ANNUAL
SHARJAH ARCHAEOLOGY

Issue 17

MOLLUSC REMAINS FROM THE QUELBA/KALBA FORTIFICATION (LATE 16TH TO 18TH CENTURIES, SHARJAH, UAE): TAXONOMICAL, TAPHONOMICAL, ENVIRONMENTAL AND CULTURAL IMPLICATIONS

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ABSTRACT: Archaeological works on the site of the former Quelba/Kalba fortification (late 16th to 18th centuries, Sharjah, UAE) yielded a significant bulk sample of marine invertebrates, with 24 species of Bivalvia, 32 species and subspecies of Gastropoda, a Scaphopoda, and several crustaceans and scleractinian coral debris. The taphonomical and palaeoecological analysis of this assemblage revealed a mix of elements with different origins and ages, including older shells reworked from the substrate of Holocene accretionary littoral sands where the structure was built, elements of lagoonal and mangrove origin, with emphasis on *Terebralia palustris*, and many specimens from tidal flat and inner shelf environments with sandy or rocky substrates. The presence of several edible species suggests a low scale exploration of the environment with fishing and shellfish gathering activities, and food consumption of molluscs and crabs. Several shells could also have been used as containers, and other perforated examples as adornments, including the common olive shell *Oliva bulbosa*. A few specimens of *Monetaria annulus* and *M. moneta* point out for a possible local use of these shells as traditional currency. All this ecological and cultural diversity reveals the importance of the studied assemblage as an example of the interaction between a strategic human settlement and their natural surrounding environment in the Gulf of Oman, during the period of the Portuguese discoveries.

KEYWORDS: Marine molluscs, archaeological context, environmental setting, cultural habits, Quelba/Kalba fortification, Sharjah Emirate.

INTRODUCTION

Marine molluscs are a common occurrence in many archaeological sites located in coastal areas, regardless their chronologies and cultural contexts. Their carbonated shells can survive to rather adverse physical and chemical conditions of the burial environment, when the remains of other invertebrate groups with weaker skeletal parts were not able to be preserved. They can be so abundant under certain conditions that the archaeological context itself is almost built by shell concentrations. This is the case of many known examples of shell-middens, from where repeated practices of shellfish gathering have being documented since the Palaeolithic.

Most frequently, mollusc shells of the classes Bivalvia, Gastropoda, Cephalopoda and, more rarely, Scaphopoda and Polyplacophora have been found in variable number, together with other invertebrate remains, such as corals, bryozoans, crustaceans and serpulids. They may also occur with vertebrate or plant remains and a variety of microorganisms, including foraminifera and ostracod tests, oogonia, dinoflagellates and palynomorphs, as a diverse taxonomical background available side to side with the archaeological data, and relevant for the overall characterization of the studied site.

The diversity and complexity of settings that can occur with marine molluscs is obviously high. By this way, any integrated quantitative data based on molluscan assemblages found together with artefacts and other archaeological evidence, would include their taxonomic composition, diversity, relative and absolute abundance, and taphonomical imprint.

These data can provide us with valuable information about the local and neighbouring environments contemporaneous of the deposit, including the record of sedimentary events, the ecological structure of the living biotic communities, and biogeographic and climatic features.

They also put in evidence several aspects of human interaction with marine molluscs and their shells, which can be intentional or casual. There are many edible species of bivalves (mussels, oysters, clams), gastropods (limpets, abalones, topshells, whelks) and cephalopods (octopuses, squids, cuttlefish) whose abundant remains can reveal habits of shellfish gathering and consumption, sometimes related with a food economy that included a relative degree of seasonal production and exportation to other areas. Marine shells also have been extensively used as adornments or in a variety of tools, revealing cultural habits and practices of past.

This multiplicity of data and their interpretation is precisely reflected in our case study, where a late 16th to 18th centuries archaeological context located in Sharjah (UAE) yielded a significant collection of marine shells (Gomes *et alii*, 2017) representative of the latest Holocene shallow-water marine assemblages of the Oman Gulf thermophilic molluscan fauna. These studied materials were collected during an archaeological excavation made in the first two weeks of January 2017, in the site of the ancient Quelba/Kalba fortification, a local defence structure mentioned by several bibliographic fonts from the period of Portuguese discoveries. The main purpose of this text is to quantitatively describe this collection, including its taxonomical composition, taphonomical and anthropic imprints, palaeoenvironmental and palaeogeographical signifycance, and cultural meaning.

Geographical and environmental setting

The Quelba fortification archaeological site is located at the seaside of Kalba, a coastal town of Sharjah Emirate opened to the Oman Gulf, in the northeast border of the Arabian Peninsula (fig. 1). The mid geographical coordinates of the studied area are 25°01'39.3" Lat. N; 056°21'39.1" Long. E. The fortress itself was built in the landscape of a large coastal plain area covered by aeolian sands, and formed by Holocene fluvial, estuarine and lagoonal sands and muds, beach and nearshore sands with interbedded coquina. This sedimentary system evolved in the proximity of the Kalba creek (fig. 2), who presently shows the remains of a lagoonal environment with mangroves, probably much more developed in past, but gradually silted up by marine and wind accretion. The existence of this marginal marine environment and its transition to the nearby seashore means that several ecological ecotones have been developed side to side, being a source of shell remains that contributed to the relatively high diversity of the studied molluscan assemblage, with co-occurrence of species from different coastal morphologies and abiotic conditions. As expected, the local faunas are typical of warm shallow water environments, with normal to brackish salinity conditions, and reveal adaptations to sandy soft bottoms or rocky substrates with a relative contribution of carbonate elements.

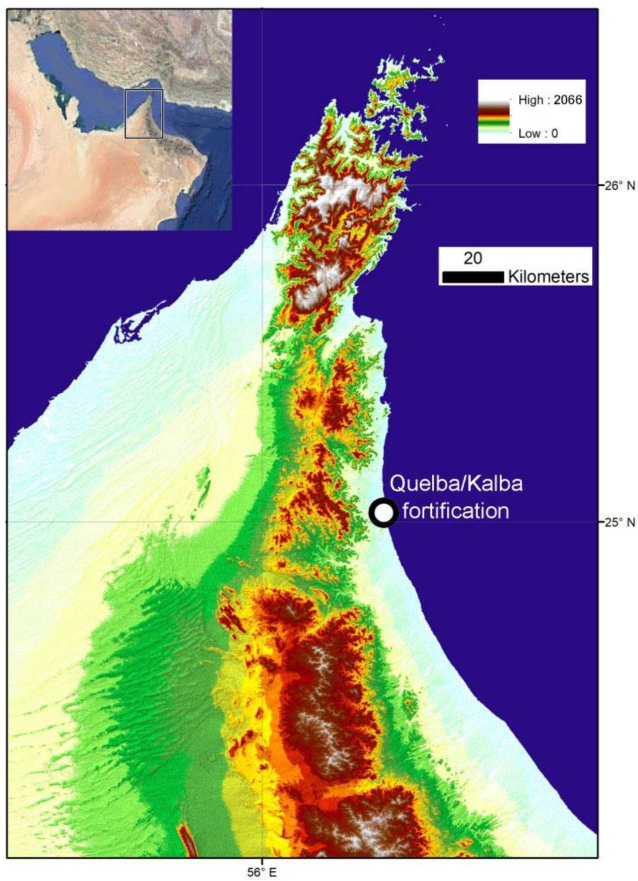

Figure 1. Location of the Quelba/Kalba fortification in the western margin of the Gulf of Oman. Digital elevation model (DEM) from SRTM 1 Arc-Second Global elevation data (https://earthexplorer.usgs.gov/)

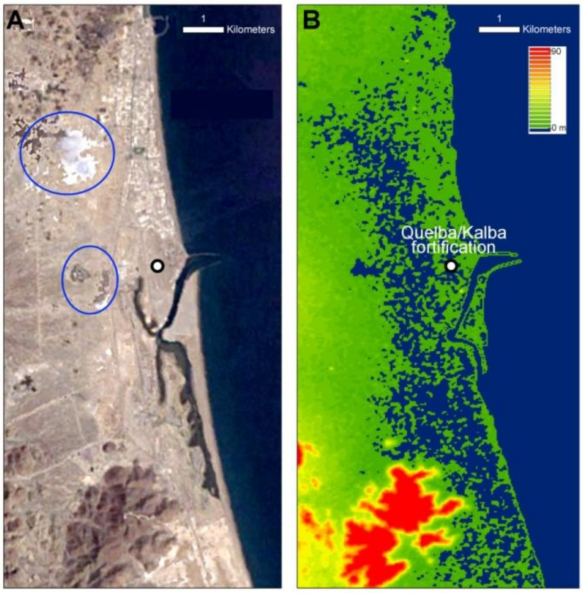

Figure 2. The Kalba creek and the coastal area surrounding the fortification. (A) Coastal lagoons visible in a 1995 Google Earth TM image (highlighted with blue ellipses). (B) DEM showing the low elevation of the coastal plain and the areas prone for lagoon development.

TAXONOMIC CHECK-LIST

The taxonomic classification and systematic arrangement of the molluscan assemblage sampled in the archaeological context of Quelba/Kalba fortification follows the proposals of Bieler *et alii* (2010; 2014) and Carter *et alii* (2011) for the Bivalves, and Bouchet *et alii* (2005) for the Gastropods. The monographs of Wenz (1938-44) and Moore (1960; 1969) have been also consulted, as well as the extensive books of Huber (2010; 2014) for the Bivalves. For the classification at the species level special attention was given to several works available for the Central and Northern Indian Ocean, Red Sea, Oman Sea and Arabian Gulf areas, where many elements of the typical Indo-Pacific Province warm shallow-water faunas occur together with short range species and several endemic molluscs. These areas have been investigated by Smythe (1972; 1979; 1982), Briggs (1973), Bosch and Bosch (1982; 1989), Sharabati (1984), Jones (1986), Vine (1986), Drivas and Jay (1987), Coloumbel (1994), Bosch *et alii* (1995), Brower *et alii* (2000), Feulner and Hornby (2006), Dekker and Gemert (2008), Rushmore-Villaume (2008), Al-Yamani *et alii* (2012), and El-Sorogy *et alii* (2016), among others. Finally, the monographs of Lorenz and Hubert (2002) and Tucker and Tenorio (2009) were considered respectively for the families Cypraeidae and Conidae.

The proposed taxonomic check-list comprises a total diversity of 57 taxa, including 12 families, 21 genera and 24 species of Bivalvia, 21 families, 29 genera and 32 species and subspecies of Gastropoda, and a single Scaphopoda. Most elements were classified to the specific level, with a few exceptions of abraded and uncoloured shells remaining in open nomenclature (pls. 1-8).

