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Morphometric and meristic characters of *Otolithoides pama* (Hamilton, 1822) occurring in Hooghly-Matlah estuarine system of West Bengal, India

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ABSTRACT

The present study analysed the morphometric and meristic characters of *Otolithoides pama* (Hamilton, 1822) collected from the Hooghly-Matlah estuarine system of West Bengal, India. A total of 618 specimens (298 males and 320 females) were collected during the period of 18 months from November 2016 to April 2018 with length ranging from 100-384 mm and weight 7.29-470.71 g, respectively. The analysis of 14 morphometric characters revealed that standard length has the fastest growth rate when compared to total length, while eye diameter has the lowest growth rate compared with head length. A high degree of significant positive correlation with the 'r' values ranging from 0.978 to 0.997 was observed among different morphometric characters of *O. pama*. Among nine of the meristic counts, the coefficient of variation was found to be highest in anal fin rays (6.31%) and minimum in dorsal fin rays (1.12%). Based on the meristic counts, the fin formula of *O. pama* from the present study can be described as B. $\overline{7}$, D. 9-10/1/₄₄₋₄₅, P. \overline{i} /₁₆₋₁₇, V. $\overline{1}$ /₅, A. $\overline{2}$ /₇₋₈, C. $\overline{19-21}$, L. 48-52. The number of gill rakers on the first left gill arch ranged from 19-21.

Keywords: Hooghly-Matlah Estuary, Meristic counts, Morphometric characters, *Otolithoides pama*, West Bengal

Introduction

Morphological characters, such as body shape and meristic counts, have long been used to delineate fish stocks (Heincke, 1898; Teugels, 1982; Villaluz and Maccrimmon, 1988; Haddon and Willis, 1995; Silva, 2003; Turan, 2004). It includes the analysis of body shape or the shape of particular morphological features of various dimensions or parts and provides adequate information for identifying marine fish stocks and describing their spatial distributions (Ihssen *et al.*, 1981). Morphometric data are continuous (*e.g.* head length and body length) while meristic characters are enumerable morphological features (*e.g.* fin rays, gill rakers and scales in rows) of fishes. An important aspect of the meristic analysis is that data obtained are discrete. Data on morphometric measurements can identify differences between fish populations and used to describe the shape of fish. They are measurable features that are helpful to separate closely related genera, species and even populations within (Cadriin, 2000).

Statistical analysis of morphometric characters gives a better idea of relationships within species and also to compare with the same species in different geographical areas. The taxonomic classification of organisms and understanding the diversity of biological life, were

historically based on descriptions of morphological forms (Dean *et al.*, 2003). Morphological characters have been commonly used in fisheries biology to measure discreteness and relationships among various taxonomic categories (Quilang *et al.*, 2007).

Several works on morphometric and meristic parameters have been done on sciaenids in the Indian context. Some of the studies are by Rao (1963) on *Pseudosciaena* (= *Protonibea*) *diacanthus*, Jayaprakash (1974) on *Johnnieops sina* (= *Johnius dussumieri*). Basu (1975) on *Otolithes argenteus*, Gandhi (1982) on *Pennahia anea* from Porto Novo waters, Jayasankar (1989) on *Nibea maculata* from Mandapam waters, Manojkumar and Acharya (1990) on *Otolithoides biauritus* from Bombay waters, Chakraborty (1992) on *Otolithes cuvieri*, *Johnius macrorhynchus* and *Johnius vogleri* (= *borneensis*) from Bombay waters, Bhuyan (2003) on *Johnius carutta*, *Pennahia macrophthalmus* (= *anea*) and *Otolithes ruber* from Odisha coast, Manojkumar (2011) on *J. sina* and *O. cuvieri* along the Malabar coast and off Veraval, Kumar (2012) on *J. sina* and Sandhya (2015) on *O. cuvieri*.

