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Carapace Length-Weight and Width-Weight Relationships of Mud Crab *Scylla serrata* (Forsskål, 1775) from Ye Estuary, Mon Coastal Area

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Abstract
The current study was attempted to determine the basic biological information such as length weight relationship and condition factor of on *Scylla serrata* from Ye Estuary, Southern Mon Coastal Area during the period of January-October 2022. The average value of male and female crabs was 6.12±0.73 in length, 6.80±2.24 in width and weighing between 40 and 440 g were collected and analyzed. The sex ratio of total collected samples (male: female) was 1:1.42. The carapace length weight relationships of total samples showed logarithmic equations as follow: Log W = 1.245 Log CL + 0.9994 for male, Log W = 0.3553 Log CL + 1.6287for female and Log W = 0.642 Log CL + 1.4303 for combined sex. While the carapace width weight relationships are as follow: Log W = 1.3455 Log CW + 0.844 for male, Log W = 0.9434 Log CW + 1.1683 for female and Log W = 1.0901 Log CW + 1.0549 for combined sex. The b values for the carapace length weight relationship of *S. serrata* in males and females were 1.245 and 0.3553 and for the carapace width weight relationship in males and females were 1.3455 and 0.9434, indicated that the growth patterns were negative allometric. The condition factor in males and females were 49.07±23.78 and 39.94±19.16. Moreover, the linear regressions between the carapace length or width and weight were highly significant ($p > 0.01$).

Key words
Carapace length/width distribution, Carapace length/width weight relationship, Condition factor, *Scylla serrata*, Ye Estuary

1. Introduction

Mud crab, *Scylla serrata* is the only species of the family Portunidae inhabiting the mangroves of the tropical latitudes particularly Indo-Pacific (Overton et al., 1997) and subtropical environments of China and Japan (Myla et al., 2017), having tolerance to a wide range of environmental variations. The length-weight or width-weight relationships are important prerequisites to know the variations in weight from the known length or width indicating feeding, growth, breeding etc., and to estimate the population size of a stock for the purpose of its exploitation (Atar and Secer, 2003).

Moreover, mud crab species such as *Scylla serrata* and *Scylla olivacea* are important fishery production in Myanmar and Indo-Pacific region. Mud crab and *Scylla* species have been subjected to increase exploitation during recent years. It is regarded as a valuable commodity, with high quality meat content (Vay, 2001).

According to Mohapatra (2008) the carapace width-weight relationship, condition factors and relative condition factors in mud crabs are important for biological studies like catch data, yield recruit, model analysis and so on (as cited in Myla et al., 2017). Individual variation in length-weight relationships has been considered as the general condition of the organism to analyze the condition factor or k-factor or prepondral index (Cren, 1951).

The mud crab, genus *Scylla* is extensively distributed in the muddy river and intertidal areas of mangrove wetlands in Myanmar Coastal regions. Crab fishery is one of the most valuable products in coastal area in Mon State. The crab

fisheries and processing were conducted for commercial scale. The mud crab, *Scylla serrata* is an edible crab with high commercial and nutritive value, as it is distributed throughout Mon Coastal Area. Crab production has been derived from natural catches; therefore, aquaculture efforts continue to be supported to meet domestic and export market demands.

The crab fisheries in Mon State have been developing since 1987 (Moe, 2017). Nyunt Sandar Aung (2016) reported the crab fisheries on mangrove areas from Mon and Taninthayi Coastal areas. Moreover, Moe (2017) also repoted that the mud crab fishery in Bilin Township, Mon Coastal area.

The study is perceived to establish precise mathematical equations between the length and weight, width and weight, so that if one is measured, the other dimension could be computed. There have been many investigations on length-weight relationship of finfishes. However, information available on such a study in mud crab species *S. serrata* is very fragmentary. The study of length weight relationship and condition of mud crabs received little attention in the current study area. Therefore, the objective of the present study was to determine the carapace length, carapace width weight relationship and condition factor of *S. serrata* from Asin landing area, Ye Estuary.

