



Research Article

Length-weight Relationship, Condition Factor and Percentage Edibility of Lyrate Hard Clam, *Meretrix lyrata* (Swerby, 1851) Collected from The Sundarbans Mangrove Forest of BangladeshShah Rafia Tangin Mohona¹, Mirza Sadia Rahman² and Md. Jasim Uddin^{1,2✉}¹Department of Marine Fisheries Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh²Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

ARTICLE INFO	ABSTRACT
Article history Received: 13 June 2026 Accepted: 24 September 2026 Published: 30 September 2026 Keywords Hard clam; <i>Meretrix lyrata</i>; Length-weight relationship; Condition factor; Percentage edibility; Sundarbans Correspondence Md. Jasim Uddin ✉: jasimfm@bau.edu.bd OPEN ACCESS	Length-weight relationships (LWR) and condition factor (K) are crucial biological parameters for understanding growth patterns, population dynamics, and the well-being of bivalve populations. This study aimed at investigating the LWR, condition factor, and percentage edibility of the Asiatic hard clam, <i>Meretrix lyrata</i> collected from Alorkol, adjacent to Dubla Island in the Sundarbans East Mangrove Forest of Bangladesh. A total of 130 individuals were sampled, with shell lengths (SL) ranging from 3.87 to 6.53 cm, shell height (SH) varying from 2.34 to 4.68 cm, shell thickness (ST) changing from 3.31 to 5.61 cm and total weights (TW) ranging from 23.75 to 85.95 g. The SL-TW, SH-TW and ST-TW relationship, regression parameters (a and b) and coefficient of determination (R^2) were established for <i>M. lyrata</i> obtained from the habitat. The regression equation obtained for SL-TW was $TW = 1.077 SL^{2.333}$. The same in logarithmic equation can be written as $\ln(TW) = 0.074 + 2.333 \times \ln(SL)$. The correlation coefficient (r) between SL and TW was 0.934 indicated very strong positive correlation between the variables. The regression equation constructed for SH-TW was $TW = 8.281 SH^{1.535}$ and for ST-TW was $TW = 1.992 ST^{2.037}$. The b value obtained for three different lengths-TW relationships (2.333 for SL-TW, 1.535 for SH-TW and 2.037 for ST-TW) indicated negative allometric growth of <i>M. lyrata</i> along the southeast coast of the Sundarbans Mangrove Forest of Bangladesh. Fulton's condition factor (K) for <i>M. lyrata</i> ranged from 0.09 to 0.65, with a mean value of 0.36 ± 0.07 is comparable with the K values reported for other clam species from different geographic locations. Percentage edibility (PE) of <i>M. lyrata</i> ranged from 6.42 to 14.19%, indicating poor well-being of the species in the habitat. These findings provide baseline biological data for sustainable management of <i>M. lyrata</i> in the Sundarbans of Bangladesh.
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Introduction

Molluscan shellfish play a significant role in global fisheries, ranking as the second largest contributor to global fisheries production, following finfish and excluding seaweeds (FAO, 2022). Among the molluscs, bivalves represent one of the most significant groups of invertebrates in aquatic ecosystems, both ecologically and economically. They play crucial roles as filter feeders, contributing to water clarification, nutrient cycling, and the maintenance of ecosystem health (Cranford et al., 2011; Islam et al., 2020; Shah et al., 2022). Globally, bivalve aquaculture and capture fisheries have shown consistent growth over the past two decades, driven by increasing demand for high-quality seafood protein (FAO, 2012; Gallardi, 2014; Ayesha et al., 2026). In Bangladesh, fisheries contribute

substantially to national food security, employment, and GDP. The country produced 50.18 lakh MT of fish in 2023-24, of which marine fisheries sector accounted for 6.286 lakh MT (12.5% of total production) (DoF, 2024). Among marine resources, mollusks, particularly bivalves such as clams, oysters, mussels, and cockles hold considerable untapped potential (Mia et al., 2024; Uddin et al., 2024a, 2024b; Asadujjaman et al., 2026).