Sciaenid fishes are represented by 49 species, belonging to 22 genera in the Indian Ocean of which 40 species belonging to 20 genera, inhabit the seas of India (Talwar, 1995). Two large-size species *viz.*, *Macrospinosa*

cuja (Hamilton-Buchanan) and *Daysciaena albida* (Cuvier) contribute to significant fisheries in Indian estuarine waters, while two fairly small species, *Pama* (= *Otolithoides*) *pama* (Hamilton-Buchanan) and *Johnius gangeticus* form a fishery in Ganga River (Talwar, 1995; Bhakta *et al.*, 2020). *Otolithoides pama* (Hamilton, 1822) is the third most abundant fish species after hilsa (*Tenualosa ilisha*) and Bombayduck (*Harpodon nehereus*) from Hooghly-Matlah estuarine system, West Bengal (Kumar *et al.*, 2012). *O. pama* earlier known as *P. pama* (*Sciaenoides pama*) locally called as ‘Bhola’ or ‘Poa Bhola’ or ‘Coi-bola’ or ‘Jat Bhola’ forms an important fishery in Hooghly-Matlah estuarine system (Bhakta *et al.*, 2009a; b). No reports on details of morphometric relationships of *O. pama* from the Hooghly-Matlah estuarine system is available till now. So, an attempt was made to estimate the morphometric relationship of *O. pama* occurring in the Hooghly-Matlah estuarine system of West Bengal, India.

Materials and methods

The present study is based on 618 specimens of *O. pama* in the length range of 107-384 mm (195.65 ± 38.35 mm) and weight range from 10.20 to 470.71 g (65.57 ± 47.55 g) collected from three selected landing sites such as Godakhali, Diamond Harbour and Frasergang of Hooghly-Matlah estuarine system of West Bengal during November 2016 to April 2018. Fresh specimens were utilised for the study of morphometric and meristic characters. The total

length of all individuals was measured from the tip of the snout to the tail to the nearest 0.1 mm and weight was taken using an electronic balance (to an accuracy of 0.01 g). A total of fourteen morphometric and nine meristic characters were studied (Fig. 1) following the standard procedure adopted by Lowe-McConnel (1971), Dwivedi and Menezes (1974); Grant and Spain (1977). For the analysis of morphometric characters, scatter diagrams were plotted and then the linear regression equation was fitted using the least square method described by Laevestu (1965) and Snedecor and Cochran (1967).

Meristic characters included the number of spines and rays on pectoral, dorsal, anal, pelvic and caudal fins. The first gill arch was taken from the left operculum for the count of gill rakers. The characters were counted using a magnifying lens and needle to separate the rays. Relationships between various body measurements to the total length and head length have been calculated. Range, mean, standard deviations, standard errors and coefficient of variation were also calculated for characters under study.

Results and discussion

The morphometric study was carried out on 618 specimens of *O. pama* with size ranging from 100 to 384 mm total length. The calculated descriptive statistics like the range, mean, standard deviation, standard error and coefficient of variation of various morphometric

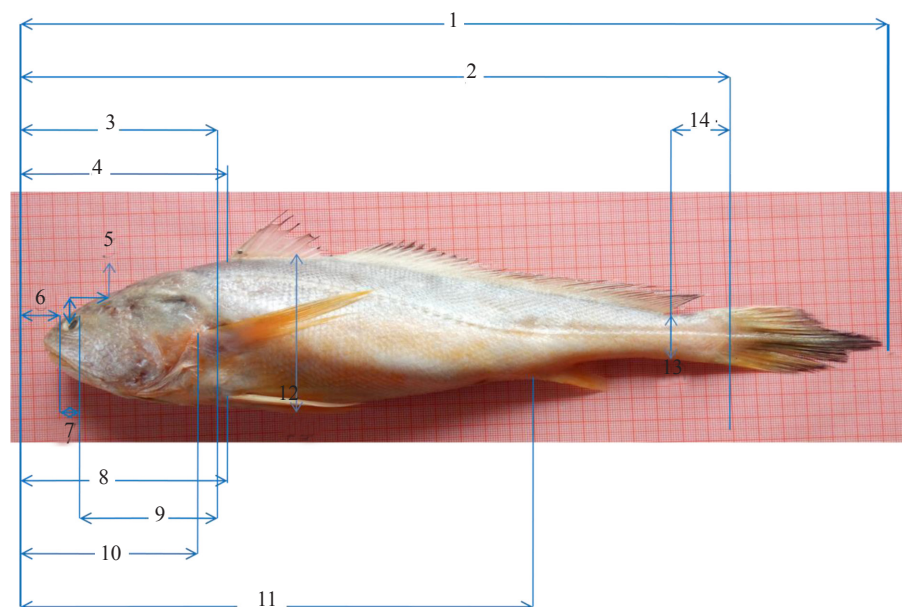


Fig. 1. Morphometric characters of *O. pama*. 1. Total length (TL), 2. Standard length (SL), 3. Head length (HL), 4. Pre-dorsal length (PDL), 5. Inter-orbital length (IOL), 6. Snout length (SNL), 7. Eye diameter (ED), 8. Pre-pelvic length (PPL), 9. Post-orbital length (POL), 10. Pre-pectoral length (PPeL), 11. Pre-anal length (PAL), 12. Body depth (BD), 13. Caudal depth (CD), 14. Caudal peduncle length (CPL)

characters are presented in Table 1. The results indicated maximum coefficient of variations in caudal depth (22.63%) followed by post-orbital length (22.30%), pre-dorsal length (20.60%) and pre-pectoral length (19.96%).