2. Materials and Methods

2.1. Study Area and Sampling

The present study was conducted for a period of 10 months from January 2022 to October 2022 from Asin landing area (15° 13' N latitude and 097°47' E longitude) in Ye Estuary, Southern Mon Coastal Area (Fig. 1). A total of 271 wild individuals of mud crabs were analyzed out of which 112 were male and 159 were female of *Scylla serrata* were measured from a commercial landing center of Asin, located near the Sitaw mangrove forest. Sampling was done monthly over the period of January-October 2022. Sexes were separated, observing external morphology as well. A total of 271 mud crabs were collected out of which 112 were male and 159 were female were measured from a commercial landing center of Asin, located near the Sitaw mangrove forest, Southern Mon Coast. Sampling was done monthly over the period of January-October 2022.

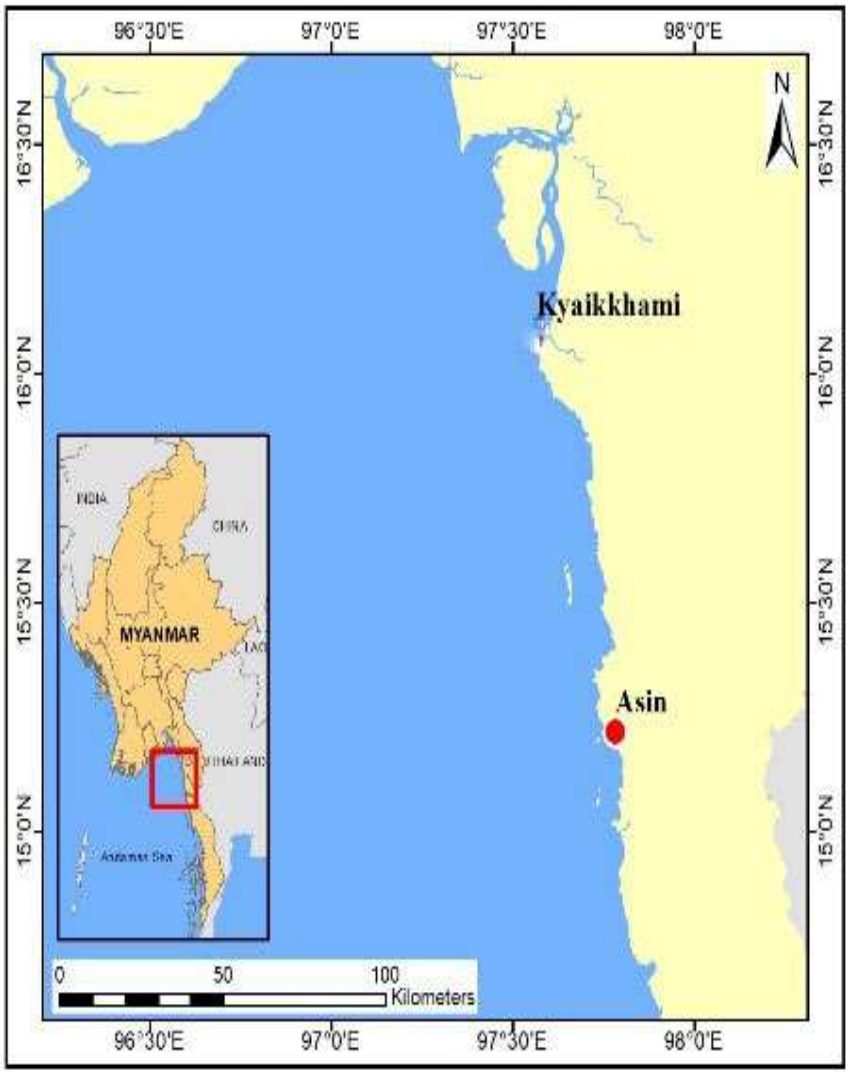

Fig.1. Map showing the present study landing area in Mon Coastal Area

Table 1 Carapace length, width, and weight characteristics (mean, minimum and maximum) for *Scylla serreta* in Ye Estuary. (SD = Standard deviation)

