

Archaeozoology of marine mollusks from Sambaqui da Tarioba, Rio das Ostras, Rio de Janeiro, Brazil

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ABSTRACT. A reference inventory of prehistoric marine mollusks from the Rio das Ostras region was created based on an excavation carried out at the Sambaqui da Tarioba shellmound. Patterns of richness and biogeography were studied, and the representativeness of bivalve and gastropod diversities found at this archaeological site were inferred. A total of 47 taxa belonging to 28 families, most of which from unconsolidated substrates, was identified. The shellmound species composition does not differ from the present-day composition. All recorded species are characteristic of a wide transition zone between the south of the states of Espírito Santo (21°S) and Rio Grande do Sul (32°S). Thus, the data show little evidence of evolution in the composition, richness, and biodiversity distribution patterns of mollusks in the Rio das Ostras region. Likewise, a reconstitution of the paleoenvironment from the functional characteristics of the shellmound species indicates that the locality's geomorphology and climate remained largely unchanged in the last 4,000 years BP.

KEY WORDS. Biodiversity; bivalves; gastropods; shellmound.

Shellmounds are archaeological sites found in almost all coastal areas around the world that, since a little over a century ago, have been recognized as artificial constructions built by prehistoric human populations (STEIN 1992). In Brazil, particularly between the states of Espírito Santo and Santa Catarina, there are hundreds of shellmounds that attest to the human occupation of the coast between at least 8,000 years ago and the start of the common era (ANDRADE LIMA *et al.* 2002, 2003).

The sites chosen for shellmound construction seem to be directly related to food gathering, and they are found near embayments, bays and lagoons, on the interface between marine and terrestrial environments, and between salt and fresh water. The construction of shellmounds in these estuarine environments was not fortuitous, given that these are the environments with the highest biotic productivity on the coast, harboring a high density and diversity of life forms. The biological remains found in shellmounds indicate that the diet of the humans living in those sites was based on shellfish, for they produced wastes with an abundance of very resistant elements such as mollusk shells, crustacean and sea urchin carapaces, fish, bird and mammal bones, etc. (LIMA 2000, FIGUTI 1993).

In addition to information on prehistoric societies, their food supplies and the use of resources for making ornaments and artifacts, the remains found in shellmounds may yield data leading to the examination of other issues. For instance, the

fact that these sites contain sets of organisms representative of the flora and fauna existing at the time of their creation makes it possible to recover paleoenvironmental aspects related to species biodiversity and biogeography (FROYD & WILLIS 2008, FÜRSICH 1995, LINDBLADH *et al.* 2007, SCHEEL-YBERT *et al.* 2006).

Paleoenvironmental analyses, among other aspects, allow one to infer the impacts caused by climatic changes on community composition (MILLAR & WOLFENDEN 1999). Thus, the definition of an environment's pristine state, generally a necessary condition for the construction of ecological models, cannot dispense with long-term information, which otherwise might compromise the accuracy of these models and therefore restrict their usefulness in management and conservation strategies (PEARSON & DAWSON 2003, ARAÚJO & RAHBEK 2006, WILLIS & BIRKS 2006).

Another aspect that can be analyzed from archaeological remains is the issue of bioinvasion. Paleoecological studies provide data that can help to understand fundamental issues such as determining the natural expansion of species over time; confirming the status of a species, whether native or exotic; analyzing the rate and patterns of dispersal of invasive species over time; and, finally, assessing the long-term impact of exotic species on native ecosystems (DI CASTRI 1989, DIDHAM *et al.* 2005).

The knowledge of the biodiversity in a given location should include not only an inventory of living organisms but also an inventory of fossils of the studied region (FURON 1969).

In other words, a comprehensive approach to the biodiversity issue must include the history of a location, placed on an evolutionary perspective. Thus, based on zooarchaeological research it is possible to recover data about the past and build biodiversity scenarios over time. To that end, it is important to be familiarized with the taxonomic classification, the behavior, and the ecology of organisms, especially with concepts related to biogeography, ecosystems, population ecology, and organism habits and habitats (TCHERNOV 1992).

