

Research Article

Descriptive morphometric analysis of three common bivalve species from Chandipur, Odisha, Eastern India

S K Kolay*

Department of Geology and Geophysics, Indian Institute of Technology Kharagpur, Kharagpur – 721 302, India

*[E-mail: kolaysudipto1234@gmail.com]

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The present study addresses a comprehensive morphometric analysis of three prevalent bivalve species from the Chandipur coast (latitude 21°3' – 21°47' N and longitude 86°02' – 87°20' E), Odisha, India. About 1875 specimens are used in this comprehensive analysis, belonging to the representative species *Mactra luzonica* Reeve, 1854, *Timoclea scabra* (Hanley, 1845), and *Donax scortum* (Linnaeus, 1758) from three different families viz. Mactridae, Veneridae, and Donacidae. The morphometric analysis found strong linear correlations between shell length (L), height (H), and width (W) with statistical significance at $p < 0.01$, however, the correlation between body size and thickness is weak. Further analysis of morphometric indices, including elongation (H/L), narrowness (W/L), and flatness (W/H) for each species, revealed moderate variations for *D. scortum* and *T. scabra*, while the variations were more profound in *M. luzonica*. An analysis of body shape (L/H) reveals *D. scortum* being more elliptical (L/H: 1.5 to 2.0) and *T. scabra* being more oval (L/H < 1.5), while *M. luzonica* has almost equal distributions in both shapes. This morphological variation is attributed to various ecological stresses as well as habitat conditions. The data provided here can further aid in research related to ecology and conservation of these valuable marine resources.

[Keywords: Bivalves, Descriptive analysis, Morphology, Morphometric indices, Morphometry, Odisha]

Introduction

Bivalves display a diverse range of morphological differences in their shell characteristics, including biometric features and ornamentation. These morphological aspects are shaped by the environmental conditions that define their habitat^{1,2}. Contemporary bivalve species are often investigated for correlation with environmental conditions³. These findings can then be extended to interpreting fossilised remains, shedding light on palaeoecological settings⁴. Investigations on the widely available bivalve *Pisidium subtruncatum* have revealed the effects of environmental heterogeneity on morphology⁵. The findings suggested that shell shape variation is controlled by sediment grain size, with asymmetric shells predominant in sandy settings, while more rounded shells occur in muddy sediments. A similar investigation⁶ on the genus *Cerastoderma* revealed that external factors like salinity and tidal energy bear significant implications on shell morphology and growth parameters. Meanwhile, a recent study⁷ showed that for the contemporary bivalve species, *Donax scortum*, the shell morphometric elements (shell length, shell height),

along with ornamentation, dictates much of the post-mortem transportation.

The beaches along the Eastern coast of India are ideal for investigating the variability in bivalves in a shallow coastal environment. It is a littoral zone that corresponds to a tidal flat environment, with full sedimentological characteristics of the shallow subtidal, intertidal bars, beaches to intertidal marshes, dunes zones⁸⁻⁹. This variation in environment is characterised by a variation of salinity levels, grain size (2 to 2.5 Φ)⁸, and nutrient availability. The high tide region along the coast is characterised by well-sorted, medium-fine sands, while coarser and moderate to poorly sorted sands dominate the low tide area. Grain size studies⁸ have yielded that mean diameter in high tide zones varies from 2.38 to 2.5 Φ while for low tide regions it is at around 1.82 Φ . The salinity content of the seawater varies from 33.5 – 34.5 ppt during the premonsoon months, while it varies from 26.6 – 27.0 ppt during the post-monsoon. The variation in the seawater pH levels has been noted to be from 7.87 \pm 0.24 during the post-monsoon to 7.44 \pm 0.12 during the premonsoon¹⁰. In terms of nutrient availability, the Bay of Bengal is relatively

less productive due to limited nutrient supply. Submarine Groundwater Discharge (SGD) makes a significant contribution to nutrient availability ($240 \text{ mM NO}_3^- \cdot \text{m}^{-2} \cdot \text{day}^{-1}$) in the Chandipur coastal region¹⁰. Additional research¹¹ has indicated the productivity variation in the Chandipur coast. It has been noted that nutrient availability and productivity were higher in winter compared to that of in summer or monsoon. Relative rates of productivity were estimated through chlorophyll concentrations, which varied from $0.32 \pm 0.35 \text{ mg/m}^3$ in winter to $3.17 \pm 0.12 \text{ mg/m}^3$ in summer, while in monsoon, it dropped to $2.51 \pm 0.16 \text{ mg/m}^3$ (ref. 11). These variable physical parameters contribute significantly to the remarkable diversity of molluscan species found in this area. A comprehensive taxonomic study¹² revealed the presence of approximately 59 bivalve species belonging to 37 genera and 47 gastropod species distributed among 27 genera. Notably, within the bivalve category, species from the families Mactridae¹³, Veneridae¹⁴, and Donacidae¹⁵ are particularly prevalent in this region. Numerous investigations have addressed the range of diversity, interplay within prey-predator dynamics, dietary preferences, and habitat inclinations exhibited by the examined bivalve taxa in the Indian region, including Odisha¹⁶⁻¹⁷. Considering the immense importance of the bivalves in maintaining the coastal ecosystem, it is necessary to address their biometric features to facilitate further steps in their cultivation and conservation. The present study aims to investigate the morphometric variation of bivalve shells in the intertidal zone at the Chandipur beach (Odisha State) based on growth rates, at intra- and interspecies level. This study encompasses three bivalve species, namely *Maetra luzonica*¹⁸, *Donax scortum*¹⁹, and *Timoclea scabra*²⁰ from the families Mactridae, Donacidae and Veneridae, respectively.

