

Holocene molluscs from Rio de Janeiro state coast, Brazil

Rosa Cristina Corrêa Luz de Souza^{1*}, Tania Andrade Lima² and Edson Pereira Silva¹

1 Departamento de Biologia Marinha, Instituto de Biologia, Universidade Federal Fluminense, Outeiro São João Batista s/nº, Caixa Postal 100.644, CEP 24.001-970 Niterói, RJ, Brasil.

2 Departamento de Antropologia, Museu Nacional/UFRRJ, Quinta da Boa Vista s/nº, CEP: 20940-040 Rio de Janeiro, RJ, Brasil.

* Corresponding author E-mail: rcclsouza@yahoo.com.br

ABSTRACT: A list of marine species of bivalves and gastropods found in seventy archeological sites of the shellmound type from Rio de Janeiro state was produced, based on the archeological material deposited in the collections of Museu Nacional (Rio de Janeiro, RJ), Instituto de Arqueologia Brasileira (Belford Roxo, RJ) and Museu do Sambaqui da Tarioba (Rio das Ostras, RJ). A total of 124 taxa were identified, of which 65 bivalves and 59 gastropods. The data retrieved from the shellmounds indicate stability of the composition patterns of mollusc biodiversity on the Rio de Janeiro state coast, at least in the period between 8,000 and 2,000 years B.P. The listing presented may be useful as a reference inventory for research pertaining to biological invasions, biogeography, conservation and management.

INTRODUCTION

Shellmounds are archeological sites built by prehistoric human populations that lived on the Brazilian coast between 8,000 and 2,000 years B.P. (Lima *et al.* 2002; 2003). Mounds built with food remains, basically shells and sediments, have been recorded on the coast of the Rio de Janeiro state. Among the biological remains recovered in shellmounds, there is an abundance of very resistant materials such as mollusc shells, crustacean and sea urchin carapaces, fish, bird and mammal bones, etc (Stein 1992; Figuti 1993; Lima 2000; Gaspar 2000). The remains allow the retrieval of information on prehistoric societies, such as the origin of their food supply and the use of these resources for making ornaments and artifacts. In addition, because these sites contain sets of organisms representatives of the fauna and flora existing at the time they were built, they enable the reconstruction of paleoenvironmental aspects related to species biodiversity and biogeography (Fürsich 1995; Scheel-Ybert *et al.* 2006; Lindbladh *et al.* 2007; Froyd and Willis 2008). Thus, from zooarcheological studies at sites of the shellmound type it is possible to retrieve important information on the mollusc fauna of the recent Holocene (Reitz and Wing 2008).

This study presents a taxonomic list of the marine species of bivalves and marine gastropods found at seventy archeological sites of the shellmound type distributed over sixteen municipalities of Rio de Janeiro state. This list constitutes the first reference inventory of the mollusc fauna of a part of the Brazilian coast in the Holocene, and it is significant for research aimed at reconstructing scenarios of past mollusc biodiversity, as well as reconstitutions of ecological history in an evolutionary perspective. The list indicates the importance of using shellmounds as a reference in retrieving data on the biodiversity of a recent epoch of the Quaternary.

MATERIAL AND METHODS

Initially, a survey was made of the archeological sites integrating the collections of Museu Nacional/ Universidade Federal do Rio de Janeiro (Rio de Janeiro, RJ), Instituto de Arqueologia Brasileira (Belford Roxo, RJ) and Museu do Sambaqui da Tarioba (Rio das Ostras, RJ). All the malacological material pertaining to the analyzed collections from the coastal sites of the shellmound type in Rio de Janeiro state was investigated.

The boxes containing archeological material were located and the material was sorted, shell matter being separated from the sediment and other faunal remains by means of a 0.5 mm sieve and/or brush. The malacological material was sorted in its totality by the following procedure: a) selection of bivalves and gastropods; b) cleaning with the help of a brush, in those cases where there was much sediment adhering to the shells and c) washing the shells so as to facilitate observation. In the case of bivalves still closed, the sediment in their interior was preserved for other studies.

Shells were identified at the lowest possible taxonomic level, based on: Abbott (1974), Garcia-Cubas (1981), Rios (1994), Merlano and Hegedus (1994), Amaral *et al.* (2005) and Mikkelsen and Bieler (2007). The following shell characteristics were analyzed: a) bivalves - shape, type of hinge and sculpture, presence and shape of muscle scars, palial sinus and palial line; b) gastropods - shape, type of spire and sculpture, outer lip, columellar folds, siphonal and posterior canals. After identification, the shells were bagged, labeled and placed in the original bags and boxes.

In addition, a survey of all publications related to the studied sites was carried out in the libraries of the institutions where the collections were inspected. This survey aimed to obtain data on the sites, such as location, dating, description, conservation state, dimensions, as well as verification of malacological citations.

RESULTS AND DISCUSSION

The sorting work and bibliography survey yielded information on 70 archeological sites: 44 % of them had a complete malacological list published and had their original data checked; 37 % presented a partial list and further data were included, and 19 % did not have any publication, or else they did not contain a list of species. Therefore, the data were produced by this study. The sites studied are located at the coast of the 16 municipalities on the Rio de Janeiro state between 22°24'31" S and 23°09'34" S (Figure 1). Table 1 gives the list of sites studied, the localization and the institutions where the material is deposited.

Table 2 presents a list of species of marine bivalves and gastropods found in the shellmounds of the coast of Rio de Janeiro state. A total of 124 taxa were listed, of which 65 are bivalves and 59 gastropods. A taxonomic list of bivalves, for which 26 families were recorded, the most representative being Veneridae Rafinesque, 1815, with 16 species, followed by Arcidae Lamarck, 1809 with 6 species, and Lucinidae Fleming, 1828 with 5 species. These three families account for about 40 % of the total bivalves identified. *Lucina pectinata* (Gmelin, 1791) and *Anomalocardia brasiliiana* (Gmelin, 1791) were the species of class Bivalvia that occurred with greatest frequency, being present in over 70 % of sites.

