



# Gardens on the coast: Considerations on food production by Brazilian shellmound builders

Rita Scheel-Ybert\*, Célia Boyadjian

Museu Nacional, Universidade Federal do Rio de Janeiro, Laboratório de Arqueobotânica e Paisagem, Programa de Pós-Graduação em Arqueologia, Quinta da Boa Vista, São Cristóvão, 20940-040 Rio de Janeiro, RJ, Brazil

## ARTICLE INFO

### Keywords:

Sambaqui  
Food production  
Subsistence economy  
Landscape  
Archaeology  
Archaeobotany  
Coastal Brazil

## ABSTRACT

Shellmounds of different sizes and characteristics mark the landscape along the Southern and Southeastern Brazilian coast, attesting to a multimillennial occupation that is dated from at least 8500 until 1000 calibrated years before present. Their builders are currently recognized as fisher-gatherers, and until quite recently plants were thought to represent only a minor part of their diet. However, evidence of wild and domesticated plant remains obtained from diverse proxies across sites, contexts, and chronologies point to a different scenario. The importance of a variety of tubers, fruits, and seeds, including yam, sweet potato, leren, squash, and maize has been documented. The evidence demonstrates that shellmound builders subsisted in a system of mixed economy, where fishing and gathering were associated with horticulture. They modified the landscape, tended home gardens, and exploited substantial amounts of tuberous crops. This paper discusses the significance of plant remains to a low-level food production system while contextualizing them over the landscape.

## 1. Introduction

The Brazilian coast was intensely occupied by shellmound builders for several millennia. Traditionally, following cultural ecological interpretations, these people were seen as nomadic foragers, organized into small shellfish gathering bands who would have shifted their economic system to fishing in more recent times (Heredia et al., 1989). According to this interpretation, shellmounds were considered to be food middens. Important research during the 1990s led to the interpretation of people as sedentary “fishers-gatherers-hunters”, and of mounds as loci for dwelling, burying the dead, and accumulating food remains (Gaspar, 1998). Presently, they are largely recognized as sedentary fisher-gatherers, and mounds are generally interpreted as funerary monuments (DeBlasis et al., 1998, 2007; Gaspar, 2014). Following the theoretical trend towards what has been called “complex hunter-gatherers”, some scholars have argued for more complex sociocultural patterns (DeBlasis et al., 1998; Lima and Mazz, 1999/2000; Scheel-Ybert et al., 2003; Fish et al., 2013; Lessa and Gaspar, 2014; Gaspar, 2014), but presently the postulation of a heterarchical system seems more widely accepted (DeBlasis et al., 2007; Kneip et al., 2018).

The role of plants in this social system, however, is still largely underestimated. For many archaeologists the very concept of “fisher-gatherers” still implies “mollusk gatherers” (cf. Gaspar, 2014). Archaeologists tend to value what they see with the naked eye, thus

animal remains have historically been overestimated when compared to plant remains. Hence, mollusks (which are more visible in the stratigraphy) have long been considered as the major staple food, until fish was proven to be their most important source of protein (Figuti, 1993; De Masi, 2001; Colonese et al., 2014). But plants were also essential to their lives. And botanical remains, albeit frequently inconspicuous and underrepresented due to differential preservation, provide meaningful evidence.

Archaeobotanical studies have been demonstrating that plants played a pivotal part in these people’s diet and way of life, while also providing robust evidence of wild and domesticated plants obtained from varying proxies across sites, contexts, and chronologies. In this paper, we intend to discuss the significance of these plant remains to a food production system while contextualizing them in the landscape. By doing this, we will try to demonstrate the importance of environmental manipulation, horticultural practices, and of domesticates in this sociocultural system. We argue that these shellmound builders are to be considered as a middle ground society engaged in low-level food production with domesticates (*sensu* Smith, 2001), or rather in a “low-impact” food production system (*sensu* Watling et al., 2018).

In the given context, we argue that the concept of “fisher-gatherers”, heretofore adopted to describe their economy, is inaccurate. Even if these people were indeed collecting shells (mostly for building material) and a variety of wild plant resources, foraging was performed in a

\* Corresponding author.