Materials and Methods

Study area

The Chandipur coast (Fig. 1) is situated within the geographical coordinates of latitude $21^\circ 3' - 21^\circ 47' \text{ N}$ and longitude $86^\circ 02' - 87^\circ 20' \text{ E}$, located in the Balasore district of Odisha state. This coastal region is distinguished by its high tide and low tide zones and the formation of an estuarine system due to the discharge of the Buribalam river into the Bay of Bengal. The physical characteristics of the coast include a dynamic mouth bar, shifting coastline²¹, that

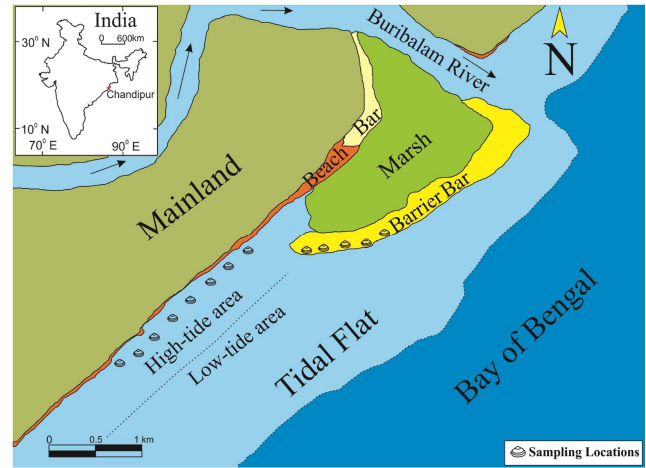


Fig. 1 — Map of Chandipur coast showing facies distribution of littoral zone and sampling locations

are a result of interactions among climatic factors, tectonic activity, and sea level fluctuations occurring throughout the holocene period⁹. From a geomorphological context, the coastal landscape exhibits two zones: (a) an undulating lowland inland, shaped predominantly by the fluvial processes of the Buribalam river, and (b) a coastal dune aligned parallel to the shoreline, positioned on older marine terraces. The foreshore zone is occupied by tidal flat, distinguished by two prominent zones: (a) a gently sloping (6°) high tide region facing the shoreline, and (b) an extensive silty plain 1.5 km wide, characterised by the presence of wave ripples²²⁻²³.

Sample collection

Sample collection was carried out from January to August 2023. All the specimens were collected by handpicking during low tides, from the top sediment layer from various sites along the high-tide area and the barrier bar (Fig. 1) proximal to the Buribalam river mouth. A targeted sampling approach was adopted to ensure representation of all three species of bivalve molluscs (Fig. 2). It facilitated the acquisition of a statistically meaningful number of specimens randomly distributed within the species (and families). It should be noted that the collection comprises only post-mortem disarticulated but unbroken shells that exhibit complete morphological characteristics. It is important to emphasise that no deliberate preference was given to specific taphonomic alterations or specimen dimensions during the collection process. In total, 1875 individual specimens were collected, with the majority comprising 1148 valves of *M. luzonica*, 516

specimens of *T. scabra*, and 211 specimens of *D. scortum*.

Morphometry

Shell morphometry elements dealt in present study include shell length (L), height (H), width (W), and thickness (T) (Fig. 3a, b). Following the established indices²⁴, shell length is defined as the longest distance along the antero-posterior axis, while shell height is measured from the umbo to the ventral margin. For the present study, using only disarticulated valves, individual valve width is defined as the maximum distance on the lateral axis between the maximum curvature point on the shell exterior and the horizontal plane on which the valve rests with its convex side up (Fig. 3b). Shell thickness is measured at the umbo region²⁵ (Fig. 3b).

