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Morphological description of two scallops, *Chlamys albida* (Arnold, 1906) and *Volachlamys tranquebaria* (Gmelin, 1791) from the coastal waters of the northern Bay of Bengal

MD ROYHANUR ISLAM♥, M. SHAHADAT HOSSAIN
Institute of Marine Sciences, Faculty of Marine Sciences and Fisheries, University of Chittagong, Chittagong- 4331, Bangladesh.
♥email: royhanur.islam@cu.ac.bd

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Abstract. *Islam MDR, Hossain MS. 2024. Morphological description of two scallops, Chlamys albida (Arnold, 1906) and Volachlamys tranquebaria (Gmelin, 1791) from the coastal waters of the northern Bay of Bengal. Biodiverstas 25: 900-906.* The commercial marine scallop *Chlamys albida* (Arnold, 1906) was first discovered in the Sonadia, Bangladesh coastal island. It was acquired and deposited in the Institute of Marine Sciences (IMS) museum catalog, University of Chittagong. The species was taxonomically studied based on its external morphology as well as compared with *Volachlamys tranquebaria* (Gmelin, 1791), a species from the same family of Pectinidae, which was previously reported along the coast of Bangladesh. Study specimens were collected randomly and hand-picked from the intertidal zone of Sonadia Island. This study examined morphological characteristics as well as morphometric measurements. The study also determined the studied species distribution pattern, habitat biology, and ecology. This species has not yet been registered in this region, presumably due to the lack of long-term research on bivalves and its low abundance. The present study increased the number of reported mollusc species in Bangladesh, which may facilitate further molluscan research.

Keywords: Bangladesh, bivalve, biodiversity, *Chlamys albida*, scallop, Sonadia Island, systematics, *Volachlamys tranquebaria*

Abbreviations: Somatic morphology: ARD: anterior rib diameter; DBAA: Distance between anterior ribs; DBN: Diameter of byssus notch; DBPR: Distance between posterior ribs; HAA: Height of anterior auricle; HPA: Height of posterior auricle; HS: Height of species; LAA: Length of anterior auricle; LPA: Length of posterior auricle; LS: Left side; LS: Length of species; PRB: posterior rib diameter; RS: Right side

INTRODUCTION

The biodiversity of the scallops remains poorly understood despite their abundance and ecological importance. It is known that the marine scallop is an important source of animal protein throughout the world. As a result of their high nutritional value, scallops have steadily increased in popularity. For centuries, scallops have been raised as a traditional fishery worldwide, one of the most important commercial bivalve molluscs (Ivin et al. 2006). These molluscs are members of the Pectinidae family of benthic marine pelecypods. Several benefits can be derived from eating scallop flesh rich in omega-3 polyunsaturated fatty acids, potassium (K), and magnesium (Mg), with the potential for reducing the risk of blood clots, reducing the risk of heart attacks, and preventing strokes (Hu et al. 2018). Scallops may possess anti-inflammatory properties, and they also should have antitumor and immunomodulatory effects (Collins et al. 1986; Su and Babb 2007; Telahigue et al. 2010; Sasaki et al. 2011; Wu et al. 2015; Santhanam 2018a; Santhanam 2018b; Mawatari et al. 2020). The scallop is one of the most commercially viable seafood, which has a greater contribution to worldwide revenue because it is heavily traded and widely consumed (Berik et al. 2017; Coleman et al. 2021). Coleman et al. (2021) also reported that in 2018, the global value of scallop aquaculture was over USD 5.8 billion, with farms producing nearly three times the total biomass of the wild harvest.

