La alimentación en la América precolombina y colonial: una aproximación interdisciplinaria

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Subsistence and lifeway of coastal brazilian moundbuilders

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RESUMEN. Se presenta una síntesis de los resultados de diferentes programas de investigación y disciplinas en relación con los recientes datos obtenidos sobre los modos de vida y subsistencia de los constructores de concheros de la costa sur y sureste de Brasil. Han sido estudiados doce concheros de considerable unidad cultural datados entre c. 6180 y 1180 cal BP. Se discuten los estudios paleoambientales, paleoetnobotánicos y bioantropológicos en relación con el análisis de la cultura material. Los datos indican que las poblaciones que vivían en los ecotones costeros estaban bien adaptadas a su medio, con un sistema de subsistencia basado esencialmente en los recursos acuáticos. Asimismo, se documentan frecuentes infecciones, pequeña estatura entre los adultos y el consumo de alimentos ricos en carbohidratos. Estos resultados sugieren un espectro económico y de subsistencia más amplio del que previamente se suponía.

ABSTRACT. A synthesis of results from different research programs and disciplines associated to a review of recent research achievements concerning life way and subsistence of shellmound builders from the Southern and Southeastern Brazilian coast is presented. Twelve shellmounds of considerable cultural unity dated from c. 6180 to 1180 cal yrs BP were studied. Palaeoenvironmental, palaeoethnobotanical, and bioanthropological studies, supplemented by material culture analyses, are discussed. Data point to populations living in coastal ecotones, very well adapted to their environment, with a subsistence system essentially based on aquatic resources, as well as to small walking distances, frequent infections (especially during growth), small adult stature, and use of carbohydrate-rich food. These results suggest economic, subsistence, and health spectra larger than previously supposed.

* This paper is the result of a deep collaboration between the authors, all of which have contributed with significant data. The first three authors have equally contributed to its contents.
Introduction

Shellmounds, locally named «sambaguis», occur all along the Brazilian coast, with a large distribution across space (8000 km) and time (7000 to 1000 yrs BP). They vary from small 2m-high to 400m-long and 30m-high mounds, usually clustered in groups composed by sites of different size, morphology, relative contents, and function (DeBlasis et al., 1998). Their stratigraphy present a complex sequence of shellfish-rich and sandy layers of variable composition and thickness, containing different archaeological vestiges, such as hearths, technological implements, and burials. The typical technological assemblage is composed by different industries on bones, shells, and lithics.

Although they are among the first recognized and better-studied archaeological sites in this country (DeBlasis et al., 1998; Gaspar, 1998), recent research is drastically changing the traditional views about this society. This paper presents a synthesis of results from different research programs and disciplines associated to a review of recent research achievements concerning the shellmound dwellers from the Southern and Southeastern Brazilian coast. As it would be impossible to present here an extensive discussion about these sites and the culture associated to them, only a brief description is given. More detailed information may be found in the specific literature (DeBlasis et al., 1998; Gaspar, 1998).

Sambagui builders from all over the Brazilian coast are considered to belong to the same sociocultural system (Gaspar, 1992; DeBlasis et al., 1998), but there are regional particularities. Southern sites are much larger than the others and present beautiful lithic sculptures as funerary offerings (Proux, 1991). They seem to have been exclusively funerary (Fish et al., 2000), while at Southeastern and more Northern shores the sites combined in the same space habitation and funerary loci (Gaspar, 2000; Barbosa, 2001).