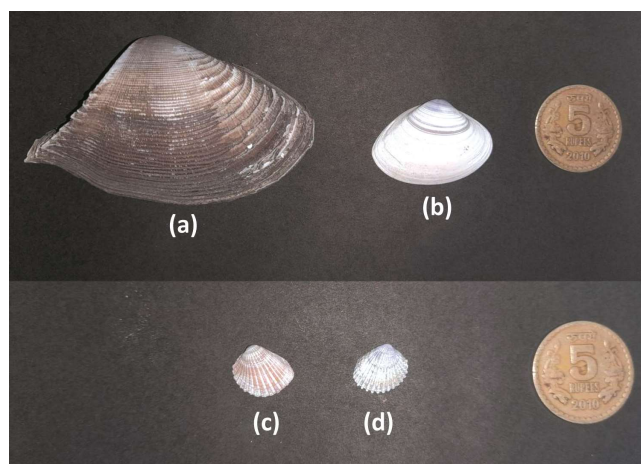


Fig. 2 — Species used in the study: a) *Donax scortum*, b) *Maetra luzonica*, and c, d) *Timoclea scabra*

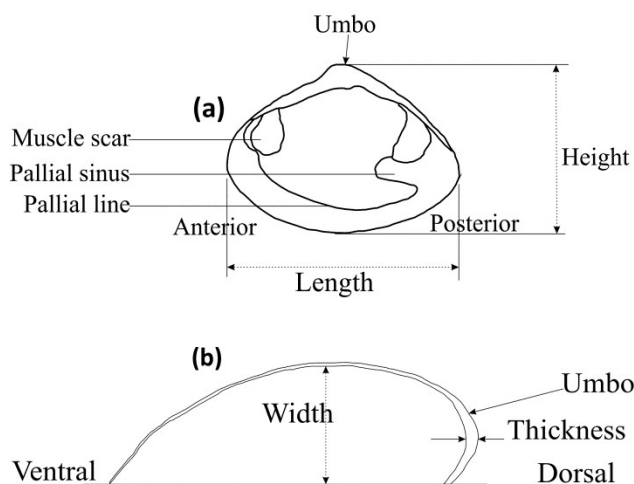


Fig. 3 — Schematic representation of shell morphometries: a) Internal view; and b) Sectional view

For determining Body Size (BS), the geometric mean of L and H has been adopted²⁶. A set of additional morphometric indices has been addressed in the study to further characterise the shell morphometries. The indices used are elongation index (H/L), narrowness index (W/L), and flatness index (W/H)²⁷. Body shape is represented by L/H ratio and is classified as: oval (L/H < 1.5), elliptical (L/H: 1.5 to 2.0), and elongate (L/H > 2.0)^{28,29}.

The morphometric analysis has been established by examining the interrelationships among shell dimensions such as L-H, L-W, and BS-T. Given the primary focus of this study on dimensions, all morphometric connections were elucidated using a linear regression equation: $Y = aX + b$. Here, Y represents the dependent variable, X stands for the independent variable, ' a ' denotes the regression coefficient slope, ' b ' signifies the constant or the intercept of the regression line. The coefficient ' a ' indicates the rate at which the dependent variable Y changes corresponding to variations in the independent variable X . All the morphometric associations and correlations of individual parameters were systematically investigated using this linear equation, along with pertinent statistical parameters and coefficients. A comprehensive morphometrics of the studied specimens has been provided in Table 1.

Methodology

Morphometric data for 1875 specimens have been collected using slide callipers with a resolution of 0.01 mm. Statistical analyses have been carried out in PAST version 4.11^(ref. 30). For all statistical studies, significance has been assumed at $p < 0.01$. All the plots have been made using Microsoft Excel Version 2310 (Build 16924.20150).

Results

Descriptive statistics

A comprehensive overview of the variations in different morphological parameters across the studied specimens is given in Figure 3. Within the studied species, *Timoclea scabra* exhibits the smallest average body size, measuring 10.16 ± 1.25 mm, with a range from 5.81 mm to 14.04 mm. *Maetra luzonica* demonstrates an average body size of 14.23 ± 4.24 mm, spanning from 5.92 mm to 8.82 mm, while the *Donax scortum* showed the highest average body size of 43.17 ± 9.77 mm, ranging from 20.28 mm to 57.82 mm (Table 1).

Table 1 — Morphometry parameters of the shell assemblage of the studied species

Species	Morphometric parameter	Mean±SD	Maximum value	Minimum value
<i>Donax scortum</i>	L	54.24±12.84	73.98	25.01
	H	34.32±7.44	45.18	16.43
	W	11.35±2.64	15.96	5.03
	T	1.05±0.27	1.64	0.22
	BS	43.17±9.77	57.82	20.28
<i>Timoclea scabra</i>	L	10.74±1.32	14.39	6.21
	H	9.60±1.21	13.69	5.43
	W	2.93±0.38	4.03	1.53
	T	0.25±0.05	0.436	0.01
	BS	10.16±1.25	14.04	5.81
<i>Mactra luzonica</i>	L	16.92±5.04	45.04	6.98
	H	11.97±3.58	33.45	3.38
	W	3.9±1.08	10.67	1.65
	T	0.37±0.31	1.39	0.01
	BS	14.23±4.24	38.82	5.92