Clams are among the most important edible bivalves worldwide (Johnson et al., 2025). They inhabit a wide range of environments, from freshwater to fully marine habitats (Gosling, 2003), and are valued for their nutritional profile, including high protein, essential minerals, omega-3 fatty acids, and low-fat content (Karnjanapratum et al., 2013). The Asiatic hard clam,

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Meretrix lyrata, belonging to the family Veneridae. It has thick, equivalved and moderately inflated shell that is subtrigonal to ovate in outline with a lyre-like posterior slope, fine concentric grooves on the surface, anterior umbones and a strong hinge with cardinal teeth. Physiologically, as a filter feeder, it consumes phytoplankton and organic detritus via fused siphons; exhibits gonochoristic sexual reproduction and reaches sexual maturity at approximately 3.1-4.2 cm (Hossain et al., 2023).

M. lyrata is a commercially significant species widely distributed across Asian coastal waters, including Bangladesh, India, Malaysia, Vietnam, and the Philippines (Admodisastro et al., 2021; Phyu et al., 2019). *M. lyrata* is not only significant in terms of its commercial value as food for human consumption but also remarkable as an edible species in the marine ecological food web. It serves as a major food source for wading birds, intertidal-feeding fish, and crustaceans such as shore crabs and shrimps (Burdon et al., 2014). In addition, it has the ability to act as a sentinel species and as a bioindicator for marine pollutants such as heavy metals and polycyclic aromatic hydrocarbons (PAHs) (Dan et al., 2001). Locally known as “hamaguri” or “Asiatic hard clam,” this species is harvested from intertidal and shallow subtidal zones, particularly in mangrove-associated estuarine systems.

The Sundarbans mangrove forest, the largest in the world and a UNESCO World Heritage Site, serves as a critical habitat for *M. lyrata* in Bangladesh (Hamli et al., 2017). This unique ecosystem, located in the southwestern part of the country, provides ideal conditions characterized by muddy-sandy sediments, fluctuating salinity, and high organic matter input from mangrove detritus. However, the Sundarbans is increasingly threatened by climate change, sea-level rise, salinity intrusion, pollution from upstream rivers, and over-exploitation of resources. These pressures may significantly influence the growth, condition, and population dynamics of resident bivalve species (Hamli et al., 2015).

The Chandpai range in the Sundarbans features a tropical moist, equable climate with an average annual temperature ranging from 12 to 32.4°C (Hossain et al., 1998). There is wide temporal variation in conductivity (from 201 μ S/cm to 43.7 mS/cm) and TDS (0.13 to 31.2 g/L) from the eastern to western Sundarbans suggests low flow of freshwater into the western Sundarbans. BOD and COD are higher in coast than the inner part of the Sundarbans (Ahmad and Rahman, 2010). There are distinct salinity gradients that gradually decrease from the eastern to western parts of the forest. Its salinity profile heavily relies on freshwater discharge from the

Ganges-Brahmaputra River system, fluctuating dramatically by season between 0.5 to 25 ppt (Siddique et al., 2017). Neutral to slightly alkaline environment (pH 6.5 to 8.0) of the Sundarbans mangrove forest are reported which changes due to tidal amplitude and seasonal freshwater influx and water logging effects (Ahmad and Rahman, 2010).

Understanding population parameters such as length-weight relationship (LWR), condition factor (K), and percentage edibility (PE) is fundamental for effective fisheries management and aquaculture development. The length-weight relationship ($TW = a \times SL^b$) provides essential information on growth patterns (isometric or allometric), which helps in converting length data to weight for biomass estimation, stock assessment, and yield prediction (Pauly, 1993; Froese, 2006). Deviations from isometric growth ($b = 3$) often reflect environmental influences, food availability, or reproductive status. The condition factor (Fulton's K) serves as a proxy for the overall well-being, nutritional status, and physiological health of the organism (Le Cren, 1951). Meanwhile, percentage edibility indicates the proportion of soft tissue (edible portion) relative to total body weight, which is critical for assessing market value, nutritional quality, and food safety (Lagade et al., 2014; Mohite et al., 2009).