E-mail address: [scheelybert@mn.ufrj.br](mailto:scheelybert@mn.ufrj.br) (R. Scheel-Ybert).

scenario where food production was also relevant. Therefore, we propose the binomial “fisher-gardeners” (following Killion, 2013), considering that their economic system would be better described by emphasizing food production.

## 2. Archaeological context

Shellmound builders occupied the Brazilian coast from at least c. 8500 to 1000 cal yrs BP<sup>1</sup>, with a strong population growth between 5000 and 3000 cal yrs BP (Gaspar, 1998, 2014; DeBlasis et al., 2007; Calippo, 2008; Kneip et al., 2018). In Southeastern Brazil, riverine shellmounds situated about 100 km inland in intermontane valleys 200–1200 m asl date from c. 10,500 to 1000 cal yrs BP. They are less studied than coastal sites, but similarities in cultural traits and monumentality, which are assumed to have paramount social meaning, point to a cultural relation (Figuti et al., 2013). These populations’ origins and colonization routes are unknown, yet it is possible that coastal shellmounds precede riverine shellmounds. Many scholars believe that the first settlements occurred along the large continental platform that is now submerged due to relative sea-level rise from late Pleistocene to the Holocene (Angulo et al., 2006; Calippo, 2008; Scheel-Ybert et al., 2009b; Figuti et al., 2013; Kneip et al., 2018).

Shellmounds (locally named “*sambaquis*”) occur nearly along the entire Brazilian coast and in some riverine contexts, reaching up to the Amazon Basin (Fig. 1). Some authors have argued that the typological homogeneity of the lithic and bone industries, as well as the structural characteristics of the sites themselves, suggest the existence of a single sociocultural system crossing space and time (cf. Gaspar, 2014). However, there is no consistent data about the political or even cultural integration at the supra-regional level as yet.

In Southern Brazil, especially in the Santa Catarina state, shellmounds may attain exceptionally large dimensions; elsewhere on the coast, they are smaller. Southern sites may present elaborated lithic sculptures (zooliths), generally representing highly naturalistic animals, interpreted as ceremonial artefacts. Southern and Southeastern sites are aceramic; pottery, when present, is restricted to upper levels and generally associated with reoccupation by later groups (Gaspar, 1998, 2014). Conversely, shellmounds from the Northern coast and Amazonia present ceramics throughout their stratigraphy; the latter are associated to the earliest ceramics produced in the American continent, dating back to 8000 cal yrs BP (Bandeira, 2011; Pugliese et al., 2018). Sites are much rarer in the Northeastern coast, which may be due to both a lack of studies and to a distinct geomorphological history, for coastal lagoons and estuaries with which they are associated are uncommon.

In this paper, we will focus on coastal Southern and Southeastern sites. The archaeological synthesis and data presented hereafter are based on research performed mostly in Santa Catarina and Rio de Janeiro states (cf. Fig. 1).

Brazilian shellmounds have long been considered as waste deposits (middens), habitational structures, or places where habitation, domestic trash deposition, and human burial were performed simultaneously (cf. Heredia et al., 1989; Gaspar, 1998). Important field projects since the 1990s have altered these views. In the Southern/Southeastern coast, they are presently understood as funerary monuments and ceremonial spaces, intentionally erected as landscape markers and sites of social congregation (DeBlasis et al., 1998, 2007; Gaspar, 2014). A few small sites devoid of burials have also been identified (Klokler et al., 2010). Site formation patterns and functions are not clear in every case, but it seems to be established that none of the mounds, large or small, are habitational. Despite abundant food remains and the presence of features that would be commonplace in habitation loci, recognizable dwellings have not been encountered, nor distributions and arrangements of features that would indicate

sustained domestic activity (DeBlasis et al., 2007; Fish et al., 2013; Gaspar et al., 2013; Kneip et al., 2018; Scheel-Ybert et al., 2020). The location of habitational areas still eludes archaeologists. Hence, little is known about where and how these people actually lived. Did people live in areas very close to the shellmounds and, therefore, “under their shadows”? Were they established in stilt houses, as suggested by Kneip and colleagues (2018)? Or were settlements located in paludal environments such as the lagoon’s edges, where soils are more fertile? The issue has been extensively debated over the years, but considerable field research is still needed to yield answers.