In relation to mollusks, classes Bivalvia and Gastropoda are well represented in shellmound archaeological remains. Therefore, the present study proposes to investigate the mollusk fauna of the Sambaqui da Tarioba shellmound (Rio das Ostras, state of Rio de Janeiro), aiming to create a reference inventory of the marine mollusks that composed the region's prehistoric community. Studies of this nature may constitute valuable tools for a better understanding of the biodiversity and marine biogeography of the Brazilian coast.

MATERIAL AND METHODS

The archaeological site of Sambaqui da Tarioba, located in the municipality of Rio das Ostras, state of Rio de Janeiro (22°31'40"S, 41°56'22"W) (Fig. 1), was discovered in 1967 and was well preserved at the time. However, the first phase of digging took place only in 1998-99, when 2/3 of the site had already been destroyed. As a result of this digging, the Sambaqui da Tarioba Museum was created, presenting an *in situ* sample of the material recovered during the excavation. Datings obtained for the site range from 3,620 to 3,440 years BP (DIAS 2001).

In 2007, excavation of another part of this site was carried out, which was located on a plot of land next to the museum. Field work consisted in delimiting seventeen 2 x 2 m quadrats, for a total of 68 m² of excavated area. Delaying of the soil was done by artificial 10-cm layers, revealing the 5 cultural stratigraphic layers which, according to DIAS (2001),

constitute the site. The stratigraphic profile became evident when the original soil, prior to human occupation, was reached. In the case of Tarioba Shellmound, in some quadrats it was possible to reach mangrove sand at a depth of 1.4 m; in other quadrats, digging was interrupted before that depth due to the presence of concretions.

Sediment from each sector was collected with mason's trowel, spatula, brush, and shovel and deposited in buckets. So as to facilitate visualization of the smaller elements and to reduce the selection effect of larger remains, the archaeological material was passed through a 5-mm mesh sieve. The malacological material was sorted, packaged, labeled and later sent to the laboratory, where it was washed. Following the SCHEEL-YBERT *et al.* (2006) protocol, samples were dried naturally, without the aid of ovens, in order to avoid sudden water loss which might cause an increase in shell fragmentation and hamper identification. The malacological material recovered from the excavations was deposited in the collection of the Instituto de Arqueologia Brasileira (Rio de Janeiro, RJ). This study also analyzed the malacological samples obtained in the 1998-99 excavation, also deposited in the same collection.

In addition to taxonomic identification, ecological data on each species, such as habitat, preferred substrate and diet, was investigated in ABBOTT (1974), GARCIA-CUBAS (1981), RIOS (1994), MERLANO & HEGEDUS (1994), AMARAL *et al.* (2005) and MIKKELSEN & BIELER (2008). Richness and biogeography patterns of the Tarioba Shellmound bivalve and gastropod mollusks were compared to other studies done in Brazil between 22°24'S and 25°32'S – Arquipélago de Santana, RJ (ABSALÃO & PIMENTA 2005); Rio das Ostras, RJ (COUTINHO *et al.* 2005, GLOBALTECH 2002); Lagoa de Araruama, RJ (SILVA *et al.* 2005); Arraial do Cabo, RJ (SOARES-GOMES & FERNANDES 2005); Ilha Grande, RJ (SANTOS *et al.* 2007); São Sebastião, SP (ARRUDA *et al.* 2003, DENADAI *et al.* 2001, 2005) and Paranaguá, PR (BOEHS *et al.* 2004). Species distribution was analyzed according to the western South Atlantic zoogeographical provinces proposed by PALACIO (1982).