Despite the ecological and socioeconomic importance of *M. lyrata* in Bangladesh, scientific information on its population biology from the Sundarbans remains limited. Hossain et al. (2023) reported the taxonomic affiliation, reproductive biology and nutritional value of *M. lyrata* from the Bay of Bengal. Annual gametogenic phenology and gross biochemical composition of *M. meretrix* were also reported from the southeast coast of the Bay of Bengal of Bangladesh (Khanom et al., 2023; Mia et al., 2024). Majority of the current research on the species have been conducted in Malaysia (Admodisastro et al., 2021), Myanmar (Phyu et al., 2019), and India (Takar et al., 2023), where growth patterns, condition indices, and edibility percentages have shown considerable spatial and temporal variations. Currently, there is no comprehensive study focusing on LWR, condition factor, and percentage edibility of *M. lyrata*, particularly from the Sundarbans mangrove ecosystem of Bangladesh. Therefore, the study was undertaken to establish the length-weight relationship, condition factor and percentage edibility of hard clam, *M. lyrata* collected from the Sundarbans of Bangladesh.

Materials and Methods

Sampling efforts

Asiatic hard clam (*Meretrix lyrata*) samples were collected from Alorkol (latitude 21.71°N, longitude 89.59°E), adjacent to Dubla Island in the Sundarbans East Mangrove Forest of Bangladesh as shown in Figure

1. A total of 130 individuals were handpicked with assistance from local fishers during May, 2024. Samples were cleaned, placed in an icebox, and transported to the Aquatic Ecology Laboratory, Bangladesh Agricultural University, for further processing.

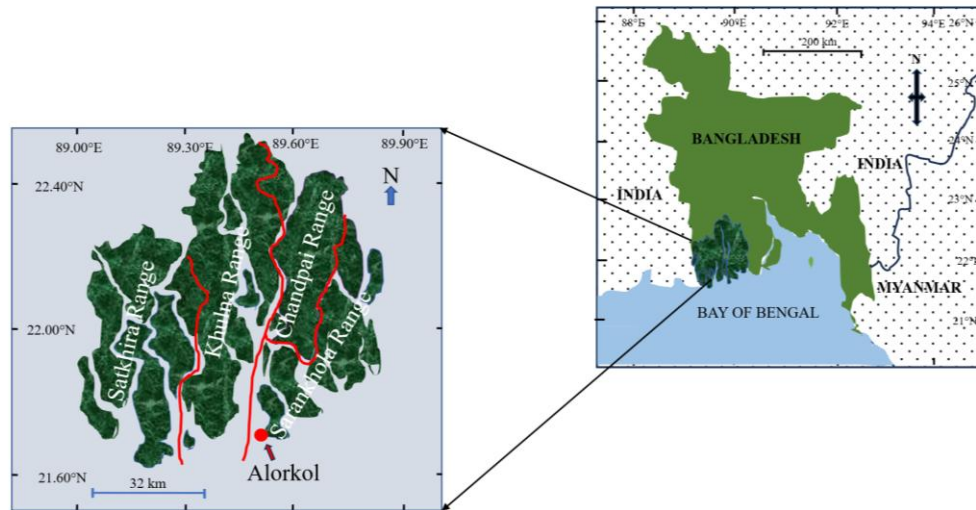


Fig. 1: Map showing the sampling location (Red circle) at Alorkol, adjacent to Dubla Island, Sundarbans East Mangrove Forest of Bangladesh

Biometric measurements

Upon arrival, the samples were washed in running tap water to remove mud and other waste materials. Shell length (SL, cm) was measured using digital calipers (Heng Liang, China) as the maximum anterior-posterior dimension. Shell height (SH, cm) and shell thickness (ST, cm) were also measured using the same calipers. Total weight (TW, g) was recorded using an electronic balance (Eki 300-2n, EKI Series Balance). Soft tissues were carefully dissected out, and tissue wet weight (TWW) was recorded by an electronic balance after blotting excess water.

