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MORPHOMETRIC RELATIONSHIPS AND MERISTIC CHARACTERISTICS OF *MEGALASPIS CORDYLA* (LINNAEUS, 1758) FROM THE BAY OF BENGAL

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ABSTRACT: *Megalaspis cordyla* is one of the Carangid fish species commonly found in marine areas of the Sundarbans and the Bay of Bengal in Bangladesh. This study described the morphometric relationships including length-weight and length-length relations (LWRs and LLRs) and meristic characteristics of *M. cordyla*. A total of 100 individuals were collected from commercial fishers' catch in the Bay of Bengal, Bangladesh during January-December 2021. For each individual, a total of fourteen various lengths were measured by measuring board with 0.01 cm and body weight (BW) was taken by digital balance with 0.01 g accuracy. Fin-ray numbers from all fins as well as scutes were counted by a magnifying glass. Total length (TL) varied from 17.0-36.5 cm and the total body weight (BW) ranged from 75.0-416.6 g. All LWRs were significantly related ($p < 0.001$), with r^2 values ≥ 0.910. Based on r^2 value (0.979), LWR by BW *vs*. TL ($W = a \times L^b$) was the best fitted model among 14 equations. Besides, the LLRs were also significant with r^2 values ≥ 0.908. According to r^2 value (0.995), LLR by TL *vs*. FL ($TL = a + b \times FL$) was the best fitted model among 14 equations. The fin formula of *M. cordyla* is: first dorsal, D_1 I+VII; second dorsal, D_2 I/14-18+6-8 finlets; pectoral, P_1 20-26; pelvic, P_2 I/5; anal, A II+I/12-16 +5-7 finlets. This study provided knowledge on morphometric and meristic features that would be very useful for species identification and stock assessment of *M. cordyla* in the Bay of Bengal and other marine ecosystems.

KEYWORDS: Bay of Bengal; *Megalaspis cordyla*; meristic characters; morphometric relationship; relative growth

INTRODUCTION

Megalaspis cordyla (Linnaeus, 1758), known as Torpedo scad is a Carangid fish species under Perciformes order found in both inshore and offshore of the Bay of Bengal in Bangladesh. This species is abundant in the tropical and subtropical waters of the

Indian Ocean as well as the west Pacific Ocean (Smith-Vaniz, 1999). It is a pelagic oceanic species rarely found in coral reefs. The most common methods of capturing this species are gill, seine and trawl nets (Sivakami, 1995). The maximum size was recorded as 80 cm, although it is common at lengths of 45 cm (Froese and Pauly, 2021). The body of *M. cordyla* is bluish grey to green above and silvery below with light yellow fins, and a prominent dark spot on the upper edge of the operculum is seen. The structure of the body is generally slender, elongated and slightly compressed. This fish is a commercially important and demandable species in Bangladesh.

Morphometric and meristic traits are very helpful for the identification and classification of any fish species in the fields or in laboratories (Bagenal and Tesch, 1978; Tanjin *et al.*, 2021; Hossain *et al.*, 2021a, b) Moreover, relative growth brings up a dynamic role in the research of fisheries science as used to relate life history traits of the populations from different areas. Morphological variances based on general body type are used to differentiate and compare among species and groups (Hossain, 2010; Hossain *et al.*, 2016; Santic *et al.*, 2018).

A number of studies have been conducted on different aspects of *M. cordyla* from world-wide water bodies (Assessment of maturity, reproduction and reproductive potentials by Qamar *et al.*, 2018; length-weight, maturity, and condition factor by Oktaviani *et al.*, 2020; growth pattern and form factor by Sarmin *et al.*, 2021) but knowledge on morphometric and meristic relationship for this species is very limited from the Bay of Bengal in Bangladesh. Therefore, this study describes the morphometry through multi-linear dimensions, and meristic characters of *M. cordyla* in the Bay of Bengal with the aim of providing necessary information for species identification and further research.

MATERIALS AND METHODS

Samples collection: A total number of 100 specimens of different size groups were collected occasionally from January – December 2021 using multiple traditional fishing gears such as seine net (mesh size: 1.5-3.0 cm) and gill net (mesh size: 2.5-4.0 cm) from the Bay of Bengal in Bangladesh. The samples were rapidly preserved in ice to prevent fish spoilage on the sampling site and moved to the laboratory where all measurement was taken.