There is a great diversity of molluscs in the coastal waters of the Bay of Bengal, as well as other plants and animals (Wahab et al. 2004; Islam et al. 2019), in particular of the coastal island of Sonadia, which has been a focal area for scientific research in recent years. Since molluscs are an appropriate indicator group for local invertebrate biodiversity, most research has focused on their biodiversity and systematics compared to other invertebrates (Gladstone 2002). In the south-eastern region, Commans (1940) first reported on mollusc's species from St. Martin's Island (Hossain et al. 2014; Islam et al. 2019). Ali and Aziz (1976) described 33 species from the same island. An additional list of 301 species from 151 genera, 79 families, and 16 orders in 4 classes were recorded from St. Martin's Island to Heron Point and Dublar Char at the lower Sundarbans, along with their taxonomic description in 1990 (Ahmed 1990). Later, 437 marine and brackish, 20 land, and 22 freshwater mollusc species from 210 genera, 105 families, and 23 orders under 4 classes were listed in the Encyclopaedia of Flora and Fauna of Bangladesh and published by The Asiatic Society of Bangladesh in 2007 (Siddique et al. 2007). Hossain et al. (2014) pointed out that the rich biodiversity in Bangladesh provides an

opportunity for future work regarding mollusc taxonomy and biodiversity. The same study reported the seashells of Bangladesh and listed 317 molluscs collected from the south-eastern part, specifically nearshore islands of Kutubdia, Maheskhali, and Sonadia, of which 121 species were identified as gastropods under 27 families, and 125 species are bivalves under 19 families. The southwestern part of the country is still untouched. Studies on deep-sea molluscs are rare in both parts of the country due to a lack of funding availability as well as research interest in this group. Moreover, studies on mollusc habitat, biology, ecology, life cycle patterns, and culture availability are also scarce in Bangladesh. However, research on taxonomy study has been initiated and reported previously. Although considerable efforts have been made, many species in Bangladesh remain unregistered due to a lack of technical personnel and funds. The present study was conducted to describe *Chlamys albida* (Arnold, 1906) from the coastal environment of Sonadia Island, Bangladesh, along with a comparison with another species, *Volachlamys tranquebaria* (Gmelin, 1791), which has been previously reported from the coastal belt.

MATERIALS AND METHODS

Study area and sampling

Sonadia Island (4,916 ha) is located along the southeast coast of Bangladesh in the Cox'sBazar District. Bangladesh's Environment Conservation Act of 1995 includes a provision for declaring ecologically critical areas (ECAs), and the island declared ECAs in 1999 (Chowdhury et al. 2011). In addition to mudflats, dunes, mangroves, sand bars, lagoons, saltpans, and beaches, the island is home to various wetland habitats (CWBMP 2006). Sonadia Island is one of the biodiversity hotspots in Bangladesh.

In total, 120 scallop samples were collected from the intertidal and subtidal zones of the south-eastern coastal region, locally referred to as the Poshchimpara Sonadia Island (Figure 1), from January 2013 to December 2013; the samples were randomly hand-picked every month during the low tide period. Samples were collected and transported to the Marine Ecology laboratory at the Institute of Marine Sciences and Fisheries, University of Chittagong, Chittagong- 4331, Bangladesh, for further study. Particularly, *C. albida* and *V. tranquebaria* were sampled in February 2013 (the location of the samples is in Figure 1). Between February 2023 and August 2023, a review was conducted based on the deposited specimens in the laboratory.

Specimen collections and coding details

Specimen collections and identification

Among 120 samples of scallops, 3 specimens of *C. albida* (Figure 2A-B) were collected from the intertidal sandy areas. For reference, we examined, recorded, and deposited a specimen as Code Number: MSC/IMSFCU C0185. At the same time, 5 specimens of *V. tranquebaria* (Figure 2A1-B1) were also sampled and studied, and a specimen was preserved in the laboratory catalog (Code Number: MSC/IMSFCU C0189). The taxonomic characteristics of the studied species were determined based on the literature (Siddique et al. 2007; Abbott and Dance 2009; WoRMS; Myasnikov 1988; MacNeil1 1967). The morphometric measurements (Figure 3) were conducted using a digital caliper (Model: TOL-00204) and based on the key information mentioned in Table 1.

Identification keys to specimens

Chlamys albida and *V. tranquebaria* were identified by following the keys provided in Table 1 (Table 2 provides more details).