These shellmounds have extremely complex and varied stratigraphies (Fig. 2). Analyses of formation processes in different Southern/Southeastern sites have demonstrated that their construction was associated with the performance of funerary feasts (Gaspar et al., 2013, 2019; Klokler, 2017). The better studied sites proved to be composed of two different categories of archaeological deposits: primary funerary deposits (features, artifacts, and ecofacts associated with the mortuary rituals) and secondary construction deposits (materials used to cover the funerary areas). The latter are composed mostly of mollusk shells, frequently mixed with fish bones, charcoal, sand, and sometimes artifacts (Villagran et al., 2010; Gaspar, 2014; Scheel-Ybert, 2014; Klokler et al., 2018; Gaspar et al., 2019; Scheel-Ybert et al., 2020).

Accumulation of food remains is thought to be associated with ceremonial feasting (Klokler et al., 2018). Remains of fish (and possibly plants) consumed in funerary gatherings and of the ritual fires prepared for the occasion were probably mixed with shells and used to cover the funerary areas, thus increasing the size of the mound. Shells could also have been consumed (even if only occasionally) but they are presently interpreted as construction material. Klokler (2017) argues that although these populations seemed to be living on and being buried in trash resulting from daily meals, they were actually surrounded by powerful animals, as fish and mollusks were symbolically-charged. Animals were “special feasting food for the living, then transformed into food for the dead, and finally became markers of identity, of ancestor veneration, and of seascape construction” (Klokler, 2017:96).

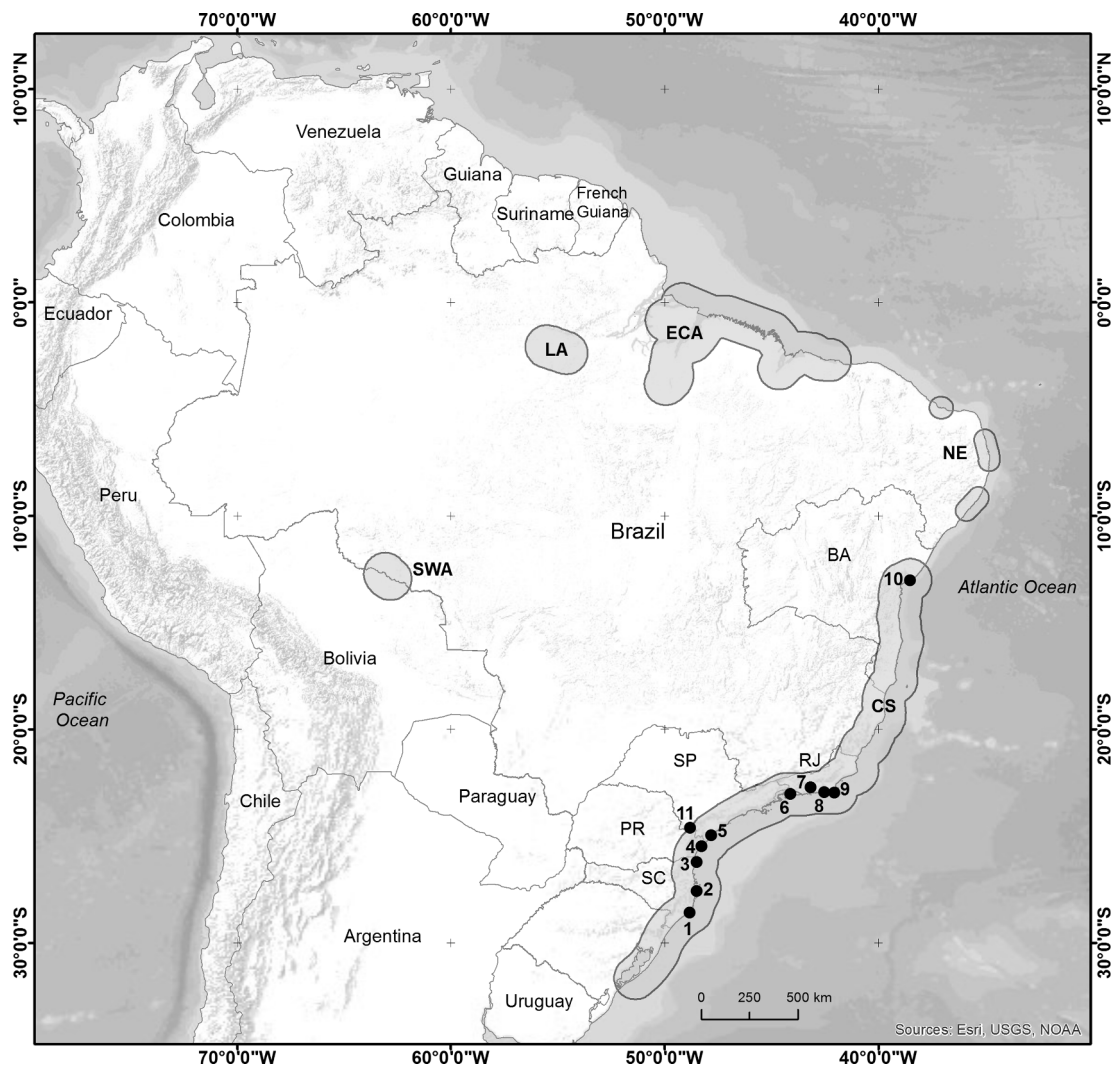
Ceremonial feasts, as well as funerary offerings, are thought to have been largely based on fish, and on a considerably smaller scale (in quantity, albeit not in significance), mammals and birds (Klokler et al., 2018). But plants were also an important part of these rituals; we have evidence that fruits and vegetables were placed as offerings, and they might also have been consumed in feasts (Bianchini and Scheel-Ybert, 2012).