Class Bivalvia Linnaeus, 1758

Subclass Pteriomorphia Beurlen, 1944

Order Arcida Gray, 1854

Superfamily Arcoidea Lamarck, 1809

Family Arcidae Lamarck, 1809

Genus *Barbatia* Gray, 1842

Barbatia obliquata (Wood, 1828)

Barbatia candida (Helbling, 1779)

Genus *Anadara* Gray, 1847

Anadara antiquata (Linnaeus, 1758)

Anadara uropigimelana (Bory de Saint-Vincent, 1827)

Family Glycymerididae Dall, 1908

Genus *Glycymeris* da Costa, 1778

Glycymeris livida (Reeve, 1843)

Genus *Tucetona* Iredale, 1939

Tucetona pectunculus (Linnaeus, 1758)

Order Pteriida Newell, 1965

Superfamily Pterioidea Gray, 1847

Family Pteriidae Gray, 1847

Genus *Pinctada* Röding, 1798

Pinctada margaritifera (Linnaeus, 1758)

Order Ostreida Férussac, 1822

Superfamily Ostreoidea Rafinesque, 1815

Family Ostreidae Rafinesque, 1815

Genus *Alectryonella* Sacco, 1897

Alectryonella plicatula (Gmelin, 1791)

Genus *Saccostrea* Dollfus & Dautzenberg, 1920

Saccostrea cucullata (Börn, 1778)

Order Pectinida Gray, 1854

Superfamily Anomioidea Rafinesque, 1815

Family Anomiidae Rafinesque, 1815

Genus *Anomia* Linnaeus, 1758

Anomia achaeus Gray, 1850

Superfamily Pectinoidea Rafinesque, 1815

Family Spondylidae Gray, 1826

Genus *Spondylus* Linnaeus, 1758

Spondylus sp. indet.

Subclass Heteroconchia Gray, *1854*

Order Carditida Dall, 1889

Superfamily Carditoidea Férussac, 1822

Family Carditidae Férussac, 1822

Genus *Cardites* Link, 1807

Cardites bicolor (Lamarck, 1819)

Order Venerida Gray, 1854

Superfamily Cardioidea Lamarck, 1809

Family Cardiidae Lamarck, 1809

Genus *Vasticardium* Iredale, 1927

Vasticardium assimile lacunosum (Reeve, 1845)

Vasticardium rubicundum (Reeve, 1844)

Superfamily Chamoidea Lamarck, 1809

Family Chamidae Lamarck, 1809

Genus *Chama* Linnaeus, 1758

Chama sp. indet.

Superfamily Mactroidea Lamarck, 1809

Family Mactridae Lamarck, 1809

Genus *Mactra* Linnaeus, 1767

Mactra olorina Philippi, 1846

Genus *Meropesta* Iredale, 1929

Meropesta cf. *nicobarica* (Gmelin, 1791)

Superfamily Tellinoidea Blainville, 1814

Family Psammobiidae J. Fleming, 1828

Genus *Gari* Schumacher, 1817

Gari maculosa (Lamarck, 1818)

Superfamily Veneroidea Rafinesque, 1815

Family Veneridae Rafinesque, 1815

Genus *Circe* Schumacher, 1817

Circe rugifera (Lamarck, 1818)

Genus *Dosinia* Scopoli, 1777

Dosinia erythraea Römer, 1860

Genus *Tapes* Megerle von Mühlfeld, 1811

Tapes sulcarius (Lamarck, 1818)

Genus *Sunetta* Link, 1807

Sunetta effossa (Hanley, 1843)

Genus *Callista* Poli, 1791

Callista sp. indet.

Genus *Tivela* Link, 1807

Tivela damaoides (Wood, 1828)

Class Gastropoda Cuvier, 1795

Subclass Vetigastropoda

Order Trochida

Superfamily Trochoidea

Family Trochidae Rafinesque, 1815

Genus *Priotrochus* Fischer, 1879

Priotrochus obscurus (Wood, 1828)

Subclass Neritomorpha

Order Cycloneritida

Superfamily Neritoidea Rafinesque, 1815

Family Neritidae Rafinesque, 1815

Genus *Nerita* Linnaeus, 1758

Nerita albicilla Linnaeus, 1758

Subclass Caenogastropoda

Superfamily Cerithioidea Fleming, 1822

Family Potamididae H.Adams & A. Adams, 1854

Genus *Terebralia* Swainson, 1840

Terebralia palustris (Linnaeus, 1767)

Genus *Pirenella* Gray, 1847

Pirenella arabica Reid, 2016

Family Turritellidae Lovén, 1847

Genus *Turitella* Lamarck, 1799

Turitella cochlea Reeve, 1849

Order Littorinimorpha

Superfamily Calyptraeoidea Lamarck, 1809

Family Calyptraeidae Lamarck, 1809

Genus *Crepidula* Lamarck, 1799

Crepidula sp. indet.

Superfamily Cypraeoidea *Rafinesque*, 1815

Family Cypraeidae Rafinesque, 1815

Genus *Erosaria* Troschel, 1863

Erosaria erosa (Linnaeus, 1758)

Erosaria lamarckii (Gray, 1825)

Erosaria turdus (Lamarck, 1810)

Genus *Monetaria* Troschel, 1863

Monetaria annulus (Linnaeus, 1758)

Monetaria moneta (Linnaeus, 1758)

Genus *Lyncina* Troschel, 1863

Lyncina carneola (Linnaeus, 1758)

Genus *Mauritia* Troschel, 1863

Mauritia arabica immanis Schilder & Schilder, 1939

Mauritia arabica grayana Schilder, 1930

Genus *Palmadusta* Iredale, 1930

Palmadusta clandestina (Linnaeus, 1767)

Superfamily Naticoidea Guilding, 1834

Family Naticidae Guilding, 1834

Subfamily Polinicinae Gray, 1847

Genus *Neverita* Risso, 1826

Neverita didyma (Röding, 1798)

Genus *Polinices* Montfort, 1810

Polinices mammilla (Linnaeus, 1758)

Superfamily Stromboidea Rafinesque, 1815

Family Strombidae Rafinesque, 1815

Genus *Conomurex* Bayle in P. Fischer, 1884

Conomurex persicus (Swainson, 1821)

Superfamily Tonnoidea Suter, 1913

Family Cassidae Latreille, 1852

Genus *Semicassis* Mörch, 1852

Semicassis sp. indet.

Family Tonnidae Suter, 1913

Genus *Tonna* Brünnich, 1771

Tonna dolium (Linnaeus, 1758)

Family Ranellidae Gray, 1854

Subfamily Cymatiinae Iredale, 1913

Genus *Cymatium* Röding, 1798

Cymatium sp. indet.

Genus *Linatella* Gray, 1857

Linatella caudata (Gmelin, 1791)

Superfamily Vermetoidea Rafinesque, 1815

Family Vermetidae Rafinesque, 1815

Genus *Vermetus* Daudin, 1800

Vermetus sp. indet.

Superfamily Buccinoidea Rafinesque, 1815

Family Nassariidae Iredale, 1916

Subfamily Bulliinae Allmon, 1990

Genus *Bullia* Gray, 1833

Bullia mauritiana Gray, 1839

Superfamily Muricoidea Rafinesque, 1815

Family Muricidae Rafinesque, 1815

Subfamily Muricinae Rafinesque, 1815

Genus *Hexaplex* Perry, 1810

Hexaplex kuesterianus (*Tapparone* Canefri, 1875)

Subfamily Rapaninae Gray, 1853

Genus *Thais* Röding, 1798

Thais sp. indet.

Order Neogastropoda

Superfamily Olivoidea Latreille, 1825

Family Olividae Latreille, 1825

Subfamily Olivinae Latreille, 1825

Genus *Oliva* Bruguière, 1789

Oliva bulbosa (Röding, 1798)

Subfamily Olivellinae Troschel, 1869

Genus *Olivella* Swainson, 1831

Olivella sp. indet.

Superfamily Conoidea Fleming, 1822

Family Conidae Linnaeus, 1758

Genus *Conus* Linnaeus, 1758

Conus quercinus Lightfoot, 1786

Conus sp. indet. [abraded fragments]

Genus *Conasprella* Thiele, 1929

Conasprella stocki (Coomans & Moolenbeek, 1990)

Subclass Heterobranchia

Superfamily Architectonicoidea Gray, 1850

Family Architectonicidae Gray, 1850

Genus *Architectonica* Röding, 1798

Architectonica perspectiva (Linnaeus, 1758)

Class Scaphopoda

Order Dentaliida

Family Dentaliidae Children, 1834

Genus *Dentalium* Linnaeus, 1758

Dentalium sp. indet.

Quantitative analysis of the invertebrate assemblage

The studied bulk sample has a total of 880 skeletal parts, which are representative of a minimal number of 817 individuals. This collection was divided in two complementary parts: the first contains the materials collected from the excavated squares, and the second a large set of shells and other skeletal parts found inside a well structure with a sedimentary infill rich on invertebrate remains. The larger part comprises 63 samples with 548 individuals collected from 61 squares of the 328 m^2 dug area (Gomes *et alii*, 2017). They include several surface samples, specimens found in modern sand sediments (bed 1), and shells from the sandy deposit contemporary of the fortress (bed 2). From the well structure there is a complementary sample of 269 individuals picked up from a succession of layers, which records several infill episodes of shellfish and food garbage.

The square sampling consists of disarticulated valves and fragments of 174 specimens of bivalve molluscs, including a few oysters and several different species of clams, together with 351 gastropod shells and fragments, and a scaphopod (tusk shell) (tables Ia, Ib, and Ic). For quantitative purposes, only the bivalve fragments with hinge parts and the gastropod fragments with spire parts have been counted. Besides these molluscan shells, also 20 abraded skeletal fragments of scleractinian corals and two parts of decapod claws (edible crabs) were found. Other invertebrate remains such as serpulid worm tubes and fragments of incrusted bryozoan colonies may occur as epizoans on the inner and outer surfaces of several shells, but they were not used for quantitative purposes. Nevertheless, they are useful to reveal the taphonomic imprint of the skeletal parts, suggesting in many cases a significant post-mortem interval of biostratonomic residence over the substrate surface.

The absolute frequency and relative abundance of the taxa collected from the 61 excavated squares are detailed in table Id and figure 3. The most representative species are the gastropods *Oliva bulbosa* (82 individuals; 14.96 %), *Conomurex persicus* (48 individuals; 8.76%), *Erosaria turdus* (46 individuals; 8.39 %), *Turritella cochlea* (36 individuals; 6.57 %), *Terebralia palustris* (34 individuals; 6.20 %) and *Olivella* sp. (23 individuals; 4.20 %), and the bivalves *Anadara antiquata* (35 individuals; 6.39 %), and *Tucetona pectunculus* (25 individuals; 4.56 %).