Although the mussel *Perna perna* (Linnaeus, 1758) was cited in the bibliography (Mendonça de Souza 1981; Kneip 1994, 2001; Magalhães et al. 2001) (see Table 1), this species could not be confirmed as present in the Holocene of Rio de Janeiro, since no valves were found in the material analyzed. Also, the citations correspond to sites that were partially destroyed at the time they were excavated and, therefore, contained vestiges of anthropogenic interference relative to the historic period. The fact that this species' presence has not been confirmed in the archeological sites studied, dating from 8,000 to 2,000 years B.P., supports the idea that this species represents a case of bioinvasion in Brazil (Souza et al. 2003; 2004; 2005; Silveira et al. 2006; Fernandes et al. 2008). Valves of only 3 species of Mytilidae were found: *Brachidontes exustus* (Linnaeus, 1758), *Brachidontes solisianus* (d'Orbigny, 1846) and *Mytella charruana* (d'Orbigny, 1842).

Likewise, *Arcinella arcinella* (Linnaeus, 1767) and *Spondylus americanus* Hermann, 1781, cited in the unpublished Doctorate Thesis of Tania Andrade Lima ("Dos mariscos aos peixes: um estudo zooarqueológico de mudança de subsistência na pré-história do Rio de Janeiro", presented to Faculdade de Filosofia, Letras e Ciências

Humanas of Universidade de São Paulo in 1991) (see Table 1), were not included in the malacological listing, since no specimens were found in the collections and, in addition, their geographic range does not include the Southeast of Brazil. These citations probably reflect classification errors, or else contamination of the archeological record. The specimens found in the collection correspond to *Arcinella brasiliiana* (Nicol, 1953) and *Spondylus ictericus* Reeve, 1856, both currently present at the coast of Rio de Janeiro state (Rios 1994), and therefore they integrate the list in Table 2.

Teredo navalis Linnaeus, 1758 was cited by Mendonça de Souza (1981) for sambaquis Amourins, Arapuan, Imenezes e Rio das Pedrinhas. However, it was not found in the survey done over the malacological vestiges of these sites. Identification of this species is done based on very tiny and delicate shells which by its size and fragility would be very difficult to be preserved in archaeological vestiges, therefore, this species were not included in Table 2 despite its record in the inventory done by Mendonça de Souza (1981).

Archaeological vestiges from sites Aldeamento Tupi da Tropa de Reforço and Sambaqui do Atolador (Rio de Janeiro), deposited respectively in Museu Nacional/Universidade Federal do Rio de Janeiro (Rio de Janeiro, RJ) and Instituto de Arqueologia Brasileira (Belford Roxo, RJ), were composed only of oysters fragments (Ostreidae) which were impossible to classify at species level. Therefore, these sites were not considered in Table 2.

Table 2 presents also the taxonomic list of gastropods, for which 32 families were recorded, the most representative being Olividae Latreille, 1825, with 6 taxons, followed by Naticidae Forbes, 1838 and Muricidae Da Costa, 1776, both with 5 species, and Fasciolaridae Gray, 1853 with 4 taxa, corresponding when added together to 34 % of total gastropods identified. *Stramonita haemastoma* (Linnaeus, 1767) occurred in 52 % of the sites and *Strombus pugilis* (Linnaeus, 1758) in 40 %, and were the most frequent species.

In conclusion, the data retrieved from the shellmounds indicate stability of the mollusc biodiversity on the coast of Rio de Janeiro state, since all the species found in the archeological records from the Holocene are still present today. The listing presented may be useful as a reference inventory for research related to biological invasions, biogeography, conservation and management, since it helps to determine the natural expansion of species through time and the rates and patterns of dispersion, as well as to define whether a species is native or exotic.

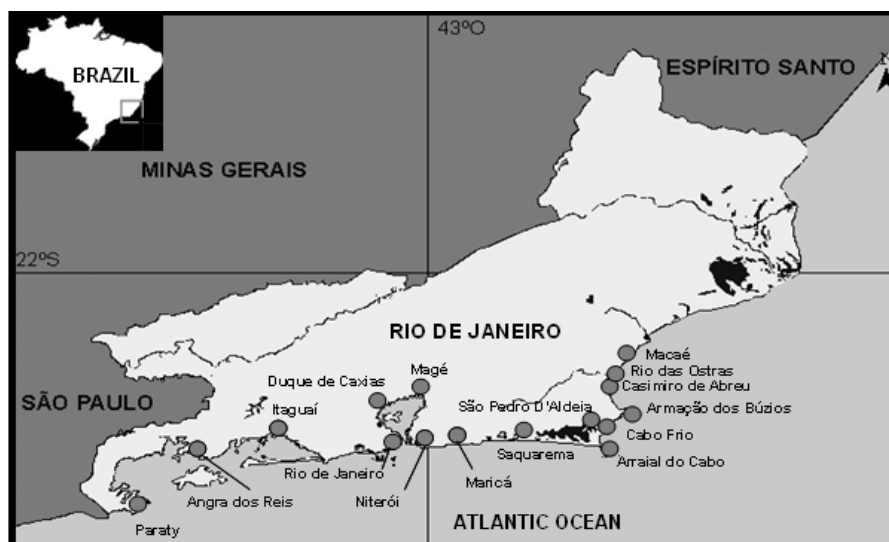


Figure 1. Map of the state of Rio de Janeiro showing the location of shellmounds studied.