Traditionally, sambagui builders were seen as small nomadic shellfish gathering bands of about 50-100 individuals, who were supposed to have shifted their economical system to fishing in a later time, due to diminution of molluscs availability (Kneip, 1980; Heredia et al., 1989). Populations were considered to present small demographic densities and an egalitarian social system. Shellmounds were thought to be waste deposits. Only few authors noticed that, even if shellfish leftovers were more visible in the stratigraphy, they were not necessarily the more important item in diet (Figuti, 1993). Later development of zooarchaeological and stable isotope studies clearly demonstrated that fishing was preponderant over mollusc gathering since the initial occupation of these sites (Figuti, 1993; De Masi, 2001). It is now broadly admitted that sambagui builders were essentially fishers and that shellfish gathering, although strategic in their economical system, was a secondary food source. Terrestrial faunal remains are relatively rare, indirectly confirming aquatic resources as the basis of their diet. On the other hand, shellfish remains probably served as building material for the construction of the mounds themselves (Afonso & DeBlasis, 1994; Fish et al., 2000), as it was also suggested for shellmounds from other parts of the world, such as in Southeast USA (Luby & Gruber, 1999).

Plant consumption, however, remains underestimated. Plant gathering is still usually considered a secondary activity, with negligible dietary importance. As it is usually difficult to prove plant use, this activity is generally underestimated in favour of diets that leave more visible evidences in the archaeological record, such as shellfish, fish, and terrestrial game.
At present, following a rather widespread theoretical trend towards what has been called «complex hunter-gatherers» (Price & Brown, 1985; Chapman, 2003), particularly regarding coastal adaptations (Lightfoot, 1993; Gamble et al., 2002), *sambaqui* builders are widely recognized to have been sedentary people with relatively large demographic parameters and more sophisticated sociocultural organizational patterns (DeBlasis et al., 1998; Gaspar, 1998; Lima & Mazz, 1999/2000). Mounds are thought to be monumental constructions intended to mark the landscape. There is no available data about political integration at regional and supra-regional level, but the typological homogeneity from the lithic and bone industries, as well as the structural characteristics of the sites themselves, argue for a great cultural homogeneity in space and time (DeBlasis et al., 1998).

Several researchers of different expertise are currently aimed at reconstructing *sambaqui* lifestyle, subsistence pattern, and sociocultural organization. In the light of the scant information about the *sambaqui* dwellers way of life, data on palaeoethnobotany and bioanthropology analyses from several South-Southeastern Brazilian shellmounds are summarized. Information about plant use, subsistence pattern, physical activities, health, and nutritional status are explored. Apart from adding some new data, this article aims to present an up to date panorama of the knowledge on these ancient coastal populations’ lifeway, subsistence, and relation to the environment.

**Material and methods**

Twelve sites from the South-Southeastern coast of Brazil were studied (figure 1, table 1). Five regions of three Brazilian States are concerned. Each one of these has climatic, geological, and ecological particularities. However, the same vegetation types occur in all of them, especially the *restinga* (a mosaic of different xerophyte vegetation types typical to the coastal beach ridges), the Atlantic Forest (an ombrophilous tropical forest), and mangroves.

![Geographical location of the studied sites, in five regions of the South-Southeastern Brazilian coast.](image)

Palaeoenvironmental reconstruction was based on anthracological analyses (Scheel-Ybert, 2000, 2001a). Charcoal was collected from sediment samples of vertical pro-
files along the entire shellmounds height and recovered by flotation. Charcoal pieces were broken by hand and directly examined under reflected light brightfield/darkfield microscopes. Systematic determination was helped by the use of a computerized key for wood determination associated to a database of anatomical characters of Brazilian species (Scheel-Ybert et al., 2002), by comparison with a comparative collection (Scheel-Ybert et al., 2006), and by consultation of the specialized literature (e.g. Détienné & Jacquet, 1983; Gregory, 1994; Barros & Callado, 1997). Seeds and tubers analyses, still preliminary, were also performed under reflected light microscopy. Systematic determination was based on comparison with a comparative collection, and on consultation of the specialized literature (e.g. Hather, 1993, 2000).

