

MORPHOMETRICS, LENGTH WEIGHT RELATIONSHIP AND CONDITION FACTOR OF *COILIA DUSSUMIERI* VALENCIANNES, 1848 FROM YE ESTUARY, MON COASTAL AREA

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Abstract

The morphometrics analysis, length weight relationship and condition factor of *Coilia dussumieri* were estimated in Ye Estuary between January and October 2022. During this study, the interrelationship of total length (TL) with various morphometric characters, namely SL, HL, ED, BD, PDL, PAL, PPL, and PVL, was found to be statistically insignificant ($p > 0.05$). A high correlation coefficient ($r = 0.95$) showed a highly significant relationship between total length and standard length, while the remaining characters showed moderate or low correlations ($0.5 < r < 0.7$). Moreover, the growth pattern between total length and other morphometric characters was negative because the value of 'b' was lower than unity ($b < 1$). The length-weight relationship of the fish indicated negative allometric growth ($b < 3$), and the condition factor showed a poor condition in fish ($K < 1$).

Keywords: *Coilia dussumieri*, morphometry, length weight relationship, condition factor, Ye Estuary, Mon Coastal Area.

Introduction

Coilia dussumieri is known as gold spotted grenadier anchovy (Nga-kyan-ywat) in Mon Coastal Areas. *C. dussumieri* is a commercial fish marketed in dried form and has become one of the major food commodities in different regions. If the intensity of fishing continues to rise, it is feared that anchovy populations will decrease.

C. dussumieri is widely distributed in the Indian Ocean, from Gujarat to West Bengal, Bangladesh, Myanmar, Thailand, and Malaysia. It is an important pelagic resource along the West Bengal coast, landed by trawlers and 'Doll' netters (Uddin and Ghosh, 2021). Furthermore, it is a major fish resource along the Southern Mon Coastal Areas, landed mainly by stationary bagnets.

When discussing fish conservation, the aims are to: (1) protect endangered fish species, (2) maintain the diversity of fish species, (3) maintain the balance and stability of the ecosystem, and (4) utilize fish resources in a sustainable manner. Therefore, the first step is to study the taxonomic status of anchovy (*Coilia dussumieri*) using morphological characteristics, which includes the early stages of identifying fish (Nugroho et al., 2015).

Morphometric characters in fish are widely used for taxonomic studies, as they contribute to the identification of populations and species inhabiting different bodies of water in different geographical regions. Statistical relationships between the measurements of various body parameters have been recorded in systematic studies worldwide (Jalbani et al., 2014).

In general, the measurement of morphometrics can be defined as a method for describing body shape. It is a technique widely used in ichthyological or taxonomic systematic studies through measurable components (measuring the length or distance between physical features or landmarks) of fish anatomies, such as the size of body parts, fins, and body length ratio (Kumaladewi et al., 2022).

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The study of the length-weight relationship of fish provides a mathematical relationship between length and weight, serving as a means of inter-conversion for estimating weight from a known length and vice versa. Knowledge of a fish's length-weight relationship is essential, as various important biological aspects, such as the general well-being of the fish, the appearance of first maturity, and the onset of spawning, can be assessed with the help of the condition factor (Le Cren, 1951). The length-weight relationship and condition factors are useful parameters for assessing the well-being of individuals and for determining possible differences among different stocks of the same species. The length-weight relationship is also important in fisheries science, particularly for scaling length frequency samples to total catch or for estimating biomass from underwater length observations (Pal et al., 2014).

Zarni Ko Ko (2021) studied the length-weight relationship, condition factor, and stock assessments for *Coilia dussumieri* from Setse and Sinpone. However, there has been no published information to date on the bagnet fishery of *C. dussumieri* from the Ye Estuary. As no previous study had been conducted on all selected morphometric characters of *C. dussumieri* along the Ye Estuary, the present study aims to examine the growth patterns of various body parts of this species in relation to total body length (TL) and also to observe the relationship between length and weight, and the condition factor for the species from the landing area of Ye Estuary.