TABLE 1. List of shellmounds studied, location and institution where the sorted material is deposited. MN = Museu Nacional (Rio de Janeiro), MST= Museu do Sambaqui da Tarioba (Rio das Ostras), IAB= Instituto de Arqueologia Brasileira (Belford Roxo), * = sites with bibliographic citation for *Perna perna* (Linnaeus, 1758), + = sites with bibliographic citation for *Arcinella arcinella* (Linnaeus, 1767), ° = sites with bibliographic citation for *Spondylus americanus* Hermann, 1781.

	SITES SORTED	MUNICIPALITY (RJ)	COLLECTION
1	Sítio da Ilha de Santana °	Macaé	MN
2	Sambaqui da Tarioba	Rio das Ostras	IAB / MST
3	Sambaqui da Barra de S. João (do Gravatá)	Casimiro de Abreu	MN
4	Sítio Geribá II	Armação dos Búzios	MN
5	Sambaqui da Fazenda Malhada	Cabo Frio	IAB
6	Sítio da Malhada	Cabo Frio	IAB
7	Ilha das Palmeiras	Cabo Frio	MN
8	Sambaqui Boca da Barra	Cabo Frio	MN
9	Sambaqui do Forte	Cabo Frio	MN
10	Sambaqui Duna Boa Vista	Cabo Frio	IAB
11	Sambaqui Fernandes do Couto	Cabo Frio	MN
12	Sítio Arqueológico do Rio Una II	Cabo Frio	MN
13	Sítio do Boqueirão	Arraial do Cabo	MN
14	Sítio Ilha de Cabo Frio	Arraial do Cabo	MN
15	Sítio Usiminas	Arraial do Cabo	MN
16	Sítio Botafoço (Corondó)*	São Pedro D'Aldeia	IAB
17	Sambaqui da Beirada	Saquarema	MN
18	Sambaqui da Pontinha	Saquarema	MN
19	Sambaqui de Barreira	Saquarema	MN
20	Sambaqui de Saquarema*	Saquarema	MN
21	Sambaqui do Boqueirão	Saquarema	MN
22	Sambaqui do Moa*	Saquarema	MN
23	Sambaqui do Saco	Saquarema	MN
24	Sambaqui Yatch Club*	Saquarema	MN
25	Sítio Manitiba I*	Saquarema	MN
26	Sítio 2 - Barra de Maricá	Maricá	IAB
27	Sítio 4 - Itaipuaçu	Maricá	IAB

TABLE 1. CONTINUED.

	SITES SORTED	MUNICIPALITY (RJ)	COLLECTION
28	Sítio Arqueológico de Itaipu	Niterói	IAB
29	Sambaqui do Amourins*	Magé	MN
30	Sambaqui do Arapuan*	Magé	MN
31	Sambaqui do Imenezes*	Magé	MN
32	Sambaqui do Rio das Pedrinhas*	Magé	MN
33	Sambaqui Sernambetiba*	Magé	MN
34	Sítio Arqueológico do Km 18 (Estrada de Ferro Leopoldina)	Duque de Caxias	MN
35	Aldeamento Tupi da Tropa de Reforço	Rio de Janeiro	MN
36	Aldeia Tupi da Estação Rádio da Marinha	Rio de Janeiro	MN
37	Aldeia Tupi do Instituto de Pesquisas da Marinha	Rio de Janeiro	MN
38	Sambaqui Capão da Bananeira	Rio de Janeiro	IAB
39	Sambaqui Capão da Benta	Rio de Janeiro	IAB
40	Sambaqui Casqueiro de Araçatiba	Rio de Janeiro	IAB
41	Sambaqui da Beira da Estrada	Rio de Janeiro	IAB
42	Sambaqui da Cabeça de Índio II	Rio de Janeiro	IAB
43	Sambaqui da Embratel	Rio de Janeiro	IAB
44	Sambaqui da Matriz	Rio de Janeiro	IAB
45	Sambaqui da Praia do Malhador	Rio de Janeiro	IAB
46	Sambaqui das Piteiras	Rio de Janeiro	IAB
47	Sambaqui das Pixunas	Rio de Janeiro	MN
48	Sambaqui do Aterrado da Pedra	Rio de Janeiro	IAB
49	Sambaqui do Atolador	Rio de Janeiro	IAB
50	Sambaqui do Caminho do Cajazeiro	Rio de Janeiro	IAB
51	Sambaqui do Cerâmio	Rio de Janeiro	IAB
52	Sambaqui do Curral das Pedras	Rio de Janeiro	IAB
53	Sambaqui do Meio	Rio de Janeiro	IAB
54	Sambaqui do Piracão	Rio de Janeiro	IAB
55	Sambaqui do Piraquê	Rio de Janeiro	IAB
56	Sambaqui do Poço das Pedras	Rio de Janeiro	IAB
57	Sambaqui do Porto da Cinza	Rio de Janeiro	IAB
58	Sambaqui do Posto 5	Rio de Janeiro	IAB
59	Sambaqui do Telégrafo	Rio de Janeiro	MN / IAB
60	Sambaqui do Vaso	Rio de Janeiro	IAB
61	Sambaqui do Zé Espinho	Rio de Janeiro	MN / IAB
62	Sítio do Rangel	Rio de Janeiro	IAB
63	Sambaqui da Estrada de Ferro	Itaguaí	IAB
64	Sambaqui da Caieira °	Angra dos Reis	MN
65	Sambaqui da Caieira II	Angra dos Reis	MN
66	Sítio da Ilha do Algodão °	Angra dos Reis	MN
67	Sítio do Bigode	Angra dos Reis	MN
68	Sítio do Major +°	Angra dos Reis	MN
69	Sítio do Peri °	Angra dos Reis	MN
70	Sambaqui do Araújo*	Paraty	MN

TABLE 2. List of species of marine bivalves and gastropods found in the shellmounds of the coast of Rio de Janeiro state. + = new record; ‡ recorded in the literature; * confirmation of the record in the literature