<table>
<thead>
<tr>
<th>Sites</th>
<th>Type of analysis</th>
<th>Location</th>
<th>Coordinates</th>
<th>Conventional Ages</th>
<th>Calibrated Ages (2)</th>
<th>N</th>
</tr>
</thead>
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<td>Cabo Frio, RJ</td>
<td>22°53′S 42°03′W</td>
<td>5520 ± 120 BP 2240 ± 70 BP</td>
<td>6180-6560 BP 1990-1670 BP</td>
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<td>Palaeoethnobotany Dental pathology</td>
<td>Saquarema, RJ</td>
<td>22°55′S 42°33′S</td>
<td>4520 ± 190 BP 3800 ± 190 BP</td>
<td>5240-4190 BP 4250-3290 BP</td>
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<td>1991-1551 BP</td>
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<td>5909-5330 BP 5891-5223 BP</td>
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<td>S: 40</td>
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<tr>
<td>Jabuticabeirinha (JAB)</td>
<td>Palaeoethnobotany Dental pathology Skeletal pathology</td>
<td>Jaguaruna, SC</td>
<td>28°36′S 48°57′W</td>
<td>2890 ± 55 BP 1781 ± 65 BP</td>
<td>3206-2849 BP 1859-1526 BP</td>
<td>P: 1904</td>
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<tr>
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<td>4120 ± 20 BP</td>
<td>4806-4453 BP</td>
<td>D: 89/1222</td>
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</table>

Table 1. General features of sites analyzed. Dates given refer to the latest and to the earliest ages obtained; when only one date is presented, it refers to the base of the site, except MdO, which refers to the midpoint of the stratigraphy. N refers to the number of charcoal pieces for palaeoethnobotany (P), and to the number of individuals/number of teeth analysed for dental (D) and skeletal (S) pathology.

Bioanthropological data were collected from 231 individuals for oral health and 527 individuals for skeletal palaeopathologies. Sex and age at death were estimated according to current international standards (Buikstra & Ubelaker, 1994). Seven bioanthropological markers were chosen to help unravel the shellmound builders'
life style. They are associated in different degrees to one or more of the following: diet, nutritional status, health, and physical activity. Diagnoses of palaeopathologies, carried out macroscopically, followed acknowledged criteria (Aufderheide & Rodríguez-Martín, 1998; Ortner & Putschar, 1981). In order to allow comparisons, palaeopathologies were scored as present or absent. Distinct clusters of burials in different stratigraphic levels of the sites Morro do Ouro and Rio Comprido were analysed separately and are referred to as «ancient» and «recent» series.

For more than half of the sites we could analyse archaeological evidence regarding at least two of the three different approaches (palaeoethnobotany, dental pathology, skeletal pathology). In one of the sites, Jabuticabeira-II, a long-term interdisciplinary research program is currently underway. This renders a rare opportunity to countercheck the results of one approach in the light of the others.

Results and specific discussion

Palaeoethnobotany

Palaeoethnobotanical results, including complete charcoal diagrams, were already published elsewhere, as well as a great part of the palaeoenvironmental data discussed below (Scheel-Ybert, 2000, 2001a, 2001b). Therefore, only a synthesis of the results is presented, in order to give a comprehensive picture of the environment in which sambaqui dwellers lived.

All the studied sites were established in the restinga environment (figure 2). Elements of «open restinga» (a shrubby sparse vegetation), restinga forest, mangrove, and coastal forests are represented in different proportions according to the site’s geographical location.

Figure 2. Selected summary charcoal diagrams showing the most representative sites of the Lagos (Forre, Boca da Barra, Ponta da Cabeça), and Camacho (Jabuticabeira-II) regions (in percentages of charcoal pieces). Species were grouped according to the vegetation types; as some taxa may occur in more than one vegetation type, compound vegetation types are presented; Myrtaceae species are presented in a separate group – this family may occur in several Brazilian plant associations, but high diversity and frequencies are typical for restinga formations (adapted from Scheel-Ybert, 2000, 2001b).
Anthracological spectra of all studied sites are essentially the same between circa 6000 and 1200 cal yrs BP, suggesting that the vegetation was not greatly affected either by climatic or by anthropogenic perturbations. However, climatic oscillations did occur, causing some variations in the mangrove vegetation from Southeastern sites during this period. At least two more humid and two drier episodes were recorded (Scheel-Ybert, 2000). These episodes were correlated with modifications of lagoon sedimentation, which also suggested regional climatic variations during the Holocene (Tasayco-Ortega, 1996).