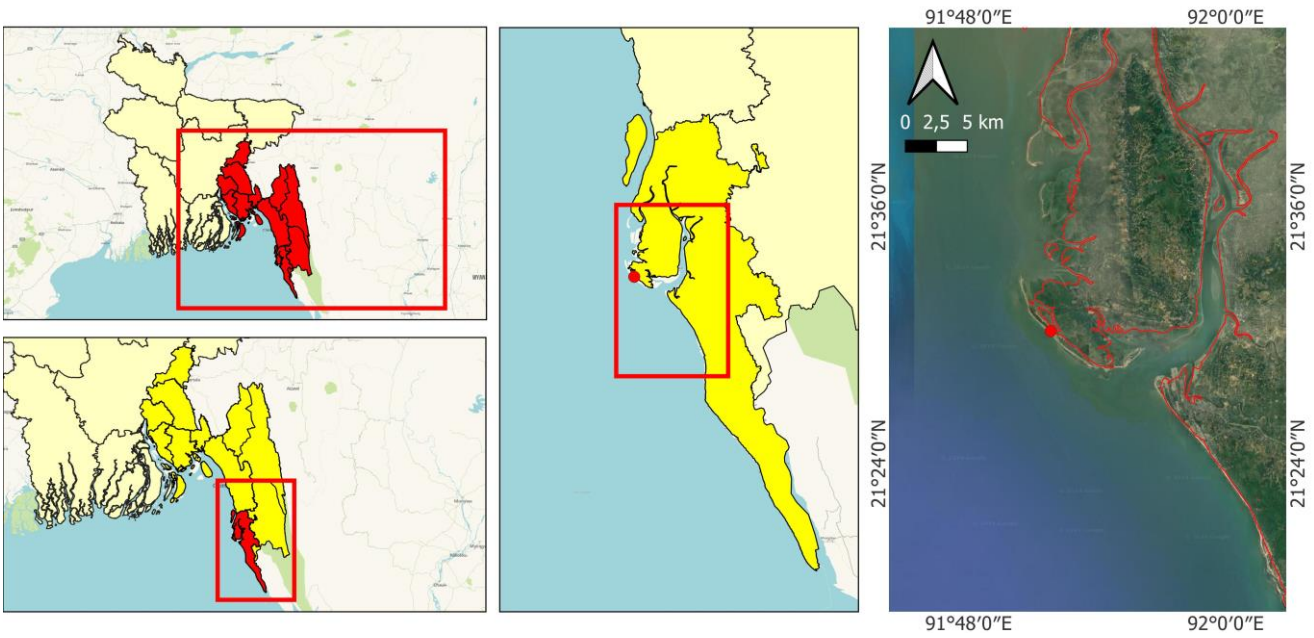
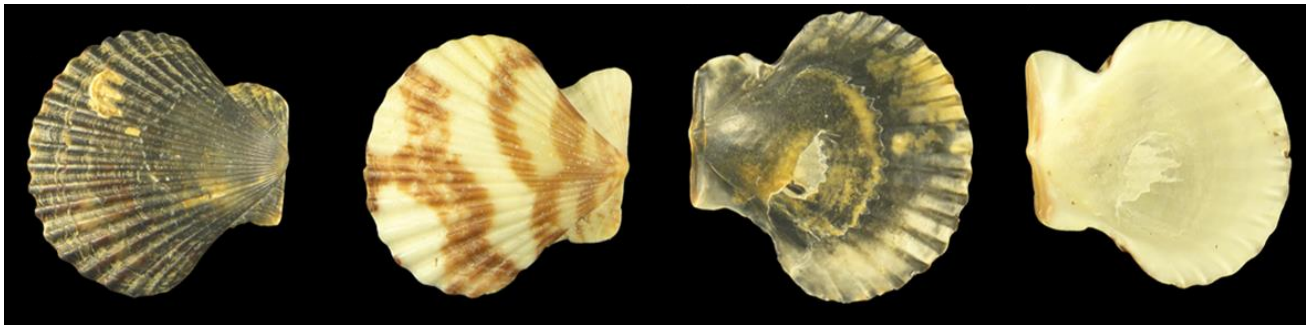