CLASS	FAMILY	SPECIES	SITES (see Table 1)
Bivalvia	Arcidae	<i>Anadara brasiliiana</i> (Lamarck, 1819)	33 ⁺
		<i>Anadara chemnitzii</i> (Philippi, 1851)	2 [*]
		<i>Anadara notabilis</i> (Röding, 1798)	1 [‡] , 2 ⁺ , 5 ⁺ , 6 ⁺ , 7 ⁺ , 8 [*] , 9 ^{**} , 10 [*] , 16 [*] , 17 [‡] , 18 [‡] , 20 [‡] , 22 [‡] , 25 [‡] , 29 [‡] , 30 [‡] , 31 [‡] , 32 [‡] , 33 ⁺ , 41 ⁺ , 56 [‡] , 59 ⁺ , 64 [*] , 65 [*] , 66 [*] , 67 [‡] , 68 [‡] , 69 [*] , 70 ⁺
		<i>Anadara ovalis</i> (Bruguière, 1789)	2 ⁺ , 6 ⁺ , 16 [*] , 33 ⁺
		<i>Arca imbricata</i> Bruguière, 1789	1 [*] , 2 ⁺ , 4 [‡] , 8 [*] , 10 [‡] , 15 ⁺ , 16 [*] , 17 [*] , 22 [‡] , 29 [‡] , 30 [‡] , 31 [‡] , 32 [‡] , 33 ⁺ , 64 [*] , 65 [*] , 66 [*] , 67 [‡] , 68 [*] , 69 [*]
		<i>Barbatia candida</i> (Helbling, 1779)	1 [*] , 15 ⁺ , 16 [*] , 22 [‡] , 64 [*] , 65 [*] , 66 [*] , 67 [‡] , 68 [*] , 69 [*]
	Noetiidae	<i>Noetia bisulcata</i> (Lamarck, 1819)	16 [‡]
	Glycymerididae	<i>Glycymeris longior</i> (Sowerby, 1833)	1 [*] , 2 ⁺ , 20 [‡] , 22 [‡] , 26 ⁺ , 27 ⁺ , 41 ⁺
		<i>Glycymeris undata</i> (Linnaeus, 1758)	2 ⁺
	Mytilidae	<i>Brachidontes exustus</i> (Linnaeus, 1758)	6 ⁺ , 17 [‡] , 18 [‡] , 19 [*] , 22 [*] , 25 [*] , 33 ⁺ , 43 ⁺ , 65 [‡] , 66 [‡] , 68 [‡] , 69 [‡]
		<i>Brachidontes solisianus</i> (d'Orbigny, 1846)	33 ⁺ , 64 [*] , 65 ⁺ , 66 ⁺ , 68 ⁺
		<i>Mytella charruana</i> (d'Orbigny, 1842)	2 ⁺ , 6, 16 [*] , 29 ⁺ , 33 ⁺ , 43 [*] , 48 [*] , 61 [‡]
	Pteriidae	<i>Pinctada imbricata</i> Röding, 1798	1 [*] , 2 ⁺ , 6 ⁺ , 7 ⁺ , 8 [*] , 12 ⁺ , 13 [*] , 14 [*] , 15 ⁺ , 16 [*] , 24 [*] , 39 ⁺ , 64 [*] , 65 [*] , 66 [*] , 67 [‡] , 68 [*] , 69 [*]
	Pinnidae	<i>Atrina seminuda</i> (Orbigny, 1846)	61 [‡] , 65 [‡] , 66 [‡] , 67 [‡] , 68 [*] , 69 [*]
	Ostreidae	<i>Crassostrea rhizophorae</i> (Guilding, 1828)	2 ⁺ , 6 ⁺ , 9 [‡] , 16 [*] , 29 [‡] , 30 [‡] , 31 [*] , 32 [‡] , 33 [*] , 40 ⁺ , 61 [‡] , 64 [‡] , 65 [‡] , 66 [‡] , 68 [‡] , 69 [‡]
		<i>Ostrea equestris</i> Say, 1834	16 [*] , 29 [‡] , 30 [‡] , 31 [‡] , 32 [‡]
		<i>Ostrea pulchreana</i> d'Orbigny, 1842	16 [*] , 29 [‡] , 30 [‡] , 31 [‡] , 32 [‡]
	Plicatulidae	<i>Plicatula gibbosa</i> Lamarck, 1801	68 [‡]