*L – Length; H- Height; W- Width; T- Thickness; BS- Body size

When shell thickness (T) values are compared, it is found that *T. scabra* has the lowest mean thickness of 0.25 ± 0.05 mm, followed by *M. luzonica* (0.37 ± 0.31 mm), and then by *D. scortum* which showed highest mean value in thickness (1.05 ± 0.27 mm). In terms of shell width (W), *T. scabra* bears the lowest mean shell width value of 2.93 ± 0.38 mm, followed by *M. luzonica* (3.9 ± 1.08 mm), and *D. scortum* (11.35 ± 2.64 mm) (Table 1). The observed variations in studied morphometric parameters across each of the three species has been given in Figure 4(a – f).

Morphometric relationships

Morphometric relationships among the shell parameters (length vs. height, length vs. width, body size vs. thickness) exhibit linear correlations (Fig. 5a – c) established through a linear regression model using the ordinary least squares method. These morphometric relationships have demonstrated significant statistical relevance ($p < 0.001$) within the context of the specific species under investigation. The correlation coefficient (R^2) or Pearson coefficient indicates a strong alignment for all analysed relationships. Nonetheless, when examining the correlation between Body Size (BS) and Thickness (T), the R^2 values are relatively low across all species studied (Fig. 4; Table 2).

Morphometric indices

Numerical values of morphometric indices (H/L, W/L, W/H) (Table 3) showed a moderate variation for *Donax scortum* and *Timoclea scabra*. In the case of

Mactra luzonica, the variations are remarkable in each individual index. Elongation Index (H/L) has a mean value of 0.637 ± 0.024 for *Donax scortum* with a variation of 17.03 % within the studied assemblage. Among the individuals of *Mactra luzonica* and *Timoclea scabra*, the mean values of Elongation Index are 0.708 ± 0.03 and 0.894 ± 0.031 , respectively, with percentage variations of 70.71 % and 35.20 %, respectively.

The Narrowness Index (W/L) exhibits the lowest average value of 0.21 ± 0.018 for *Donax scortum*, followed by *Mactra luzonica* (0.232 ± 0.023), and the highest mean value of 0.273 ± 0.018 is observed in *Timoclea scabra*. The percentage fluctuations for the Compactness Index (W/L) within each species are 44.76 % for *Donax scortum*, 40.10 % for *Timoclea scabra*, and notably elevated at 63.36 % for *Mactra luzonica*.

For the Flatness Index, *Donax scortum* displays a mean value of 0.33 ± 0.025 , *Timoclea scabra* exhibits 0.306 ± 0.021 , and *Mactra luzonica* demonstrates 0.329 ± 0.037 . The corresponding percentage variations are 42.26 %, 48.93 %, and a notably higher 76.73 %.

Variation in shell shape

The shape is indicated by the shell length to height ratio (L/H), and the comprehensive measurements for each species are outlined in Table 4. Following the shape indices²⁷⁻²⁸, the studied assemblage displays two distinct shape categories: oval ($L/H < 1.5$) and elliptical (L/H from 1.5 to 2.0). At the species level,