Sex	n	Carapace length (cm)			Carapace width (cm)			Body weight (g)		
		Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD
Male	112	4.5	7.5	6.05±0.69	3.5	12	7.22±2.17	40	440	107.83±67.88
Female	159	4.5	7.8	6.17±0.76	3.4	11	6.50±2.26	50	230	87.55±37.23
Combine	271	4.5	7.8	6.12±0.73	3.4	12	6.80±2.24	40	440	95.93±52.96

Sexes were separated, observing external morphology as well. Fresh samples with all appendages were taken and washed completely to remove excess mud and other particles. Then the carapace length (CL- length along the midline, from the frontal tooth to posterior margin of carapace) and the carapace width (CW- the distance between the last two anterolateral teeth) were measured by using a digital Vernier caliper (accuracy 0.01 cm) and the body weight was taken to the nearest 1g with the help of a digital balance, respectively. The length frequency data were pooled into groups of 1 cm length intervals by using Microsoft Excel.

2.2. Estimation on Carapace Length Weight and Carapace Width Relationships and Condition Factor of Mud Crab Scylla serrata.

Carapace length/width and weight data for the mud crab was calculated by the power function of $W=aCW^b$, and $W=aCL^b$, W denotes the weight in grams (g), CL is the carapace length and CW is the carapace width, and b is the allometric growth parameter or slop b (Afzaal et al., 2018).

Condition factor (K) is calculated by using the following formula: $K=100*(BW/CL^3)$ (Istiak and Rouf, 2018). For testing possible significant ($P > 0.01$) differences between the length and weight Student's t-test was used for comparison of the two variables.

3. Results and Discussion

3.1. Size Frequency Distribution and Sex Ratio

In the present study, the carapace length of the mud crab (*Scylla serrata*) ranged from 4.5 to 7.5 cm with average value 6.05±0.69 for male, from 4.5 to 7.8 cm with average value 6.17±0.76 for female from 4.5 to 7.8 cm with average value 6.12±0.73 for combine (Table 1). Size frequency distribution of carapace length is shown in Fig. 2. Moreover, the carapace width of the crab ranged from 3.5 to 12 cm with average value 7.22±2.17 for male, from 3.4 to 11 cm with average value 6.50±2.26 for female from 3.4 to 12 cm with average value 6.80±2.24 for combine (Table 1). Size frequency distribution of carapace width is shown in Fig. 3.

The maximum crabs of *S. serrata* were found in 6.0- 7.0 cm CL for both male and female. No male was found with carapace length more than 8.0 cm. The maximum crabs of *S. serrata* were found in 4.0- 5.0 cm CW for both male and female. According to the present results, male and female crabs exhibited some size variation.

Myla et al. (2017) conducted in India and found that CL ranged from 3.1 to 13.4 cm in males and from 3.6 to 13 cm in females. Siahainenia et al. (2016) calculated the average CW for crabs as 15.61 cm (10.5- 21.3 cm) and the average weight as 759.4 g. In the study carried out by Aneesa *et al.*, (2025) on mud crabs, the range of the carapace length/width varied from 32 to 145 CL mm and from 56 to 214 mm CW in females and from 27 to 195 mm CL and from 73 to 209 mm CW in males. The mean body weight of males and females was found as 513.53 g and 409.33 g, respectively.

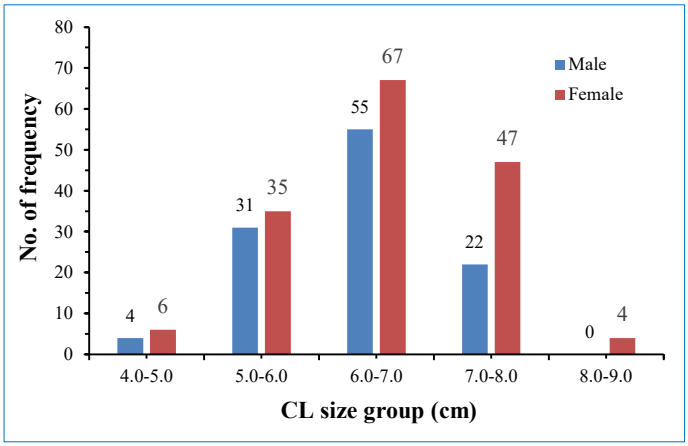

Fig. 2. Size frequency distribution of carapace length of *Scylla serrata* in Ye Estuary