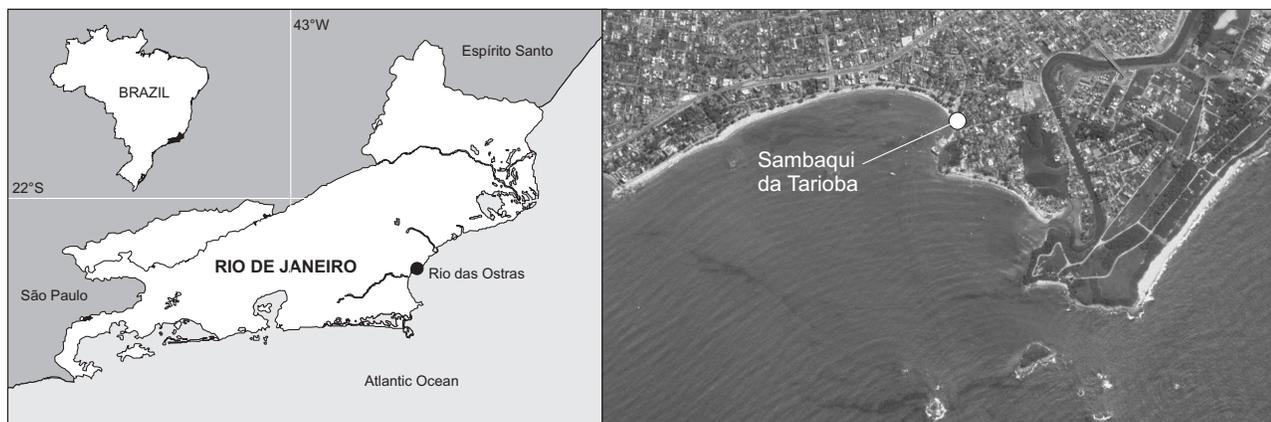


Figure 1. Location of Sambaqui da Tarioba, Rio de Janeiro.

Representativeness of mollusk diversity found at the Tarioba Shellmound was analyzed using the percentage of bivalve and gastropod species in relation to the total number of species recorded for Brazil and for the state of Rio de Janeiro, based on RIOS (1994), according to the following criteria: a) distribution in the area comprised between the states of Espírito Santo and Rio Grande do Sul; b) shell greater than 5 mm; c) not being exclusive to oceanic islands; d) benthic; and e) occurring until 200 m depth.

RESULTS

Analysis of the malacological remains from the excavations carried out at Tarioba Shellmound led to the identification of 47 taxa belonging to 28 families. Class Bivalvia presented greater richness (27 taxa) than class Gastropoda (20 taxa). Table I provides the inventory of the Tarioba Shellmound mollusk fauna.

Thirteen families of bivalves were recorded, the most representative being Veneridae Rafinesque, 1815 with nine species, followed by Arcidae Lamarck, 1809 and Cardiidae Lamarck, 1809, both with two species. These three families account for about 48% of total number of identified bivalves. Gastropods were represented by 15 families, the most common being Olividae Latreille, 1825 with four taxa, followed by Naticidae Forbes, 1838 and Fasciolaridae Gray, 1853, both with two taxa, which combined correspond to 40% of the total number of identified gastropods.

A visual estimate of the material being retrieved from the digging showed that *Iphigenia brasiliensis* (Lamarck, 1818), popularly known as "tarioba", is the most abundant species in all stratigraphic layers of the shellmound, justifying the site's name. *Anadara notabilis* (Roding, 1798) and *Crassostrea rhizophorae* (Guilding, 1828) are also common, followed by *Anomalocardia brasiliensis* (Gmelin, 1791), *Trachycardium muricatum* (Linnaeus, 1758), *Lucina pectinata* (Gmelin, 1791), and *Pinctada imbricata* Roding, 1798. Of family Mytilidae Rafinesque, 1815, only the species *Mytella charruana* (Orbigny, 1842) was found.

Among gastropods, *Cerithium atratum* (Born, 1778), *Chicoreus senegalensis* (Gmelin, 1790), *Cymatium parthenopeum* (von Salis, 1793), *Olivancillaria urceus* (Roding, 1798), *Stramonita haemastoma* (Linnaeus, 1767) and *Strombus costatus* Gmelin, 1791 are noteworthy.

Most recovered mollusks are beach species (59.5%), although mangrove, estuary, and lagoon species were also retrieved. About 85% of the bivalves are unconsolidated substrate species and all are suspensivores. Most gastropods are also unconsolidated substrate species (80%) although, in this case, 60% of the recorded species are carnivorous.

According to PALACIO's (1982) classification, whereby the zoogeographical provinces of the western South Atlantic are divided into Tropical (from 35°15'N to southern Espírito Santo/Brazil), Paulista (from southern Espírito Santo to southern Rio

Grande do Sul/Brazil), Patagonic (from southern Rio Grande do Sul/Brazil to Cabo Blanco/Argentina) and Malvina (south of Cabo Blanco/Argentina), the species found at Tarioba Shellmound were distributed as follows: Tropical/Paulista (47%), Tropical/Paulista/Patagonic (32%), Paulista/Patagonic (17%) and Paulista (4%) (Fig. 2).