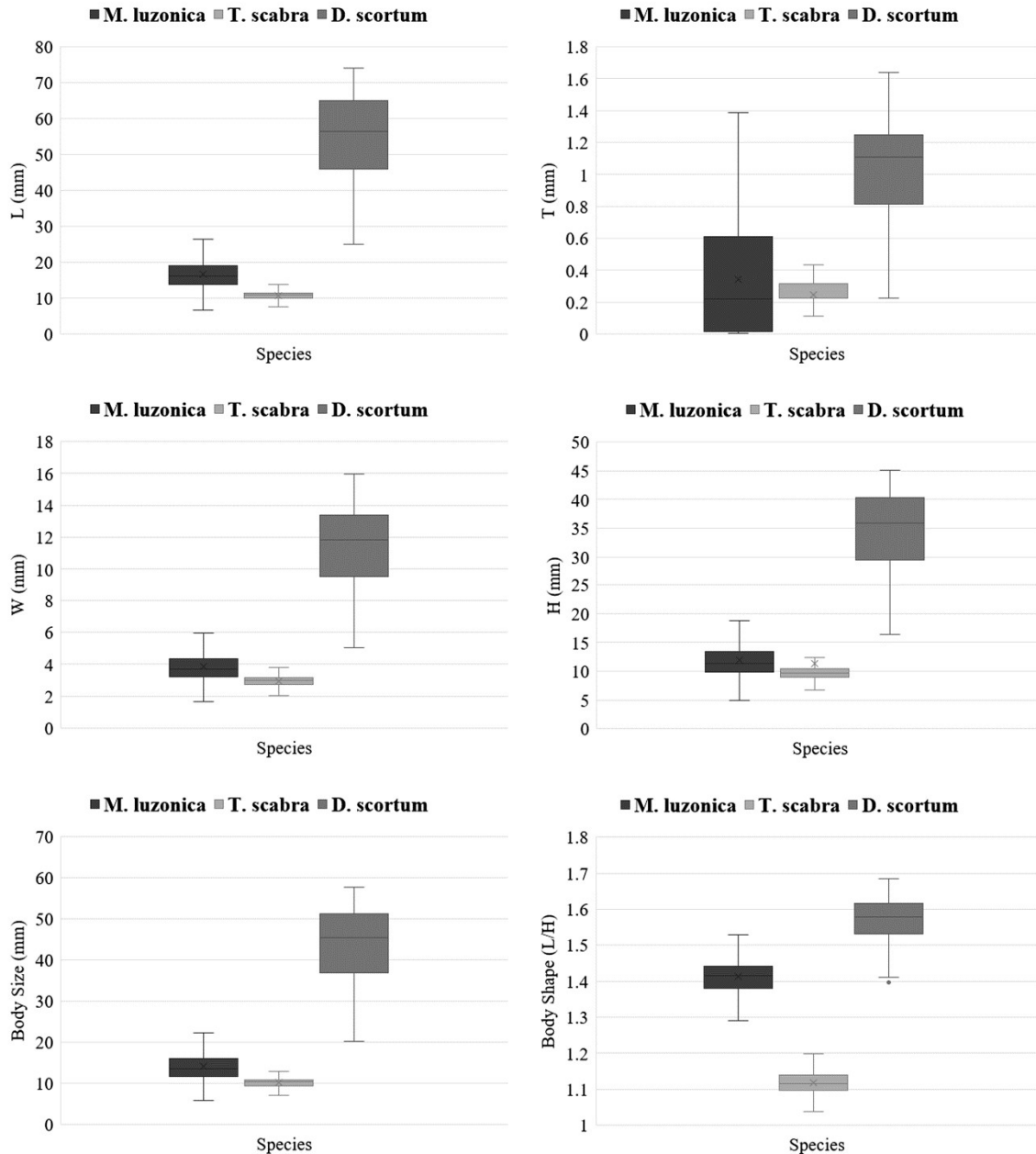


Fig. 4 — Variation of morphological parameters in *Maetra luzonica*, *Timoclea scabra*, and *Donax scortum*: a) Length; b) Thickness; c) Width; d) Height; e) Body size; and f) Body shape

both *Donax scortum* and *Maetra luzonica* exhibit oval and elliptical forms (L/H ratios from 1.396 to 1.683 and from 1.135 to 1.987, respectively). The entire *Timoclea scabra* population displays an oval shell shape (L/H from 0.803 to 1.24).

Variation in shell size and shape

The shell size variation (T, W and H) for each distinct species is given in Figure 6(a – c). Based on

their body sizes, specimens from each species were categorised into either large (with shell sizes greater than the mean body size of the assemblage) or small (with body sizes equal to or smaller than the mean body size of the assemblage).

Out of the 211 *Donax scortum* specimens, 81 (38.38 %) fall into the small size class, while 130 (61.62 %) belong to the large size class. Among the large size class, a mere 3 (2.30 %) specimens exhibit