The values of 'b' indicated the highest growth rate for standard length (0.834), followed by pre-anal length (0.627), pre-dorsal length (0.247) and lowest for caudal length (0.080) when compared with total length (Table 2). Similarly, when morphometric characters were compared against head length, the highest growth rate (b) was observed for pre-orbital length (0.808), followed by inter-orbital length (0.284) and the minimum with eye diameter (0.128). The growth rate (b) observed was 0.356 when caudal depth was compared with body depth.

The coefficient of correlation between different characters ranged from 0.978 to 0.997 (Table 2). Standard length showed a maximum degree of correlation (0.997) with total length, while caudal length showed the minimum

(0.978). Correlation coefficient of head length with other morphometric characters was found minimum with eye diameter (0.939) and maximum with caudal depth as well as inter-orbital length (0.973).

A high degree of significant positive correlation among different morphometric characters of *O. pama* was observed in the present study. The regression coefficient 'b' indicated a high degree of homogeneity within the population. Among various characters studied, total length, standard length and pre-anal length showed very high degree of positive correlation. But, body depth in relation to per unit change of total length and caudal depth in relation to per unit change in body depth showed slowest growth rate of the species compared to other morphometric characters (Fig. 2a-j).

According to Basu (1975), there was a high degree of correlation between total length and standard length of *Otolithes argentius* from Mumbai waters. A similar kind

Table 1. Statistical estimates of various morphometric characters of *O. pama*

Morphometric characters	Range (mm)		Mean (mm)	Standard Deviation	Standard Error	Coefficient of Variation (%)
	Min.	Max.				
Total length	100.00	384.00	192.65	33.61	1.35	17.45
Standard length	72.00	312.00	150.75	28.10	1.13	18.64
Pre-anal length	58.00	237.00	109.12	21.19	0.85	19.42
Pre-dorsal length	19.00	85.00	40.72	0.21	0.34	20.60
Pre-pelvic length	22.00	90.00	41.83	8.12	0.33	19.42
Pre-pectoral length	17.00	81.00	39.70	7.92	0.32	19.96
Head length	21.00	85.00	41.57	7.81	0.31	18.78
Body depth	17.00	90.00	39.04	7.56	0.30	19.37
Caudal depth	5.00	29.00	12.07	2.73	0.11	22.63
Caudal length	21.00	77.00	43.13	7.31	0.29	16.95
Snout length	4.50	24.00	10.06	1.97	0.08	19.58
Post-orbital length	7.00	62.00	28.94	6.45	0.26	22.30
Inter-orbital length	7.50	27.00	13.78	2.25	0.09	16.31
Eye diameter	3.00	11.00	6.43	1.04	0.04	16.15

Table 2. Relationship between different morphometric characters of *O. pama*

Morphometric characters	Y = a + bx	'r' value
Standard length and Total length	Y = -10.07 + 0.834	0.997
Pre-anal length and Total length	Y = -11.81 + 0.627	0.990
Pre-dorsal length and Total length	Y = -6.967 + 0.247	0.983
Pre-pelvic length and Total length	Y = -4.450 + 0.240	0.987
Pre-pectoral length and Total length	Y = -5.389 + 0.234	0.986
Head length and Total length	Y = -2.910 + 0.230	0.988
Body depth and Total length	Y = -4.004 + 0.223	0.988
Caudal length and Total length	Y = 1.525 + 0.216	0.986
Caudal depth and Total length	Y = -3.415 + 0.080	0.978
Post-orbital length and Head length	Y = -4.649 + 0.808	0.962
Inter-orbital length and Head length	Y = 1.977 + 0.284	0.973
Snout length and Head length	Y = -0.263 + 0.248	0.968
Eye diameter and Head length	Y = 1.075 + 0.128	0.939
Caudal depth and Body depth	Y = -1.842 + 0.356	0.973