Stability of the mainland coastal vegetation, in spite of the occurrence of climatic variations, was attributed to the edaphic character of the coastal vegetation (Scheel-Ybert, 2001b), but also to a conservative relationship of shellmound dwellers regarding the vegetation. Environmental stability certainly had an influence on this society. In addition to allowing a deeper knowledge about the plant associations these people dealt with, environmental stability might have been a decisive factor in triggering expansion of the sambaqui culture, sedentism, and maintenance of their sociocultural system.

Charcoal pieces bearing traces of decay before charring attested the use of dead wood for fire. The great taxonomic diversity of the charcoal assemblage and the good correspondence between charcoal spectra and the present-day vegetation are indicative of non-selective gathering of fuel wood (Scheel-Ybert, 2000, 2001a). However, it was suggested that the wood of Condalia sp (Rhamnaceae) might be selected, either for economic (this wood is reported to produce a blue pigment; the root bark of some species is used as soap or medicine; the plants bear edible fruits) or for ceremonial reasons (Scheel-Ybert, 2000). This hypothesis is based on the over-representation of this taxon in the anthracological record, as well as on evidences that its wood might have been charred green.

Carbonized plant food macro-remains were retrieved in all Southeastern shellmounds (Scheel-Ybert, 2001a). Until then, only palm nuts, probably mostly from Astrocarum, Bactris and Syagrus genera, were usually found in these sites. However, the later are either more prone to preservation than seeds and tubers as easiest to find during the excavations. Most seeds and monocotyledonous tuber fragments remain as yet unidentified, but some fragments could be attributed to Dioscorea sp (yam), and another one to a Gramineae or Cyperaceae (figure 3). Tubers are never very abundant, but they occur in almost all the archaeological levels of the studied sites. The abundance of plant food remains in the different sites was estimated using food remains: wood charcoal ratios (table II). Charcoal was used in the denominator rather than sediment volume, to control for differential preservation (Miller, 1988).

<table>
<thead>
<tr>
<th>level</th>
<th>Forte</th>
<th>Salinas Peroano</th>
<th>Boca da Barra</th>
<th>Ponta da Cabeça</th>
<th>Beirada</th>
<th>Pontinha</th>
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<tr>
<td></td>
<td>FR-ch</td>
<td>T-ch</td>
<td>FR-ch</td>
<td>T-ch</td>
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<td>0-10</td>
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<td>0.03</td>
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<td>0.03</td>
<td>0.02</td>
<td>0.04</td>
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<td>0.04</td>
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<tr>
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<td>0.14</td>
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</table>
Table 2. Food remains: wood charcoal (FR:ch) and tubers: wood charcoal (T:ch) ratios in Southeastern Brazilia sites. Ratios represent the number of food remains (seeds, palm nuts, and tubers) or the number of tuber fragments reported to the total number of charcoal pieces in each sample. In the inner table, total number of nuts and seeds, tubers, and charcoal pieces analyzed and ratios for each site, all levels combined.

Bioarchaeology

Food procurement, production, preparation, and consumption are important daily life concerns that can directly affect health in different ways. Consumed foodstuffs influence health, but the means by which people procure and prepare food can also have effects on it. For this reason, nutritional issues and subsistence strategies can be inferred through teeth and bone analyses (Larsen, 1999).

Very low caries frequencies, traditionally found among sambaqui dwellers (Mendonça de Souza, 1995), are confirmed for most of the sites analysed here (figure 4). However, in both strata from Morro do Ouro and in ancient Rio Comprido caries prevalence are analogous to agriculturalists in general (Wesolowski, 2000).