Length-weight relationships (LWRs)

The length-weight relationships of *Meretrix lyrata* in terms of SL-TW, SH-TW and ST-TW was constructed using the equation of Le Cren (1951): $W = aL^b$ as $TW = aSL^b$, $TW = aSH^b$, and $TW = aST^b$.

After logarithmic transformation of length-weight data, this equation was expressed as- $\ln(TW) = \ln a + b \times \ln(SL)$, $\ln(TW) = \ln a + b \times \ln(SH)$, and $\ln(TW) = \ln a + b \times \ln(ST)$ where, TW = Total weight of the clam in g, SL = Shell length of clam in cm, SH = Shell height of the clam in cm, ST = Shell thickness in cm, $\ln a$ = Intercept of the regression curve, and b = Slope of the

regression curve (exponent). The constants “ $\ln a$ ” and “ b ” are determined through the application of the least squares method. The coefficient of determination (R^2) was used to calculate the degree of association between the variables. The “ b ” value was compared to the isometric value of $b = 3$; negative allometry was inferred if $b < 3$, while positive allometry was concluded if $b > 3$ (Le Cren, 1951).

Condition factor (K)

The condition factor (K) of *M. lyrata* was calculated for each clam individual following the equation given by Fulton (1904):

$$K = \frac{TW}{SL^3} \times 100_0$$

where, TW = Total weight (g), and SL = Shell length (mm).

Percentage edibility (PE)

The percentage edibility of the lyrata hard clam, *M. lyrata*, generally refers to the ratio of its edible parts (usually the soft tissue) to its total body weight. Percentage edibility was determined by the following

equation as described by Venkataraman and Chari (1951):

$$PE(\%) = \frac{TWW}{TW} \times 100$$

where, TWW = Soft tissue wet weight (g), and TW = Total weight (g)

Data analysis

All the data recorded from the study were tabulated in the Microsoft Excel spreadsheet and expressed as mean ($\pm$ SD). Regression parameters, correlation coefficients, and descriptive statistics were computed applying Microsoft Excel. Spearman rank correlation coefficient (r) matrices were tested among different lengths and total weight of the investigated species and were interpreted according to Schober et al. (2018) (0.10 to 0.39 as weak correlation; 0.40 to 0.69 as moderate correlation; 0.70 to 0.89 as strong correlation; and 0.90 to 1.00 as very strong correlation).

Results

Length-weight relationships

Out of 130 specimens of *Meretrix lyrata* analyzed, the SL, SH and ST ranged from 3.87 to 6.53 cm, 2.34 to 4.688 cm, and 3.31 to 5.61 cm, respectively. TW and TWW of the individual *M. lyrata* varied from 23.75 to 85.95 g, and 3.33 to 7.33 g, respectively.

The SL-TW, SH-TW and ST-TW relationships, regression parameters (a and b), correlation coefficient (r) and coefficient

lyrata population obtained from the Alorkol, adjacent to Dubla Island in the Sundarbans Mangrove Forest, Bangladesh are presented in Table 1. The regression equations obtained for SL-TW, SH-TW and ST-TW were $TW = 1.077 SL^{2.333}$, $TW = 8.281 SH^{1.535}$, and $TW = 1.992 ST^{2.037}$, respectively. The same in logarithmic equations can be written as $\ln(TW) = 0.074 + 2.333 \times \ln(SL)$, $\ln(TW) = 2.114 + 1.535 \times \ln(SH)$, and $\ln(TW) = 0.0886 + 2.037 \times \ln(ST)$, respectively for SL-TW, SH-TW and ST-TW relationships. The correlation coefficient (r) between SL-TW was 0.934 indicated very strong positive correlation between the variables. In case of SH-TW, the r value was noted as 0.698, reflected strong positive correlation between the variables. The r value between ST and TW was 0.830 reflected very strong positive correlation between the variables. The coefficient of determination (R^2) was found as 0.873, 0.487 and 0.689 for SL-TW, SH-TW and ST-TW, respectively. The b value obtained for three different lengths-TW relationships (2.233 for SL-TW, 1.535 for SH-TW and 2.037 for ST-TW) indicated negative allometric growth of *M. lyrata* sample along the coast of Sundarbans East Mangrove Forest of Bangladesh. At 95% confidence limits, the b values obtained for different lengths-weight relationships were significantly less than 3.0 reflected a negative allometric growth of *M. lyrata* population in the habitat. The generalized length-weight relationships in logarithmic form for SL-TW, SH-TW and ST-TW of *lyrata* hard clam, *Meretrix lyrata* collected from Alorkol, adjacent to Dubla Island, Sundarbans East Mangrove Forest of Bangladesh are shown in Figure 2.