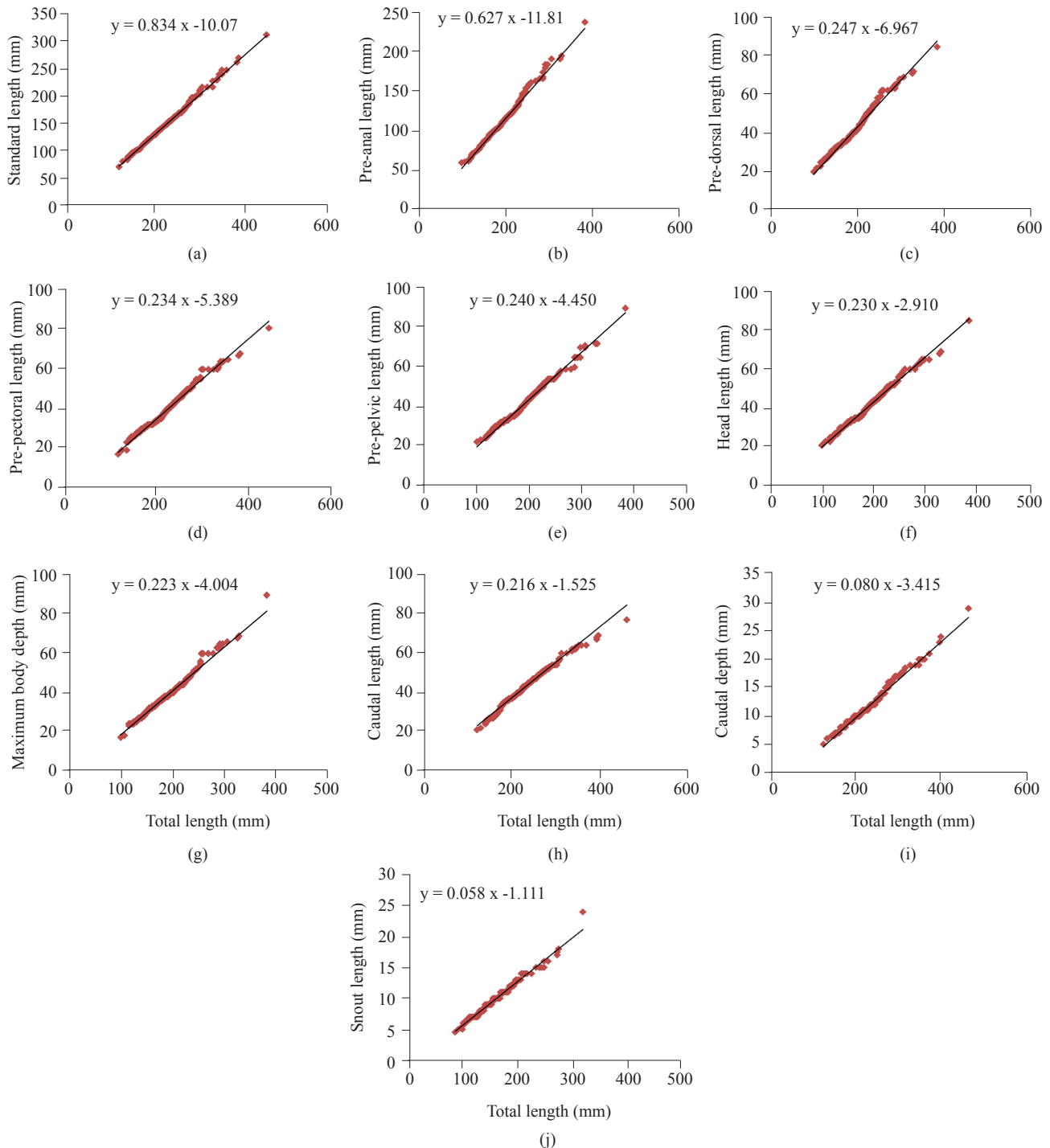


Fig. 2. Scatter diagram showing different morphometric characters against the total length of *O. pama*

of result was also reported by Chakraborty (1992) in his studies and mentioned a high degree of correlation between standard length and the total length of *Otolithes cuvieri* from Mumbai waters. Body parts of the respective species grow with increase in total length and have been reported by Dobriyal *et al.* (2006). Growth rates in other parts like

pre-pelvic length, head length, pre-pectoral length, caudal length and pre-dorsal length in relation to per unit change in total length, as well as post-orbital length, snout length and inter-orbital length in relation to per unit change in head length, were faster than other compared characters for the species (Fig. 3a-d).

