –1.5252 + 0.4305 X	0.9970
Pectoral fin height (Y) on total length (X)	Y = 0.3946 + 0.1284 X	0.9902
Pectoral fin base (Y) on total length (X)	Y = 0.3740 + 0.0471 X	0.9924
Anal fin length (Y) on total length (X)	Y = 3.9829 + 0.0884 X	0.9333
Anal fin base (Y) on total length (X)	Y = –0.1691 + 0.1180 X	0.9912
Ventral in height (Y) on total length (X)	Y = 1.7138 + 0.1223 X	0.9948
Ventral fin base (Y) on total length (X)	Y = 0.9250 + 0.0361 X	0.9627
Length of caudal peduncle (Y) on total length (X)	Y = 0.3430 + 0.1056 X	0.9968
Least height of caudal peduncle (Y) on total length (X)	Y = –0.3300 + 0.1091 X	0.9957
Eye diameter (Y) on head length (X)	Y = 1.5371 + 0.1530 X	0.9926
Pre-orbital length (Y) on head length (X)	Y = 0.0617 + 0.1849 X	0.9867
Inter-orbital distance (Y) on head length (X)	Y = 0.3521 + 0.3274 X	0.9886
Post-orbital length (Y) on head length (X)	Y = –1.2000 + 0.5298 X	0.9969
Length of upper jaw (Y) on head length (X)	Y = 1.6399 + 0.2689 X	0.9913
Length of lower jaw (Y) on head length (X)	Y = 1.4159 + 0.2463 X	0.9846
Gape (Y) on head length (X)	Y = –0.5253 + 0.3363 X	0.9803

Table 4. : Mean Biometric indices of *Nandus nandus* at different length groups.

Mean parameters in total length	Length Groups						
	Gr–I	Gr–II	Gr–III	Gr–IV	Gr–V	Gr–VI	Gr–VII
TL / HL	2.69	2.74	2.76	2.87	2.81	2.80	2.90
TL / HD	4.83	4.70	4.44	4.37	4.23	4.28	4.23
TL / BD	4.00	3.82	3.67	3.55	3.44	3.37	3.08
TL / Girth	1.51	1.52	1.48	1.50	1.45	1.44	1.33
TL / Gape	8.28	9.50	9.69	8.93	7.96	8.36	8.82
HL / ED	4.03	4.09	4.66	4.71	5.06	5.63	5.49
HL / POL i	2.74	3.21	2.96	2.99	2.76	2.94	3.09
HL / IOL	4.60	5.45	5.60	5.27	5.66	5.56	5.11
HL / POL ii	2.48	2.16	2.06	2.05	2.11	1.96	1.98
HL / Gape	3.07	3.46	3.50	3.11	2.83	2.98	3.04

Note : TL = Total length, HL = Head length, HD = Head depth, BD = Body depth, ED = Eye diameter, POL i = Pre-orbital length, IOL = Inter-orbital length, POL ii = Post-orbital length

Table 5. : Morphometric analysis of males and females of *Nandus nandus*.

Parameters	% Total length (mean values)	
	Males	Females
Head length	35.39	35.22
Pre-dorsal length	37.38	37.38
Anal length	57.28	58.91
Girth length	67.22	67.25
Body depth	28.29	29.04
Head depth	23.30	23.34
Dorsal fin height	13.51	12.87
Dorsal fin base	40.10	42.22
Pectoral fin length	15.29	13.08
Pectoral fin base	05.34	03.35
Anal fin length	14.03	13.70
Anal fin base	11.94	11.12
Ventral fin length	15.29	14.00
Ventral fin base	04.71	05.04
Length of caudal peduncle	10.78	10.50
Least height of caudal peduncle	10.78	10.40

Table 5. : *(Cont'd.).*

Parameters	% Total length (mean values)	
	Males	Females
Pre-orbital length	34.91	33.04
Inter-orbital length	17.78	17.54
Post-orbital length	47.04	47.95
Eye diameter	21.00	21.93
Upper jaw length	32.84	34.50
Lower jaw length	29.58	33.04
Gape width	40.23	31.28

(b = 0.5961) and lowest in case of ventral fin base (b = 0.036). High values of correlation coefficient, 'r' (Table 3) obtained indicates a high degree of positive correlation between the different morphometric parameters with the reference length (total length).