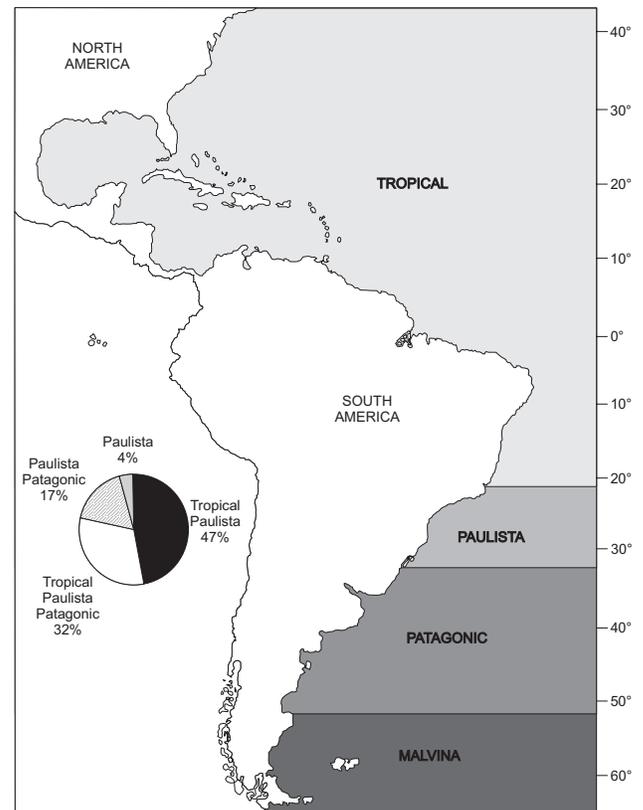


Figure 2. Zoogeographical provinces of the western South Atlantic according to PALACIO (1982) and distribution of bivalve and gastropod species recorded for Sambaqui da Tarioba, Rio de Janeiro.

Table II indicates the species richness data obtained in the present study and compares them to other studies. In absolute terms, the number of identified taxa in this study (47 taxa/1 station) was only surpassed by those found by SANTOS *et al.* (2007) for the Ilha Grande, RJ region (368 taxa/42 stations), by ABSALÃO & PIMENTA (2005) for Macaé, RJ (146 taxa/17 stations) and by DENADAI *et al.* (2005) for São Sebastião, SP (74 taxa/13 stations).

DISCUSSION

Many zooarchaeological studies have been carried out in recent years, so as to allow paleoecological interpretations (ROY *et al.* 2001, PRUMMEL & HEINRICH 2005, REITZ & WING 2008). In

Table I. Inventory of the mollusk fauna at Sambaqui da Tarioba. The category Environment in the table presents obtained information about depth, habitats and marine systems.