Materials and Methods

Sampling site and Sample Collection

The samples of *Coilia dussumieri* were collected from Ye Estuary, Asin Landing Area, Mon Coast, with coordinates 15° 13' N and 097°47' E (Fig. 1) in the months from January 2022 to October 2022.

Analysis of Morphometric Characters

Nine morphometric characters were analyzed in the present study using standard procedures previously followed by Mahapatra et al. (2015). All these morphological parameters and their acronyms are listed in Table 1.

Table 1. Quantitative morphometric characters used for differentiation analysis of *Coilia dussumieri* collected from Ye Estuary.

No.	Morphometric characters	Acronyms
1	Total body length	TL
2	Standard length	SL
3	Head length	HL
4	Eye diameter	ED
5	Body depth	BD
6	Pre dorsal fin length	PDL
7	Pre pectoral fin length	PPL
8	Pre anal fin length	PAL
9	Pre pelvic fin length	PVL

Morphometric characters were measured to the nearest centimeter (nearest $\pm 0.1\text{cm}$) with the help of a measuring scale. To obtain the length - length relationship among various

parameters with dependent variables, Total length (TL) and independent variables, various lengths was established with the formulae.

$$Y = a + b X$$

Where, 'Y' is the dependent variable, 'X' is the independent variable, 'a' is constant (intercept) and 'b' is the regression coefficient (slope).

Linear regression relationship and coefficient of correlation (r) were calculated to determine the relationship between total body length (TL) and all these morphometric characters. The significance of regression was assessed by t-test analysis at $p < 0.05$. These values of the t-test were obtained during linear regression analysis, which provides the method for observing the statistically significance of correlations between total length and all selected morphometric characters at 5% level ($p < 0.05$). All statistical analysis of data was calculated using Microsoft Excel 2010 version.

Analysis of Length Weight Relationship and Condition Factor (K)

A total of 430 fish samples were collected from Setse and Sinpone fish landing sites from January 2022 to October 2022. The total length (TL) of each individual fish was measured in centimeters from the snout to the end of the caudal fin using the measuring board and the weight was measured in grams (g) by using the digital balance. The monthly length frequency data were pooled into groups of 1.7 cm length intervals by using Microsoft Excel.

The length weight relationship was determined by the methods of least square using the formula, which was followed after Le Cren (1951) as; $W = a L^b$
Where, W = weight of fish (g), L = total length of fish in (cm), a = constant (intercept), b = length exponent (slope).

The mean weight and length of the experimental fish were used to estimate condition factor using the equation below: $K = W/L^3 \times 10^2$ (Fulton, 1904)

Where, W= Weight in gram (g), L = Total length of fish in centimeter (cm)



Figure 1. Map showing the present study site of Ye Estuary

Results

Morphological characteristics of *Coilia dussumieri* during the present study.

In the present study, the external morphology of the fish body was observed as strongly compressed, with the ventral and dorsal profiles being in convex shapes. The minimum, maximum and mean with standard deviation values of morphometric characters are depicted in Table 2. Although morphometric measurements of the current study disclosed that total length (TL) was found in a range from 8.6 to 16.1 cm (in male) and from 8.3 to 16.5 cm (in female), standard length (SL) ranged from 6.8 to 14.5 cm (in male) and 5.8 to 14.6 cm (in female), head length (HL) varied from 1.5 to 2.6 cm (in male) and from 1.1 to 2.4 cm (in female), eye diameter (ED) was between 0.2 and 0.5 cm (in male and female), body depth ranged from 1.6 to 2.7 cm (in male) and from 1.3 to 2.8 cm (in female), pre dorsal length (PDL) ranging from 2.2 to 5.2 cm (in male) and 2.1 to 4.1 cm (in female), pre pectoral length (PPL) was between 2.1 and 4.2 cm (in male and female), per anal length (PAL) ranged from 3.2 to 5.6 cm (in male) and from 2.8 to 5.8 cm (in female), and pre pelvic length (PVL) varied from 0.9 to 2.7 cm (in male) and from 0.9 to 2.4 cm (in female), as shown in Table 2.