Biometric Index of *N. nandus* indicates that the indices of head length and girth in relation to total length are almost constant (Fig. 1). According to Bayagbona (1963), a constant index in any of the biometric characters in relation to its reference length is isometric. Similar observations has been reported by Dasgupta (1989) in *Acrossocheilus hexagonolepis*. The indices of body depth and head depth increase in relation to total length (Fig. 1). The eye diameter becomes progressively smaller in relation to head length (Fig. 1) and showed negative allometry. A similar case has been reported by Tobor (1974) in *Lates niloticus* and Dasgupta (1989) in *Acrossocheilus hexagonolepis*. The growth of inter-orbital length and gape in relation to head length was found to be allometric and showed variations. Dasgupta (1990) also reported allometric growth of inter-orbital distance in relation to head length in *Tor tor*.

The use of 'r' statistic thus indicates that predorsal length is the most significantly correlated (r = 0.9988) body part of the fish in relation to total length. The least significantly correlated (r = 0.9333) body part is the anal fin length. The head length is the second highly correlated (r = 0.9986) body part. Nautiyal and Lal (1988) showed predorsal length as the most significantly correlated variable in the Garhwal Himalayan Mahseer while Johal *et al.*, (1994) and Bhatt (1997) found the standard length as the most correlated body part in *Tor putitora* from Gobind sagar reservoir and in the river Ganga between Rishikesh and Hardwar.

In the present case of study of the fish, high degree of positive correlation was also found among the different head parts with the head length as indicated by high values of correlation coefficient 'r' (Table 3). The post orbital length is the most significantly correlated (r = 0.9969) head part of the fish in relation to head length, and gape width the least correlated (r = 0.9803) variable. Bhatt (1997) reported the eye diameter to be the least correlated variable in *Tor putitora* from the river Ganga between Rishikesh and Haridwar.