| Species | Ecology | | Distribution (Western Atlantic) | | |
|---------------------------------|----------------------------------|---|---------------------------------|----------------------------------|-----------|
| | Environment | Substrate | Feeding | Provinces | Depth (m) |
| Bivalvia | | | | | |
| Arcidae | | | | | |
| <i>Anadara chemnitzii</i> | subtidal | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 5 – 75 |
| <i>Anadara notabilis</i> | beach | unconsolidated | suspensivorous | Tropical/Paulista | 0 – 10 |
| <i>Anadara ovalis</i> | subtidal, beach | consolidated, unconsolidated, epibiotic | suspensivorous | Tropical, Paulista and Patagonic | 0 – 35 |
| <i>Arca imbricata</i> | subtidal | consolidated and epibiotic | suspensivorous | Tropical/Paulista | 0 – 10 |
| Glycymerididae | | | | | |
| <i>Glycymeris longior</i> | subtidal | unconsolidated | suspensivorous | Paulista/Patagonic | 10 – 75 |
| <i>Glycymeris undata</i> | beach | unconsolidated | suspensivorous | Tropical/Paulista | 2 – 55 |
| Mytilidae | | | | | |
| <i>Mytella charruana</i> | mangrove | consolidated and epibiotic | suspensivorous | Tropical, Paulista and Patagonic | 0 – 10 |
| Pteriidae | | | | | |
| <i>Pinctada imbricata</i> | subtidal, mangrove | consolidated and epibiotic | suspensivorous | Tropical/Paulista | 0 – 10 |
| Ostreidae | | | | | |
| <i>Crassostrea rhizophorae</i> | mangrove | consolidated and epibiotic | suspensivorous | Tropical, Paulista and Patagonic | 0 – 30 |
| Lucinidae | | | | | |
| <i>Lucina pectinata</i> | beach, estuary, lagoon, mangrove | unconsolidated | suspensivorous | Tropical/Paulista | 0 – 10 |
| Ungulinidae | | | | | |
| <i>Phlyctiderma semiaspera</i> | subtidal | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 5 – 100 |
| Cardiidae | | | | | |
| <i>Trachycardium muricatum</i> | beach, lagoon | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 0 – 30 |
| <i>Laevicardium brasilianum</i> | beach | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 0 – 70 |
| Mactridae | | | | | |
| <i>Mactra isabelleana</i> | subtidal, beach | unconsolidated | suspensivorous | Paulista/Patagonic | 0 – 10 |
| Semelidae | | | | | |
| <i>Semele proficua</i> | beach | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 0 – 75 |
| Solecurtidae | | | | | |
| <i>Tagelus plebeius</i> | estuary | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 0 – 10 |
| Donacidae | | | | | |
| <i>Donax hanleyanus</i> | beach | unconsolidated | suspensivorous | Paulista/Patagonic | 0 – 10 |
| <i>Iphigenia brasiliana</i> | beach, estuary | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 0 – 10 |
| Veneridae | | | | | |
| <i>Ventricolaria rigida</i> | beach | unconsolidated | suspensivorous | Tropical/Paulista | 10 – 100 |
| <i>Chione paphia</i> | beach | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 10 – 100 |
| <i>Anomalocardia brasiliana</i> | beach, lagoon | unconsolidated | suspensivorous | Tropical, Paulista and Patagonic | 0 – 30 |
| <i>Protothaca antiqua</i> | subtidal, beach | unconsolidated | suspensivorous | Paulista/Patagonic | 0 – 30 |
| <i>Tivela mactroides</i> | beach | unconsolidated | suspensivorous | Tropical/Paulista | 0 – 30 |
| <i>Pitar fulminatus</i> | beach | unconsolidated | suspensivorous | Tropical/Paulista | 0 – 30 |

Continue

Table I. Continued.