Figure 4. Frequencies of dental pathologies in the studied sites. Sites are presented by region and in each region by approximate chronological order. BEI: Beirada; PIA: Piaçaguera; TEN: Tenório; RC: Rio Comprido; MDO: Morro do Ouro; CAB: Cabeçuda; JAB: Jabuticabezinha-II. (a) ancient series; (r) recent series. A: Caries and tooth wear (Morro do Ouro, burial #59); B: tooth wear (Jabuticabezinha-II, burial #17a).
Caries is a multifactorial infectious disease whose etiological agent is a specific multicomponential bacterial flora. Although diet is one of the main factors influencing caries type and intensity, association between caries frequency and diet is indirect. Diets rich in carbohydrates usually increase decay probability, but there are evidences that this is not always the case (Tayles et al., 2000). Diets based on seafood can render some protection against caries development. The presence of minerals in the diet, such as fluoride, is known to be a caries inhibitor (Leverett, 1982).

Masticatory tooth wear is considerably high in the analysed samples. Earlier studies attributed it to sand, tiny shellfish fragments (Mendoça de Souza, 1995), and phytoliths (Reinhard et al., 2001) present in the food. In foragers, severity of anterior wear is usually greater than, or equal to, posterior wear (Larsen, 1999). Despite the high caries frequencies in some of the series, posterior wear is smaller than anterior dental wear and as such suggestive of foraging in all sites, except ancient Rio Comprido, where tooth wear pattern, apart from the high caries frequency, suggests cultivation (figure 4).

Bioanthropological markers also helped unravel shellmound builders’ lifestyle. Osteoarthritis is often used as a marker of activity intensity (Goodman et al., 1984; Bridges, 1991). In Brazilian shellmounds its frequency is usually higher in upper than in lower limbs (Mendoça de Souza, 1995; Neves, 1984), which is confirmed in this study (figure 5). This is suggestive of small walking distances, indicating smaller terrestrial resource catchment areas than observed among continental hunter-gatherers (Neves, 1984).

The high frequency of osteoarthritis in arms suggests high intensity/frequency of activities such as swimming and rowing. This pattern is more often seen in preagricultural populations, especially fishers, than in farmers from different regions of the world (Larsen et al., 2002). Accepting higher arms osteoarthritis severity among foragers than agriculturalists, we would expect the hypothesized horticulturalists from ancient Rio Comprido and Morro do Ouro to present less arthritis in arms than the others, but this is not the case (figure 5). However, other aquatic populations also do not conform to the general trend of osteoarthritis reduction occurring with the shift away from foraging. High prevalence of osteoarthritis in arms may persist in cultivators if they remain highly dependent on aquatic resources, what seems to have been the case in these shellmounds. A similar trend was recorded in North-American populations from Georgia Bigth (Larsen et al., 2002).

Very high cribra orbitalia frequencies (figure 5) conform to earlier sambaqui studies (Mello e Alvim & Gomes, 1989; Neves & Wesolowski, 2002). Most lesions are remodelled, suggesting that physiological stressors occurred during growth but healed. Originally considered an anaemia indicator (Stuart-Macadam & Kent, 1992), cribra orbitalia is presently attributed to different types of physiological stress (Wapler et al., 2004). Its higher prevalence in tropical/subtropical regions, when compared to foragers from temperate zones (Larsen et al., 2002), is attributed to an increased pathogen-load near the Equator (Stuart-Macadam & Kent, 1992). Bacterial infection, resulting from constant contact with animal remains used as food and construction material, proliferation of insects attracted by organic waste, and the geographical setting of shellmounds, might have contributed to this pathology development (Mendoça de Souza, 1995).
Figure 5. Frequencies of skeletal pathologies and stature ranges in the studied sites (legends as in figure 4). A: Cribra orbitalia (Cabeçuda, burial #1882); B: periostitis (Cabeçuda, burial #1805); C: osteoarthritis (Jabuticabeira-II, burial #10b).