	Pectinidae	<i>Nodipecten nodosus</i> (Linnaeus, 1758)	1 [‡] , 4 ⁺ , 8 ⁺ , 16 [*] , 17 [‡] , 21 ⁺ , 22 [*] , 23 [‡] , 25 [‡] , 61 [‡] , 65 [*] , 66 [*] , 68 [*] , 69 [*]
		<i>Pecten ziczac</i> (Linnaeus, 1758)	65 [*] , 66 [*] , 68 [*] , 69 [*]
	Spondylidae	<i>Spondylus ictericus</i> Reeve, 1856	1 ⁺ , 65 ⁺ , 66 ⁺ , 68 ⁺ , 69 ⁺
	Anomidae	<i>Anomia ephippium</i> Linnaeus, 1758	2 ⁺
	Lucinidae	<i>Codakia costata</i> (Orbigny, 1842)	8 ⁺ , 16 [‡] , 29 ⁺ , 31 ⁺ , 33 ⁺ , 64 [‡] , 65 [‡] , 66 [*] , 68 [*] , 69 [*]
		<i>Codakia orbicularis</i> (Linnaeus, 1758)	1 [*] , 6 ⁺ , 8 [*] , 16 [*]
		<i>Divaricella quadrisulcata</i> (Orbigny, 1842)	64 [‡] , 65 [‡] , 66 [*] , 69 [‡]
		<i>Lucina pectinata</i> (Gmelin, 1791)	1 [*] , 2 ⁺ , 3 ⁺ , 4 [*] , 5 ⁺ , 7 ⁺ , 8 [*] , 9 [*] , 10 [*] , 13 [*] , 15 ⁺ , 16 [*] , 17 [*] , 18 [*] , 19 [*] , 20 [*] , 21 ⁺ , 22 [*] , 23 [*] , 24 [*] , 25 [‡] , 27 ⁺ , 29 [*] , 30 [*] , 31 [‡] , 32 [*] , 33 ⁺ , 34 ⁺ , 36 ⁺ , 37 ⁺ , 38 ⁺ , 40 [*] , 41 ⁺ , 42 [‡] , 43 [*] , 45 [‡] , 46 [‡] , 47 ⁺ , 48 [*] , 50 ⁺ , 55 [*] , 56 [*] , 57 ⁺ , 59 [*] , 60 [*] , 61 [*] , 64 [*] , 65 [*] , 66 [*] , 67 [*] , 68 [*] , 69 [*] , 70 ⁺
		<i>Parvilucina multilineata</i> Tuomey & Holmes, 1857	29 [‡] , 30 [‡] , 31 [‡] , 32 [‡]
	Ungulinidae	<i>Felaniella vilardeboana</i> (Orbigny, 1846)	64 [‡] , 65 [‡] , 66 [*] , 69 [‡]
	Chamiidae	<i>Arcinella brasiliiana</i> (Linnaeus, 1767)	68 ⁺
		<i>Chama macerophylla</i> (Gmelin, 1791)	1 [‡] , 64 [‡] , 65 [‡] , 66 [*] , 67 [‡] , 68 [*] , 69 [*]
		<i>Pseudochama radians</i> (Lamarck, 1819)	1 [‡]
	Cardiidae	<i>Laevicardium brasilianum</i> (Lamarck, 1819)	2 ⁺ , 16 [*] , 30 [‡] , 31 [‡]
		<i>Papyridea soleniformis</i> (Bruguière, 1789)	16 [*]
		<i>Trachycardium muricatum</i> (Linnaeus, 1758)	1 [*] , 2 ⁺ , 4 ⁺ , 8 [*] , 16 [*] , 17 [‡] , 22 [‡] , 25 [‡] , 29 [‡] , 32 [*] , 33 ⁺ , 36 ⁺ , 41 ⁺ , 53 [‡] , 54 [‡] , 56 [‡] , 58 [‡] , 59 ⁺ , 60 [‡] , 61 [‡] , 64 [*] , 65 [*] , 66 [*] , 67 [‡] , 68 [*] , 69 [*] , 70 ⁺
	Mactridae	<i>Mactra fragilis</i> Gmelin, 1791	7 [‡] , 16 [*] , 22 [‡] , 29 [‡] , 30 [‡] , 31 [‡] , 32 [‡]
		<i>Mactra isabelleana</i> Orbigny, 1846	1 [*] , 2 ⁺