Figure 1. Location of the study area at Sonadia Island in the northern Bay of Bengal, Cox'sBazar, Chittagong, Bangladesh

Table 1. Characteristics used to identify the specimens

SL	Characters	Species (*C. albida*=1; Nos= 3; *V. tranquebaria*= 2; Nos=5)
1	Unequal (decaying) dorsal margins, with the anterior margin being wider than the posterior margin	1
-	The anterior margin is narrower and less identical in comparison to the dorsal margin	2
2	The low, rounded, straight-sided rib is located on the right valve	1
-	On the right valve, some ribs are wider and less sharp	2
3	Convex, both valves have unequal-sized ears	1
-	Convex, both valves have approximately equal-sized ears	2
4	The right valve is very weakly inflated	1
-	The right valve is fairly inflated	2



A **A1** **B** **B1**

Figure 2. Photograph showing: A. The dorsal; B. Ventral view of *C. albida*; A1. Dorsal; and B1. ventral view of *V. tranquebaria*

RESULTS AND DISCUSSION

Systematics

Species 1 Chlamys albida

Class : Bivalvia (Linnaeus, 1758)
Order : Pectinoida (Gray, 1854)
Family : Pectinidae (Rafinesque, 1815)
Genus : *Chlamys* (Roding, 1798)
Chlamys albida (Arnold, 1906) (Figure 3. A, B)
Source:1. (WoRMS 2014a); 2. (COL 2023a)

Species 2 Volachlamys tranquebaria

Class : Bivalvia (Linnaeus, 1758)
Order : Pectinoida (Gray, 1854)
Family : Pectinidae (Rafinesque, 1815)
Genus : *Volachlamys* (Iredale, 1939)
Volachlamys tranquebaria (Gmelin, 1791) (Figure 3. A1, B1)
Source:1. (WoRMS 2014b); 2. (COL 2023b)

Species coding details

Species 1

Chlamys albida. Higher geography: South East Asia; continent: Asia; water Body: Northern Bay of Bengal; island: Sonadia; country: Bangladesh; country code: Bangladesh/BD; verbatim locality: Paschimpara, Sonadia Island; verbatim elevation: 2-3 m; verbatim elevation: 2-3 m; verbatim coordinates: 21°48'21"E, 91°88'62"N; verbatim latitude: 21°48'21"E; verbatim longitude: 91°88'62"N; georeference protocol: GPS; sampling protocol: hand-picking; sampling effort: 4 observer-hours, 2 km by foot; event date: 12 Feb 2013; event time: 12.10 pm; date Identified: 10 Aug 2013; language: English; rights holder: IMS, University of Chittagong; collection ID: C0185; institution code: IMSCU; collection Code: MSC/IMSFCU C0185.

Species 2

Volachlamys tranquebaria. Higher geography: South East Asia; continent: Asia; water body: Northern Bay of Bengal; island: Sonadia; Country: Bangladesh; country code: Bangladesh/BD; verbatim locality: Paschimpara, Sonadia Island; verbatim Elevation: 2-3 m; verbatim coordinates: 21°48'21"E, 91°88'62"N; verbatim latitude: 21°48'21"; verbatim longitude: 91°88'62"N; sampling protocol: hand-picking; sampling Effort:4 observer hours, 2 km by foot; event Date:12 Feb 2013; event Time:12.30 pm; date Identified: 5 Sep 2013; language: English; rights holder: IMS, University of Chittagong; collection ID: C0189; institution Code: IMSCU; collection Code: MSC/IMSFCU C0189.