Fire was a central element in the life of *sambaqui* people. Numerous and commonly very large hearths occur in funerary contexts, possibly associated with both the interment ceremonies and subsequent visits to the funerary area. At least some of these fires were long-lasting events (attested by high species diversity in anthracological analysis), suggesting that hearths were maintained for long periods to honor the dead (Bianchini and Scheel-Ybert, 2012). Persistent fires might add to the monumentality of *sambaquis*, for they increased the sites visibility by the continuously burning flames upon them (Scheel-Ybert, 2018).

The ritual nature of at least some of the sites and the central role of death in the cosmology of *sambaqui* builders is well demonstrated. Yet the actions that gave rise to the sites’ construction, successively repeated and elaborated over millennia, included many activities besides the ceremonies directly related to the interment of the bodies: funerary feasts were held, feasting remains were used as construction material, intense remobilizations of materials and sediments were made (attested by interventions in the stratigraphy to ends other than burial activities), and fires were maintained over long periods of time. Even if funerary in nature, these sites consisted of living spaces, where multiple activities were developed around the mortuary rites and the celebration of the ancestors (Scheel-Ybert et al., 2020).

Shellmounds are not randomly distributed along the seashore. Rather, they are generally concentrated in strategic locations such as around coastal lagoons, bays, and estuaries. Lagoons and similar

<sup>1</sup> All calibrated ages are informed with 2 $\sigma$  interval.



**Fig. 1.** Occurrence areas of Brazilian shellmounds. CS: Coastal Shellmounds; NE: Northeastern sites; ECA: Estuary and Coastal Amazonia/Northern Coast; LA: Lower Amazon; SWA: Southwestern Amazonia. Areas mentioned in the text: (1) Santa Marta region; (2) Santa Catarina Island; (3) Babitonga Bay; (4) coastal bays of Paraná state; (5) Ribeira Valley; (6) Mangaratiba Bay; (7) Guanabara Bay; (8) Saquarema region; (9) Cabo Frio region [8 + 9 = Lagos region]; (10) Todos os Santos Bay; (11) riverine shellmounds from Ribeira valley. SC: Santa Catarina state; PR: Paraná state; SP: São Paulo state; RJ: Rio de Janeiro state; BA: Bahia state (Map provided by Jasiel Neves; ECA/LA/SWA according to Pugliese et al., 2018).

waterbodies are considered to have been the center of the *sambaqui* social sphere, both for subsistence and social networking, throughout the coastal occupational history. As epicenters of the social lives, lagoons are pointed to as spaces of multiple activities, such as fishing, diving, canoeing, gathering shells and maybe shrimp, among others (DeBlasis et al., 2007; Kneip et al., 2018).