Morphometric and meristic measurements: Body weight (BW) for each individual was measured to the nearest of 0.01 g by an electronic balance and body lengths (Fig. 1), i.e., total length, TL (tip of snout – end of caudal fin); standard length, SL (tip of snout – base of caudal fin); fork length, FL (tip of snout – middle of caudal fin rays), etc., were taken by measuring board (measuring tape fitted wooden board) to the nearest of 0.01 cm.

The relative growth between total body weight (BW) and several body lengths was estimated by LWRs using the equation: $W = a \times L^b$, where W is BW (g) and L denotes different body lengths in cm and parameters a and b of the growth pattern were measured through the natural logarithms*: ln (W) = ln (a) + b ln (L)*. Extreme outliers from the regression analyses were eliminated (Froese, 2006). Moreover, the 95% confidence level (CL) of a and b and the coefficient of determination (r^2) were assessed. Generally, b

values designate the fish growth pattern, i.e., nearby 3, indicates that fish grow isometrically and different from 3.0 indicate allometric growth (>3 positive allometry and <3 negative allometry) (Tesch, 1971). A t-test was applied on validating *b*-values obtained from the linear regressions if dissimilar from the isometric value (Sokal and Rohlf, 1987). A number of 14 LLRs were assessed by linear regression. The best model from LWRs and LLRs was considered depending on the maximum r^2 value.

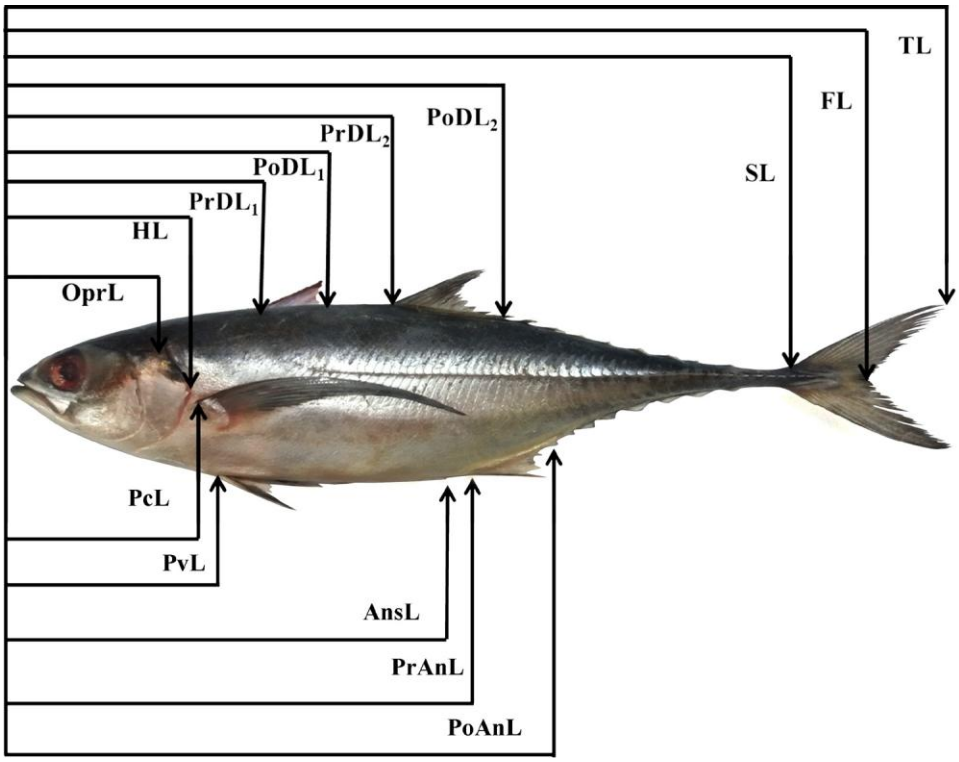

Fig. 1. Morphometric measurements of *Megalaspis cordyla* from the Bay of Bengal, Bangladesh.

By using a magnifying glass, we counted the different fin rays (unbranched-single fin ray; branched-upper portion divided into several rays) of *M. cordyla* across body parts and made a fin formula. The last two soft rays are counted as two separate rays (Kottelat and Freyhof, 2007). The number of scutes on the lateral line were also figured out.

Statistical analysis: GraphPad Prism 6.5 software was used to carry out statistical analyses. The values of statistical analyses were considered at 5% level of significance ($p< 0.05$).