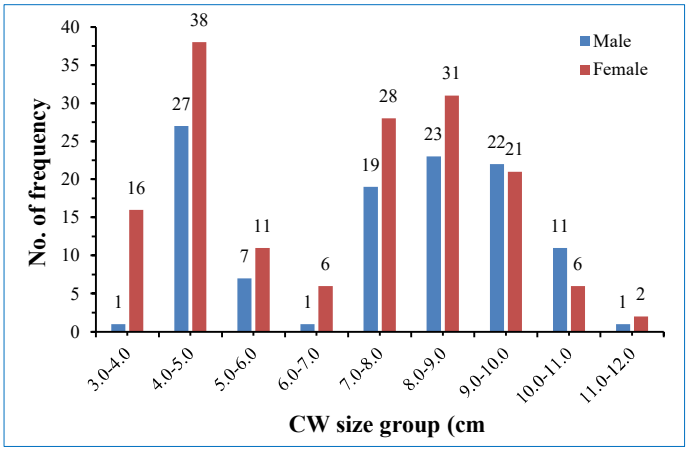

Fig. 3. Size frequency distribution of carapace width of *Scylla serrata* in Ye Estuary

In Indonesia, Yudiati et al. (2020) calculated the size distribution of *S. serrata* rahging from 52 mm to 156.4 mm CW with the dominant size CW 80.5-99.4 mm for all individuals. The size distributions (CL) of crabs ranging from 20 to 240 mm, from 17 to 126 mm, from 46 to 215 mm, from 50 to 125 mm and from 1.5 to 13.5 cm were reported by Mohanty et al. (2006), Devi (1985), Sarada (1997), Fondo et al. (2010) and Zafar et al. (2006). The size distributions (CW) of crabs ranging from 32 to 130 mm and from 27 to 168 mm were found by Ali et al. (2004) and Devi (1985). Therefore, the maximum size distributions of previous results from different regions were greater than that of the present result.

Moreover, Widigdo et al. (2017) also conducted the size distribution of mud crabs from Indonesia. In their findings, the caparace length and width varied from 40 to 89 mm CL

and from 59 to 128 mm CW in males while the females ranged from 32 to 91 mm CL and 53 to 122 mm, respectively.

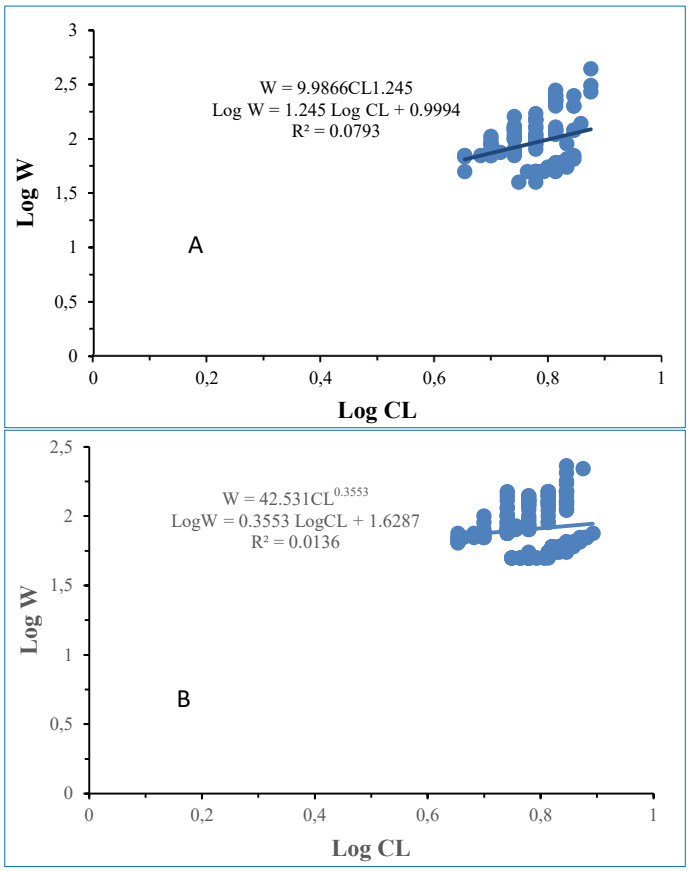

Fig. 4. A scatter plot of log transformed carapace length and body weight for mud crab Scylla serrata during the present study; A) Male and B) Female