In such locations, sites of various sizes and chronologies, frequently clustered (Gaspar, 1998; Kneip et al., 2018), were maintained over thousands of years. Several of the sites demonstrate long periods of occupation, extending up to 3000 years with no indication of abandonment (Fish et al., 2013; Scheel-Ybert, 2014; Kneip et al., 2018; Scheel-Ybert et al., 2020).

Preliminary demographic calculations estimate that 20 or more people might be buried in each of the larger sites per year, making over 500 people per generation of 25 years (Fish et al., 2013). Although imprecise, these figures suggest an impressive concentration of people, at least in some areas, and indicate relatively sizable and stable populations, especially if we consider regional chronologies attesting that several sites were active concomitantly (DeBlasis et al., 2007).

DeBlasis and colleagues (2007) and Kneip and colleagues (2018) interpret site clusters as communities, each one corresponding to

specific and concomitant sociological units, possibly lineages or clans. Different communities would take part in integrated strategies for the management of the socially shared lagoon environment. Concurrently, communities and clusters would have maintained social bonds at the regional level and beyond. At a local level, this integration is archaeologically expressed by the spatial configuration of the settlements and by socially important funerary rituals with wide participation within the communities surrounding the lagoons. At a regional level, it is manifested in the great cultural (and possibly genetic) similarities that are observed among *sambaqui* people over space and time.

This model, proposed for the Santa Marta region, in the Southern coast, also fits to data from the Lagos region and the Guanabara Bay, in the Southeastern (Gaspar et al., 2019). It might also apply to different coastal regions where *sambaqui* clusters presenting similar settlement systems and construction patterns were identified, such as Santa Catarina Island, Babitonga Bay, coastal bays in Paraná state, Ribeira Valley, Mangaratiba Bay, Todos os Santos Bay, among others (Klokler, 2017; Kneip et al., 2018; Gaspar et al., 2019 – cf. Fig. 1).

Fish and colleagues (2013) highlight the persistence of the material and behavioral correlates of the ideological tradition of *sambaqui* builders over several millennia. They point out that *sambaquis* and the