The percentage of morphometric characteristics with respect to total length (TL) is shown in Table 3. The head length of *C. dussumieri* was 15.14 % (in males) and 17.01 % (in females) of total body length. The body depth was 16.25 % (in males) and 18.82 % (in females) of the total body length. The percentages of pre dorsal length, pre pectoral length, pre anal length and pre pelvic length for male were 23.85 %, 23.25 %, 34.09 % and 14.90 % while the percentages of pre dorsal length, pre pectoral length, pre anal length and pre pelvic length for female were 28.02 %, 27.41 %, 39.43 % and 17.27 %, respectively.

Table 2. Range, mean, and standard deviation values of morphometric characters of male and female for *Coilia dussumieri* during the present study.

Sir No.	Morphometric characters	Male (N=115)			Female (N= 315)		
		Min (cm)	Max (cm)	Mean±SD	Min (cm)	Max (cm)	Mean±SD
1	TL	8.6	16.1	13.29±1.27	8.3	16.5	11.64±1.98
2	SL	6.8	14.5	11.84±1.22	5.8	14.6	9.49±2.29
3	HL	1.5	2.6	1.98±0.21	1.1	2.4	1.98±0.24
4	ED	0.2	0.5	0.37±0.07	0.2	0.5	0.34±0.08
5	BD	1.6	2.7	2.16±0.28	1.3	2.8	2.19±0.29
6	PDL	2.2	5.2	3.17±0.39	2.1	4.1	3.26±0.41
7	PAL	3.2	5.6	4.53±0.52	2.8	5.8	4.59±0.64
8	PPL	2.1	4.2	3.09±0.41	2.1	4.2	3.19±0.42
9	PVL	0.9	2.7	1.98±0.28	0.9	2.4	2.01±0.28

Symbol: N=sample size, S.D = standard deviation

Table 3. Percentage of morphometric characteristics with respect to total length (TL) of male and female for *Coilia dussumieri* during the present study.

Morphometric Characteristics Percentage of Total length (TL)	Average (%)	
	Male	Female
HL (% TL)	14.90	17.01
ED (% TL)	2.78	2.92
BD (% TL)	16.25	18.81
PDL (% TL)	23.85	28.01
PAL (% TL)	34.09	39.43
PPL (% TL)	23.25	27.41
PVL (% TL)	14.90	17.27

Linear regression relationships between total body length (TL) and morphological characters of *Coilia dussumieri* during the present study.

In order to determine the linear regression relationships between total length (TL) and various morphometric characteristics, the total length (TL) was taken as X (Independent variable) and various morphometric measurements were taken as Y (dependent variables). The regression coefficient 'b' and the correlation coefficient 'r' of different variable characters (Y), including standard length, head length, dorsal fin length, pectoral fin length, anal fin length etc., on the total length (X) were described in Table 4.

The morphometric study of *Coilia dussumieri* for males indicated that a strong correlation ($r > 0.70$) exists between total length (TL) against standard length (SL), body depth (BD), and pre anal length (PAL). The moderate correlation ($r = 0.51-0.69$) was observed between total length (TL) against head length (HL), pre dorsal length (PDL), and pre pectoral length (PPL). And then, the weak correlation ($r < 0.50$) was found between total length (TL) and eye diameter (ED), and pre pelvic length (PVL), while the correlation between head length (HL) and eye diameter (ED) was also weak correlation ($r < 0.50$). The regression coefficient 'b' of total length against other morphometric characters ranged from 0.69 to 1.06. The relationship showed negative allometric growth except standard length and body depth. Moreover, the present findings of linear regression relationships between total length (TL) and all morphometric characters of males reveal insignificant correlations ($p > 0.05$) (Table 4).