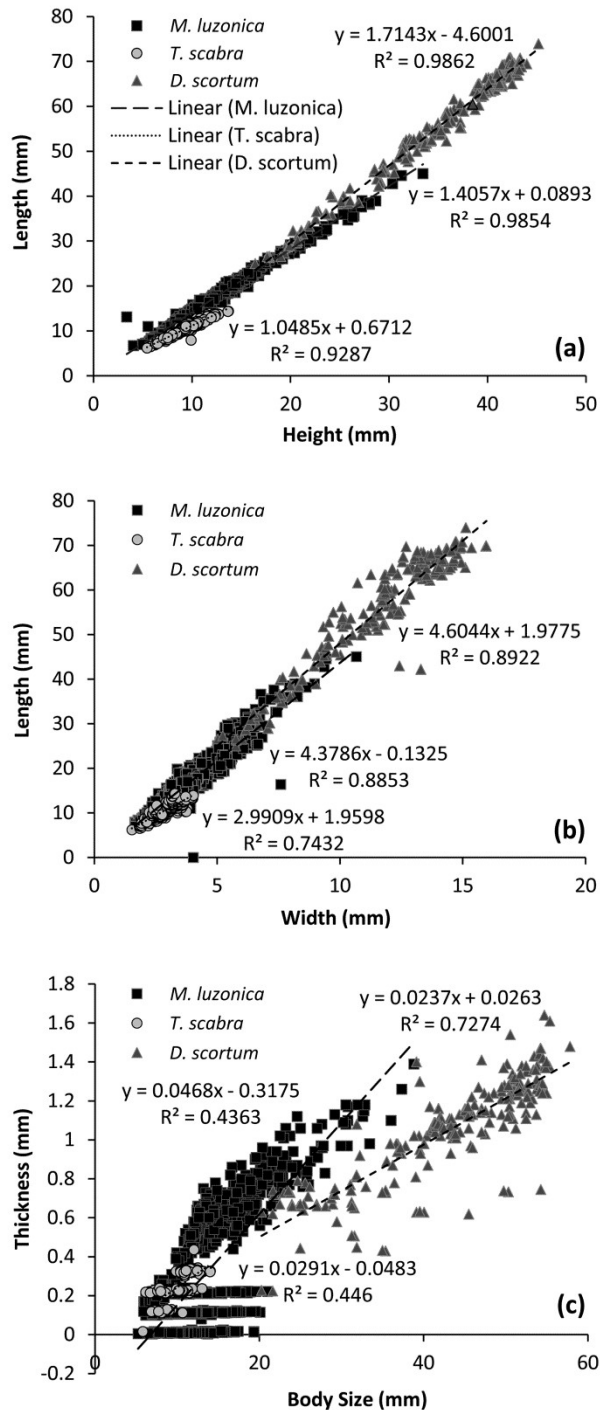


Fig. 5 — Morphometric relationships within studied species: a) Length vs height; b) Length vs width; and c) Thickness vs body size

an oval shape, whereas 127 (97.7 %) specimens are elliptical. Within the small size class, 28 (34.56 %) specimens were oval-shaped, and the remaining 53 (65.44 %) were elliptical.

In the case of *Maetra luzonica*, 605 (52.7 %) individuals are classified in the small size class, and 543 (47.3 %) specimens are assigned to the large size class. Among the large size class, 529 (97.6 %) specimens display an oval shape, with the remaining 13 (2.40 %) showcasing an elliptical morphology. Among the small size class, the majority 590 individuals (97.5 %) exhibited an oval shape, while 15 (2.50 %) specimens showed an elliptical shape.

For *T. scabra*, 306 (59.30 %) individuals fall into the large size class, while 210 (40.70 %) are classified within the small size class. Irrespective of their sizes, all specimens of *Timoclea scabra* were oval in shape.

Drilling Frequency (DF)

The collected specimens demonstrate a presence of predatory drillholes mostly located at the umbonal region. While drilling predation is common in Chandipur region^{7,12,17}, it can be distinguished from non-predatory holes by: a) clear and distinct circular outline; b) hole remains confined to one valve; and c) regular hole outline^{31,32}. Drilling Frequency (DF) has been computed using the formula: $DF = N_d/N_t$ (where N_d = Total number of valves with complete drill holes; N_t = Total number of valves studied)³³. DF can serve as a key proxy for understanding prey-predator interactions coupled with morphological parameters. For instance, it can be expected that well-ornamented forms like *D. scortum* would demonstrate lesser DF compared to a lesser ornamented forms like *M. luzonica*. Therefore, the present study has adopted DF as a direct measure to look into prey-predator interactions in the studied region. In the case of *M. luzonica* (poor ornamentation), the DF is 0.0898 or 8.98 %, while for *T. scabra* (well ornamented), the DF is 0.2273 or 22.73 %. *Donax scortum*, which is comparatively larger in size with more prominent ornamentation, shows a DF of 0.0663 or 6.63 %.

Discussion

The studied species assemblage demonstrates a broad spectrum of morphometric variations. Upon comparing morphometric traits among individuals within each species, it becomes evident that strong linear relationships ($R^2 > 0.9$) exist between shell length (L) and height (H) (Fig. 5a) across all three species. Evidently, a good correlation exists between shell length (L) and width (W), as seen in Figure 5(b), with $R^2 > 0.70$ in all three species. However, considering shell thickness in relation to the growth

Table 2 — Correlation statistical data of the studied species: a & b) Slope and intercept of regression line; R^2 : Proportion of variance of one variable that is explained by other variable; SE: Standard error, which measures the variability of the regression line; P: Determines if the observed correlation is statistically significant (for $P < 0.05$) and is not by chance; t : t-statistic which determines if the estimated slope is statistically significant (Larger t -statistic with small p -value indicates a statistically significant slope); 95 % confidence interval: Range for 95 % confidence that the true population correlation coefficient falls and provides an estimate of the uncertainty in the correlation coefficient

Species	Parameters	a	b	R^2	SE	P	t	95 % confidence	
								Lower	Upper
<i>Donax scortum</i>	L vs H	0.575	3.121	0.986	0.004	<0.001	122.19	0.567	0.583
	L vs W	0.193	0.84	0.892	0.004	<0.001	41.58	0.186	0.202
	BS vs T	0.023	0.026	0.727	0.001	<0.001	23.62	0.021	0.025
<i>Timoclea scabra</i>	L vs H	0.885	0.09	0.928	0.011	<0.001	81.91	0.859	0.913
	L vs W	0.248	0.263	0.743	0.006	<0.001	38.55	0.233	0.264
	BS vs T	0.029	-0.048	0.445	0.001	<0.001	20.32	0.025	0.032
<i>Mactra luzonica</i>	L vs H	0.702	0.074	0.984	0.002	<0.001	270.97	0.695	0.709
	L vs W	0.202	0.47	0.885	0.002	<0.001	94.358	0.197	0.207
	BS vs T	0.045	-0.28	0.634	0.001	<0.001	27.76	0.042	0.047