Ahmadoon (2019) studied *S. serrata* conducted in Red Sea Coast analyzed 100 specimens and found that CW ranged from 11.64 to 19.95 mm in males and from 12.73 to 20.86 mm in females. Khan and Mustaqeem (2013) estimated the average CL and CW for *S. serrata* as 68.09 mm and 102.48 mm and the average weight as 182.80 g in Karachi coast. Therefore, the previous findings for CL and CW were closely coincided with the present findings.

Sex ratio is important to understand the population structure and reproductive performance in crustaceans, and it may vary from 1:1 ratio depending on the environmental conditions, maturity stage of the animal, migratory behaviour and so on (cited in Tirumani et al., 2017). Sex ratio of male to female of mud crabs were 1:1.42 in the present result. Chi-Square test of sex found a significantly different ($p > 0.05$), indicating that the variation of mud crabs between the number on male and female was significantly observed in both sexes. Therefore, the sex ratio showed that female is excessive than male in the present study.

The result of the present study agreed with other study by Tirumani et al. (2017). However, the dominance of males over females was proved to occur frequently in the previous studies by Yudiati et al. (2020), Bonine et al. (2008), Widigdo et al. (2017), Ali et al. (2004) and Fondo et al. (2010).

3.2. Carapace Length / Width Relationships and Condition Factor

The carapace length weight and carapace width weight relationships of *Scylla serrata* were examined during the present study from Asin landing area, Ye Estuary. A Scatter diagram was composed of plotting logarithm of carapace length/width against logarithm of weight of individual crabs (Figs. 4-6). In the present study, the carapace length of *S. serrata* ranging from 4.5 cm to 7.8 cm; carapace width ranged from 3.4 cm to 12 cm and weight ranged from 40 g to 440 g. In the present findings, the carapace length weight relationship showed the logarithmic equations was as follows: log W = 0.9994 + 1.245 Log CL for male, log W = 1.6287 + 0.3553 log CL for female and log W = 1.4303 + 0.6420 Log CL for combined. The b values of male, female and combined sexes were 1.245, 0.3553 and 0.642 (Table 2). The R-squared obtained for the carapace length and weight of males, females and combined were ranged from 0.0136 to 0.0793. These values indicated that correlations of length and weight for mud crabs were negative correction in the present study.