Other rather representative taxa are the gastropods *Hexaplex kuesterianus* (15 individuals; 2.74 %), *Monetaria annulus* (10 individuals; 1.82 %), *Nerita albicilla* (nine individuals; 1.64 %), and *Architectonica perspectiva* (six individuals; 1.09 %), and the bivalves *Barbatia obliquata* (18 individuals; 1.38 %), *Anadara uropigimelana* (17 individuals; 3.10 %), *Anadara uropigimelana* (17 individuals; 3.10 %), *Mactra olorina* (16 individuals; 2.92 %), *Vasticardium assimile* (13 individuals; 2.37 %), *Vasticardium rubicundum* (25 individuals; 4.56 %) and *Saccostrea cucullata* (eight individuals; 1.46 %). Besides molluscs, this sampling contains 20 abraded fragments of undetermined scleractinian corals (5.65 %).

Species / Grid Unit	**1**	**2**	**3**	**5**	**6**	**7**	**8**	**9**	**11**	**12**	**19**	**20**	**22**	**24**	**26**	**33**	**34**	**35**	**43**	**44**	**45**	**46**
Barbatia obliquata	1	1																1	1			
Barbatia sp.																						
Anadara antiquata		1				1			1					1		1		4	1			
Anadara uropigimelana	1				1	2			1	1												
Glycymeris livida							1															
Tucetona pectunculus							1					1					1		1	1		
Pinctada margaritifera																						
Alectryonella plicatula																		1				
Saccostrea cucullata	1																			1		
Anomia achaeus						1											2					
Spondylus sp. indet.						1																
Cardites bicolor													1									
Vasticardium assimile			2						2													
Vasticardium rubicundum									1		1						2					
Chama sp.						1																
Mactra olorina	1						1														1	
Callista sp.																				1		
Nerita albicilla				1													1				1	
Terebralia palustris				1		2						1						3	2			
Pirenella arabica														1								
Erosaria erosa														1								
Erosaria lamarckii																						
Erosaria turdus	1										1				1	1			2			
Monetaria annulus							1															1
Neverita didyma	1																					
Polinices mammilla																				1		
Conomurex persicus		1	1	3		3			3		1						1			1		
Semicassis sp.																						
Tonna dolium														1								
Vermetus sp.			1																			
Hexaplex kuesterianus		2														1						
Thais sp.																			1			
Oliva bulbosa	1	1	1	3			1	1	1		1					2	4		2	1		
Olivella sp.			1											2			2		2			
Conus quercinus													1									
Sample size	7	6	6	8	1	14	6	1	9	1	4	2	2	6	1	5	13	9	12	6	2	1
Taxonomic diversity	7	5	5	4	1	8	6	1	6	1	4	2	2	5	1	4	7	4	8	6	2	1

Table 1a. Quantitative distribution of the invertebrate taxa collected in the Quelba/Kalba fortification archaeological site (grid units 1 to 46).

Species / Grid Units	**49**	**52**	**54**	**55**	**58**	**59**	**60**	**61**	**66**	**68**	**69**	**76**	**78**	**80**	**82**	**83**	**84**	**86**	**87**	**88**	**89**
Barbatia obliquata													1		2						
Barbatia sp.																			1	1	
Anadara antiquata								1	2		1			1	1						1
Anadara uropigimelana	1						1		1					2				1		1	
Glycymeris livida																					
Tucetona pectunculus		1			1				1						1			1		1	
Pinctada margaritifera													1								
Alectryonella plicatula						1			1												
Saccostrea cucullata												1			2		1				
Spondylus sp. indet.																		1			
Cardites bicolor												1									
Vasticardium assimile												1		1	1			1		1	
Vasticardium rubicundum															1		1				
Mactra olorina								1			1				1						
Meropesta sp.																				1	
Circe rugifera																			1		
Tapes sulcarius											1										
Callista sp.										1											
Priotrochus obscurus																				1	
Terebralia palustris						2			1	1				1	3			1			
Pirenella arabica																			1		
Turitella cochlea																				5	
Mauritia arabica grayana														1							
Erosaria lamarckii											1										
Erosaria turdus		1	2							1	1	1	2		2		2			2	
Monetaria annulus					1											1					
Conomurex persicus			1			1							1	1	1		1	1		4	
Semicassis sp.																				2	
Tonna dolium									1												
Bullia mauritiana																				1	
Hexaplex kuesterianus									1						1		1				
Thais sp.																					
Oliva bulbosa									2						4	1	1	2			
Olivella sp.				1					1								1	1	1	3	
Conus sp. indet.																		1			
Architectonica perspectiva			1																	1	
Sample size	1	2	4	1	2	4	1	2	12	3	5	5	6	8	20	2	9	10	7	24	1
Taxonomic diversity	1	2	3	1	2	3	1	2	10	3	5	5	5	7	12	2	8	9	5	13	1

Table 1b. Quantitative distribution of the invertebrate taxa collected in the Quelba/Kalba fortification archaeological site (grid units 49 to 89).

Species / Grid Units	90	92	94	96	97	98	101	102	103	107	108	110	112	113	114	119	121	123	cln	srf
Barbatia obliquata	1					1	2			2		1					1			3
Barbatia sp.															1					
Anadara antiquata		1				1	1		1	2		1			3	1	1			6
Anadara uropigimelana						1													1	2
Glycymeris livida																				
Tucetona pectunculus		4		1		1	1		1	1		1						1		3
Pinctada margaritifera																				1
Alectryonella plicatula												1								
Saccostrea cucullata		1										1								
Cardites bicolor																				1
Vasticardium assimile							1			1								1	1	
Vasticardium rubicundum							1					1							2	1
Chama sp.																				
Mactra olorina		2					1	2	1				1						1	2
Gari maculosa									1											
Circe rugifera																	1			1
Dosinia erythraea	1																			
Tapes sulcarius																			1	
Sunetta effossa																		1		
Tivela damaoides																				1
Nerita albicilla		2										1						1		2
Terebralia palustris	3	2			1	1			2	1	1			2	1				1	1
Pirenella arabica		1											1							
Turitella cochlea		26															2	2		1
Crepidula sp.		1												1						1
Mauritia arabica immanis												1								1
Mauritia arabica grayana		1																		
Lyncina carneola carneola									1											
Erosaria erosa												1			1					
Erosaria turdus		4	1				1		2			1		1	1			2	1	12
Monetaria annulus	2	1																3		
Monetaria moneta														1						2
Polinices mammilla							1													
Conomurex persicus	2	4	1		1		1			1		1			1	1	2	3	2	3
Semicassis sp.		1																		
Tonna dolium	1																		1	
Cymatium sp.		1																		
Bullia mauritiana																				1
Hexaplex kuesterianus		1								1							5		1	1
Oliva bulbosa	2	3				1	27	1	1		1			2			3	1	1	10
Olivella sp.		6							1											2
Conus quercinus							1													
Conus sp. indet.				1					1											1
Architectonica perspectiva	1																	2		1
Dentalium sp.		1																		
Sample size	13	67	3	2	2	6	38	3	13	9	2	12	2	7	8	2	15	17	14	61
Taxonomic diversity	7	21	3	2	2	6	12	2	13	7	2	12	2	5	6	2	7	10	12	25

Table 1c. Quantitative distribution of the invertebrate taxa collected in the Quelba/Kalba fortification archaeological site (grid units 90 to 123; cln - square cleaning; srf - surface specimens).

Species / Grid Units	sum	%abd
Barbatia obliquata	18	3,28
Barbatia sp.	3	0,55
Anadara antiquata	35	6,39
Anadara uropigimelana	17	3,10
Glycymeris livida	1	0,18
Tucetona pectunculus	25	4,56
Pinctada margaritifera	2	0,36
Alectryonella plicatula	4	0,73
Saccostrea cucullata	8	1,46
Anomia achaeus	3	0,55
Spondylus sp. indet.	2	0,36
Cardites bicolor	3	0,55
Vasticardium assimile	13	2,37
Vasticardium rubicundum	11	2,01
Chama sp.	1	0,18
Mactra olorina	16	2,92
Meropesta cf. *nicobarica*	1	0,18
Gari maculosa	1	0,18
Circe rugifera	3	0,55
Dosinia erythraea	1	0,18
Tapes sulcarius	2	0,36
Sunetta effossa	1	0,18
Callista sp.	2	0,36
Tivela damaoides	1	0,18
Priotrochus obscurus	1	0,18
Nerita albicilla	9	1,64
Terebralia palustris	34	6,20
Pirenella arabica	4	0,73
Turitella cochlea	36	6,57
Crepidula sp.	3	0,55
Erosaria erosa	3	0,55
Erosaria lamarckii	1	0,18
Erosaria turdus	46	8,39
Monetaria annulus	10	1,82
Monetaria moneta	3	0,55
Lyncina carneola carneola	1	0,18
Mauritia arabica immanis	2	0,36
Mauritia arabica grayana	2	0,36
Palmadusta cladestina	1	0,18
Neverita didyma	1	0,18
Polinices mammilla	2	0,36
Conomurex persicus	48	8,76
Semicassis sp.	3	0,55
Tonna dolium	3	0,55
Cymatium sp.	1	0,18
Linatella caudata	1	0,18
Vermetus sp.	1	0,18
Bullia mauritiana	2	0,36
Hexaplex kuesterianus	15	2,74
Thais sp.	1	0,18
Oliva bulbosa	82	14,96
Olivella sp.	23	4,20
Conus quercinus	2	0,36
Conus sp. indet.	4	0,73
Architectonica perspectiva	6	1,09
Dentalium sp.	1	0,18
Scleractinian corals	20	3,65
Decapoda claws	2	0,36
Sample size	548	-

Table 1d. Overall quantitative distribution and relative abundance of the invertebrate taxa collected in the Quelba/Kalba fortification archaeological site (grid units 1 to 123).