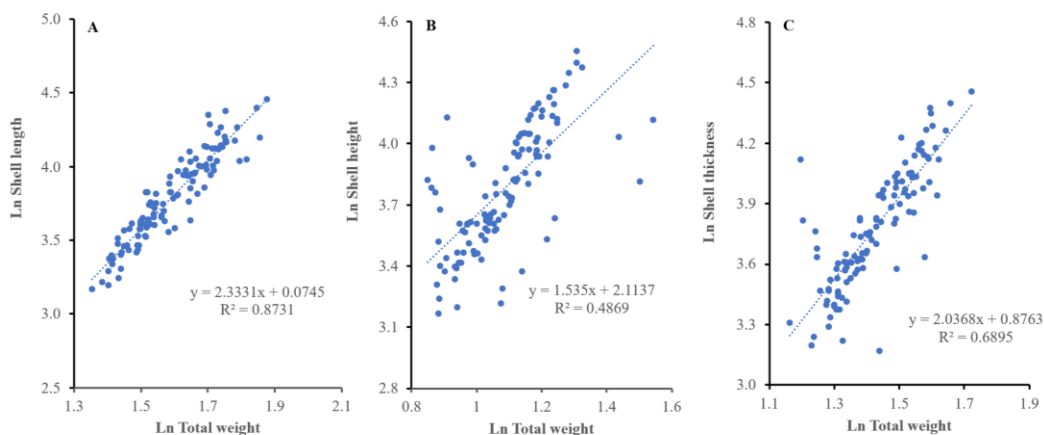


Fig. 2: Generalized length-weight relationships in logarithmic form, A. Ln shell length-total weight; B. Ln shell height-total weight; and C. Ln shell thickness-total weight of *lyrata* hard clam, *Meretrix lyrata* collected from Alorkol, adjacent to Dubla Island, Sundarbans East Mangrove Forest of Bangladesh

Table 1. Descriptive statistics and estimated parameters of the shell length (SL)-total weight (TW), shell height (SH)-TW, and shell thickness (ST)-TW relationships for *M. lyrata* collected from Alorkol, Sundarbans East Mangrove Forest, Bangladesh. Sample size, n = 130; TW, total weight (g); SL, shell length (cm), SH, shell height (cm); ST, shell thickness (cm); a and b, constants in the equation $\ln TW = \ln a + b \times \ln SL$; CI, confidence intervals; “lna”, intercept of the regression curve; and “b”, slope of the regression curve (exponent indicating growth pattern).

Species name	Relation	Equation	Regression parameters		Correlation coefficient (r)	Co-efficient of determination (R ²)	95% CI of b		95% CI of lna		Growth inference
			lna	b			Lower	Upper	Lower	Upper	
Asiatic hard clam	SL-TW	$TW = 1.077 SL^{2.333}$	0.074	2.333	0.934	0.873	2.167	2.499	-0.191	0.340	Negative allometric
	SH-TW	$TW = 8.281 SH^{1.535}$	2.114	1.535	0.698	0.487	1.239	1.830	1.790	2.437	Negative allometric
	ST-TW	$TW = 1.992 ST^{2.037}$	0.876	2.037	0.830	0.689	1.781	2.293	0.509	1.243	Negative allometric

Condition factor (K)

As the SL-TW exhibited highest correlation among the 3 different length–weight relationships, only the SL was considered for the estimation of condition factor (K). The K value of the individual *M. lyrata* varied from 0.09 to 0.65 with a mean value of 0.36 ± 0.07 (Figure 3A). The lowest K value (0.09) was reported for the clam having 79.22 mm in SL and 45.23 g in total weight. In contrast, the maximum K value (0.65) was noted for the clam measuring 46.18 mm in SL and 63.78 g in TW.