TABLE 2. CONTINUED.

CLASS	FAMILY	SPECIES	SITES (see Table 1)
	Mesodesmatidae	<i>Mesodesma mactroides</i> Deshayes, 1854	16‡, 20*, 22‡, 38+, 39+, 50+, 55+, 61*
	Tellinidae	<i>Macoma constricta</i> (Bruguière, 1792)	16*, 33+
		<i>Tellina angulosa</i> Gmelin, 1791	64*, 65+
		<i>Tellina listeri</i> Roding, 1798	64*, 65+, 68*
		<i>Tellina</i> sp.	1*, 17*
	Semelidae	<i>Semele proficua</i> (Pulteney, 1799)	2+, 6+, 16*, 38+, 48*
	Psammobiidae	<i>Sanguinolaria cruenta</i> (Lightfoot, 1786)	16*
	Solecurtidae	<i>Tagelus plebeius</i> (Lightfoot, 1786)	2+, 17‡, 18‡, 20‡, 22‡, 23*, 25‡, 29‡, 30‡, 31‡, 32*, 33+, 64‡, 66*, 68+, 70+
	Donacidae	<i>Donax hanleyanus</i> Philippi, 1842	1*, 2+, 8‡, 16*, 17*, 18‡, 20*, 21+, 22*, 23*, 24*, 25*, 26+, 27+, 41+
		<i>Iphigenia brasiliana</i> (Lamarck, 1818)	1*, 2+, 3+, 4+, 6+, 16*, 20*, 24*, 29‡, 30*, 31‡, 32*, 33+, 47+, 56+, 64*, 65*, 66*, 67‡, 68*, 69*, 70+
	Veneridae	<i>Amiantis purpuratus</i> (Lamarck, 1818)	1‡, 2+, 14+, 16*, 17‡, 18*, 20*, 22*, 25‡, 61‡, 62+
		<i>Anomalocardia brasiliana</i> (Gmelin, 1791)	1*, 2*, 4*, 5*, 6+, 7‡, 8*, 9‡, 12*, 15+, 16*, 17*, 18*, 19*, 20*, 21+, 22*, 23*, 24*, 25‡, 28*, 29*, 30*, 31*, 32*, 33*, 36*, 37*, 38+, 39+, 41+, 43*, 44+, 47+, 51*, 52*, 54*, 55+, 56*, 57+, 58+, 59*, 60*, 61*, 63+, 64*, 65*, 66*, 67‡, 68*, 69*, 70+
		<i>Chione cancellata</i> (Linnaeus, 1767)	1*, 4*, 6+, 7+, 8+, 13*, 14+, 15+, 16*, 29‡, 30*, 31‡, 32*, 33+, 38+, 55+, 59+, 64‡, 65‡, 66*, 69‡
		<i>Chione paphia</i> (Linnaeus, 1767)	2+, 16*, 39+, 41+, 55+, 64*, 65*, 66*, 67‡, 68*, 69*
		<i>Chione pubera</i> (Bory Saint-Vincent, 1827)	1*
		<i>Dosinia concentrica</i> (Born, 1778)	1*, 2+, 16*, 29‡, 30‡, 31‡, 32‡, 33+, 39+, 64‡, 65‡, 66‡, 68*, 69‡
		<i>Macrocallista maculata</i> Linnaeus, 1758	1‡, 2+, 6*, 8*, 15+, 16*, 17‡, 18‡, 20‡, 22‡, 41+, 57+, 64*, 65*, 66*, 67‡, 68*, 69*
		<i>Pitar fulminatus</i> (Menke, 1828)	1‡, 2+, 8+, 13*, 16*, 17*, 18‡, 22‡, 23‡, 29+
		<i>Pitar rostratus</i> (Koch, 1844)	14+, 16*
		<i>Protothaca antiqua</i> (King & Broderip, 1835)	2+, 6+, 11+, 16*, 29+, 30+, 33+
		<i>Protothaca pectorina</i> Lamarck, 1818	16*, 43+, 64*, 65*, 66*, 67‡, 68*, 69*
		<i>Tivela fulminata</i> Valenciennes, 1827	1‡, 22‡
		<i>Tivela isabelleana</i> (Orbigny, 1846)	1‡, 17‡, 18‡, 20‡, 22‡, 25‡
		<i>Tivela mactroides</i> (Born, 1778)	1*, 2+, 6+, 8+, 18‡, 27+, 41+
		<i>Tivela ventricosa</i> (Born, 1778)	16*, 18‡
		<i>Ventricolaria rigida</i> (Dillwyn, 1817)	2+, 6+, 8+, 15+, 16*, 64*, 65*, 66*, 68*, 69*
	Petricolidae	<i>Petricola typica</i> (Jonas, 1844)	68+
	Corbulidae	<i>Corbula caribaea</i> Orbigny, 1842	29‡, 30‡, 31‡, 32‡, 64*, 65*, 66*, 68*, 69‡
	Pholadidae	<i>Cyrtopleura costata</i> (Linnaeus, 1758)	16*, 59+
Gastropoda	Fissurellidae	<i>Diodora</i> sp.	1*, 64*, 65*, 66*, 68*, 69‡
		<i>Fissurella</i> sp.	16*
	Acmaeidae	<i>Collisella subrugosa</i> (Orbigny, 1846)	65‡, 69‡
	Trochidae	<i>Calliostoma adpersum</i> (Philippi, 1851)	15+
		<i>Calliostoma jujubinum</i> (Gmelin, 1791)	65+, 68*, 69+
		<i>Tegula viridula</i> (Gmelin, 1791)	1‡, 2+, 6+, 8*, 16*, 64*, 65*, 66*, 67‡, 68*, 69*
	Turbinidae	<i>Astraea latispina</i> (Philippi, 1844)	1‡, 2+, 4+, 8*, 13*, 33+, 64*, 65*, 66*, 68*, 69‡

TABLE 2. CONTINUED.