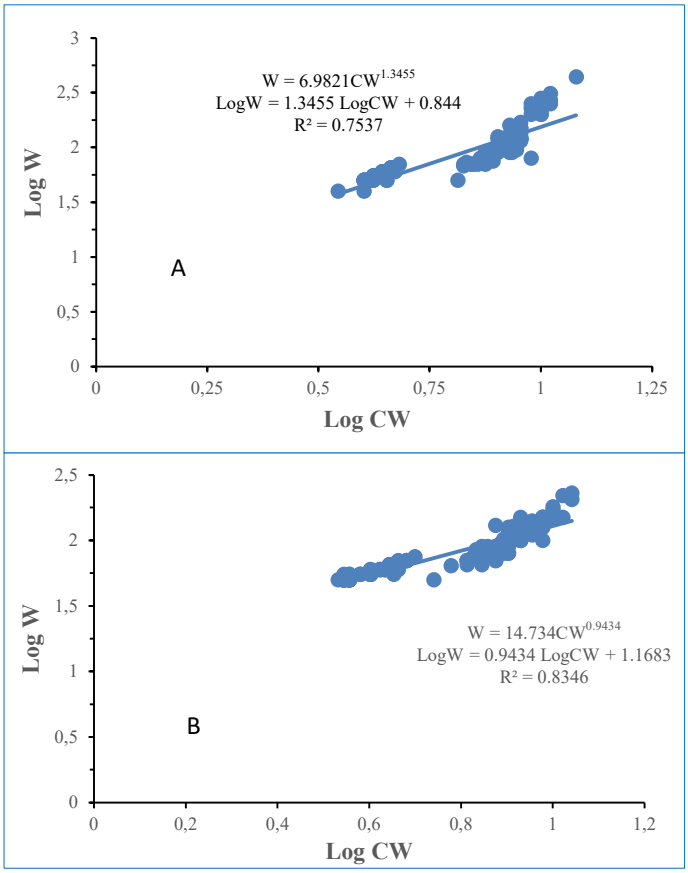

Fig. 5. A scatter plot of log transformed carapace width and body weight for mud crab Scylla serrata during the present study; A) Male and B) Female

In the present findings, the carapace width weight relationship showed the logarithmic equations was as follows: log W = 0.8440 + 1.3455 Log CW for male, log W = 1.1683 + 0.9434 log CW for female and log W = 1.0549 + 1.0901 Log CW for combined. The b values of male, female and combined sexes were 1.3455, 0.9434 and 1.0901 (Table 2). The R-squared obtained for the carapace length and weight of males, females and combined were ranged from

0.7537 to 0.8346. These values indicated a high degree of positive correlation of width and weight for male and female crabs in the present findings

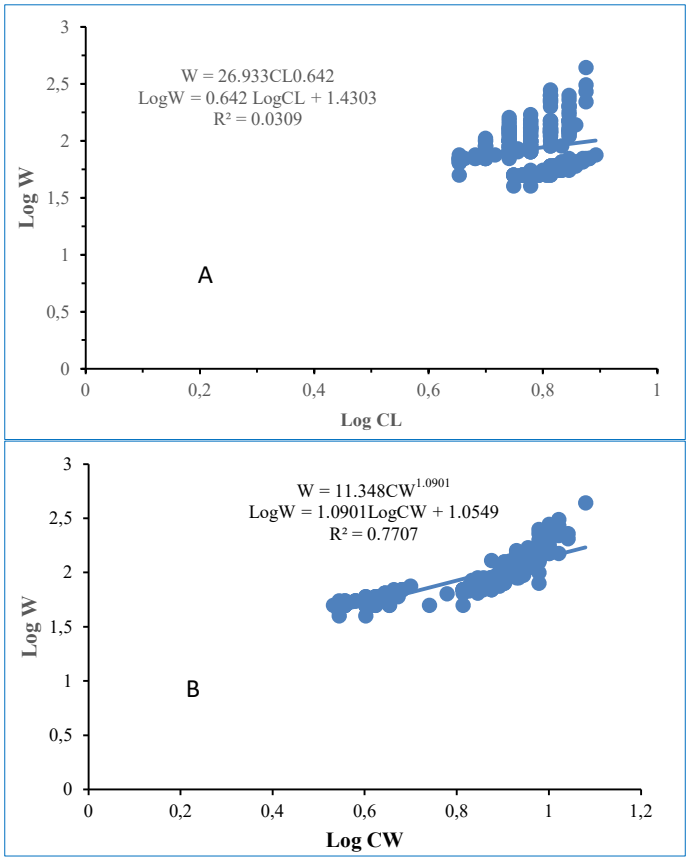

Fig. 6. A scatter plot of log transformed; A) carapace length and body weight and B) carapace width and body weight for the combined mud crab Scylla serrata during the present study

The length weight relationships for the crustaceans are suitable for the crab population which is also useful for the stock assessment model (Al-Rumaidh et al., 2005). The length weight relationship of any species is important to know about the gonadal maturity, estimation of metamorphosis and and rate of feeding and important parameter for the fisheries stock assessment for the better management (Afzaal et al., 2018).