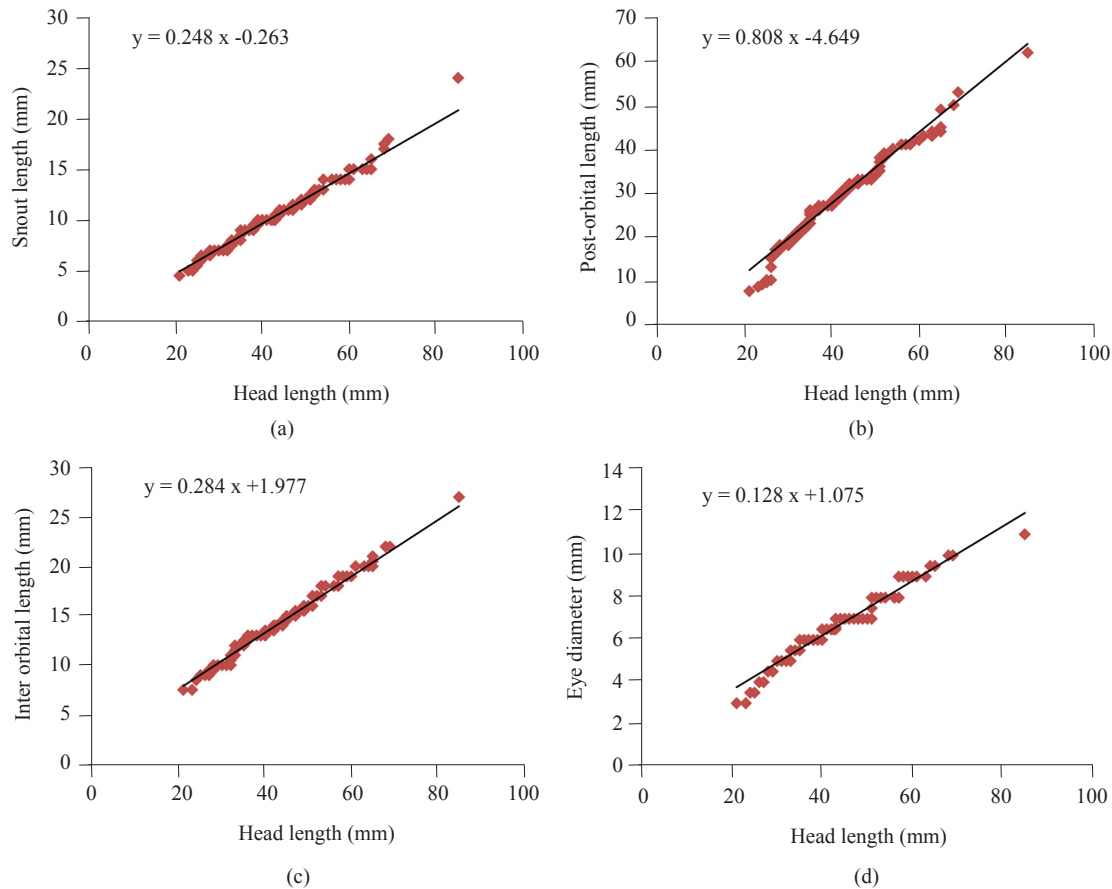


Fig. 3. Scatter diagram showing different morphometric characters against the head length of *O. pama*

Several workers have reported similar kinds of growth pattern in their respective studies in Indian waters like Gandhi (1982) in *Pennahia anea*, Pillai (1983) in *O. ruber*; Manojkumar and Acharya (1990) in *O. biauritus*, Chakraborty (1992) in *J. macrorhynchus* and *J. vogleri*, Bhuyan (2003) in *O. ruber*, *J. carutta* and *Pennahia macrophthalmus* and Telvekar (2006) in *J. sina*.