Percentage edibility (PE)

The PE obtained from the analysis of *M. lyrata* samples are shown in Figure 3B. The mean PE calculated for *M. lyrata* sample was $10.72 \pm 2.35\%$. The minimum PE value of 6.42% was recorded for the clam with a shell length of 5.25 cm and a total weight of 51.90 g. Conversely, the highest PE value of 14.19% was observed for the clam that measured 5.30 cm in standard length and weighed 45.38 g.

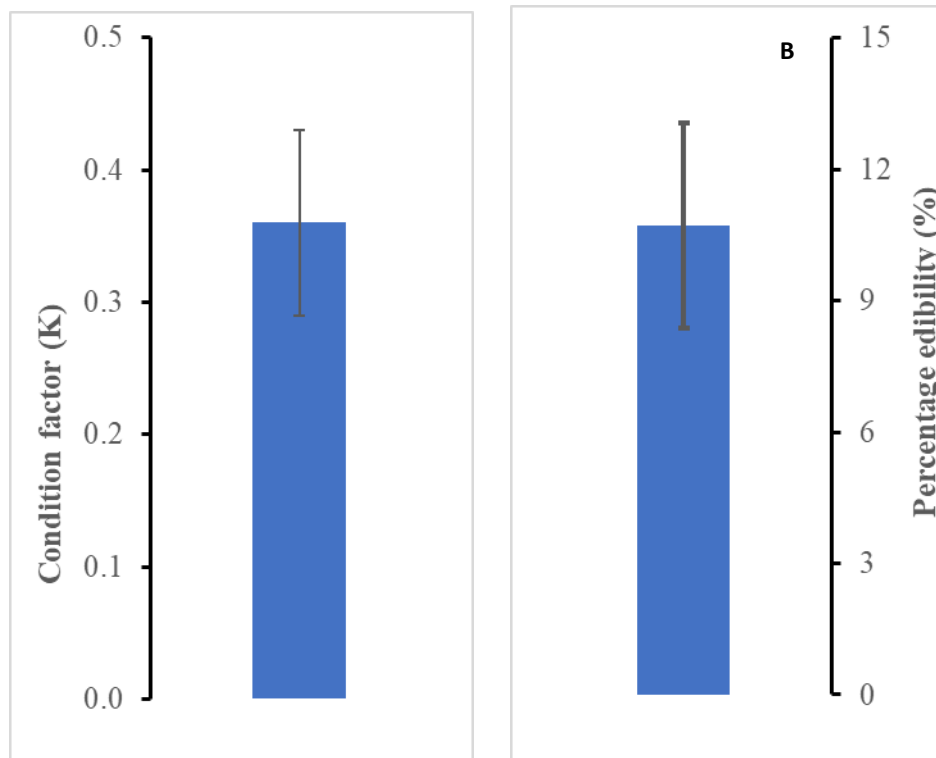


Fig. 3: Mean condition index, K (A), and percentage edibility (B) of lyrate hard clam, *Meretrix lyrata* collected from Alorkol, adjacent to Dubla Island, Sundarbans East Mangrove Forest of Bangladesh

Discussion

The length-weight relationships (LWRs) of lyrate hard clam (*Meretrix lyrata*), as SL-TW, SH-TW and ST-TW obtained from Alorkol, adjacent to Dubla Island in the Sundarbans Mangrove Forest, Bangladesh showed distinct growth patterns. In the present study, negative allometric growth of the *M. lyrata* population was reported for all three LWRs as evidenced from the range of b values < 3 at 95% confidence interval. This means that in the studied population, lengths increase at a faster rate than total body weight as energy allocation toward soft tissue growth is comparatively lower. Negative allometry is very common in case of bivalves, although positive allometry was also reported in some species of the same genus. Negative allometric growth has been reported in several venerid clams, including *M. meretrix* from various Asian locations (Hariyadi et al., 2023; Takar et al., 2023; Hira et al., 2025; Adriani et al., 2026). The relatively low b-value observed in the current study may reflect environmental constraints typical of the Sundarbans, such as fluctuating salinity, high sediment load, variable food availability from mangrove detritus, and possible anthropogenic stressors. In bivalves, negative allometry often occurs when energy is preferentially allocated to shell growth for protection against predation and physical stress rather than somatic tissue accumulation (Bayne, 1985; Turra et al., 2015). In contrast, bivalves in nutrient-rich or stable habitats might demonstrate isometric or positive allometric growth in tissue weight due to abundant resources.