RESULTS AND DISCUSSION

Result: In our study, total length ranged from 17.0 to 36.5 cm (mean ± SD = 29.42 ± 4.15) and the body weight varied from 75.0 to 416.6 g (mean ± SD = 236.91 ± 75.41). All

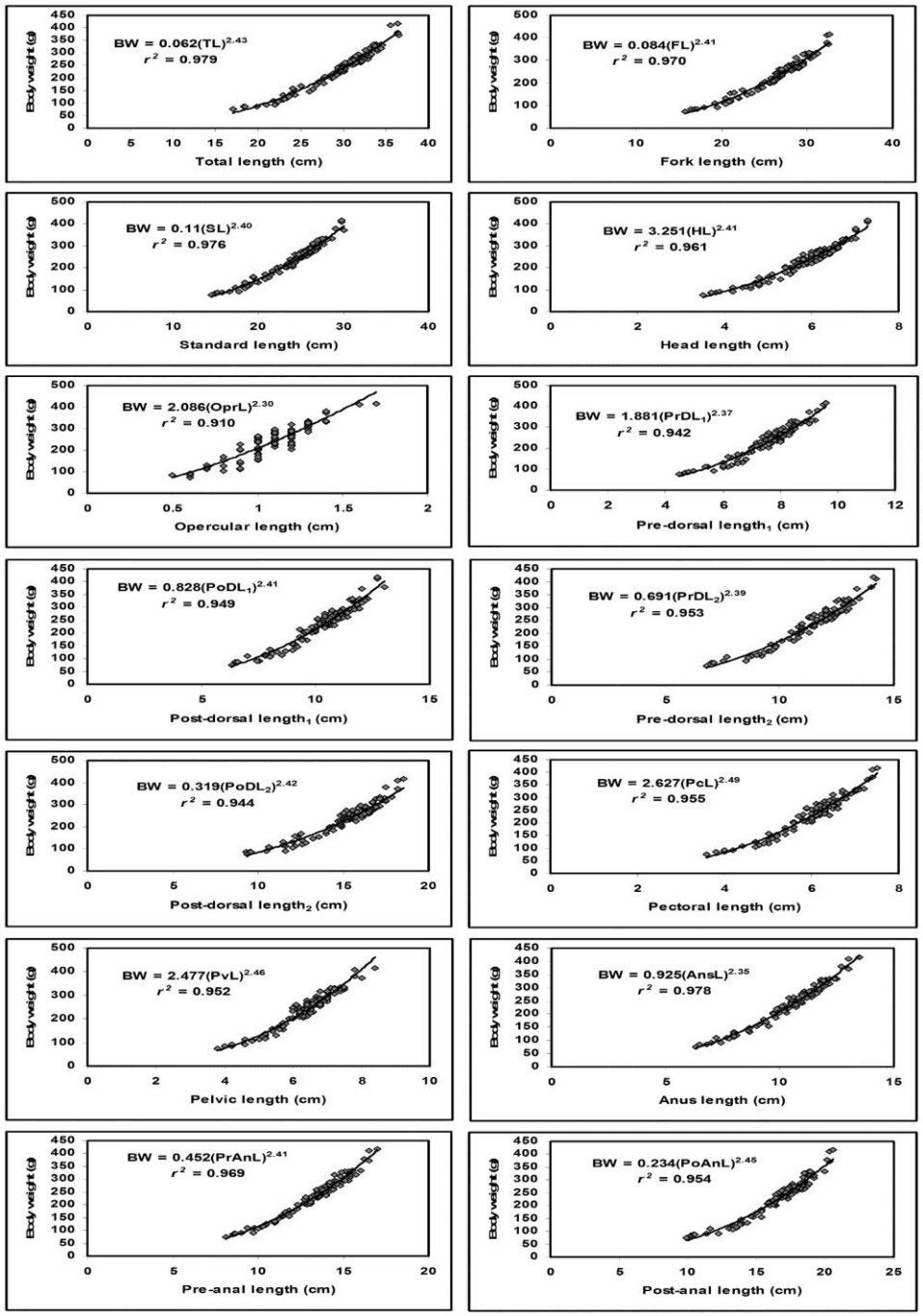

Fig. 2. Length-weight relationships for *Megalaspis cordyla* from the Bay of Bengal, Bangladesh.