Table 3 — Morphometric indices of the shell assemblage of the studied species

Species	Indices	Minimum	Mean	SD	Maximum	Standard error	% Variation
<i>Donax scortum</i>	(H/L)	0.594	0.637	0.024	0.716	0.001	17.04
	(W/L)	0.174	0.21	0.018	0.315	0.001	55.24
	(W/H)	0.265	0.33	0.025	0.459	0.001	57.74
<i>Timoclea scabra</i>	(H/L)	0.806	0.894	0.031	1.244	0.001	64.79
	(W/L)	0.218	0.273	0.018	0.364	0.0007	59.9
	(W/H)	0.216	0.306	0.021	0.423	0.0009	51.06
<i>Mactra luzonica</i>	(H/L)	0.258	0.708	0.03	0.881	0.0009	29.28
	(W/L)	0.17	0.232	0.023	0.464	0.0006	36.63
	(W/H)	0.215	0.329	0.037	0.924	0.001	23.26

Table 4 — Variation of body shape within the studied species

Species	Minimum	Mean	SD	Maximum	Standard error	Shape
<i>Donax scortum</i>	1.396	1.571	0.059	1.683	0.004	Oval to elliptical
<i>Timoclea scabra</i>	0.8038	1.119	0.037	1.24	0.001	Oval
<i>Mactra luzonica</i>	1.135	1.412	0.056	1.987	0.001	Oval to elliptical

parameter (body size – the geometric mean of L and H), and conducting comparisons, failed to yield any significant correlation (R^2 values < 0.45) for *M. luzonica* and *T. scabra*, while moderately significant correlations ($R^2 > 0.70$) exist for *D. scortum* (Fig. 5c). Therefore, shell thickness remains independent of body size parameters throughout the majority of studied assemblages.

Bivalve shells are composed of distinct aragonitic nacreous and calcitic prismatic layers. The nacreous layer is deposited at the umbo (the thickest part), while prismatic layers are added at the active growth regions³⁴. As a result, shell erosion disproportionately impacts the umbo, leading to varying thickness values for specimens of the same species that are of similar sizes.

Shape analysis (L/H) investigations reveal that within the same species, *D. scortum* specimens

demonstrate a higher percentage of elliptical individuals (85.30 %) compared to oval individuals (14.70 %). A similar analysis for *M. luzonica* shows that 97.4 % of individuals have an oval shape, while the remaining 2.6 % exhibit an elliptical shape. In contrast, all studied specimens of *T. scabra* (100 %) are of an oval shape. These shape disparities reflect the influence of phenotypic plasticity in response to distinct habitats and ecological stresses experienced by the individuals^{27,29}.

Analysis of body size and population frequency reveals a significant prevalence (61.62 %) of larger *D. scortum* specimens, highlighting their dominance over the smaller (and younger) counterparts (38.38 %). Meanwhile, individuals of *M. luzonica* exhibit nearly equal distribution across size categories, whereas *T. scabra* shows a larger (older) majority, accounting for approximately 60 % of the population. This