| Species | Ecology | | Distribution (Western Atlantic) | | |
|--|------------------------------|------------------------------------|---------------------------------|----------------------------------|-----------|
| | Environment | Substrate | Feeding | Provinces | Depth (m) |
| <i>Amiantis purpuratus</i> | beach | unconsolidated | suspensivorous | Paulista/Patagonic | 0 – 30 |
| <i>Macrocallista maculata</i> | beach | unconsolidated | suspensivorous | Tropical/Paulista | 0 – 100 |
| <i>Dosinia concentrica</i> | beach | unconsolidated | suspensivorous | Tropical/Paulista | 0 – 60 |
| Gastropoda | | | | | |
| Trochidae | | | | | |
| <i>Tegula viridula</i> | intertidal | consolidated | herbivorous | Tropical/Paulista | 0 – 10 |
| Turbinidae | | | | | |
| <i>Astraea latispina</i> | intertidal | consolidated | herbivorous | Tropical/Paulista | 0 – 10 |
| Neritidae | | | | | |
| <i>Neritina virginea</i> | estuary, lagoon, mangrove | unconsolidated and epibiotic | herbivorous | Tropical/Paulista | 0 – 10 |
| Cerithidae | | | | | |
| <i>Ceritium atratum</i> | beach, lagoon | consolidated and unconsolidated | herbivorous | Tropical/Paulista | 0 – 30 |
| Strombidae | | | | | |
| <i>Strombus costatus spectabilis</i> | subtidal | unconsolidated and epibiotic | herbivorous | Tropical/Paulista | 5 – 40 |
| Calyptraeidae | | | | | |
| <i>Crepidula aculeata</i> | subtidal | unconsolidated and epibiotic | herbivorous | Tropical, Paulista and Patagonic | 12 – 36 |
| Naticidae | | | | | |
| <i>Natica canrena</i> | subtidal, beach | unconsolidated | carnivorous | Tropical/Paulista | 0 – 30 |
| <i>Polinices hepaticus</i> | subtidal, beach | unconsolidated | carnivorous | Tropical/Paulista | 0 – 30 |
| Ranellidae | | | | | |
| <i>Cymatium parthenopeum</i> | subtidal | consolidated | carnivorous | Tropical, Paulista and Patagonic | 0 – 30 |
| Muricidae | | | | | |
| <i>Chicoreus senegalensis</i> | beach | unconsolidated | carnivorous | Paulista | 0 – 70 |
| Thaididae | | | | | |
| <i>Stramonita haemastoma</i> | subtidal | consolidated | carnivorous | Tropical, Paulista and Patagonic | 0 – 10 |
| Nassariidae | | | | | |
| <i>Nassarius vibex</i> | beach, lagoon, mangrove | unconsolidated | necrophagous | Tropical/Paulista | 0 – 10 |
| Fascioliariidae | | | | | |
| <i>Fusinus brasiliensis</i> | subtidal | unconsolidated | carnivorous | Tropical/Paulista | 12 – 50 |
| <i>Pleuroploca aurantiaca</i> | subtidal | unconsolidated | carnivorous | Tropical/Paulista | 10 – 50 |
| Olividae | | | | | |
| <i>Olivancillaria carcellesi</i> | subtidal | unconsolidated | carnivorous | Paulista/Patagonic | 10 – 30 |
| <i>Olivancillaria urceus</i> | beach | unconsolidated | carnivorous | Paulista/Patagonic | 0 – 30 |
| <i>Olivancillaria vesica auricularia</i> | beach | unconsolidated | carnivorous | Paulista/Patagonic | 0 – 30 |
| <i>Olivancillaria vesica vesica</i> | beach | unconsolidated | carnivorous | Paulista | 0 – 30 |
| Bullidae | | | | | |
| <i>Bulla striata</i> | beach | unconsolidated | herbivorous | Tropical/Paulista | 0 – 10 |
| Epitoniidae | | | | | |
| <i>Cirsotrema dalli</i> | subtidal | unconsolidated | carnivorous | Tropical/Paulista | 0 – 30 |

Table II. Bivalve and gastropod richness in malacological surveys of the Brazilian coast. (B) Number of bivalves, (C) number of gastropods, (S) south, (n) number of taxa, (FU) federation unit, (BR) Brazil, (+) subtidal benthos, (*) data not given by the authors. Representativeness values are percents.

| Site | Latitude (S) | Substrate | # Stations | Sampler | Mesh (mm) | Richness | | | Representativeness | | | References |
|----------------------------|---------------|----------------|------------|-----------------------|-----------|----------|-----|-----|--------------------|-------|---------------------------------|------------|
| | | | | | | B | C | n | B | FU | BR | |
| Sambaqui da Tarioba, RJ | 22°31'40" | * | 1 | Digging | 5.0 | 27 | 20 | 47 | 10.20 | 6.76 | This study | |
| Rio das Ostras, RJ | 22°31'37" | Consolidated | 5 | Quadrat | 0.5 | 5 | 5 | 10 | 2.17 | 1.44 | COUTINHO <i>et al.</i> (2005) | |
| Rio das Ostras, RJ | 22°31'37" | Consolidated+ | 21 | Quadrat | 0.5 | 5 | 5 | 10 | 2.17 | 1.44 | COUTINHO <i>et al.</i> (2005) | |
| Rio das Ostras, RJ | 22°31'37" | Unconsolidated | 21 | Petersen grab | 0.5 | 19 | 9 | 28 | 6.07 | 4.03 | COUTINHO <i>et al.</i> (2005) | |
| Rio das Ostras, RJ | 22°31'37" | Unconsolidated | 22 | Manual coring, diving | 0.5 | 14 | * | 14 | 6.86 | 5.00 | GLOBALTECH (2002) | |
| Lagoa de Araruama, RJ | 22°49'-22°57' | Unconsolidated | 26 | Manual collection | 5.0 | 6 | 9 | 15 | 3.25 | 2.16 | SILVA <i>et al.</i> (2005) | |
| Ilha Grande, RJ | 23° | Unconsolidated | 42 | Manual coring | 0.5 | 97 | 271 | 368 | 79.65 | 52.95 | SANTOS <i>et al.</i> (2007) | |
| Arquipélago de Santana, RJ | 22°24' | Unconsolidated | 17 | * | * | 42 | 104 | 146 | 31.60 | 21.01 | ABSALÃO & PIMENTA (2005) | |
| Arraial do Cabo, RJ | 23° | Unconsolidated | 6 | Van Veen grab | 0.5 | 44 | - | 44 | 21.57 | 15.71 | SOARES-GOMES & FERNANDES (2005) | |
| São Sebastião, SP | 23°42'-23°48' | Unconsolidated | 4 | Manual coring | 1.0 | 22 | 3 | 25 | 6.54 | 3.60 | ARRUDA <i>et al.</i> (2003) | |
| São Sebastião, SP | 23°43'-23°52' | Unconsolidated | 13 | Manual coring | 1.0 | 50 | 24 | 74 | 19.37 | 10.65 | DENADAI <i>et al.</i> (2005) | |
| São Sebastião, SP | 23°43'-23°52' | Unconsolidated | 2 | Manual coring | 1.0 | 10 | 3 | 13 | 3.40 | 1.87 | DENADAI <i>et al.</i> (2001) | |
| Paranaguá, PR | 25°30'-25°32' | Unconsolidated | 2 | Manual coring | 1.0 | 24 | 20 | 44 | 13.54 | 6.33 | BOEHS <i>et al.</i> (2004) | |