CLASS	FAMILY	SPECIES	SITES (see Table 1)
		<i>Astraea tecta olfersii</i> (Philippi, 1846)	1*, 4*, 8*, 13*, 14*, 15*, 16*, 33*, 64‡, 65‡, 66*, 68‡, 69*
	Neritidae	<i>Neritina virginea</i> (Linnaeus, 1758)	2*, 4*, 8*, 17‡, 18‡, 20*, 22*, 23‡, 24*, 25‡, 29*, 30*, 31‡, 32‡, 33*, 64‡, 65‡, 66*, 67‡, 68‡, 69‡
	Littorinidae	<i>Littorina flava</i> King & Broderip, 1832	29‡, 30‡, 31‡, 32‡, 43*, 64*, 65*, 66*, 67‡, 68‡, 69‡
		<i>Littorina ziczac</i> (Gmelin, 1791)	33*
	Modulidae	<i>Modulus modulus</i> (Linnaeus, 1758)	8‡, 64*, 65*, 66*, 67‡, 68*, 69‡
	Cerithiidae	<i>Ceritium atratum</i> (Born, 1778)	1*, 2*, 6*, 8*, 9‡, 14*, 15*, 16*, 17‡, 20*, 22*, 23‡, 24*, 29‡, 30*, 31*, 32*, 33*, 38*, 39*, 40*, 43*, 64‡, 65‡, 66*, 67‡, 68‡, 69*
		<i>Ceritium literatum</i> (Born, 1778)	29‡, 30‡, 31‡, 32‡, 64‡, 65‡, 66*, 68‡, 69*
	Strombidae	<i>Strombus costatus</i> Gmelin, 1791	2*, 8*, 9*, 10‡, 15‡
		<i>Strombus pugilis</i> (Linnaeus, 1758)	8*, 10*, 15*, 16*, 20*, 22*, 29*, 30*, 31‡, 32*, 33*, 36*, 37*, 38*, 40*, 41*, 47*, 53‡, 54‡, 56‡, 58‡, 59*, 61‡, 64*, 65*, 66*, 67‡, 68*, 69*, 70*
	Calyptraeidae	<i>Crepidula aculeata</i> (Gmelin, 1791)	2*, 8*, 15*, 16*, 65‡, 66*, 67‡, 68‡, 69‡
	Cypraeidae	<i>Cypraea zebra</i> Linnaeus, 1758	1‡, 4*, 8*, 13*, 14*, 15*, 16*, 17‡, 20‡, 22‡, 25‡, 65‡, 66*, 68*, 69*
		<i>Simnia uniplicata</i> (Sowerby, 1848)	65‡, 66*, 69*
		<i>Natica canrena</i> (Linnaeus, 1758)	2*, 8*, 33*, 61*
		<i>Natica limbata</i> Orbigny, 1840	5*, 20‡, 22‡, 33*
		<i>Polinices hepaticus</i> (Roding, 1798)	2*, 61‡
		<i>Polinices lacteus</i> (Guilding, 1833)	8*, 9‡
		<i>Sinum perspectivum</i> (Say, 1831)	65‡, 66‡, 68*, 69‡
		<i>Tonna galea</i> (Linnaeus, 1758)	16*, 18‡, 22‡, 29‡, 30‡, 31‡, 32‡, 61*, 70*
		<i>Cassis tuberosa</i> (Linnaeus, 1758)	1‡
		<i>Cymatium parthenopeum</i> (von Salis, 1793)	1‡, 2*, 4*, 6*, 8*, 9‡, 16*, 22‡, 29‡, 30‡, 31‡, 32‡, 33*, 38*, 61‡, 64*, 65*, 66*, 67‡, 68*, 69*
		<i>Seila adamsi</i> (H. Lea, 1845)	64‡, 65‡, 66*, 68*, 69‡
		<i>Chicoreus senegalensis</i> (Gmelin, 1770)	2*, 4*, 6*, 7‡, 8*, 9‡, 10‡, 13*, 16*, 29‡, 30‡, 31‡, 32*, 33*, 41*, 57*, 61‡, 64*, 65*, 66*, 68*, 69*
		<i>Farvatia cellulosa</i> (Conrad, 1846)	64*, 65*, 66*, 67‡, 68‡, 69‡
		<i>Trachypollia nodulosa</i> (C.B. Adams, 1845)	64‡, 65‡, 66*, 67‡, 68*, 69‡
		<i>Trachypollia turricula</i> (von Maltzan, 1884)	64‡, 65‡, 66*, 68*, 69‡
		<i>Urosalpinx haneti</i> (Petit, 1856)	33*, 64‡, 66*
		<i>Stramonita haemastoma</i> (Linnaeus, 1767)	1‡, 2*, 4*, 6*, 8*, 9‡, 13*, 15*, 16*, 17‡, 18‡, 20*, 22*, 23‡, 24*, 25‡, 27*, 29‡, 30*, 31‡, 32‡, 33*, 37*, 41*, 43*, 47*, 53‡, 54‡, 57*, 58‡, 61*, 62*, 64*, 65*, 66*, 67‡, 68*, 69*
		<i>Pisania auritula</i> (Link, 1807)	15*
		<i>Pisania pusio</i> (Linnaeus, 1758)	64‡, 66*
		<i>Columbella mercatoria</i> (Linnaeus, 1758)	65‡, 69*
		<i>Parvanachis obesa</i> (C.B. Adams, 1845)	64‡, 65‡, 66*, 67‡, 68‡, 69‡
		<i>Nassarius vibex</i> (Say, 1822)	2*, 13*, 17‡, 20*, 22*, 23‡, 24*, 25‡, 29*, 30*, 31‡, 32*, 33*, 43*, 64‡, 65‡, 66*, 67‡, 68‡, 69‡
		<i>Pugilina morio</i> (Linnaeus, 1758)	8*
		<i>Fusinus brasiliensis</i> Grabau, 1904	2*
		<i>Latirus</i> sp.	64‡, 65‡, 66*, 68*, 69‡

TABLE 2. CONTINUED.

CLASS	FAMILY	SPECIES	SITES (see Table 1)
		<i>Leucozonia nassa</i> (Gmelin, 1791)	8*, 64‡, 65‡, 66*, 69*
		<i>Pleuroploca aurantiaca</i> (Lamarck, 1816)	2*, 4*, 6*, 16*
		<i>Adelomelon brasiliense</i> (Lamarck, 1811)	16‡
		<i>Zidona dufresnei</i> (Donovan, 1823)	17‡, 22‡
		<i>Oliva circinata</i> Marrat, 1870	8*
		<i>Olivancillaria carcellesi</i> Klappenbach, 1965	2*
		<i>Olivancillaria urceus</i> (Roding, 1798)	2*, 6*, 11*, 16*, 22‡, 70*
		<i>Olivancillaria vesica auricularia</i> (Lamarck, 1810)	2*, 4*, 5*, 8*, 9*, 16*, 17‡, 22‡
		<i>Olivancillaria vesica vesica</i> (Gmelin, 1791)	2*, 4*, 8*, 10‡, 17‡, 20*, 22*, 27*, 28‡, 29*, 30‡, 31‡, 32‡, 33*, 40*, 55*, 59*, 61*
		<i>Olivella</i> sp.	64‡, 65‡, 66‡, 67‡, 68‡, 69*
		<i>Conus regius</i> Gmelin, 1791	59*
		<i>Hastula cinerea</i> (Born, 1778)	22‡
		<i>Terebra</i> sp.	16*
		<i>Iselica anomala</i> (C.B. Adams, 1850)	64‡, 66‡, 67‡
		<i>Bulla striata</i> Bruguiere, 1792	2*, 6*, 8*, 16*, 17‡, 23*, 24*, 29*, 30*, 31‡, 32‡, 33*, 38*, 39*, 43*, 64*, 65*, 66*, 68‡, 69*
		<i>Melampus monilis</i> (Bruguiere, 1789)	29‡, 30‡, 31‡, 32‡, 65‡, 66*, 67*, 68*, 69*
		<i>Cirsotrema dalli</i> Rehder, 1945	2*