Figure 3. Relative frequency of the invertebrate taxa collected from the excavated squares of Quelba/Kalba fortification archaeological site. a - *Barbatia obliquata*; b - *Barbatia* sp.; c - *Anadara antiquata*; d - *Anadara uropigimelana*; e - *Glycymeris livida*; f - *Tucetona pectunculus*; g - *Pinctada margaritifera*; h - *Alectryonella plicatula*; i - *Saccostrea cucullata*; j - *Anomia achaeus*; k - *Spondylus* sp. indet.; l - *Cardites bicolor*; m - *Vasticardium assimile*; n - *Vasticardium rubicundum*; o - *Chama* sp.; p - *Mactra olorina*; q - *Meropesta* cf. *nicobarica*, r - *Gari maculosa*; s - *Circe rugifera*; t - *Dosinia erythraea*; u - *Tapes sulcarius*; v - *Sunetta effossa*; w - *Callista* sp.; x - *Tivela damaoides*; y - *Priotrochus obscurus*; z - *Nerita albicilla*; A - *Terebralia palustris*; B - *Pirenella arabica*; C - *Turitella cochlea*; D - *Crepidula* sp.; E - *Erosaria erosa*; F - *Erosaria lamarckii*; G - *Erosaria turdus*; H - *Monetaria annulus*; I - *Monetaria moneta*; J - *Lyncina carneola carneola*; K - *Mauritia arabica immanis*; L - *Mauritia arabica grayana*; M - *Palmadusta cladestina*; N - *Neverita didyma*; O - *Polinices mammilla*; P - *Conomurex persicus*; Q - *Semicassis* sp.; R - *Tonna dolium*; S - *Cymatium* sp.; T - *Linatella caudata*; U - *Vermetus* sp.; V - *Bullia mauritiana*; W - *Hexaplex kuesterianus*; X - *Thais* sp.; Y - *Oliva bulbosa*; Z - *Olivella* sp.; *a* - *Conus quercinus*; *b* - *Conus* sp. indet.; *c* - *Architectonica perspectiva*; *d* - *Dentalium* sp.; *e* - scleractinian corals; *f* - Decapoda claws.

Figure 4. Relative frequency of the invertebrate taxa collected in a well structure filled with garbage remains at Quelba/Kalba fortification archaeological site. a - *Barbatia obliquata*; b - *Barbatia* sp.; c - *Anadara antiquata*; d - *Anadara uropigimelana*; e - *Tucetona pectunculus*; f - *Saccostrea cucullata*; g - *Spondylus* sp. indet.; h - *Cardites bicolor*; i - *Chama* sp.; j - *Mactra olorina*; k - *Circe rugifera*; l - *Dosinia erythraea*; m - *Tapes sulcarius*; n - *Sunetta effossa*; o - *Callista* sp.; p - *Priotrochus obscurus*; q - *Nerita albicilla*; r - *Terebralia palustris*; s - *Pirenella arabica*; t - *Turitella cochlea*; u - *Erosaria turdus*; v - *Monetaria annulus*; w - *Neverita didyma*; x - *Polinices mammilla*; y - *Conomurex persicus*; z - *Bullia mauritiana*; A - *Hexaplex kuesterianus*; B - *Thais* sp.; C - *Oliva bulbosa*; D - *Olivella* sp.; E - *Conus quercinus*; F - *Conus* sp. indet.; G - *Conasprella stocki*; H - *Dentalium* sp.; I - scleractinian corals; J - Decapoda claws.

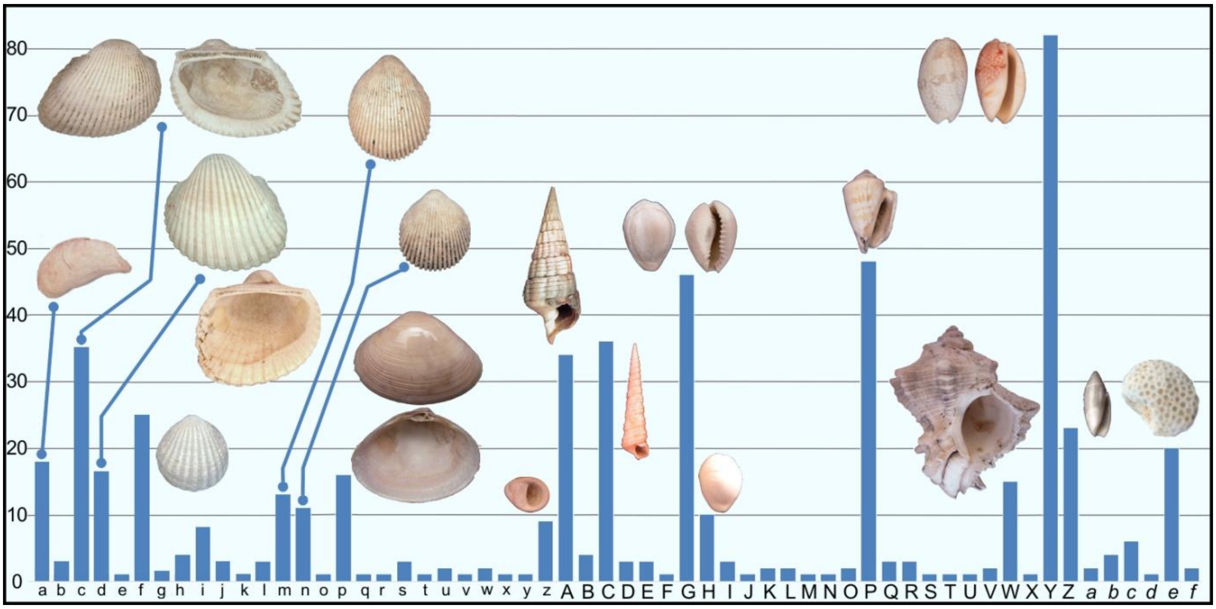

Figure 3.

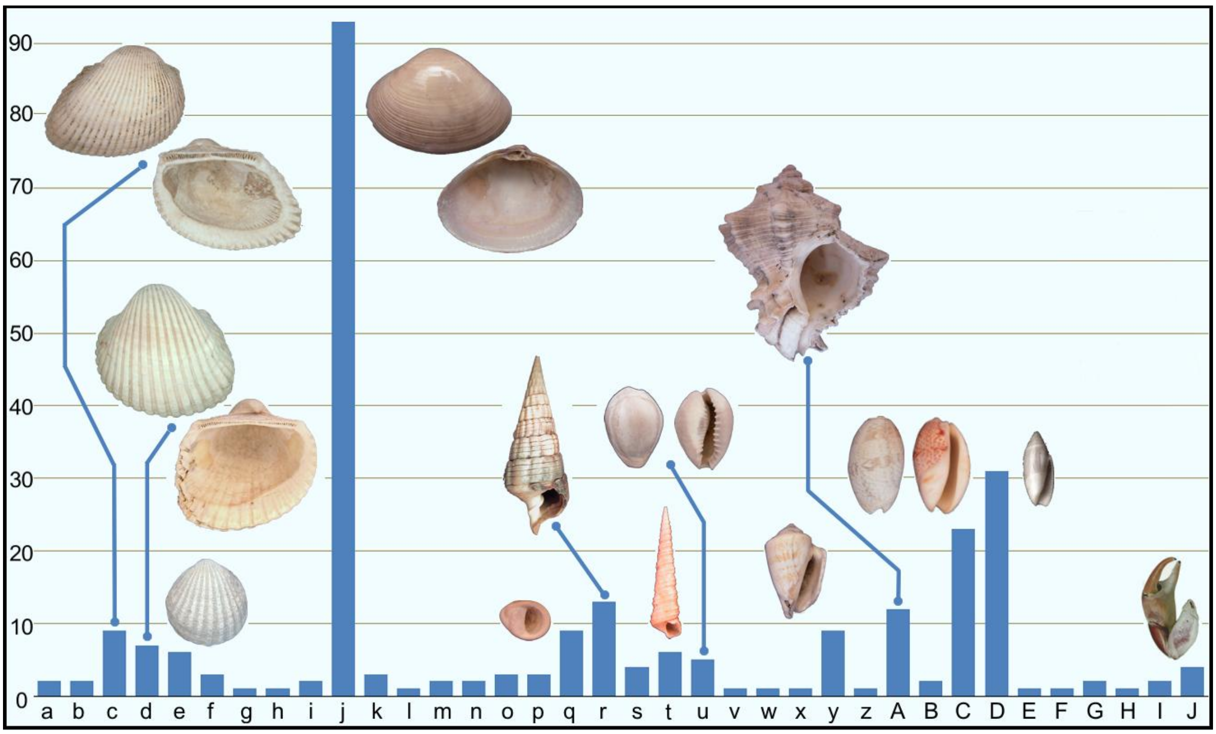

Figure 4.

Species / square number	wsrf	wl1	wl3	wl4	wl5	wl6	wl7	wl8	sum	%abd
Barbatia obliquata	1	-	-	-	-	1	-	-	2	0,74
Barbatia sp.	1	-	-	-	-	-	-	-	2	0,74
Anadara antiquata	7	-	-	-	1	1	-	-	9	3,35
Anadara uropigimelana	2	2	-	-	2	-	1	-	7	2,60
Tucetona pectunculus	4	-	-	-	1	-	1	-	6	2,23
Saccostrea cucullata	-	3	-	-	-	-	-	-	3	1,12
Spondylus sp. indet.	-	1	-	-	-	-	-	-	1	0,37
Cardites bicolor	-	1	-	-	-	-	-	-	1	0,37
Chama sp.	1	-	1	-	-	-	-	-	2	0,74
Mactra olorina	25	33	-	1	20	8	4	2	93	34,57
Circe rugifera	1	-	-	-	2	-	-	-	3	1,12
Dosinia erythraea	-	-	-	-	1	-	-	-	1	0,37
Tapes sulcarius	-	1	-	-	1	-	-	-	2	0,74
Sunetta effossa	2	-	-	-	-	-	-	-	2	0,74
Callista sp.	1	1	-	-	1	-	-	-	3	1,12
Priotrochus obscurus	1	1	-	-	-	-	1	-	3	1,12
Nerita albicilla	5	1	-	-	1	2	-	-	9	3,35
Terebralia palustris	3	7	-	-	-	2	1	-	13	4,83
Pirenella arabica	2	2	-	-	-	-	-	-	4	1,49
Turitella cochlea	5	1	-	-	-	-	-	-	6	2,23
Erosaria turdus	1	2	-	-	1	1	-	-	5	1,86
Monetaria annulus		1	-	-	-	-	-	-	1	0,37
Neverita didyma	1	-	-	-	-	-	-	-	1	0,37
Polinices mammilla	1	-	-	-	-	-	-	-	1	0,37
Conomurex persicus	6	2	-	-	-	1	-	-	9	3,35
Bullia mauritiana	1	-	-	-	-	-	-	-	1	0,37
Hexaplex kuesterianus	5	4	-	-	2	1	-	-	12	4,46
Thais sp.		2	-	-	-	-	-	-	2	0,74
Oliva bulbosa	16	2	-	-	1	4	-	-	23	8,55
Olivella sp.	9	13	-	-	1	8	-	-	31	11,52
Conus quercinus	1	-	-	-	-	-	-	-	1	0,37
Conus sp. indet.	-	-	-	-	-	1	-	-	1	0,37
Conasprella stocki	1	-	-	-	-	-	-	1?	2	0,74
Dentalium sp.	-	1	-	-	-	-	-	-	1	0,37
Scleractinian corals	2	-	-	-	-	-	-	-	2	0,74
Decapoda claws	-	4	-	-	-	-	-	-	4	1,49
Sample dimension	106	85	1	1	35	30	8	3	269	-
Taxonomic diversity	26	21	1	1	13	11	5	2	-	-

Table 2. Quantitative distribution and relative abundance of the invertebrate taxa collected in a well structure filled with garbage remains at the Quelba/Kalba fortification archaeological site.