Table 1. Descriptive statistics on different measurements with their 95% confidence limits of *Megalaspis cordyla* in the Bay of Bengal, Bangladesh.

Measurements	Min	Max	Mode	Mean±SD	95 % CL
Body weight (BW) g	75.0	416.6	86.0	236.91±75.41	222.10-251.72
Total length (TL) cm	17.0	36.5	28.8	29.42±4.15	28.61-30.24
Fork length (FL) cm	15.7	32.6	27.0	26.42±3.75	25.68-27.16
Standard length (SL) cm	14.5	30.0	24.0	24.04±3.45	23.36-24.71
Head length (HL) cm	3.5	7.3	6.0	5.86±0.83	5.69-6.02
Opercular length (OprL) cm	0.5	1.7	1.0	1.07±0.22	1.03-1.11
Pre-dorsal length$_1$ (PrDL$_1$) cm	4.5	9.6	8.0	7.57±1.08	7.36-7.78
Po-dorsal length$_1$ (PoDL$_1$) cm	6.3	13.0	11.1	10.28±1.46	10.0-10.57
Pre-dorsal length$_2$ (PrDL$_2$) cm	6.8	14.2	12.0	11.33±1.60	11.01-11.64
Post-dorsal length$_2$ (PoDL$_2$) cm	9.3	18.5	14.8	15.08±2.10	14.67-15.49
Pectoral length (PcL) cm	3.6	7.5	6.3	6.01±0.83	5.85-6.17
Pelvic length (PvL) cm	3.8	8.4	6.8	6.31±0.89	6.13-6.48
Anus length (AnsL) cm	6.3	13.5	10.8	10.41±1.53	10.11-10.71
Pre-anal length (PrAnL) cm	8.1	17.0	14.0	13.30±1.92	12.92-13.68
Post-anal length (PoAnL) cm	9.9	20.6	18.4	16.67±2.30	16.21-17.12

Min, minimum; Max, maximum; SD, standard deviation; CL, confidence limit for mean values

Table 2. Descriptive statistics and estimated parameters of different length-weight relationships for *Megalaspis cordyla* from the Bay of Bengal, Bangladesh.

Equations	Regression parameters		95% CL of *a*	95% CL of *b*	r^2
	a	*b*			
BW = $a \times TL^b$	0.062	2.43	0.046-0.083	2.34-2.52	0.979
BW = $a \times FL^b$	0.084	2.41	0.064-0.111	2.33-2.50	0.970
BW = $a \times SL^b$	0.110	2.40	0.087-0.139	2.33-2.48	0.976
BW = $a \times HL^b$	3.251	2.41	2.745-3.849	2.31-2.50	0.961
BW = $a \times OprL^b$	2.086	2.30	2.024-2.148	2.20-2.40	0.910
BW = $a \times PrDL_1^b$	1.881	2.37	1.486-2.382	2.25-2.49	0.942
BW = $a \times PoDL_1^b$	0.828	2.41	0.640-1.072	2.30-2.52	0.949
BW = $a \times PrDL_2^b$	0.691	2.39	0.536-0.891	2.29-2.50	0.953
BW = $a \times PoDL_2^b$	0.319	2.42	0.232-0.438	2.31-2.54	0.944
BW = $a \times PcL^b$	2.627	2.49	2.166-3.184	2.38-2.60	0.955
BW = $a \times PvL^b$	2.477	2.46	2.028-3.027	2.35-2.57	0.952
BW = $a \times AnsL^b$	0.925	2.53	0.786-1.088	2.28-2.42	0.978
BW = $a \times PrAnL^b$	0.452	2.41	0.376-0.542	2.34-2.48	0.969
BW = $a \times PoAnL^b$	0.234	2.45	0.173-0.315	2.34-2.55	0.954

See Table 1; *a* and *b*, regression parameters; CL, confidence limit; r^2, coefficient of determination