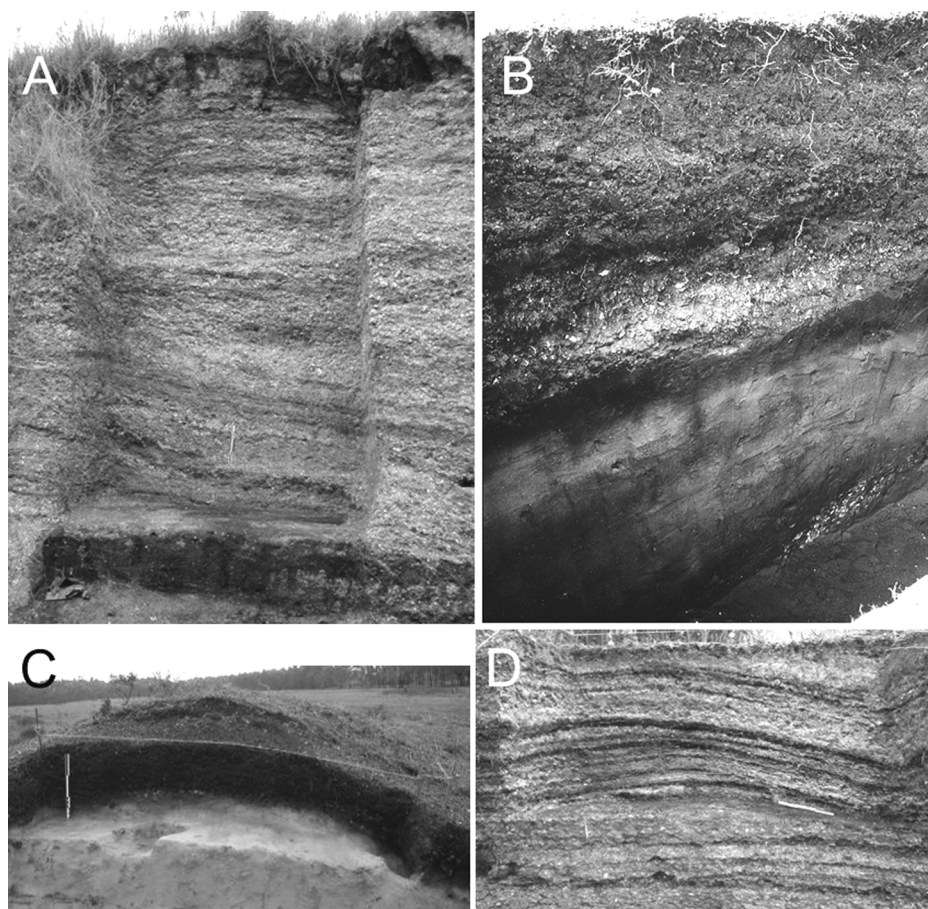


Fig. 2. Examples of stratigraphy in some Southern and Southeastern Brazilian shellmounds. (A): Jabuticabeira-II, Santa Marta region; (B) Sambaqui do Forte, Cabo Frio region; (C): Encantada-III, Santa Marta region; (D) Sernambetiba, Guanabara Bay.

sustained mortuary rituals that generated them persisted for much longer than the typical chronological divisions of complex societies and their corresponding monument styles. The persistence of occupation patterns and cultural practices in time and space, however, does not signify a static society. Recent studies at a particularly long-lasting *sambaqui* from Santa Marta region pointed to a social unity that was simultaneously extremely conservative, when investing in the construction of the same funerary monument for more than two or three millennia of continuous occupation, yet whose cultural patterns also changed according to the group's cosmological/ideological views (Scheel-Ybert et al., 2020).

The persistence and long duration of social practices over several generations and across a vast geographical area suggest an articulated and territorially organized social structure (DeBlasis et al., 2007; Kneip et al., 2018; Gaspar et al., 2019). There is still little direct evidence for these populations' sociopolitical organization, but the available data points to a heterarchical system that was essentially egalitarian (DeBlasis et al., 2007; Kneip et al., 2018). There is neither evidence of social differentiation, established hierarchy, interpersonal violence, nor of any feature suggesting centralized power or authority (DeBlasis et al., 2007; Gaspar et al., 2011; Lessa and Gaspar, 2014; Scheel-Ybert et al., 2020). These elements point to tenuous political connections, based on local communities and lineages. On the other hand, the emphasis on the funerary ritual and on ceremonial apparatus suggests that religious structures associated with mythical ancestors may have taken over the function of integrating the various *sambaqui* communities and orchestrating the labor of the sites' construction (DeBlasis et al., 2007).

### 3. Territory and landscape

Available palaeoenvironmental and landscape reconstructions are based on anthracological studies performed for ten *sambaquis* from the Southeastern and Southern Brazilian coasts. Eight sites are situated in the Lagos region (Forte, Boca da Barra, Salinas Peroano, Ponta da Cabeça, Corondó, Pontinha, Beirada, Meio – Scheel-Ybert, 2000; Scheel-Ybert and Dias, 2007), and two in the Santa Marta region (Jabuticabeira-II, Encantada-III – Scheel-Ybert et al., 2003, 2009a; Bianchini et al., 2011). Their chronology ranges between  $5270 \pm 80$  and  $1430 \pm 55$  yrs BP (6190–5760 to 1380–1180 cal yrs BP). Most sites were active for long periods, spanning from about 500 years (Pontinha, Beirada) or 1000 (Ponta da Cabeça, Corondó, Jabuticabeira-II) to more than 2000 (Boca da Barra, Salinas Peroano) or 3000 years (Forte). All sites present evidence of funerary contexts, except for two small shellmounds without burials and with short-term occupational patterns (Meio, Encantada-III). Those small sites' functions could not be asserted, but for Encantada-III a probable episodic occupation was demonstrated, with no evidence of domestic activities nor of a repeated use of fire (Scheel-Ybert et al., 2009a).