From the second part of the bulk sample, the well infill layers yielded shells and skeletal fragments of 34 mollusc taxa, including the remains of 137 bivalves, 125 gastropods and a single scaphopod (table 2; fig. 4). Two fragments of branched coral and several of Decapoda claws belonging to at least two large individuals have also been found together. The commonest taxa are the gastropods *Olivella* sp. (31 individuals; 11.52 %), *Oliva bulbosa* (48 individuals; 8.76%), *Terebralia palustris* (13 individuals; 4.83 %), *Hexaplex kuesterianus* (12 individuals; 4.46 %), *Nerita albicilla* (nine individuals; 3.35 %) and *Conomurex persicus* (nine individuals; 3.35 %), and the bivalves *Mactra olorina* (93 individuals; 35.57 %), and *Anadara antiquata* (nine individuals; 3.35 %). Other rather frequent taxa are the gastropods *Turritella cochlea* (four individuals; 1.49 %), and the bivalves *Anadara uropigimelana* (seven individuals; 2.60 %) and *Tucetona pectunculus* (six individuals; 2.23 %).

TAPHONOMY AND SHELL HISTORY

The post-mortem history of biogenic skeletal parts can be very useful to recognise environmental and cultural aspects of the archaeological contexts. There is a wide range of biostratinomical processes, both constructive and destructive, that can interact with shells and other invertebrate remains, to produce physical, chemical and/or biological changes, as a sort of individual taphonomic imprint that can tell us much about each pre-burial pathway (*e.g.* Lopez, 2000). Nevertheless, the more effective mechanisms in seashore and marginal marine environments can be those of biodegradation-decomposition, disarticulation, breakage, abrasion, reorientation, concentration, ressedimentation, distortion, bioerosion and encrusting. They can act at the same time or sequentially, during the time residence of the skeletal parts over the subtract, and before their definitive burial in the sediments.

An overview of the studied bulk sample shows evidence that all these mechanisms would have been present in some extent, changing many of the original shells in their natural environment, before being transported to the archaeological site. By this way, it can be stated that autochthonous and parautochthonous elements are absent from the assemblage. All invertebrate remains have been subjected to a natural transport and ressedimentation, or in alternative to intentional or fortuitous human gathering from their primary environments to the archaeological context.

Except for a single specimen of *Mactra olorina*, all bivalves from the collection were recorded as disarticulated valves. Shell breakage is high for many taxa, both bivalves or gastropods. It is often associated to mechanical abrasion of the skeletal parts, bioerosion and epizoan encrusting. More rarely, other shells show evidence of intentional breakage, such as the large specimens of *Hexaplex kuesterianus*, and the edible clams *Callista* sp. and *Tapes sulcarius*. This kind of human produced fragments is also extensible to a short number of crab claws found together with the shell assemblage, suggesting a low scale shellfish diet.

Bioerosion marks are common in the studied shells. They result from the destructive activity of boring sponges such as *Cliona*, polychaete worms or carnivorous gastropods. Most epizoans consist of agglomerated tubes of serpulid worms, colonies of encrusting bryozoans, small barnacles and calcareous algae. Both bioerosional structures and epizoan encrusting can only affect the external surface of the shells, or be present in both outside and inside surfaces, frequently with abrasion. In the first case they could be produced during the life cycle of the animal, and persist after death, through the biostratonomical phase that precedes the burial. If present in both sides of the skeletal elements, these bioerosional structures and epizoan encrusting were surely post-mortem.

These signs of a long and complex biostratonomical history have been found in many shells of the studied assemblage, including specimens of the bivalves *Barbatia obliquata*, *Tucetona pectunculus*, *Spondylus* sp. indet., *Vasticardium assimile* and *V. rubicundum*, and the gastropods *Terebralia palustris*, *Erosaria turdus*, Conus sp. and *Olivella* sp. At least in part, the origin of these "old" shells would much likely be related to the Holocene sedimentary accretion of the sandy littoral plain where the Quelba/Kalba fortification was built. Thus, these reworked skeletal parts can be interpreted as sedimentary particles (bioclasts in the sense of Folk, 1959) of the natural environment, which have been accumulated by the conjugated action of swelling, longshore drift and tide currents. Their age also can be much older than the chronology of the archaeological context itself, meaning that the studied association has a fraction of mixed heterochronous elements. Nevertheless, it is probable that other shells with high biostratonomic changes have resulted from fishing and shellfish activities followed by a fortuity transport to the site, for example during the cleaning of fishing nets.

PALAEOENVIRONMENTAL BACKGROUND

The main ecological requirements and present day biogeographic ranges of the sampled species suggest that all of them are shallow water, nearshore to upper offshore benthic molluscs, both epifaunal or infaunal, typical of warm surface waters from the tropical Indo-Pacific Realm. Several palaeoenvironments with modern equivalents in the Kalba coastal area and characterised by a conjugation of abiotic factors, such as salinity, substrate and batimetry, can be recognised from the ecological analysis of the association:

(a) *Lagoonal and mangrove areas with low-energy brackish conditions, including sandy mud or muddy sand intertidal and upper infralittoral flats with soft substrates*. These transitional environments are representative of the large mud creeper *Terebralia palustris* (Hellyer and Aspinall, 2006) and several other Potamididae gastropods such as *Pirenella arabica*, besides the edible oysters *Saccostrea cucullata* and *Alectryonella plicatula* (Feulner, 2000; Feulner and Hornby, 2006), both recorded in the studied samples. *Meropesta nicobarica* and other infaunal bivalves can also be present, as well as the intertidal gastropods *Priotrochus obscurus* and *Nerita albicilla*, which can live attached to mangrove roots and other hard substrates locally available. It is likely that the lagoonal system of Khor Kalba and its mangrove swamps were more extensive in past, before being gradually filled by accretionary beach and dune sands of the present-day Holocene littoral plain.

(b) *Beach shoreface and tidal flat, medium to high energy sandy soft substrates*. This kind of intertidal and upper infralittoral environments located above the wave-base level is very advantageous for several types of infaunal bivalves adapted to unstable and well-oxygenated unconsolidated bottoms, including many edible clams such as *Mactra olorina*, *Circe rugifera*, *Dosinia erythraea* and *Tapes sulcarius*. It is also the preferred environment for the olive shells *Oliva bulbosa*, *Olivella* sp., which sometimes are recorded in large numbers. Other gastropod species may include *Turritella cochlea*, the cowries *Erosaria turdus*, *E. erosa*, *E. lamarcki*, *Monetaria annulus* and *M. moneta*, the moon snails *Neverita didyma* and *Polinices mamilla*, the nassa snail *Bullia mauritiana*, several *Conus* and the sundial *Architectonica perspectiva*.

(c) *Infralittoral rocky and coralline substrates*. Submerged rocky bottoms and coral buildups and are common morphological elements of Oman Sea nearshore and upper offshore areas located not far away from Kalba, where they integrate the noteworthy diversity of biotopes available in the Sharjah Emirate. The ecology of several species known from the studied collection is interrelated to this type of environment, where a large availability hard-substrates with algal assemblages and cryptic niches allows their proliferation and protection against predators. These areas are suitable for a variety of adaptations of byssate and cemented bivalves, such as *Barbatia obliquata*, *Anomia achaeus*, *Spondylus* sp. and *Chama* sp., together with many examples of herbivorous and carnivorous gastropods, including several species of cowries, *Semicassis* sp., *Hexaplex kuesterianus*, and *Thais* sp.

(d) *Infralittoral soft sandy substrates*. The inner shelf sandy shoals with depths located below the wave base and within the photic zone can be high-diversity environments for marine molluscs. Many tidal flat species can extend their bathymetric range to these deeper areas, besides other typically infralittoral. The rich algal assemblages and the oxygenated and more stable substrates also provide good ecological conditions for herbivorous gastropods and endobenthic species. Several bivalves such as *Glycymeris livida, Tucetona pectunculus*, *Vasticardium assimile* and *V. rubicundum* are well adapted to these niches, as well as the gastropods *Turritella cochlea*, several cowrie species, *Tonna dolium, Conus quercinus* and *Architectonica perspectiva*, among others, and the tusk shell *Dentalium* sp.

MOLLUSCS IN LOCAL CULTURE AND TRADITION

Seashore molluscs and crustaceans have always been an available source of nutrients for human populations living near coastal areas. They were an important complement of diet and motivated recollection strategies and activities since Palaeolithic times (*e.g.* Prieur, 2005). From more recent periods, a generalization of traditional activities based on the shellfish production and gathering of edible molluscs also occurred in many regions worldwide, including the Arabian Peninsula, where the widespread consumption of molluscs and crabs has been widely documented by a variety of archaeological contexts of different ages (*e.g.* Biagi, 1994; Charpentier *et al*., 1998; Boivin and Fuller, 2009).

The location of Kalba as a seaside settlement with natural conditions for fishing and shellfish traditional activities explains why the studied assemblage contains zooarchaeological remains with edible species, suggesting that the consumption of molluscs and crustaceans was part of the daily life of local population. These resources could include the arcid bivalves *Anadara antiquata* and *A. uropigimeleana* (*e.g.* Kasigwa and Mahika, 1991; Tebano and Paulay, 2001), the local mangrove oysters *Saccostrea cucullata* and *Alectryonella plicatula* (*e.g*. Chesalin *et al*., 2012), and the clams *Mactra olorina*, *Circe rugifera*, *Dosinia erythraea*, *Tapes sulcarius*, *Callista* sp. and *Tivella damaoides*. Among the gastropods stand out the large muricid *Hexaplex kuesterianus* and the strombid

Conomurex persicus, both known as edible species captured by fishermen. Representative specimens of these taxa have been found scattered in the sampled squares, but specially inside the well structure (table 2), where concentrated shells and intentionally broken fragments of *Mactra olorina* and several *Hexaplex kuesterianus* and crab claws suggest the existence of a local garbage deposit.