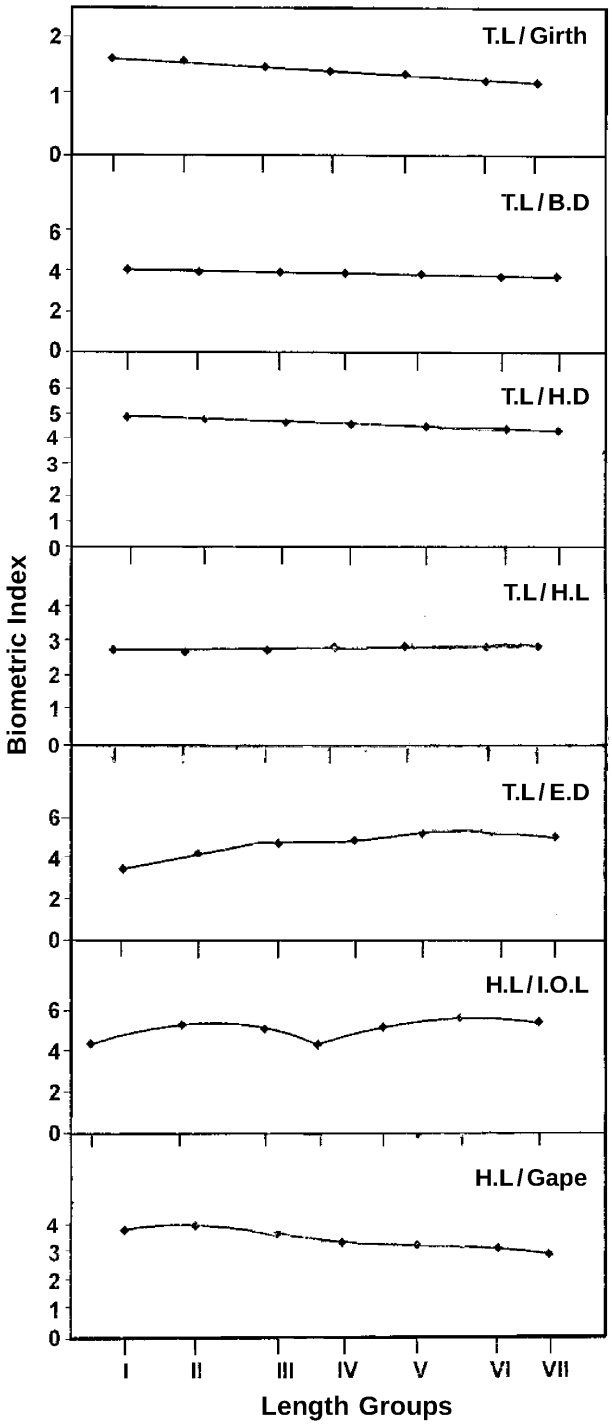

Fig. 1. : Biometric indices of *Nandus nandus* at different length groups

In the fish-sample lot of *N. nandus* under study, considerable difference in the morphometric characters has been observed between males and females (Table 5). The males were found to have greater height of dorsal, pectoral, anal, ventral fins and greater length of caudal peduncle than those of the females. On the other hand the females had greater eye diameter, upper and lower jaw length, body depth and head depth. Similar cases have been reported by Dasgupta (1989 and 1990) in *A. hexagonolepis* and *Tor tor*. Nikolsky (1963) has stated that males and females often differ in the length and shape of the fins. According to him, in the males of many cyprinoids, both the paired and the unpaired fins are slightly larger than those of the females, as has been observed in the present study too. He cited examples of some species where males were found to differ in length and shape of fins. For example, in the males of certain Lake Baikal sculpins, *Cotio comephorus* spp., the thoracic fins were found to be significantly larger. He further stated that in *Xiphophorus* (Fam. Poeciliidae) there is a long outgrowth of the caudal fin whereas in the males of many pleuronectes of the family Bothidae, the rays of the dorsal fin are elongated, and so on. In majority of cases the difference in the structure of the fins between males and females is connected with the pecularities of reproduction. As for example, the dorsal fin of the grayling, *Thymallus*, which is larger in the male than in the female and increases still further towards the time of spawning, creates a turbulance close to the spawning fish during the spawning process, and delays the dispersal of the sperm by fast currents (Brown, 1938). The larger size of the pelvic fins of the male *Tinch* facilitates a more successful fertilization of the eggs and their attachment to plant stalks (Nikolsky, 1963). Hence such a difference in the morphometric characters of males and females may be represented as sexually dimorphic characters in *Nandus nandus* also.

According to Gould (1966), ratios between morphological characters of fish will not necessarily be constant for the organisms of the same species due to variation resulting from differences in sex, race and nutrition and/or other environmental factors.

Various authors have shown that morphometric characters of fish can vary under the influence of the environment and, in particular, the thermal factor during the period of incubation and the begining of larval life (Schmidt, 1921; Barlow, 1961). According to Hubbs (1922) and Tanning (1944) variation occurs in the number of rays in the unpaired fins in several species which is also related to an adaptation to movement of water of various density.

Variation in the body proportions in the same species, according to hydrographic conditions, have also been reported by various authors (Hubbs, 1922; Barlow, 1961). They associated these variations with the effect of the duration of periods of growth and of the relating differentiations which determine the number of vertebrae and of segments.

Many authors (Schmidt, 1921; Vladykov, 1934; Tanning, 1944; Lindsay, 1954; Barlow, 1961) have reported that meristic characters, exhibit plasticity under the influence of environmental factors.

Zupanovic (1968) stated, "as it is essential to distinguish between different species, so it is essential to distinguish between the self perpetuating sub-groups within the species. These sub-groups may be equivalent to what taxonomists calls sub-species, but they may be generally of lesser rank. In the fishery literature, they are often called races or populations". This study will be helpful in comparing the morphological and meristic data with populations of *Nandus nandus* from geographical regions.

SUMMARY

A study on the morphometric and meristic characters of *Nandus nandus* was conducted from the New Alluvial Zone of West Bengal. A total of 23 morphometric characters and a total of 7 meristic characters were analysed. The morphometric characters of the species showed proportional positive growth with the increasing length of the fish and a high degree of positive correlation with the reference length. Some of the meristic characters were found to be constant while some varied. The biometric index indicated that the growth of head length, head depth, body depth and girth in relation to total length is isometric while the growth of inter-orbital length and gape in relation to head length is allometric. The eye diameter becomes progressively smaller in relation to head length. Some difference has been observed between male and female of the species.

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