Gandhi (1982) reported that total length showed the fastest growth rate followed by pre-anal length and eye diameter has the lowest growth rate in *P. anea* from Port Novo waters. According to Pillai (1983), out of 17 morphometric characters studied, the growth rate of pre-anal fin length was found to be the fastest in *O. ruber* from the Port Novo coast. A similar kind of growth rate was also reported by Chakraborty (1988) on *Otolithes cuvieri*, *Johnnieops vogleri* from Mumbai waters and *J. macrorhynchus* and Raje (1988) on *Atrobuca nibe* off Veraval coast of India. Manojkumar and Acharya (1990) mentioned that anal length showed maximum ($r=0.996$) and pectoral length minimum ($r=0.908$) correlation when compared to total length while orbital width and snout length showed highest and lowest ($r=0.998$ and

0.898) correlation respectively compared to head length in *Otolithoides biauritus* collected from Bombay waters. A relatively poor correlation of total length against body depth and head length for *J. macrorhynchus* was observed by Chakraborty (1992) from Bombay waters. Bhuyan (2003) reported that pre-anal length has the fastest growth rate in relation to total length while eye diameter has the lowest growth rate in relation to head length in *O. ruber* off Paradip coast.

Telvekar (2006) also reported that standard length followed by pre-anal length has the fastest growth rate in relation to total length while eye diameter has the lowest growth rate in relation to the head length of *Otolithes cuvieri* from Mumbai waters. Kumar (2012) mentioned that in *J. sina* collected from Ratnagiri waters, standard length and pre-anal length showed a very high degree of positive correlation among the various characters while caudal depth and body depth showed a low degree of positive correlation. Sandhya *et al.* (2015) found that standard length and pre-anal length showed the highest growth rate against total length and caudal length growth rate was very slow in *O. cuvieri* from Ratnagiri waters.

The pre-orbital length indicated the highest growth rate and eye diameter the slowest compared with head length.

The range, mean, mode, median, standard deviation, standard error as well as coefficient of variance for various meristic characters were estimated and provided in Table 3. It has been observed that the first part of dorsal fin has 9 to 10 spines followed by a deep notch and the second part of the fin has 1 spine and 44 to 45 fin rays. Ventral fin has 1 spine followed by 5 rays and anal fin 2 spines and 7 fin rays. Pectoral fin has 1 unbranched fin ray and branched fin rays ranged from 16 to 17; caudal fin rays from 19-21, lateral line scales 48 to 52 and branchiostegal fin rays were 7 and did not show any variation from individual to individual. The coefficient of variation was found to be highest in anal fin rays (6.31%) and minimum in dorsal fin rays (1.12%).

Meristic characters of *O. pama* are presented in Table 3 and were compared with the available literature from earlier workers (Jayaprakash, 1974; FAO, 1983; Talwar and Kacker, 1984) and it is in agreement with most of such works (Table 4). The correlation of different morphometric values of *O. pama* is presented in Table 5.

In the present study, the number of spines and branched dorsal fin rays *O. pama* varied from IX-X+I and 44 to 45 respectively. Bhuiyan (1964) reported X+I spine and 40-43 fin rays, Shafi and Quddus (1982) reported X+I spine and 40-43 fin rays, FAO (1974) reported X+I spine

and 40-45 fin rays, Mohan (1991) observed 40-45 fin rays, Talwar (1995) noticed IX-X+I spine and 40-45 rays, Talwar and Jhingran (2001) reported IX-X+I spine and 40-45 rays and Rahman (2005) reported X+I spine and 40-43 fin rays. The number of pectoral fin rays observed in the present study was 16, which was found similar to the works of Talwar (1995) and Talwar and Jhingran (2001) who found 16 number of fin rays in their respective studies. But Bhuiyan (1964) and Shafi and Quddus (1982) reported 17 numbers of pectoral fin rays. A total five pelvic fin rays were recorded in the present study which was also similar to the works of Bhuiyan (1964), Shafi and Quddus (1982), Talwar (1995), Talwar and Jhingran (1991) and Rahman (2005). The number of anal fin rays recorded were 7 which is similar to the finding of Bhuiyan (1964), Fischer and Whitehead (1974), Shafi and Quddus (1982), Talwar (1995), Talwar and Jhingran (1991) and Rahman (2005). The caudal fin numbers recorded were 18-20. The number of gill rakers in the lower limb of first-gill arch was found to be 19 to 21, while FAO (1974) reported 11-14 lower gill rakers and Mohan (1991) observed 16-21 and Talwar (1995) recorded 16-22 gill rakers in their respective studies. The total number of lateral line scales observed was of 48-52, but Talwar (1995) reported only 44-48 numbers of lateral line scales. In the present study, maximum number of meristic characters was found similar to the earlier studies with little difference in the number of gill rakers and the total number of lateral line