The study of the morphometrics in females showed a strong correlation between total length (TL) and standard length (SL) ($r > 0.70$). And then the moderate correlation ($r = 0.51-0.69$) showed between total length (TL) and head length (HL), pre pectoral length (PPL), and pre pelvic length (PVL) while the correlation between head length (HL) and eye diameter (ED) was also moderate ($r = 0.51-0.69$). Furthermore, the weak correlation observed between total length (TL) against body depth (BD), eye diameter (ED), pre dorsal length (PDL), and pre anal length (PAL) ($r < 0.50$). The regression coefficient 'b' of total length against other morphometric characters ranged from 0.33 to 1.33. The relationship showed negative allometric growth except for standard length. Moreover, the present findings of linear regression relationships between total length (TL) and all morphometric characters of females reveal insignificant correlations ($p > 0.05$) (Table 4).

Table 4. Linear relationship between total body length (TL) and various morphometric characters of male and female for *Coilia dussumieri* during the present study.

Variables		Male					Female				
X	Y	a	b	r	CT	p-value	a	b	r	CT	p-value.
TL	SL	-0.12	1.06	0.95	***	0.49 ^{NS}	-0.33	1.33	0.95	***	0.49 ^{NS}
TL	HL	-0.51	0.72	0.66	**	0.49 ^{NS}	-0.20	0.47	0.58	**	0.45 ^{NS}
TL	ED	-0.36	0.82	0.45	*	0.44 ^{NS}	-1.01	0.54	0.42	*	0.16 ^{NS}
TL	BD	-0.80	1.01	0.74	***	0.49 ^{NS}	-0.01	0.33	0.39	*	0.44 ^{NS}
TL	PDL	-0.42	0.82	0.67	**	0.48 ^{NS}	0.13	0.36	0.46	*	0.43 ^{NS}
TL	PAL	-0.30	0.85	0.71	***	0.48 ^{NS}	0.20	0.43	0.49	*	0.46 ^{NS}
TL	PPL	-0.41	0.80	0.58	**	0.49 ^{NS}	0.07	0.44	0.51	**	0.44 ^{NS}
TL	PVL	-0.48	0.69	0.43	*	0.48 ^{NS}	-0.14	0.42	0.55	**	0.44 ^{NS}
HL	ED	-0.66	0.75	0.45	*	0.46 ^{NS}	-0.72	0.98	0.60	**	0.45 ^{NS}

Note: CT = correlation type; *** shows the strong correlation ($r > 0.70$); ** shows moderate correlation ($r = 0.51-0.69$); * represent weak correlation ($r < 0.50$); – shows negative correlation; ^{NS} shows insignificant correlation when $p > 0.05$; ^a shows significant correlation when $p < 0.05$ (Massod *et al.*, 2024).

Length frequency distribution, length weight relationship and condition factor of *Coilia dussumieri* during the present study.

During the present study, a total of 430 *Coilia dussumieri* (315 males and 115 females) were examined. The total length ranged from 8.6 to 16.1 cm and weight from 1.89 to 8.9 g for males, and for females, the length ranged from 8.3 to 16.5 cm and weight from 1.74 to 7.5 g. Therefore, total length varied between 8.3 cm and 16.5 cm and body weight varied between 1.79 g and 8.9 g during the present period.

The variation of length frequency in the number of *C. dussumieri* recorded in different size groups is presented in figure 2 after grouping them at intervals of 1.7 cm. The maximum number (150) of fishes were found in 11.5 to 13.2 cm size group, followed by the 13.2 to 14.9 cm (148) sized group. The remaining fish are distributed from 8.1 to 9.8 cm (26), 14.9 to 16.6 cm (43), and 9.8 to 11.5 cm (63).