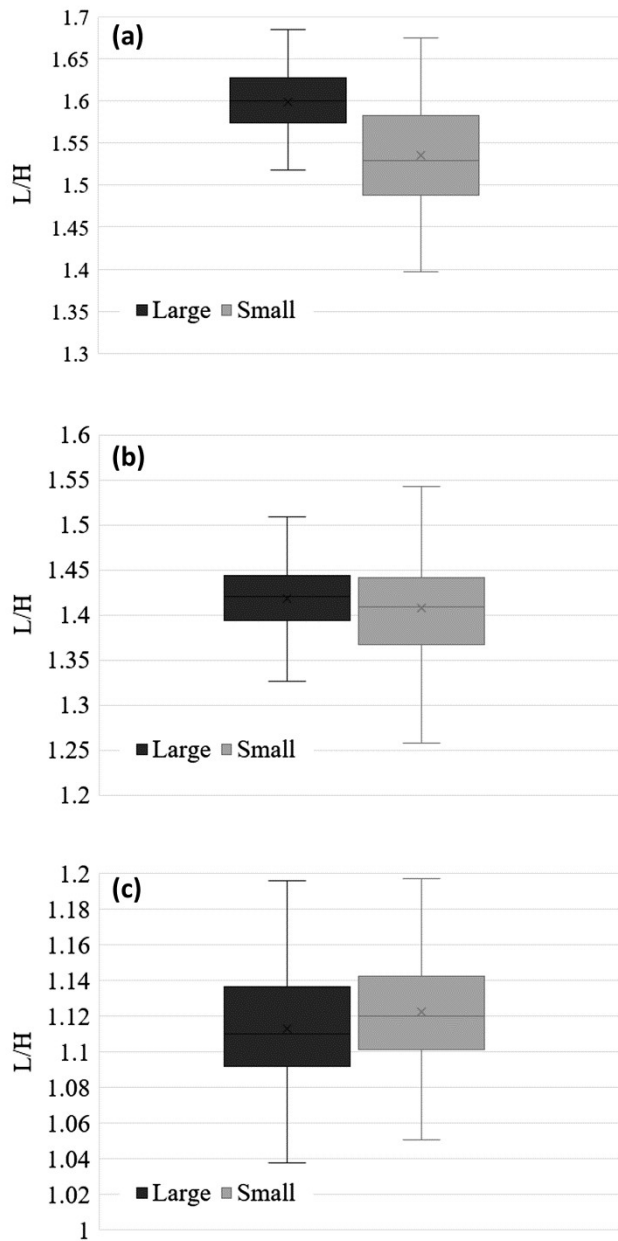


Fig. 6 — Body shape variation within size classes of a) *Donax scortum*; b) *Mactra luzonica*; and c) *Timoclea scabra*

overarching prevalence of larger sizes (and correspondingly older individuals) across the entire studied population potentially suggests the influence of size-dependent predation^{35,36} within the distinct habitats of these species. It is evident from previous studies^{17,33} that predation of molluscan individuals is quite prevalent in the study area. Therefore, selective predation of younger and weaker individuals could result in potentially higher numbers of larger and older forms.

It is essential to note that the Chandipur coast, characterised by its geomorphological variability and dynamism, creates a high-energy environment with crashing waves and seasonal thunderstorms. The presence of mesoscale scour³⁷ on the intertidal flats indicates high-energy crashing waves. This dynamic setting could contribute to the accelerated deterioration of smaller (and therefore more vulnerable) shells. Additional insights from recent research^{7,33,38} have shown that bivalve shells are most vulnerable at the umbonal region owing to lesser thickness and less prominent ornamentation. Investigations on mechanical properties³⁸ of certain bivalves (*T. granosa*, *M. meretrix*, *S. meroe*, *M. turgida* and *D. scortum*) in the Chandipur region have yielded that apart from shell thickness, the shell density and hardness are equally essential in deciding the survival of bivalves against potential predators. A microstructural analysis has also been made in the same study which showcases that the juxtapositioning of the crystals can have key implications for shell stability, in species that show various life modes³⁸. Bivalve shell morphological analysis also reveals a key correlation between post-mortem transport and fragmentation. Under higher energy conditions, as those in high tide regions, shells are more likely to experience fragmentation and taphonomic alterations. In this regard, the presence of predatory drillholes play a crucial role⁷. It has been noted that drilled shells are more selectively entrained during tidal transport as compared to undrilled shells. Therefore, such shells are expected to be more prone to taphonomic breakage. An evaluation of prey-predator dynamics can be made from the relative drilling frequency. While it might be expected that ornamented forms will somehow provide more resistance to naticid gastropod drilling, yet the present study shows that *T. scabra* has a higher DF in the studied specimen pool. This can be explained from previous research investigations³⁹ where it was shown that predators selectively prey on species under a rigorous cost-benefit analysis. That is, whether it is easier to catch one large prey or multiple smaller preys. Since *T. scabra* has overall smaller mean body size compared to the other two species studied, it therefore can be ascertained that they were easier to prey upon. Hence, the studied DF shows that prey-predator dynamics in the region is not exclusively controlled by ornamentation or shell thickness, but also is subject to the predator's cost-benefit analysis

among other environmental stressors like prey population, competition, and nutrition availability.

Conclusion

The present study involves a comprehensive morphometric analysis of individuals from three species, exploring their morphological parameters and indices at the inter as well as intra-specific levels. It is evident that morphological variation exists across species as well as within individuals of the same species. This variation is attributed to ecological stresses and habitat conditions. Further elucidation of detailed morphometry in fossil equivalents, as well as comparing their correlations with adequate statistical sophistication could indicate a plethora of information on the molluscan ecology, possible instances of predation and nutrition availability. Using detailed sedimentological facies analysis and geochemical investigations within the fossil record, coupled with morphometric analysis can provide valuable insights into species' habitat, and of paleoecology and paleoenvironments. It is also evident that morphology alone doesn't control the predation dynamics, while other environmental factors are equally effective. Also, a high-resolution shell internal study looking into shell microstructures can be beneficial to understand shell strength stability and responses to ecological stresses.

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Conflict of Interest

The author declares no conflict of interest.

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