Table 3. Statistical estimates of various meristic characters of *O. pama*

Meristic character	Range (mm)		Mean	Mode	Median	Standard Error	Standard Deviation	Coefficient of Variation (%)
	Min	Max						
Dorsal fin spine	9	10	9.83	10	10	0.02	0.37	3.81
Dorsal fin rays	44	45	44.50	44	44.5	0.02	0.50	1.12
Pectoral fin rays	16	17	16.56	17	17	0.02	0.50	3.00
Pelvic fin rays	5	5	5.00	5	5	-	-	-
Anal fin spine	2	2	2.00	2	2	-	-	-
Anal fin rays	7	8	7.31	7	7	0.02	0.46	6.31
Caudal fin rays	19	21	20.00	20	20	0.03	0.67	3.37
Gill rakers	19	21	20.00	20	20	0.02	0.50	2.50
Branchiostegal rays	7	7	7.00	7	7	-	-	-

Table 4. Comparison of meristic characters of *O. pama* based on other studies

Author(s)	Nos. of dorsal fin	Nos. of pectoral fin	Nos. of pelvic fin	Nos. of anal fin	Nos. of caudal fin	Nos. of gill rakers
Bhuiyan (1964)	10+I. 40-43	17	I. 5	II. 7	-	-
Talwar (1975)	X.I. 40-45	-	-	II. 7	-	-
Shafi and Quddus (1982)	X.I. 40-43	17	I. 5	II. 7	-	-
FAO (1974)	X.I. 40-45	-	-	II. 7	-	11-14
Mohan (1991)	2 nd dorsal 40-45	-	-	-	-	5-7/1/10-13
Talwar (1995)	IX-X. I. 40-45	i. 16	I. 5	II. 7-8	-	(4-6)+1+(11-15)
Talwar and Jhingran (1991)	IX-X. I. 40-45	i. 16	I. 5	II. 7	-	-
Rahman (2005)	X.I. 40-43	19	I. 5	II. 7	-	-
Present study	IX-X.I. 44-45	i. 16	I. 5	II. 7	19-21	19-21

Table 5. Correlation of different morphometric values of *O. pama*

Correlations															
	TL	ST	PAL	PDL	PPL	PPeL	HL	MBD	CD	CL	SL	POL	IOL	ED	CPL
TL	1.000	-0.031	-0.016	-0.015	-0.021	-0.022	-0.026	-0.014	-0.025	-0.023	-0.023	-0.023	-0.014	-0.027	-0.035
ST	-	1.000	.997**	.992**	.992**	.992**	.992**	.995**	.990**	.991**	.988**	.983**	.992**	.976**	.970**
PAL	-	-	1.000	.992**	.990**	.989**	.989**	.995**	.989**	.985**	.985**	.978**	.991**	.974**	.963**
PDL	-	-	-	1.000	.995**	.992**	.993**	.988**	.993**	.984**	.980**	.972**	.988**	.964**	.961**
PPL	-	-	-	-	1.000	.995**	.997**	.985**	.988**	.989**	.982**	.979**	.986**	.970**	.966**
PPeL	-	-	-	-	-	1.000	.996**	.984**	.988**	.987**	.984**	.977**	.983**	.965**	.966**
HL	-	-	-	-	-	-	1.000	.985**	.988**	.991**	.984**	.980**	.986**	.969**	.971**
MBD	-	-	-	-	-	-	-	1.000	.987**	.982**	.982**	.972**	.990**	.967**	.960**
CD	-	-	-	-	-	-	-	-	1.000	.979**	.977**	.971**	.987**	.961**	.958**
CL	-	-	-	-	-	-	-	-	-	1.000	.981**	.987**	.988**	.977**	.979**
SL	-	-	-	-	-	-	-	-	-	-	1.000	.980**	.985**	.969**	.977**
POL	-	-	-	-	-	-	-	-	-	-	-	1.000	.982**	.983**	.984**
IOL	-	-	-	-	-	-	-	-	-	-	-	-	1.000	.973**	.975**
ED	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000	.962**
CPL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.000

N-618; **Significant at $p < 0.01$

scale. Such variations may be due to the environmental factors including temperature, salinity, oxygen, pH, food availability and growth rate as being noticed in other species (Barlow, 1961; Lindsey, 1988). The range, mean, mode, median and standard deviation indicates a high degree of homogeneity within the population of *O. pama* occurring in Hooghly-Matlah Estuary of West Bengal, India.

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