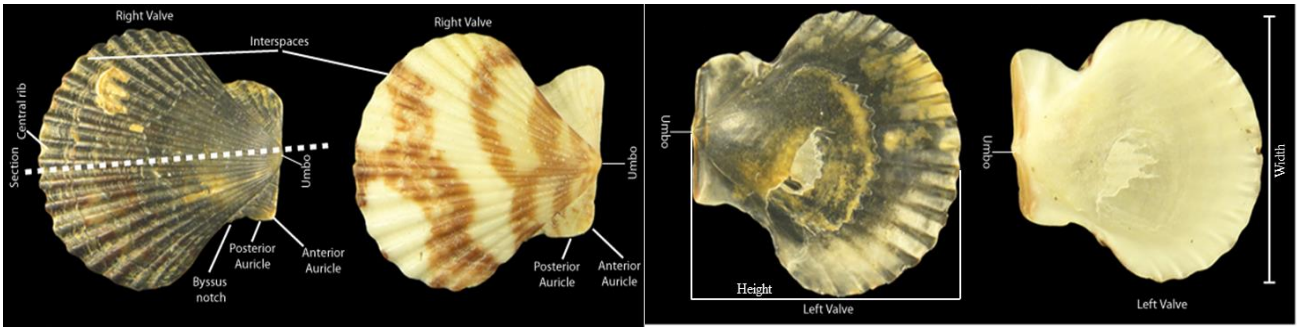


Figure 3. Photograph showing the morphological view of A, B. *Chlamys albida* (Arnold 1906) and; A1, B1. *Volachlamys tranquebaria* (Gmelin, 1791) along with their identification keys

Diagnosis

Species 1

Chlamys albida. There were unequal dorsal margins, with the anterior margin being longer than the posterior margin, giving the shell a slightly asymmetrical appearance, and a low, rounded, straight-sided rib was located on the right valve. Specimen measured Height (MHS) 39.66 mm, Measured Length (MLS) 36.03 mm, Length of Posterior Auricle (LPA) 18.72 mm, Length of Anterior Auricle (LAA) 10.00 mm, Height of Anterior Auricle (HAA) 10.00 mm, Height of Posterior Auricle (HPA) 8.34 mm, Distance between Anterior Ribs (DBAA) 0.82 mm, Distance between Posterior Ribs (DBPR) 0.78 mm, Anterior Rib Diameter (ARD) 2.98 mm, Posterior Rib Diameter (PRB) 3.01 mm, Diameter of Byssus Notch (DBN) 2.83 mm.

Species 2

Volachlamys tranquebaria. Species ribs are sharp and rounded. Interspaces between the ribs are relatively small. Specimen measured Height (MHS) 24.28 mm, Measured Length (MLS) 21.75 mm, Length of Posterior Auricle (LPA) 13.65 mm, Length of Anterior Auricle (LAA) 8.00 mm, Height of Anterior Auricle (HAA) 5.06 mm, Height of Posterior Auricle (HPA) 6.16 mm, Distance between Anterior Ribs (DBAA) 1.05 mm, Distance between Posterior Ribs (DBPR) 0.92 mm, Anterior Rib Diameter (ARD) 1.62 mm, Posterior Rib Diameter (PRB) 1.80 mm, Diameter of Byssus Notch (DBN) 1.84 mm.

Description of the specimens

Species 1

Chlamys albida. Species have a slightly asymmetrical anterior margin, with a longer dorsal margin than the posterior margin. The left valve of the species was very inflated, while the right valve was very weakly inflated. The left valve has weakly concave, broad dorsal slopes, whereas the right has narrow ones. Right valves have straight-sided lower-rounded ribs, and split ribs can occasionally occur; a strong correlation existed between split ribs on the shell and the species' maturity. Interspaces were gently rounded and roughened by growth lines, while other specimens of the same species had a small interstitial riblet as the shell grew. Metal lathlike or reticulate micro sculptures cover most of the interspaces. Occasionally, this cover is absent from the ribs. The left valve has higher and sharper ribs than the right valve. Primary, secondary, and tertiary ribs were differentiated by a very weak propensity on the shell. White-yellowish ash was alternating on the right valves of specimens. It was observed that specimens have sometimes been found with a narrower purple band above the white band. The dark brown coloration is almost uniform throughout the left valve.