Periostitis, porosity on the osseous outer layer of long bones, is due to inflammations and/or infections associated to either isolated traumatic events or systemic diseases (Ortner & Putschar, 1981). Most of the individuals studied here present it in at least two non adjacent bones and in the absence of detectable traumatic events. Periostitis is more frequent on legs than arms (figure 5), as expected, since legs are physiologically more prone to infections (Ortner & Putschar, 1981). These frequencies greatly surpass those observed for temperate foragers and even agriculturalists (Larsen et al., 2002). Since traumatic events among sambaqui dwellers are rare (Lessa & Medeiros, 2001; Storto et al., 1999, Okumura & Eggers, 2005), this result seems to confirm the high pathogen-load discussed above.

Stature is the net result of genetic determination, nutrition and health during development and growth. Chronic diseases, recurrent acute pathological states, and/or malnutrition can lead to growth retardation. Compensatory growth, allowing the child to return to its genetically determined growth curve, only occurs if it is cured and well nourished (Bogin, 1999). If not, there is adult stature stunting. In the samples studied here, adult stature ranges between 151-159 cm for males and 148-156 cm for females (figure 5). Thus, they were rather short and in the lower range for past and extant Amerindians (Storto et al., 1999; Steckel & Rose, 2002). Since malnutrition seems unlikely in such a rich environment, this could be due
either to a particular genetic background or to a long-term adaptation to chronic and/or acute and recurrent infectious diseases during development and growth.

Discussion

In the past, Brazilian shellmounds were regarded as mountains of waste left over by small nomadic bands whose diet was based on molluscs. More recently, *sambaqui* dwellers were proved to have subsisted mainly on fish and to have intentionally used mollusc shells to construct sites of specific functions such as huge cemeteries. A higher social complexity than formerly believed is suggested by the sites monumental dimensions and by the existence of exclusively funerary sites, funeral feastings, and variation in burial patterns and offerings (Fish et al., 2000; Gaspar, 2000). However, many questions remain yet to be answered, including aspects of their subsistence, the use of plants, and their way of life.

The present study aimed at uniting different approaches to answer these questions in an interdisciplinary way innovative for Brazilian archaeology. New data is reported about plant use, diet, health, physical activity, and stature, while already published data on palaeoenvironment and on material culture are reviewed. As such, data point towards more complex subsistence strategies and more diversified modes of life among Brazilian shellmounds populations than earlier assumed.

Palaeoethnobotanical studies allowed palaeoenvironmental reconstruction and provided information on firewood utilization and diet for seven of the twelve sites analysed. Palaeopathological analyses, also from seven sites, revealed important information regarding these groups life way and their relation with the environment. The combination of results from both disciplines confirmed the importance of plants for this society, providing more solid bases for the debate on human management and plant cultivation.

Direct vestiges of plant consumption are very difficult to find, especially in the lowland tropics, where the humid climate and the acid soils account for a very poor preservation of plant remains. In this context, conservation is achieved almost exclusively by carbonisation, although microfossils like phytoliths or starch grains may also be trapped in plant grinding stones (Piperno et al., 2000; Friarte, 2004), into the dental calculus matrix (Reinhard et al., 2001) and in sediments. Tuber macro-remains are rarely identified in archaeological sites (Hather, 1993). Their presence in most of the studied sites may be taken as indicative that they were much used by *sambaqui* builders. These plant remains alone do not imply in any kind of cultivation, but their association with other results, as those from bioanthropology discussed below, point to the possibility of human management or some incipient cultivation.

Some series analysed here show caries prevalence compatible with cultivation (Turner, 1979; Larsen et al., 2002). Caries frequencies from Rio Comprido and Morro do Ouro sites, which largely surpass those observed for foragers, are similar to those found in some American natives, such as post-contact groups from Georgia Bight (Larsen et al., 2002) and prehispanic Cuicuilco, who both practiced intensive agriculture (Marquez Morfin et al., 2002). High caries frequencies in shellmounds can be explained by the consumption of cariogenic plants, such as tubers, and possibly their cultivation. Unfortunately, there are as yet no palaeopatho-
logical data for Southeastern Brazilian sites, in which palaeoethnobotany suggests important tuber consumption.