From the results, it is observed that weight of *C. dussumieri* bears a linear relationship with the length of a logarithmic transformation (Figure 3). The regression equation for length weight relation in males, females and combined was $\text{Log } W = 2.2463 \text{ Log } \text{TL} - 1.8184$ (males), $\text{Log } W = 1.3613 \text{ Log } \text{TL} - 0.7649$ ($r = 0.44652$) (females), and $\text{Log } W = 1.4917 \text{ Log } \text{TL} - 0.9536$ (combined). The value of the exponent ('b') for males was 2.25, for females it was 1.36, and for combined it was 1.49 (Table 4), and the exponent value was tested against '3' and was found to be negative allometric growth in fish. The length and weight measurements of the fish are related to each other with a high degree of correlation coefficient for males, $r = 0.79$, and females and combined showed a moderate degree of correlation coefficient, $r = 0.69$ (Table 4). Moreover, the condition factor of *C. dussumieri* was observed; 0.221 for males, 0.690 for females and 0.252 for combined was presented in Table 5.

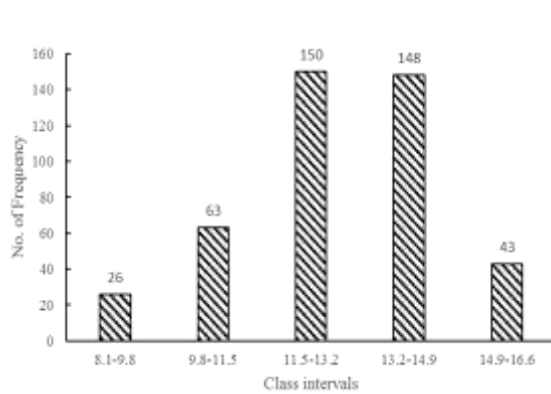


Figure 2. Length frequency distribution of *C. dussumieri* during the present study (Combined).

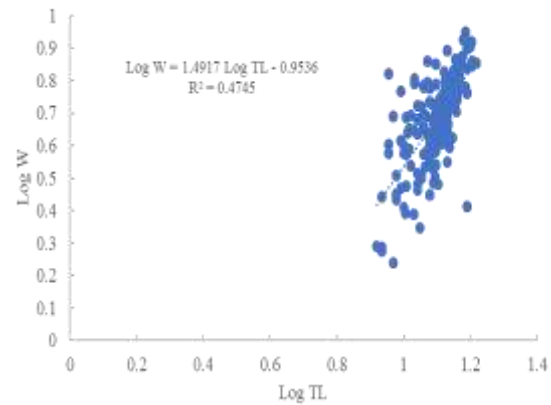


Figure3. Length weight relationship of *C. dussumieri* during the present study (Combined).

Table 5: Length weight relationship equation and “K” value of *Coilia dussumieri* during the present study.

Sex	Regression Equation	“b” value	K value	r
Male	Log W= 2.2463 Log TL- 1.8184	2.25	0.221	0.79
Female	Log W = 1.3613 Log TL- 0.7649	1.36	0.690	0.69
Combined	Log W = 1.4917 Log TL- 0.9536	1.49	0.252	0.69

Discussion

The morphometric measurement of a species is important in fisheries management activities. In the present study, the maximum values of morphometric characters of males were lower than those of females. The value of ‘b’ = 1.0 shows an isometric pattern of growth between length to length of various parts of fish’s body, $b > 1$ shows allometric growth (positive), while $b < 1$ shows allometric growth (negative) (Khalid and Naeem, 2017). In the present study, the regression coefficient ‘b’ ranged from 0.69 to 1.06 (males) and 0.33 to 1.33 (females).

During the present study, HL, ED, PDL, PAL, PPL and PVL (for males) showed ‘b’ value less than unity, with TL representing negative allometric growth, while isometric growth was indicated in SL and BD. For females, the negative allometric growth was observed in HL, ED, BD, PDL, PAL, PPL and PVL with TL. SL indicated ‘b’ value more than unity, with TL, representing positive allometric growth, while ED with HL was found to have isometric growth because the value of b (0.98) was very close to 1.0. Therefore, the overall present findings of morphometric characters showed a negative growth pattern, revealing the indirect relationship between total body length and growth of various body parts of this species.