Besides the edible species, other exist in the bulk sample whose remains could have been accidentally transported during fish or shellfish activities and incorporated in the deposit after the local cleaning of fishing nets, traps or fish baskets. Others still, due to their dimension and form, could have been used as containers for domestic purposes, including several valves of *Pinctada margaritifera* and a large and convex *Tonna dollium,* both recorded as fragments in the collection. The first of these species is also well-known as a common source of pearls (Ellis and Haws, 1999) and their nacreous valves have been traditionally used in the confection of hooks (Bavutti *et al*., 2015).

The presence of several perforated shells without biostratonomical signs of reworking also points out for their possible use as adornment elements. This is the case of the olive shell *Oliva bulbosa,* a quite common species in the bulk sample where is recorded by many "fresh" specimens with traces of their original colour. Some of them show apical perforations for possible suspension in composite adornments, a cultural practice already reported in other regional contexts of diverse chronologies, at least since the Stone Age (*e.g.* Uerpmann and Uerpmann, 2003). Other possible adornment elements are the small tusk shells of *Dentalium* sp.

The occurrence of a small number of well-preserved *Monetaria annulus* and a single *M. moneta* stand out as an additional curious aspect of the studied shell assemblage. These cowries, but specially the last species, have been widely diffused as shell money across the whole Africa and used by Arabian merchants, slave traders and sailors during the Islamic Period. Its presence in the ancient Quelba/Kalba fortification could be a light but interesting sign of the proximity of these centennial land and maritime routes, where the Portuguese navigators and dealers played an important role in the dissemination of cultural, political and economic sceneries.

CONCLUSIONS

As expected from the diversity of materials collected in the archaeological excavation of the former Quelba/Kalba fortification (late 16th to 18th centuries, Sharjah, UAE), the zooarchaeological study of the abundant skeletal remains of marine invertebrates found in the same context resulted in a substantial set of data that revealed some main aspects of the surrounding environment and cultural habits of the local community.

The studied bulk sample yielded 24 species of Bivalvia, 32 species and subspecies of Gastropoda, a Scaphopoda, and several crustaceans and scleractinian coral debris. Its taphonomical and palaeoecological analysis suggests the presence of elements with different origins and ages, including older shells reworked from the substrate of Holocene accretionary littoral sands where the fortress was built, several elements of lagoonal origin, with emphasis on *Terebralia palustris*, and many others typical of tidal flat and inner shelf environments with sandy or rocky and coralline substrates.

The occurrence of several edible bivalves and gastropods in the assemblage also points out for a low scale exploration of the environment through fishing and shellfish gathering activities, and food consumption of molluscs and crabs. Several shells could also have been used as containers, and other perforated specimens as adornments, including the common olive shell *Oliva bulbosa*. A few specimens of *Monetaria annulus* and *M. moneta* may have been used as traditional currency.

This diversity of ecological and cultural examples based in invertebrate remains reveals the importance of the studied assemblage as an example of the interaction between a strategic human settlement and their natural surrounding environment in the Oman Sea, during the period of Portuguese presence.

ACKNOWLEDGEMENTS: Our thanks go to Prof. Mário Varela Gomes and to the Sharjah authorities for the opportunity to study the zooarcheological remains from the Quelba/Kalba fortification. This work also had the institutional support of CITEUC – Earth and Space Research Centre from the University of Coimbra (Science and Technology Foundation, Portugal).

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Plate 1.

1a-b *Barbatia obliquata* (Wood, 1828);

2a-b *Barbatia obliquata* (Wood, 1828);

3a-b *Anadara uropigimelana* (Bory de Saint-Vincent, 1827);

4a-b *Barbatia candida* (Helbling, 1779);

5a-b *Sunetta effossa* (Hanley, 1843);

(Scale bar = 1cm).


Plate I
1a
1b
2a
2b
3a
3b
4a
4b
5a
5b

Plate 2.

1a-b *Anadara antiquata* (Linnaeus, 1758);

2a-b *Glycymeris livida* (Reeve, 1843);

3a-b *Tucetona pectunculus* (Linnaeus, 1758);

4 *Pinctada margaritifera* (Linnaeus, 1758);

5 *Saccostrea cucullata* (Börn, 1778);

(Scale bar = 1cm).

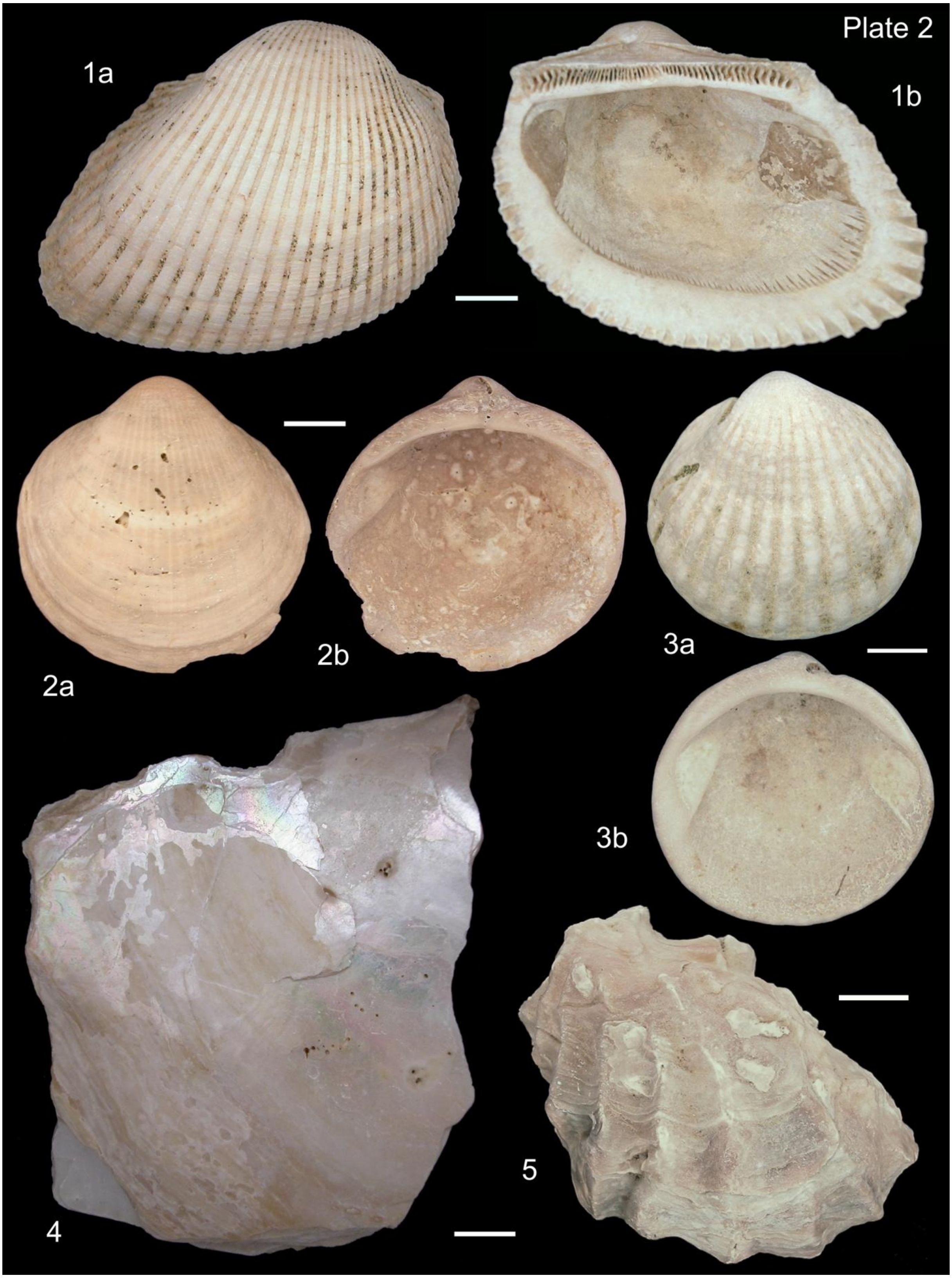
Plate 2
1a
1b
2a
2b
3a
3b
4
5

Plate 3.

1 *Saccostrea cucullata* (Börn, 1778);

2 *Pinctada margaritifera* (Linnaeus, 1758);

3a-b *Tapes sulcarius* (Lamarck, 1818);

4a-b *Alectryonella plicatula* (Gmelin, 1791);

5 *Dosinia erythraea* Römer, 1860;

6a-b *Cardites bicolor* (Lamarck, 1819);

7 *Gari maculosa* (Lamarck, 1818);

8a-b *Chama* sp. indet.;

(Scale bar = 1cm).