Brazil, few studies have taken this approach, but in recent years knowledge has been increase considerably (CASTILHO & SIMÕES-LOPES 2001, CASTILHO 2005, KOTZIAN & SIMÕES 2006, ROSA 2006, QUEIROZ & CARVALHO 2008). According to CLAASSEN (1998), investigations on paleoenvironment of a location should begin with simple observation of species proportions and their ecological requirements. Malacological assemblages, which were continuously collected over hundreds or thousands of years, must bear high fidelity to the original communities. Likewise, the presence/absence and the abundance of individuals of each species are frequently enough to establish environmental parameters and to provide an interpretation based on knowledge of the current ecological requirements of the species. Mollusk shells have thus proven to be a powerful tool in paleoenvironmental reconstitution.

Taxonomic list of the species recorded at Tarioba Shellmound makes it possible, from the reconstruction of past mollusk diversity, to use the shellmound as a referential for historical ecology reconstitutions (STAHL 2008). However, a peculiar and quite evident feature of archaeological sites is that the presence of organisms is related to the selectivity of the populations that built them. Diverse factors, such as culture, preferences, technical level, food taboos, and the way the shells were discarded and/or utilized as building material certainly played a relevant role on the composition of the fauna found in shellmounds. Other questions to be considered are differences in species preservation potential and the researcher choices (objectives, excavated area, type of mesh used etc.) (PRUMMEL & HEINRICH 2005).

In his inventory of marine mollusks, RIOS (1994) reports a total of 1,575 species for the Brazilian coast. However, new records stemming mainly from studies of descriptions of new species and reports of new occurrences (LEAL 1991, ABSALÃO *et al.* 1996, SIMONE 1999, ABSALÃO & PIMENTA 2003, PIMENTA & ABSALÃO 2004, AMARAL & JABLONSKI 2005) are being added to that inventory. In Rio de Janeiro, about 35% of those taxa are present, representing a significant fraction of Brazil's entire molluscan fauna (SANTOS *et al.* 2007). According to RIOS (1994), Gastropoda is the class that presents greatest richness (68.8%), followed by Bivalvia (24.8%). However, at Tarioba Shellmound this proportion was reversed, with bivalves accounting for 54.7% of the species, and gastropods, 42.6%. This reversal may have been caused by the habits of the fisher-hunter-gatherers who preferentially collected edible mollusks abundant in the region near the site.