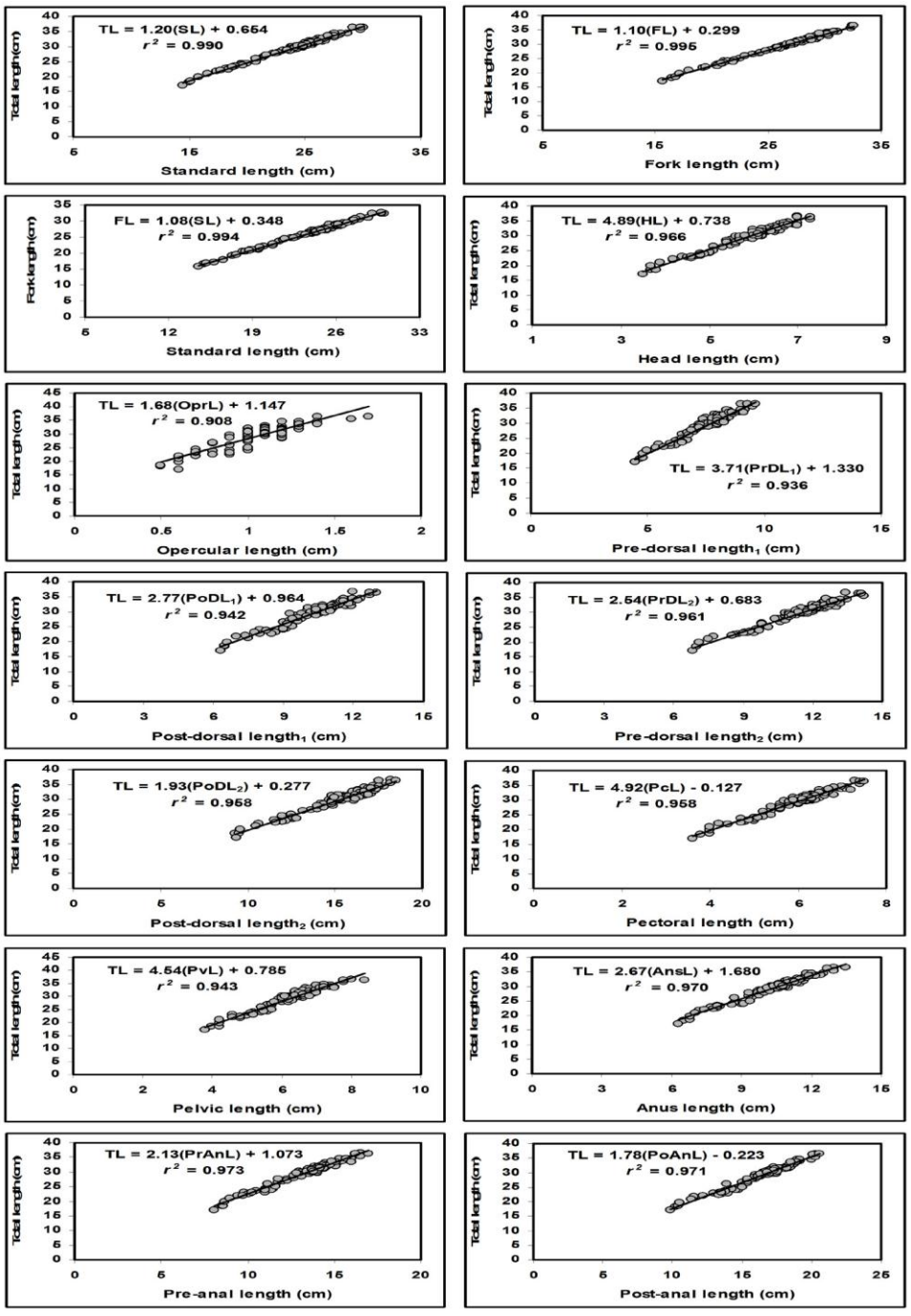

Fig. 3. Length-length relationships for *Megalaspis cordyla* from the Bay of Bengal, Bangladesh.

morphometric measurements with their 95% confidence limits (CL) are shown in Table 1. The regression parameters of LWRs and 95% confidence limit of *a* and *b* and the coefficient of determination (r^2) of *M. cordyla* are presented in Table 2 and Fig. 2. Growth was significant (p <0.001) with all r^2values 0.910 to 0.979. Based on r^2 value, BW = $0.062\times TL^{2.43}$ was the best fitted model among 14 equations. The regression parameters (*a* and *b*) of the length-length relationships (LLRs) with 95% CL of *a*, *b* and the coefficient of determination (r^2) are shown in Table 3 and Fig. 3. All the LLRs were also significantly related with r^2 values 0.902 to 0.995. On the basis of maximum r^2 value, LLRs by TL *vs.* FL was the best fitted model amongst 14 equations.