Moreover, the overall findings of linear regression relationships between total body length (TL) and all morphometric characters of males and females of *Coilia dussumieri* revealed weak or moderate correlations ($r < 0.70$) except the standard length (SL) that was accessible, a very strong type of correlation. According to the present results, there were slight variations and no significant differences (t-test, $p > 0.05$) in all morphometric characters between males and females of *C. dussumieri*. However, Dhanya *et al.*, (2004) reported that the linear regression

relationships between total body length (TL) and morphometric characters showed positive correlation with high values of correlation coefficient (r).

The study of morphological characters of fishes is reasonably necessary for detecting the taxonomic classification of a genus or species and finding the differences between geographically variant populations (Masood *et al.*, 2024). Therefore, the present findings of morphological characters of *C. dussumieri* supports the taxonomic classification of species in the Mon Coastal Areas.

During the present study, the head length of *C. dussumieri* was 15.14 % (in males) and 17.01 % (in females) of total body length. In the findings of Mahapatra *et al.* (2015), the head length of *C. dussumieri* was 15.14% of total body length, which was similar to the present finding.

The regression coefficient between total length and weight helps to understand the type of growth. Fish showing ideal growth, having the value of 'b' lies between 2 and 4, mostly close to 3. The b = 3 value of b above or below 3 shows positive and negative allometric growth. In the case of positive allometric growth (b greater than 3), a fish becomes heavier for its length as the fish increases in size, while negative allometric growth (b less than 3) indicates that the fish becomes lighter for its length as it grows (Khalid and Naeem, 2017).

In the present study, the value of "b" was less than 3, showing a negative allometric growth pattern. The calculated value 'b' (1.36-2.25) in length weight relationship of the present study closely matched the reported value of 'b' from other findings on *C. dussumieri* by Su Su Hlaing (2016) and Zarni Ko Ko (2021) from the landing centers of Mon Coast. Moreover, the negative allometric growth of this fish was also observed in previous findings, such as Fernandez and Devaraj (1988), Dhanya, *et al.*, (2004), Shingadia (2014), Mahapatra *et al.*, (2015), and Uddin and Ghosh (2021). Nevertheless, Bal and Joshi (1956) reported the positive allometric growth of *C. dussumieri* from the Sassoon Dock and Danda landing centers, Bombay.

When the condition factor of a fish is equal to or greater than 1, it means that the fish is healthy, thus its health is in a good state, but if the value of K is less than 1, it implies a poor health state and the fish is unhealthy (Jin *et al.*, 2015). In the present study, the condition factor of *C. dussumieri* was calculated as 0.69 (for males) and 0.79 (for females and combined), indicating the poor condition of fish. The present findings are similar to the previous results; Dhanya, *et al.*, (2004), Shingadia (2014), Mahapatra *et al.*, (2015), and Uddin and Ghosh (2021). However, Zarni Ko Ko (2021) reported the K value of fish was greater than 1, so that their health is in good condition. Condition factor (K) is a short-term indicator of fish health status, and the variation in K values depends on many factors such as changes in food availability, gonadal development, and other environmental parameters (Pope and Willis, 1996). However, no such changes were observed in the present investigation. Therefore, the low values in condition factor reported in the current study may be attributed to various factors such as time of the year, stages of maturity and stomach contents.

Conclusion

This is the first report on the morphometric and length weight analysis of *Coilia dussumieri* from Ye Estuary. The present study indicates negative allometric and poor growth of the fish. The results of this study would be helpful for ichthyologists and taxonomists to compare

morphometric relationships of *C. dussumieri*. The result of the current study will be useful to researchers and policy planners. Moreover, further studies on the biology and stock assessment of *C. dussumieri* should be conducted in Ye Estuary.

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