The presence of species at a given site is directly related to their morphofunctional capacity to capture food (ARRUDA *et al.* 2003). Analysis of the bivalve species found in the shellmound showed a predominance of suspensivorous organisms which probably lived associated to the unconsolidated substrata of beaches. According to McLACHLAN (1983), the trophic structure of macrofauna from sandy beaches is normally dominated by filtering organisms which significantly contribute as animal bio-

mass and in recycling nutrients from the sea bottom. The distribution and diversity of these organisms in those areas are determined by physical factors, particularly wave action, sediment particle size, and beach declivity. According to SANCHEZ-MATA *et al.* (1993), this guild predominates in fine and medium sand environments, characterized by intertidal regions, mangroves, lagoons and estuaries, places typical of several species of infaunal bivalves which occur at high densities (DAME 1996). Of the gastropods, most species (65%) were carnivorous, 35% herbivorous, and 5% necrophagous.

The environmental characteristics inferred from the analysis of the mollusks found at Tarioba Shellmound are in agreement with current data (GLOBALTECH 2002) for the Rio das Ostras region, which indicate quaternary sediments associated with fluvial/alluvial and marine deposits. The fluvial/alluvial deposits correspond to the Rio das Ostras floodplain, whereas the marine sandy accumulations (marine terraces) and the isolated restingas are composed of fine to medium-sized, well selected, quartzous sands mixed with clay and organic matter. The mangrove areas are composed of a substrate of fine organic clay. The silted lagoon deposits – corresponding to isolated sea arms between restingas – are composed of black peaty clay. It is thus possible to infer that no substantial geomorphological changes seem to have taken place in the Rio das Ostras region and that the paleoenvironment and past molluscan richness coincide with those seen in the present day.

When the shellmound data of the present study are compared to other studies carried out on the Brazilian coast, the representativeness of the former appears to be reduced. However, if one assumes that the shellmound corresponds to an intensive sampling at just one point (or region) of sampling, and that the mesh size used in the sampling is 5 to 10 times greater than that used in other studies, the mollusk record preserved in the shellmound is considerable. The species composition in the shellmound also seems to mirror the present-day biodiversity pattern. Among bivalves, Veneridae Rafinesque, 1815 is the most diverse family worldwide, with about 50 genera (MIKKELSEN & BIELER 2008). In Brazil, 14 genera occur and, of these, nine are represented at Tarioba Shellmound (64.29%). The family Donacidae Fleming, 1828 is represented by five genera. In Brazil *Donax* Linnaeus, 1758 and *Iphigenia* Schumacher, 1817 occur, both represented in the shellmound by the species *Donax hanleyanus* Philippi, 1842 and *Iphigenia brasiliana*, both of which being edible (RIOS 1994). The family Mytilidae Rafinesque, 1815 was represented only by *Mytella charruana* (Orbigny, 1842). An interesting datum is that *Perna perna* (Linnaeus, 1758), another edible mussel, present today in great concentrations on the rocky coasts of Brazil from Espírito Santo to Rio Grande do Sul, has had no valves found at this site. This fact reinforces the idea that this species constitutes a case of bioinvasion in Brazil (SOUZA *et al.* 2003, 2004, 2005, SILVEIRA *et al.* 2006, FERNANDES *et al.* 2008). In relation to gastropods, the family Olividae Latreille, 1825 had the greatest diversity, genus *Olivancillaria* Orbigny, 1839 being

represented by four species, of which three are considered edible (RIOS 1994). The families Naticidae and Fasciolaridae presented two genera and two species each, but for the other families only one species was recorded.

FLOETER & SOARES-GOMES (1999), testing the hypothesis that the Brazilian coast is characterized by three zoogeographical provinces, *viz.* Tropical, Paulista and Patagonic (PALACIO 1982), concluded that the Paulista province could be characterized merely as a transition zone. *Chicoreus senegalensis* and *Olivancillaria vesica vesica* (Gmelin, 1791) were the only species found at Tarioba Shellmound that occurred exclusively in Paulista province. The other bivalve and gastropod species found in the shellmound occurred in the Tropical, Paulista and Patagonic provinces. Thus, according to FLOETER & SOARES-GOMES (1999), the data from Tarioba Shellmound do not indicate any specificity of the Paulista province even as far back as 4,000 years ago.

In conclusion, the data obtained from Tarioba Shellmound indicate little or no evolution of the patterns of composition, richness and distribution of molluscan biodiversity in the Rio das Ostras region. Likewise, the reconstitution of paleoenvironmental characteristics seems to also demonstrate that the geomorphological and climatic features of the area remained mostly unchanged in the last 4,000 years BP.

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