Table 3. Descriptive statistics and estimated parameters of different length-length relationships (Y = *a* +*b* × X) for *Megalaspis cordyla* from the Bay of Bengal, Bangladesh.

Equations	Regression parameters		95% CL of *a*	95% CL of *b*	r^2
	a	*b*			
TL = *a* + *b* × SL	0.654	1.20	0.082 to 1.224	1.17 to 1.22	0.990
TL = *a* + *b* × FL	0.299	1.10	-0.166 to 0.766	1.08 to 1.12	0.995
FL = *a* + *b* × SL	0.348	1.08	-0.040 to 0.736	1.07 to 1.10	0.994
TL = *a* + *b* × HL	0.738	4.89	-0.343 to 1.819	4.72 to 5.08	0.966
TL = *a* + *b* × OprL	1.147	1.68	0.969 to 1.324	1.52 to 1.84	0.908
TL= *a* + *b* × $PrDL_1$	1.330	3.71	-0.138 to 2.798	3.52 to 3.90	0.936
TL = *a* + *b* × $PoDL_1$	0.964	2.77	-0.448 to 2.377	2.63 to 2.90	0.942
TL = *a* + *b* × $PrDL_2$	0.683	2.54	-0.478 to 1.843	2.44 to 2.64	0.961
TL = *a* + *b* × $PoDL_2$	0.277	1.93	-0.945 to 1.500	1.85 to 2.01	0.958
TL = *a* + *b* × PcL	0.127	4.92	-0.1363 to 1.109	4.71 to 5.12	0.958
TL = *a* + *b* × PvL	0.785	4.54	-0.630 to 2.200	4.32 to 4.76	0.943
TL = *a* + *b* × AnsL	1.680	2.67	0.702 to 2.657	2.57 to 2.76	0.970
TL = *a* + *b* × PrAnL	1.073	2.13	0.131 to 2.015	2.06 to 2.20	0.973
TL = *a* + *b* × PoAnL	0.223	1.78	-1.245 to 0.800	1.72 to 1.84	0.971

See Table 1; *a*, Intercept; *b*, Slope; CL, confidence limit; r^2, Coefficient of Determination

Table 4. Meristic characters of *Megalaspis cordyla* from the Bay of Bengal, Bangladesh.

Meristics Data	Numbers	Spine/ Unbranched	Branched
First dorsal fin rays (D_1)	8	I	VII
Second dorsal fin rays (D_2)	15-18	I	14-17 + (6-8 finlets)
Pectoral fin rays (P_1)	22-26	-	22-26
Pelvic fin rays (P_2)	6	I	5
Anal fin rays (A)	15-19	II+I	12-16+ (5-7 finlets)
Scutes	51-58	-	-

Table 5. Comparison of meristic characteristics for *Megalaspis cordyla* with the other findings.

Authors	1st dorsal spines	2nd dorsal (spine and rays)	Dorsal finlets	Pectoral fin (spines and rays)	Pelvic fin (spines and rays)	Anal fin (spines and rays)	Anal finlets	Scutes
Jaiswar and Devaraj (1989)	8	11-13	6-9	19-22	5	9-11	5-7	-
FAO/SIDP (2000)	8	I+18-20	7-9	-	-	I+16-17	8-10	-
Sarker *et al.* (2004)	8	1+9-14	5-9	1+19-20	1+5	I+9-11	5-8	-
Hossain *et al.* (2020)	VIII	I/18-20	7-9	25-30	I/5	II+I/16-17	8-10	51-59
Habib *et al*. (2017)	I+VII	I/11	8	22	I/5	II+I/10	6	54-56
Present study	**I+VII**	**I/14-18**	**6-8**	**20-26**	**I/5**	**II+I/12-16**	**5-7**	**51-58**

The body shape of *M. cordyla* is elongated and compressed. Upper portion body colour of this fish is bluish grey and below is silvery. Mouth is terminal and small with a prominent lower jaw (Fig. 1). The fin formula of *M. cordyla* was observed in the current study as: first dorsal, D_1 I+VII; second dorsal, D_2 I/14-18+6-8 finlets; pectoral, P_1 20-26; pelvic, P_2 I/5; anal, A II + /12 - 16 + 5 - 7 finlets (Table 4). We observed a total of 51 - 58 scutes on the lateral line. To observe the comparison of meristic data from other authors findings with this study, a table was added (Table 5).