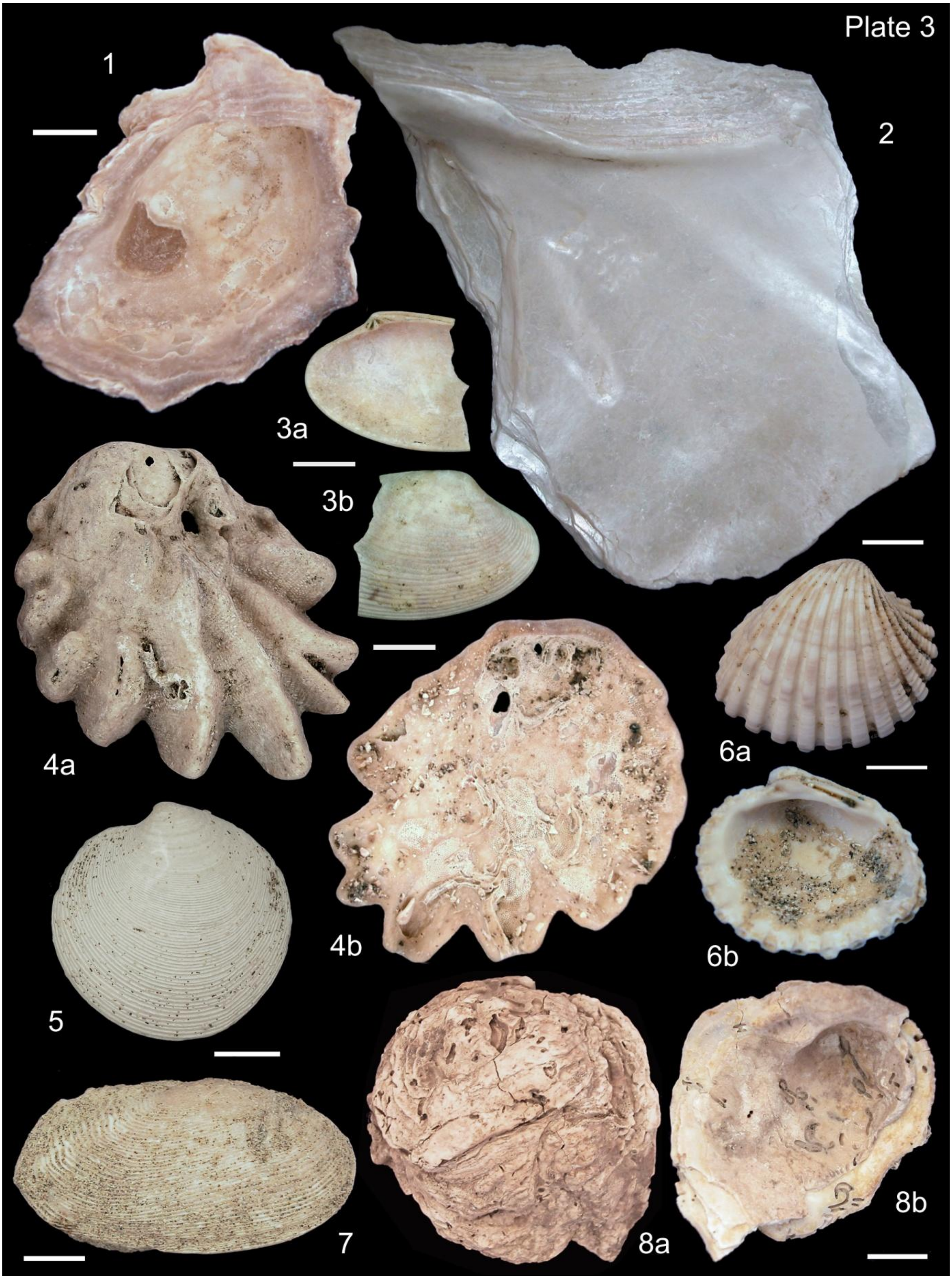
Plate 3
1
2
3a
3b
4a
4b
5
6a
6b
7
8a
8b

Plate 4.

1a-b *Spondylus* sp. indet.;

2a-b *Anomia achaeus* Gray, 1850;

3a-b *Vasticardium assimile lacunosum* (Reeve, 1845);

4 *Dosinia erythraea* Römer, 1860;

5a-b *Vasticardium rubicundum* (Reeve, 1844);

6 *Meropesta* cf. *nicobarica* (Gmelin, 1791);

7a-b *Mactra olorina* Philippi, 1846;

8 *Circe rugifera* (Lamarck, 1818);

(Scale bar = 1cm).

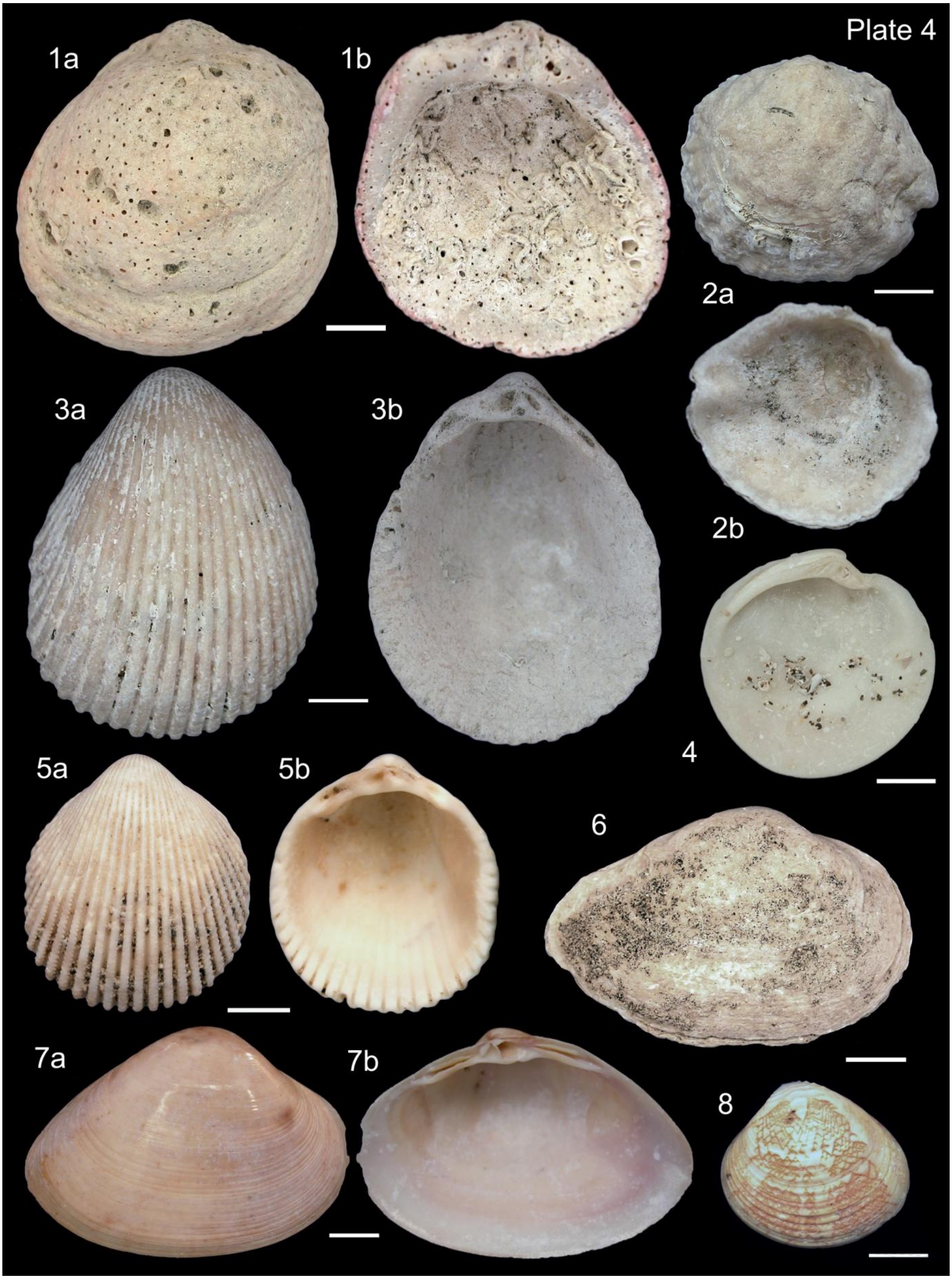
Plate 4
1a
1b
2a
2b
3a
3b
4
5a
5b
6
7a
7b
8

Plate 5.

1a-b *Meropesta* cf. *nicobarica* (Gmelin, 1791);

2 *Circe rugifera* (Lamarck, 1818);

3a-b *Tivela damaoides* (Wood, 1828);

4 *Callista* sp. indet.;

5a-b *Priotrochus obscurus* (Wood, 1828);

6a-b *Erosaria lamarckii* (Gray, 1825);

7a-b *Erosaria erosa* (Linnaeus, 1758);

8a-b *Nerita albicilla* Linnaeus, 1758;

9a-b *Nerita albicilla* Linnaeus, 1758;

10a-b *Turitella cochlea* Reeve, 1849;

11a-c *Erosaria turdus* (Lamarck, 1810);

12a-b *Terebralia palustris* (Linnaeus, 1767);

(Scale bar = 1cm).

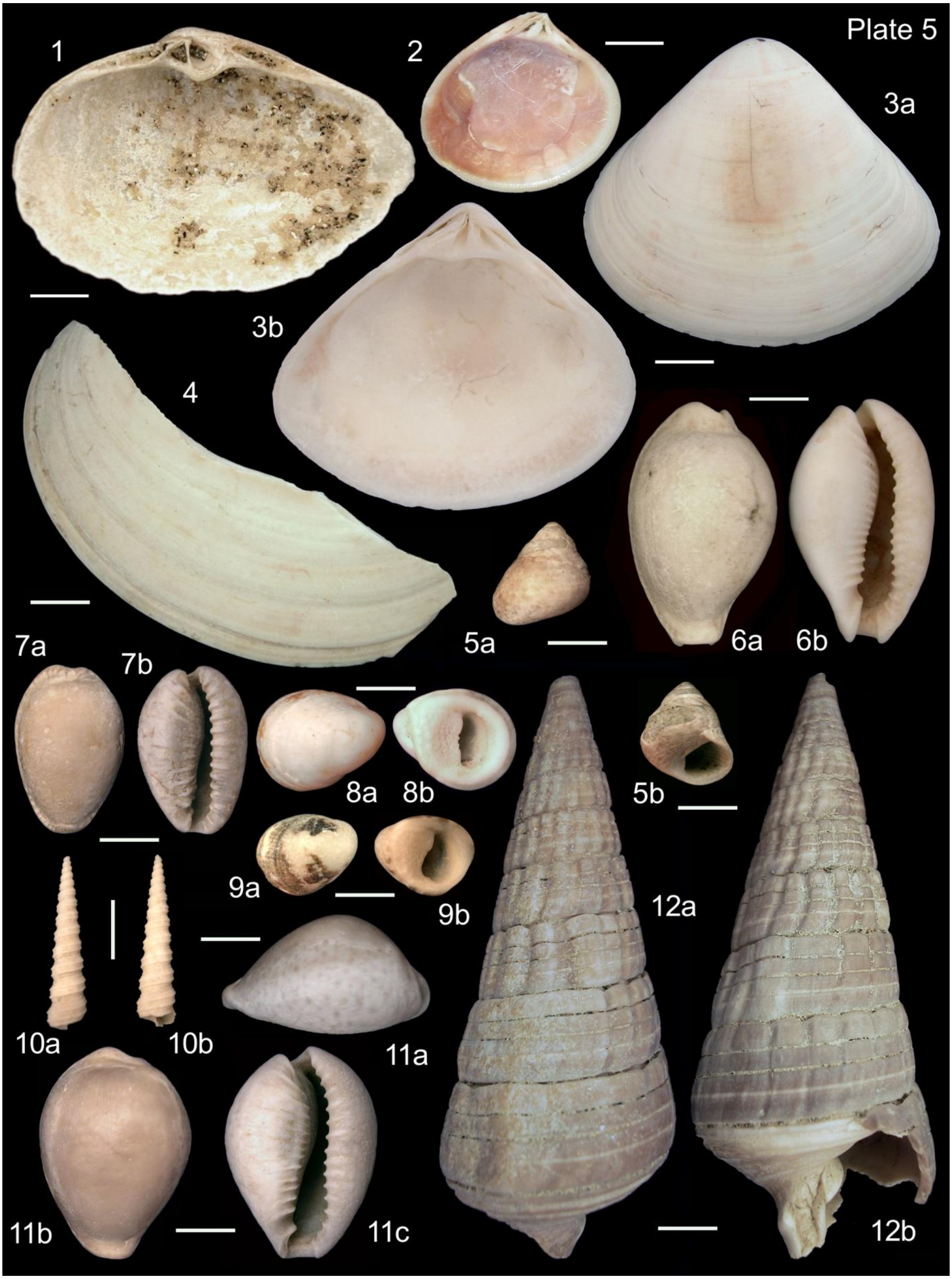
Plate 5
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2
3a
3b
4
5a
5b
6a
6b
7a
7b
8a
8b
9a
9b
10a
10b
11a
11b
11c
12a
12b

Plate 6.