Species 2

Volachlamys tranquebaria. This species appears nearly circular, and its color banding pattern is brown with white flecks. Both the external and internal surface of the shell of this species contained distinct radial ribs. It had rounded ribs with smaller interspaces between the ribs, and the valves were convex in shape. The ribs did not exhibit radial sculpture. The ear or auricle had similar sizes on both ends and clear ribbeds. The species belongs to the same family (Pectinidae) of *C. albida*; the species was the only one previously reported from this family in this region. Comparative illustrations between *C. albida* and *V. tranquebaria* are detailed in Figure 4 and Table 2. Figure 3. Shows the outline of the major identification keys for both species.

Species distribution

There are also existing reports supporting *C. albida* collected in the northern Bay of Bengal along the coast of Bangladesh. It inhabits the coastal zone of the northern Bay of Bengal. It is commonly found in the sandy areas of the intertidal zone. It should be noted that another species belonging to the same family, Pectinidae, *V. tranquebaria*, has also been reported previously in the Indian Ocean (Abbott and Dance 2000). It is the only species recorded in Bangladesh with a distribution encompassing Sonadia, Cox's Bazar, and the Tekhnaf beach area (Siddique et al. 2007; Antu et al. 2023). *C. albida* had never been recorded in Bangladeshi marine waters before this study. This species, *C. albida*, is widespread and occurs in the high boreal regions of the Pacific (Ivin et al. 2006). In its distribution range, the species is abundant and has been reported from Japan, the Russian Federation, the Republic of Korea, Canada, and the United States of America, which are all part of the Asian and North American continents (GBIF 2023). This species is recorded from the North West Pacific (WoRMS 2014a).

Table 2. Descriptive comparison between species of *C. albida* and *V. tranquebaria* collected in the northern Bay of Bengal, Bangladesh

ID	Criteria	*Chlamys albida* (Arnold, 1906)	*Volachlamys tranquebaria* (Gmelin, 1791)
A	Interspaces	Gently rounded interspaces are apparent, ribs are higher and sharper (Figure 4.A-LS)	Interspaces are as broad as the radial ribs (Figure 4.A-RS)
B	Dorsal slope of the valve	Comparatively high and flattened (Figure 4.B-LS)	Fairly inflated outer side (Figure 4.B-RS)
C	Cover of interspaces	Interspaces are covered by metal lathlike or reticulate micro-sculpture (Figure 4.C-LS)	Interspaces cover is not present (Figure 4.C-RS)
D	Ear/ Auricle	The ear or auricle is not equal at both ends, apparently decaying, unclear ribs (R-right end, L-left end) (Figure 4.D- LS)	Ear or auricle have clear ribbed (R-right end, L-left end) (Figure 4.D-RS)
E	Edge of the interior surface	Narrower finger-like long shape with a solid structure (Figure 4.E-LS)	Wider finger-like short shape with a smooth surface (Figure 4.E-RS)
F	Pallial line	Pallial line with leafy structure (Figure 4.F-LS)	No pallial line (Figure 4.F-RS)
G	Adductor scar	Interior similarly whitish-yellow with small posterior adductor scar (Figure 4.F-LS)	The interior is similarly pale yellow with a large posterior adductor scar (Figure 4.F-RS)
H	Radial ribs	About 20-23 radial ribs on each valve (Figure 4.C-LS)	Approximately 20 rounded radial ribs on each valve (Figure 4.C-RS)
I	Shell colour	Black ash color without banding pattern (Figure 3.A-B)	Outside of shell, cream to yellowish, variegated with radish to deep brown banding (Figure 3.A1-B1)

As to the origin of *C. albida*, it is unclear whether it originated in the Pacific or Atlantic oceans. Since it has been reported in the East Pacific and the Northeast Atlantic (Palomares and Pauly 2018), it is most likely that stocks of early European tertiary origin occurred in the northern Pacific through either a Tethyan or an Arctic route (MacNeil 1967). In terms of zonal-geographic terminology, *C. albida* is a Pacific species found from the Middle Primorye to the northern part of the Sea of Japan (Tatar Strait) (Lutaenko 1999). There are currently significant concentrations of the species on the southern and northern coasts of the Northern Kurile islands (Sea of Okhotsk side and Pacific Ocean side), Simushir Island, and the northern part of the Sea of Okhotsk (Myasnikov and Hen 1990; Myasnikov 1992). Species belonging to Pectinidae are found throughout the eastern Indian Ocean, tropical Indo-Pacific, and along the coasts of the Bay of Bengal, North China Sea, and Australia (Ahmed 1990).