Based on the degree of correlation, we applied SL and TW for the estimation of condition factor (K). In our study, the K value varied from 0.09 to 0.65. The K values we obtained for *M. lyrata* in our study align with those reported by Phyu et al. (2019), who found K values between 0.31 and 0.45 for *M. meretrix* in Myanmar. The observed mean K value (0.36 ± 0.07) estimated for *M. lyrata* is lower than the K value reported by Hira et al. (2025) for *M. meretrix* (6.71 ± 1.03). This discrepancy may arise from the application of Fulton's formula, which considers both the total weight and the tissue wet weight of the animal in the two distinct scenarios. Nevertheless, the K values of the current study is comparable with Ragheb (2023) who reported K values for 33 fish species ranging from 0.05 to 2.13. The wide variation in K values in our study reflected that some clams had total weight far exceeding the mean values for their shell length. Condition factor of bivalves is often associated with food availability, environmental variability, or pollution levels (Narkko et al., 2005; Ciparis et al., 2019; Barman et al., 2023). The considerable variation in K values suggests that while the environment is generally productive, inconsistent

water conditions lead to varied growth responses among individuals.

To our knowledge, this is the first report on percent edibility (PE) of *M. lyrata*. PE of the lyrate clam population ranged from 6.42% to 14.19% with a mean value of 10.72%. These values are lower than the typical 20-40% range reported for many commercial venerid clams (Wei et al., 2021; Lagade et al., 2014; Mohite et al., 2009). The relatively low edible yield may be attributed to higher shell-to-tissue ratios resulting from negative allometric growth and environmental stress. Such low PE values are often associated with limited food resources, high environmental variability, or pollution stress-conditions, increasingly documented in the Sundarbans due to climate change and upstream anthropogenic activities. Babar et al. (2017) reported the PE of freshwater mussel, *Lamellidens corrianus* as 24.9% to 26.5%, whereas, Theodoru et al. (2023) obtained the values from 20.5% to 30.7% for pearl oyster, *Pinctada imbricata radiata* from the West of the Aegean Sea, Greece. The PE may vary with species, geographic location, gametogenic cycle, seasonal changes in environmental variables etc. However, there was report on PE of the species to compare the values.

Conclusion

This study provides the first detailed account of length-weight relationships, condition factor, and percentage edibility of lyrate hard clam, *Meretrix lyrata* from the Sundarbans East Mangrove Forest of Bangladesh. The negative allometric growth pattern, moderate condition factor, and relatively low percentage edibility collectively indicate that the *M. lyrata* population in the studied area of the Sundarbans is under some degree of environmental pressure. These findings have important implications for sustainable fisheries management. These baseline parameters are valuable for stock assessment, aquaculture development, and ecosystem monitoring in the Sundarbans, a UNESCO World Heritage Site facing climate change and anthropogenic pressures. Future studies should incorporate seasonal sampling, gonadal histology, and water quality parameters for a comprehensive understanding of population dynamics and reproductive ecology of the species. Monitoring these parameters are essential for ensuring the sustainability of both the species and the ecosystem they inhabit.

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Credit authorship contribution statement

Shah Rafia Tangin Mohona: Sample collection, laboratory analysis, data analysis, preparation of first draft, revision; Mirza Sadia Rahman: Sample collection, laboratory analysis, preparation of first draft and revision; Md. Jasim Uddin: Plan, fund acquisition, research supervision, preparation of first draft and revision

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