Discussion: The present study reports the morphometric relationship through the multi-linear dimension of *M. cordyla* from the Bay of Bengal, Bangladesh with one year of occasional data. In our study, among 100 specimens of different body sizes, the small size was 17.0 cm TL and the maximum size was found as 36.6 cm which is smaller than (43.1 cm) reported by Jaiswar and Acharya (1991) from the North-west coast of India; 40.2 cm recorded by Jadhav and Mohite (2014) from the Ratnagiri coast of Maharashtra, India; 40.1 cm found by Saker *et al.* (2004) from the Mumbai coast, India and we also reported TL was 41.0 cm from the Bay of Bengal previous year (Sarmin *et al.*, 2021). But our observed length was higher than the 35.0 cm size reported by Zafar *et al.* (2000) from Bay of Bengal. However, maximum length data is necessary for determining asymptotic length and growth co-efficient of fish to develop proper fisheries management policies.

According to Froese (2006), the *b* values varied from 2.5 to 3.5 for LWRs. We found *b* values from 2.30 to 2.53 which are similar to the range seen in teleost fishes (Froese, 2006; Hossain *et al.*, 2015). Additionally, *b* values indicated negative allometric growth in this study. The overall *b* value for combined sex was also negative allometric reported by Reuben *et al.* (1992) from the east, north-west and south-west coast of India (*b* = 2.94, 2.52, 2.72); Saker *et al.* (2004) from the Mumbai coast, India (*b* = 2.88); Das *et al.* (2014) from Tanjung Sepat, Selangor, Malaysia (*b* = 2.64); and Zafar *et al.* (2000) from the Bay of Bengal (*b* = 2.82) for *M. cordyla*. But dissimilarity found by Oktaviani *et al.* (2020) reported positive allometric growth from Java Sea, Indonesia (*b* = 3.15). Though, in the same species, *b* values may differ for various factors such as physiology and food availability, and environmental causes (Le Cren, 1951; Hossain *et al.*, 2015), which were excluded from the present study. Moreover, the LLRs were highly associated, but owing to lack of information on *M. cordyla*, it was hard to compare.

There is very limited published information on the meristic count of *M. cordyla* from the Bay of Bengal. However, we counted the first dorsal fin rays D_1 was I+VII which is similar to the previous results of Jaiswar and Devaraj (1989), FAO/SIDP (2000), Sarker *et al.* (2004), Habib *et al.* (2017) and Hossain *et al.*(2020). For the second dorsal fin rays, we observed D_2 I/14-18 with 6-8 dorsal finlets, then again other studies showed slightly dissimilar findings (Jaiswar and Devaraj, 1989): 11-13 with 6-9 dorsal finlets; FAO/SIDP (2000): I+18-20 with 7-9 finlets; Sarker *et al.* (2004): 1+9-14 with 5-9 finlets; Habib *et al.* (2017): I/11+8 dorsal finlets and Hossain *et al.*(2020): I/18-20+7-9 finlets). Pectoral fin (P_1 20-26) also showed different results reported from Jaiswar and Devaraj (1989): 19-22; Sarker *et al.* (2004): 1+19-20; Habib *et al.* (2017): 22 and Hossain *et al.* (2020): 25-30.

Further, the pelvic fin (P_2 I/5) showed similar results with the other studies. Anal fin (II+I/12-16)) was more or less similar to the observation of Jaiswar and Devaraj (1989): 9-11with 5-7 anal finlets; FAO/SIDP (2000): I+16-17 with 8-10 finlets; Sarker *et al.* (2004): 1+9-11 with 5-8 finlets; Habib *et al.* (2017): II+I/10 with 6 finlets and Hossain *et*

al.(2020): II+I/16-17 with 8-10 finlets). We found 51-58 scutes on the lateral line, while Habib *et al.* (2017) observed 54-56 and Hossain *et al.* (2020) reported 51-59 scutes. These variations may ascribe due to factors such as geographical population differences as well as difference in counting methods, developmental period and temperature during larval development (Barlow, 1961).

CONCLUSION

The present study will serve the fishery manager/scientist to recognize *M. cordyla* in the laboratory or fields and commence for stock assessment of the existing stock of this species in the Bay of Bengal, Bangladesh and other marine waters. This morphological information will support further studies as well as be helpful for the management of *M. cordyla* where needed.

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