Studied specimens and observation

The length and height of the studied specimen were measured to be 39.66 mm and 36.03 mm, respectively. *C. albida* has an AphiaID 391037 registration number on the WoRMS, and has a shell length of up to 60 mm (WoRMS) (Dijkstra 2015). In a separate study, a left valve of the studied species was measured at 69 mm in height and 61 mm in length (MacNeil 1967). Observations of *C. albida* in the northern part of the Sea of Okhotsk indicate that shell heights range between 18 mm and 93 mm, with an average of 68 mm; individuals with sizes of 70-80 mm have average shell heights ranging from 41 mm to 73 mm (Myasnikov 1988). White scallop growth rate varies greatly between regions, such as scallops from different regions of Kuril Island show very different growth rates (Silina and Pozdnyakova 1986). Shell height is correlated with depth for this species. The average shell height increases from 41 to 73 mm as depth increases from 50 to 125 m, and the average shell height decreases to 62 mm at depths exceeding 125 mm (Ivin et al. 2006). Scallop weights also change irregularly with age; however, weight increases by equal rates in scallops up to 50-60 mm (Ivin et al. 2006). Some species from the genus *Chlamys* are less known because they are smaller. This species has no color banding pattern on its outer surface; however, whitish-yellow adductor scars were observed on the anterior surface. The species from the genus *Chlamys* showed varied color patterns from white, yellow, orange, pink, red, and purple to brown. Color patterns consist of concentric coloured bands, often crossed by light radiating rays and it depends on the species and their geographical environment. Therefore, as a living species of *Chlamys islandica* O.F.Müller, 1776 (synonyms of *C. albida*) ranges from white to dark red (Uozumi and Morio 1975). The dorsal slope of *C. albida* is comparatively high and flattened; however, *C. islandicus* valves are moderately inflated, ranging from subrounded to higher than long (Uozumi and Morio 1975). The right valve of the byssal notch of the studied species was shallow to moderately rounded. Coan et al. (2000) studied the byssal notch and reported similar characteristics.

The present study, which focuses on *C. albida*, will add one more species to the Encyclopedia of Flora and Fauna of Bangladesh. The country may have the opportunity to explore the commercialization of scallops further by producing this new commercial species and scallops, which are currently underutilized. Additionally, this could reduce existing pressures on resources and contribute to the conservation of natural resources while contributing to countries' achievement of sustainable development goals through the sustainable utilization of Marine Genetic Resources. Unregistered mollusc species in Bangladesh will likely go unnoticed since they are of little interest for consumption or commerce. Little research has been conducted on the identification and registration of molluscs in Bangladesh before 2007.