In the present result, the carapace length weight analysis of *Scylla serrata* for males, females and combine crabs observed that the b-values were lower than 3. Therefore, males, females, and total individuals crab showed negative allometric growth (b < 3), respectively (Table 2). In the relationship between carapace length/width and weight of *S. serrata*, the variation of mud crabs was significantly observed in both sexs (P>0,001) in the present area. The growth patterns of male and female *S. serrata* in the present study area are negative allometric (b<3). This is also expressed that the increment of crab carapace length/width is faster than the weight increment.

Widigdo et al. (2016) reported that the “b” value for *Scylla serrata* as 2.9725 for males and 2.375 for females. Zafar et al. (2006) obtained similar results for “b” values with males (2.37) and females (2.75) with CL. Myla et al. (2017), Ahmadoon (2009) and Sarada (1997) reported that the “b” values obtained in their findings were 2.9891, 2.3512 and 2.7388, respectively. Therefore, the results of the present study agree with other findings by above-mentioned researchers that the growth pattern of *S. serrata* is negative allometric. Moreover, Fondo *et al.* (2010) determined the “b” value of mud crabs for females and males were 2.5863 and 3.3827 with CL in East Africa.

Myla *et al.* (2017), Ahmadoon (2009), Gayathre et al. (2016), Siahainenia et al. (2016) and Khan and Mustaqeem (2013), study on *S. serrata*, found the “b” values in the relationship between CW and W as 2.9210, 2.2065, 2.9147, 2.992 and 2.571. Yudiati et al. (2020) obtained the results for “b” values with males (2.522) and females (2.096) with CW. Devi (1985) estimated the “b” values for males and females as 2.7183 and 2.6582. Thus, the "b" values of above-mentioned studies indicated the negative allometric (b<3) which were similar to the present study.

Table 2. Caparace length/width weght relationships of *Scylla serreta* in Ye Estuary

Sex	Caparace length weight relationship				Caparace width weight relationship			
	a	b	r	K	a	b	r	K
Male	0.9994	1.245	0.2816	49.07±23.78	0.8440	1.3455	0.8682	35.25±23.58
Female	1.6287	0.3553	0.1166	39.94±19.16	1.1683	0.9434	0.9136	48.99±38.36
Combine	1.4303	0.642	0.1758	43.71±21.62	1.0549	1.0901	0.8779	43.31±33.70

a = intercept of the regression curve (a constant); and b = regression coefficient; r = correlation coefficient; K = condition factor

However, the previous studies such as Widigdo et al. (2017) and Ali et al. (2004) reported the negative allometric for males and the positive allometric for females in Indonesia and Bangladesh. Similarly, Mohapatra et al. (2010) also reported the negative and positive allometric growth of crabs in India. Compared to the other studies, the “b” values obtained in this study were higher than the present study.

The condition factors estimated by the carapace length and weight of *S. serrata* were 49.07±23.78, 39.94±19.16 and 43.71±21.62 for males, females, and combined data, respectively (Table 2). Moreover, the condition factors estimated by the carapace width and weight of mud crabs were 35.25±23.58, 48.99±38.36 and 43.31±33.70 for males, females, and combined data, respectively (Table 2).

The high condition factors of the present study indicated the high feeding intensity and spawning activity. Compared to the other study by Ali et al. (2004), the average condition factor for *S. serrata* was 24.65. The condition factor values obtained in the other studies by Mohapatra et al. (2010), Siahainenia et al. (2016) and Aneesa et al. (2025) were lower

than those obtained in the present study as the K values were obtained using CL and CW in mud crabs.

4. Conclusion

The present study provides the first detailed information on carapace length/ width weight relationship of *Scylla serrata* from Ye Estuary. The present finding shows that the carapace length weight and carapace width weight relationships of *S. serrata* are negative allometric (b<3). The present study could be useful for crab fishery biologists to estimate the carapace length/width based on body weight. This relationship describes the species' fatness because the condition factor was 43.31. The estimation of condition factor value is essential for fisheries management activities, providing baseline data for conservation on the health of mud crab populations. Moreover, the present study recommends that the crab fishery managers take some management steps to avoid catching small size crab at landing sites.

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