Low caries frequencies, suggestive of foraging, were found in all of the other sites. However, the worldwide observation that high reliance on aquatic resources leads to protection against caries should be taken into account. Indeed, numerous starch grains were retrieved in dental calculus from individuals exhumed at Jaboticabeira-II (Boyardjian et al., 2007) and other Southern sites (Wesolowski, unpublished), attesting that carbohydrate-rich food did contribute significantly to their diet. Additionally, some of the starch grains are modified, indicating cooking.

Some authors already sustained that plant gathering, human management, and early plant domestication were practiced by *sambaqui* builders (Tenório, 2000), or that they might have developed agricultural practices (Dias & Carvalho, 1983). However, almost nothing is known about plant consumption and food production by Brazilian pre-ceramic groups, and whether domestication or cultivation has ever occurred in this cultural horizon is unknown.

Although site location, palaeopathological, chemical and zooarchaeological studies argue for a primary maritime focus for subsistence, it seems possible that *sambaqui* people practiced some kind of cultivation, perhaps under the form of garden plots holding tuber-producing and other edible/useful plants. A well-established agricultural system in the *sambaqui* dwellers society seems unlikely, as bioanthropological markers of cultivation, such as high caries rates, are not present in all sites and clear evidences of domesticated plants are lacking, but also because of the great dependence of *sambaqui* builders on marine resources. Nevertheless, the conservation of charred tuber remains, the high caries rates in some sites, and the high frequency of starch grains in dental calculus could be explained by the practice of human management or horticulture. Actually, it is broadly admitted that, well before intensification of South American known agricultural systems, based mainly on manioc and maize, different populations possessed a deep knowledge of the plant environment, practicing human management and/or incipient cultivation.

A review of lithic analyses carried out to date also supports the importance of plants to these populations, corroborating the palaeoethnobotanical and palaeopathological results.

In spite of some variations in the frequency of different lithic devices between sites (Emperaire & Laming, 1956; Uchoa, 1973; Beck, 1980; Kneip, 1994; Gaspar, 2003), the most common pieces of *sambaqui* lithic industry are simple flakes, with used edges, either small or big enough for direct handling. They were usually obtained from basalt, quartz or quartzite cobbles (Emperaire & Laming, 1956; Prous, 1992; Gaspar, 2003). Most of the artefacts are just roughly shaped, and very often cobbles, flakes and large fragments were directly used, with no retouching at all (Prous, 1992; Gaspar, 2003). Polished artefacts, made of hard basaltic rock, include small pendants, axes of various sizes, and zooliths (impressive lithic sculptures retrieved in funerary contexts from Southern sites).

There is also a great variety of groundstone tools, generally heavily used, frequently burned and broken into smaller pieces, often recycled into used or retouched pieces. Mortars and pestles of varied sizes, shapes, and use-wear patterns point to differentiated purposes, most of which probably related to plant processing. Pecked stones, usually associated to shelling palm fruits (Bryan, 1993), are
very frequent all over the country. They were found in most of the sites analysed (Uchoa, 1973; Beck, 1980; Kneip, 1994; Gaspar, 2003).

Manos and metates are traditionally considered good indicators of plant food processing and even of plant domestication (Kamminga, 1979; Schlanger, 1991). Manos, presenting smooth and polished surfaces, are frequent in many of the studied sites, and in most of the Brazilian shellmounds as well. Only few metates, however, were found in these sites. We hypothesize these implements, of considerable size and weight, might possibly be of communitarian use.