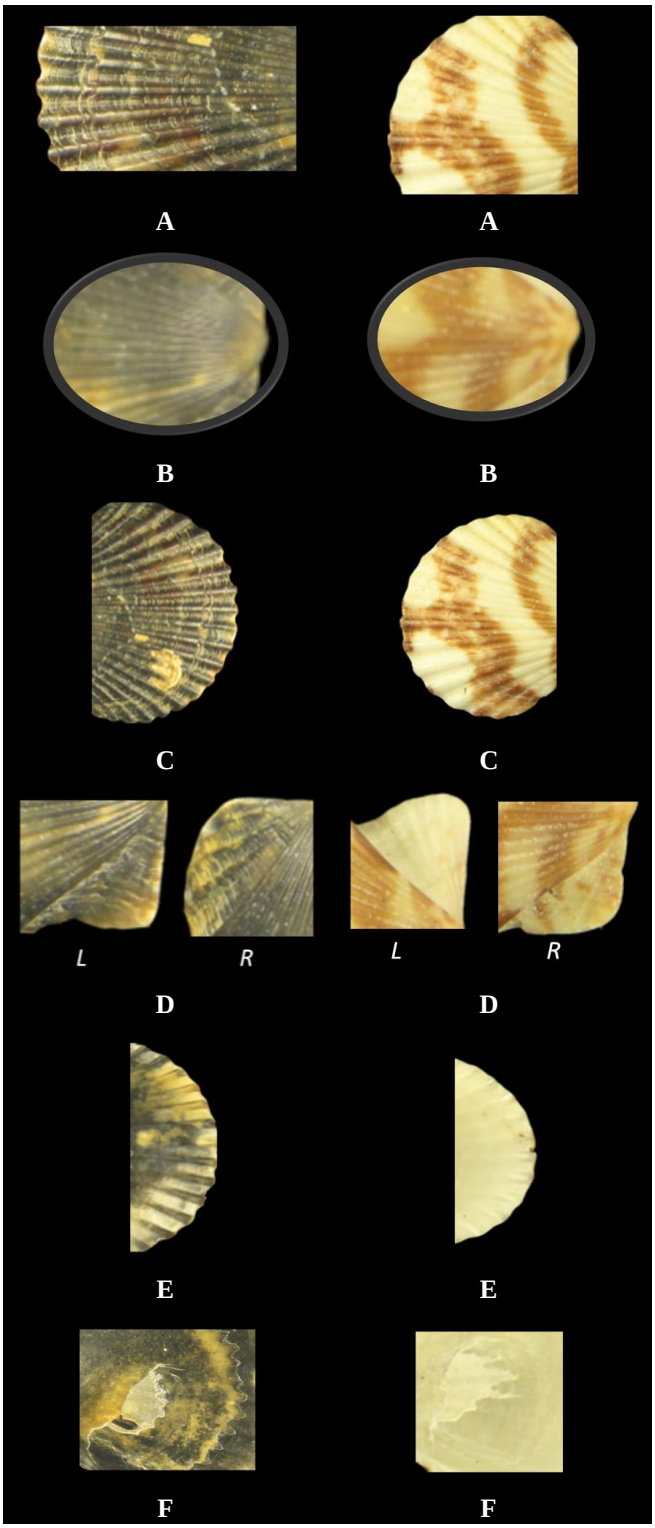


Figure 4. Morphological comparison between (*left*, LS) *Chlamys albida* (Arnold, 1906) and (*right*, RS) *Volachlamys tranquebaria* (Gmelin, 1791) collected in the northern Bay of Bengal, Bangladesh showing the difference in: A. Interspaces (LS, RS); B. Dorsal Slope; C. Cover of Interspaces; D. Auricle; E. Interior Surface Edges; and F. Parallel Line

The lack of funding for large-scale taxonomic studies and the seasonal occurrence of mollusc species could hinder similar observations. Therefore, further studies and surveys should be conducted on the taxonomy and occurrence of marine bivalves to provide valuable information for future ecological research. A study conducted on Sonadia island and adjacent coastal belts indicates that these areas may provide suitable habitats for scallops like *C. albida*, which may help expand shellfish culture in Bangladesh. Finally, studies and surveys on taxonomy and systematics will provide better perspectives on scallop research in the future. According to research on marine mollusc biodiversity off Sonadia Island, *C. albida* was discovered on the island and in Bangladesh.

In conclusion, *C. albida* is a new species found in Sonadia Island, Bangladesh, as a result of an examination of its morphological features and a comparison with another previously recorded species, *V. tranquebaria* from the same family from the coasts of Bangladesh. A recent study has reported the first records of marine bivalves of the family Pectindae, *C. albida*. A collection of opportunistic specimens from the intertidal zone resulted in the first recording of *C. albida*, suggesting that other molluscan species may exist that have yet to be identified. Therefore, genome sequencing and molecular approaches to species identification should be undertaken to facilitate future taxonomy research. The present study would be helpful for the conservation of these species and for providing livelihoods through scallop culture or aquasilviculture for these species. Consequently, new species exploration could contribute both to the conservation of natural resources and the economic viability of millions of coastal communities if proper steps are taken to scale up these resources sustainably.

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