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LITERATURE CITED

- Abbott, R.T. 1974. *American seashells*. New York: van Nostrand Reinhold. 663 p.
- Amaral, A.C.Z., A.E. Rizzo and E.P. Arruda. 2005. *Manual de identificação dos invertebrados marinhos da região sudeste-sul do Brasil*. São Paulo: Editora da Universidade de São Paulo. 288 p.
- Fernandes, F.C., R.C.C.L. Souza, A.O.R. Junqueira, L.C. Rapagnã and A. Breves-Ramos. 2008. Distribuição mundial e o impacto de sua introdução no Brasil; p. 25-30. In: Resgalla Jr., C., L.I. Weber and M.B. Conceição (eds.). *O Mexilhão Perna perna (L.): Biologia, Ecologia e Aplicações*. Rio de Janeiro: Editora Interciência.
- Figuti, L. 1993. O homem pré-histórico, o molusco e o sambaqui. *Revista do Museu de Arqueologia e Etnologia USP* 3: 67-80.
- Froyd, C.A. and K.J. Willis. 2008. Emerging issues in biodiversity and conservation management: the need for a palaeoecological perspective. *Quaternary Science Reviews* 27: 1723-1732.
- Fürsich, F.T. 1995. Approaches to palaeoenvironmental reconstructions. *Geobios* 18: 183-195.
- García-Cubas, A. 1981. *Moluscos de um sistema lagunar tropical em el sur del golfo de México (Laguna de Términos, Campeche)*. México: Publicaciones Especiales del Instituto de Ciencias del Mar y Limnología de la Universidad Nacional Autónoma de México nº 5. 182 p.
- Gaspar, M.D. 2000. *Sambaqui: Arqueologia do Litoral Brasileiro*. Rio de Janeiro: Jorge Zahar. 89 p.
- Kneip, L.M. 1994. Cultura material e subsistência das populações pré-históricas de Saquarema, RJ. *Documento de Trabalho, Série Arqueologia, Museu Nacional/UFRJ* 2: 1-120.
- Kneip, L.M. 2001. O Sambaqui de Manitiba I e outros sambaquis de Saquarema, RJ. *Documento de Trabalho, Série Arqueologia, Museu Nacional/UFRJ* 5: 1-15.
- Lima, T.A. 2000. Em busca dos frutos do mar: os pescadores-coletores do litoral centro-sul do Brasil. *Revista da Universidade de São Paulo* 44: 270-327.
- Lima, T.A., K.D. Macário, R.M. Anjos, P.R.S. Gomes, M.M. Coimbra and E. Elmore. 2002. The antiquity of the prehistoric settlement of the central-south Brazilian coast. *Radiocarbon* 44(3): 733-738.
- Lima, T.A., K.D. Macário, R.M. Anjos, P.R.S. Gomes, M.M. Coimbra and E.

- Elmore. 2003. AMS dating of early shellmounds of the southeastern Brazilian coast. *Brazilian Journal of Physics* 33(2): 276-79.
- Lindbladh, M., J. Brunet, G. Hannon, M. Niklasson, P. Eliasson, G. Eriksson and A. Ekstrand. 2007. Forest history as a basis for ecosystem restoration: a multidisciplinary case study in a south Swedish temperate landscape. *Restoration Ecology* 15: 284-295.
- Magalhães, R.M.M., M.A. Curvelo and E.M.B. Mello. 2001. O Sambaqui de Manitiba I e outros sambaquis de Saquarema, RJ: A fauna na alimentação. *Documento de Trabalho, Série Arqueologia, Museu Nacional/UFRJ* 5: 55-69.
- Mendonça de Souza, A.C. 1981. *Pré-história Fluminense*. Rio de Janeiro: Instituto Estadual do Patrimônio Cultural. 270 p.
- Merlano, J.M.D. and M.P. Hegedus. 1994. *Moluscos del caribe colombiano. Um catálogo ilustrado*. Bogotá: Colciencias, Fundación Natura, Invemar. LXXIV+291 p.
- Mikkelsen, P.M. and R. Bieler. 2007. *Seashells of Southern Florida: living marine bivalves of the Florida keys and adjacent regions*. New Jersey: Princeton University Press. 503 p.
- Reitz, E.J. and E.S. Wing. 2008. *Zooarchaeology*. Cambridge: Cambridge University Press. 455 p.
- Rios, E.C. 1994. *Seashells of Brazil*. Rio Grande: FURG. 492 p.
- Scheel-Ybert, R., D. Klökler, M.D. Gaspar and L. Figuti. 2006. Proposta de amostragem padronizada para macro-vestígios bioarqueológicos: antracologia, arqueobotânica, zooarqueologia. *Revista do Museu de Arqueologia e Etnologia USP* 15-16: 139-163.
- Silveira, N.G., R.C.C.L. Souza, F.C. Fernandes and E.P. Silva. 2006. Occurrence of *Perna perna*, *Modiolus carvalhoi* (Mollusca, Bivalvia, Mytilidae) and *Megabalanus coccopoma* (Crustacea, Cirripedia) off Areia Branca, Rio Grande do Norte state, Brazil. *Biociências* 14(1): 89-90.
- Souza, R.C.C.L., F.C. Fernandes and E.P. Silva. 2003. A study on the occurrence of the brown mussel *Perna perna* on the sambaquis of the Brazilian coast. *Revista do Museu de Arqueologia e Etnologia USP* 13: 3-24.
- Souza, R.C.C.L., F.C. Fernandes and E.P. Silva. 2004. Distribuição atual do mexilhão *Perna perna* no mundo: um caso recente de bioinvasão; p. 157-172. In: Silva, J.S.V. and R.C.C.L. Souza (eds.). *Água de Lastro e Bioinvasão*. Rio de Janeiro: Editora Interciência.
- Souza, R.C.C.L., F.C. Fernandes and E.P. Silva. 2005. Sambaqui: um baú de preciosas informações. *Ciência Hoje* 214: 72-74.
- Stein, J.K. 1992. The analysis of shell middens; p. 1-24. In: Stein, J.K. (ed.). *Deciphering a shell midden*. San Diego: Academic Press.

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