1a-c *Pirenella arabica* Reid, 2016;

2a-b *Mauritia arabica grayana* Schilder, 1930;

3a-b *Lyncina carneola* (Linnaeus, 1758);

4a-b *Mauritia arabica immanis* Schilder & Schilder, 1939;

5a-b *Monetaria moneta* (Linnaeus, 1758);

6a-c *Crepidula* sp. indet.;

7a-b *Monetaria annulus* (Linnaeus, 1758);

8 *Semicassis* sp. indet.;

9a-b *Palmadusta clandestina* (Linnaeus, 1767);

10a-b *Neverita didyma* (Röding, 1798);

11a-b *Polinices mammilla* (Linnaeus, 1758);

12a-d *Olivella* sp. indet.;

(Scale bar = 1cm).

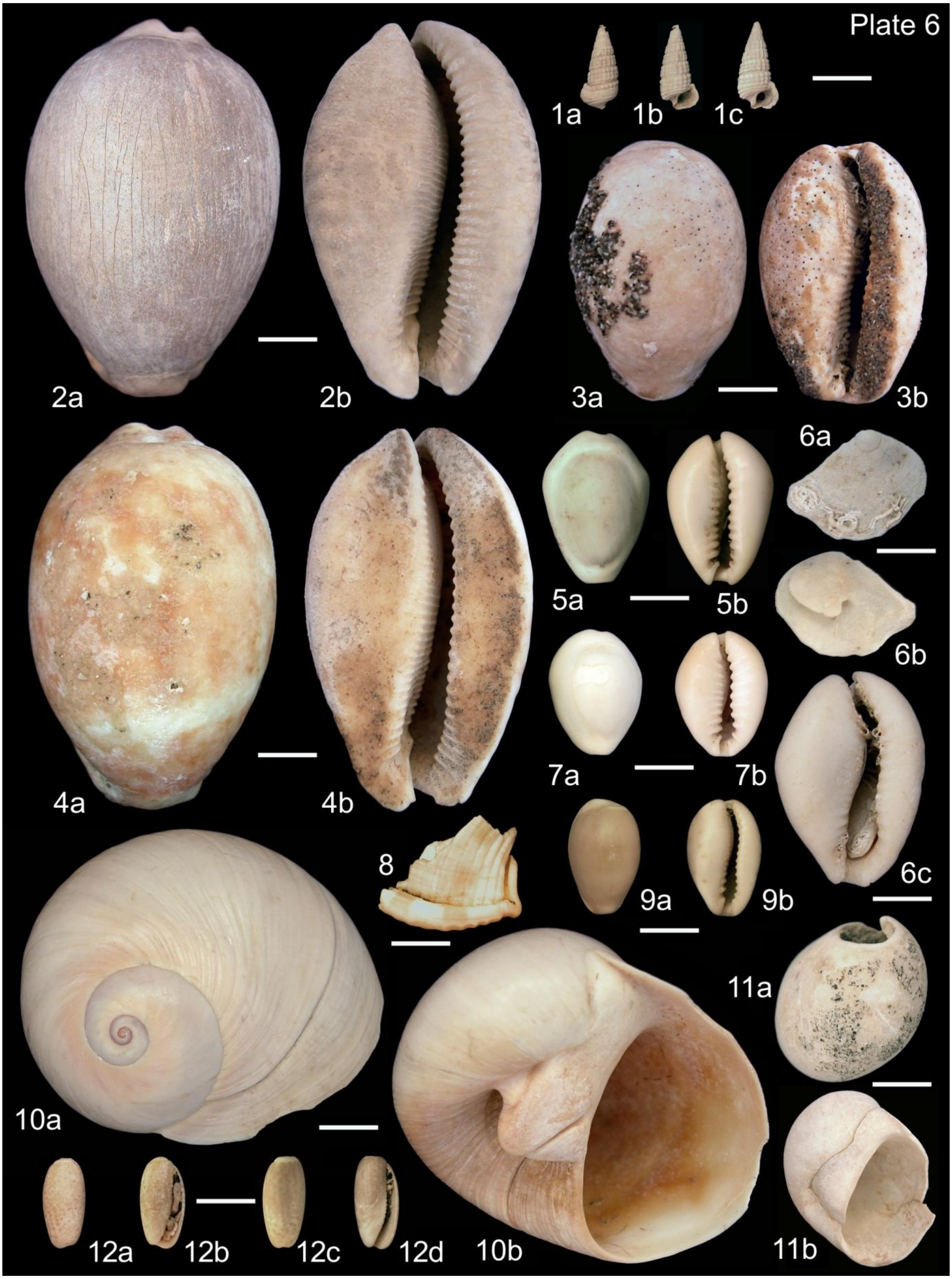

Plate 6
1a
1b
1c
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b
6c
7a
7b
8
9a
9b
10a
10b
11a
11b
12a
12b
12c
12d

Plate 7.

1 *Conomurex persicus* (Swainson, 1821);

2 *Cymatium* sp. indet.;

3a-b *Conomurex persicus* (Swainson, 1821);

4a-b *Hexaplex kuesterianus* (Tapparone Canefri, 1875);

5 *Thais* sp. indet.;

6a-b *Linatella caudata* (Gmelin, 1791);

7a-b *Conus* sp. indet.;

8 *Vermetus* sp. indet.;

9 *Tonna dolium* (Linnaeus, 1758);

(Scale bar = 1cm).


Plate 7
1
2
3a
3b
4a
4b
5
6a
6b
7a
7b
8
9

Plate 8.

1a-b *Oliva bulbosa* (Röding, 1798);

2a-b *Oliva bulbosa* (Röding, 1798);

3a-c *Conus quercinus* Lightfoot, 1786;

4a-b *Bullia mauritiana* Gray, 1839;

5a-b *Architectonica perspectiva* (Linnaeus, 1758);

6a-b *Conasprella stocki* (Coomans & Moolenbeek, 1990);

7 *Dentalium* sp. indet.;

8 *Bullia mauritiana* Gray, 1839;

9a-b Decapoda indet. (claw);

(Scale bar = 1cm).

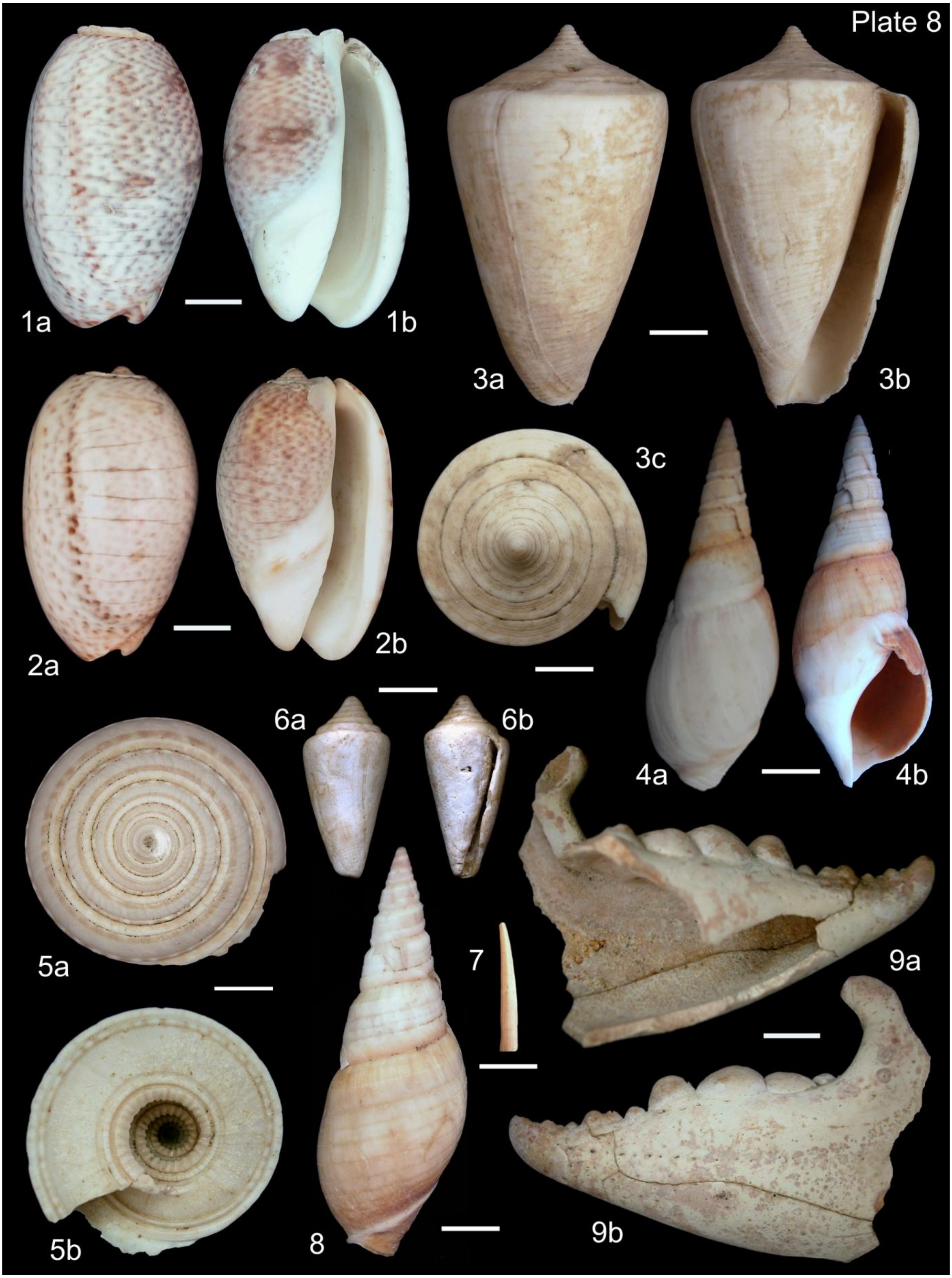
Plate 8
1a
1b
2a
2b
3a
3b
3c
4a
4b
5a
5b
6a
6b
7
8
9a
9b