Morphological and functional characteristics of shellmounds scrapers and used implements point mainly to wood and bone processing, while flakes and groundstone devices are related to food preparation (fish, wood, and plants processing). The patterning of the lithic artefact industry in a Southern Brazilian sambaqui was attributed to food processing contexts (Bryan, 1993). In Panama, very similar groundstone tool morphology and use-wear patterns are related to starch-rich plant processing, including manioc and maize, beginning c. 7000 yrs BP (Piperno et al., 2000).

More specific studies of the lithic assemblage are still needed, especially regarding use-wear and organic residues of surface analysis. However, groundstone assemblages, related to considerably intensive plant processing, point to a much more significant role of plant foods to the sambaqui people subsistence than has been considered so far.

Based on the data already obtained, we assume that sambaqui dwellers had a plentiful, previsible, and broad diet, that incorporated marine protein and a variety of wild and maybe some cultivated plants, probably including some highly cariogenic species. Their small stature would thus be due to the high prevalence of long-term infectious disease during growth, affecting many generations (Mendonça de Souza, 1995). High survivorship with chronic infections (indicated by cribra orbitalia and periostitis), analyzed together with low stature, suggests that these people were well adapted to their habitat. This hypothesis is corroborated by much extended periods of site permanency - the studied sites attest of about 500 (Beirada, Pontinha), 1000 (Ponta da Cabeça, Jabuticabeira-II), 2000 (Salinas Peroano, Boca da Barra) or over 3000 (Forte) years of occupation (table 1).

Continual occupation, without any confirmed period of site abandonment, suggests sedentism, which was probably also triggered by resource abundance. Indeed, sites were established in coastal ecotones, in the vicinity of restingas, mangroves, forests, and lagoons, allowing access to abundant renewable plant, fish, and shellfish resources. Resource abundance is indirectly confirmed by low trauma frequency. High prevalence of cribra orbitalia and periostitis in most of the sites are also suggestive of sedentism, since sedentary life leads to waste accumulation and increases the likelihood of infections and physiological stress. The great number of burials (Fish et al., 2000), as well as the occurrence of highly contagious infections such as treponematoses (Okumura & Eggers, 2005), supports this assertion, besides pointing to much higher population densities than previously assumed.

The lower and less variable arthritis in legs than in arms is suggestive of small walking distances. It could result either of foraging in a rich nearby environment or of gardening and harvesting carried out by horticulturalists. The variety, constancy, and previsibility of resources in coastal areas, and the lifestyle adapted to
the coastal environment can explain the higher osteoarthrosis in arms than in legs. This reflects how more important rowing, swimming, and throwing nets was in comparison to walking.

Despite the relative stability of cultural (DeBlasis et al., 1998; Gaspar, 1998) and ecological aspects (Scheel-Ybert, 2000) at a macro-regional level, shellmounds present particularities concerning local characteristics. These may include site landscape insertion (Scheel-Ybert, 2000), site composition (Gaspar, 1998), site function (Fish et al., 2000), frequency of palaeopathologies, and subsistence strategies (this paper). This seems to indicate that, even if all sambaqui moundbuilders were part of one single sociocultural system, they might present different ways of life and diverse subsistence strategies at the site level.

Conclusions

As archaeological research progressed, a number of prevailing preconceptions concerning the sambaqui society have been put aside. Once these people were no longer seen as nomadic shellfish gatherers, investigation on their lifeway, subsistence system, and sociocultural organization greatly improved.

This paper aimed to bring together results from different study areas, associating archaeological research to the so-called «related disciplines». Comparison of data from various disciplines, as attempted here, has the potential of enriching the discussion on prehistorical populations and of stimulating the scientific community to a more harmonious dialogue. This multidisciplinary approach, innovative in Brazilian archaeology, allowed new interpretations concerning palaeoenvironment, firewood economy, health, activity indicators, and diet.

Besides presenting new information on their way of life, some clues suggesting that plant consumption was particularly important to this society are provided. The conservation of tuber remains in many sites, along with the caries rates and tooth wear analyses indicate that plant foods were making a substantial contribution to their diet. Markers related to aquatic activities suggest continuity on the importance of marine resources.

References