All anthracological results demonstrate that *sambaqui* people dwelled in the *restinga* ecosystem. In Brazil, the term “*restinga*” is used to define both: (1) the geomorphological features parallel to the coastline, consisting in Quaternary marine sandy deposits produced by sedimentation processes associated with sea-level variations that formed the coastal lagoons, and (2) the vegetation that covers such sandbanks and the coastal plains. The *restinga* vegetation is a mosaic of plant associations with diverse physiognomies typical to sandy beach ridges. It varies from sparse open plant communities, such as

herbaceous and shrub formations (“open *restinga*”), occurring upon Holocene deposits nearer to the sea, to dense evergreen forest (“*restinga* forest”), occurring generally upon Pleistocene deposits inland (Araujo and Henriques, 1984; Araujo et al., 2009). Open *restinga* and *restinga* forest elements are the major components in all *sambaquis* charcoal records, indicating that most of the firewood was gathered locally (Scheel-Ybert, 2000, 2001; Scheel-Ybert and Dias, 2007; Scheel-Ybert et al., 2003; Bianchini et al., 2011).

The *sambaqui* builders’ territory also included the adjacent hills and valleys farther inland, where the Atlantic Rain Forest thrived. From the forest, they would fetch selected wood species and possibly other special resources. Depending on the site, firewood and other resources were also gathered from mangroves by the edges of lagoons and rivers (Scheel-Ybert, 2000, 2001; Scheel-Ybert et al., 2003, 2009a; Scheel-Ybert and Dias, 2007; Bianchini et al., 2011).

Charcoal assemblages of each studied site did not change significantly over the several centuries or even millennia of occupation. In the Southeastern coast, climatic oscillations recorded by the mangrove vegetation and corroborated by other palaeoenvironmental studies point to alternating episodes of increased humidity and dryness between c. 5500 and 2000 cal yrs BP, but they did not affect the composition of the *restinga* vegetation (Scheel-Ybert, 2000).

The predictability of this steady and resilient ecosystem may have been one of the key factors for the maintenance of this cultural system for such a long time. However, it does not mean people were living in a stationary or fixed environment, for many changes took place during the seven millennia or more of *sambaqui* occupation, involving multiple geomorphological, climatic, phytosociological, and anthropogenic processes.

Firstly, Holocene sea-level variations are key to understanding the coastal landscape. In the Southern-Southeastern coast, it is well documented that the sea was much lower during the Pleistocene; it was more than 100 m below the present level during the last glacial maximum (c. 18 kys BP), which means several tens or even hundreds of kilometers of continental platform were exposed. After that, the sea rose gradually until it overtook the present level around 7000 yrs BP, reached its highest level (c. 2.5 m above the present) around 5500/5000 yrs BP, and then fell back to the present level (Correa, 1996; Angulo et al., 2006; Castro et al., 2014). When the sea level was higher, the coastline was much farther inland and a large system of palaeolagoons existed. As it retreated, these lagoons gradually dried up. Then, through a period of changing landscapes including processes of partial isolation of water bodies by deposition of sandy barriers or submersion of pre-existing dissection valleys, a new lagoonal system was established closer to the present coastline (Martin et al., 2003).

Throughout this process, the *restinga* ecosystem thrived. Open *restinga* formations colonized recently deposited sandy sediments. The drying palaeolagoons were gradually occupied by herbaceous marsh vegetation, adapted to humid brackish soils in process of stabilization; this was eventually followed by the establishment of the *restinga* forest. This scenario is supported by both anthracological and micro-archaeobotanical results (Scheel-Ybert, 2000; Pereira, 2013).

Despite these seemingly dramatic changes, all these processes were gradual. Therefore, from the viewpoint of the people living there, the coastal landscape was, in a way, very conservative. While the coastal plain underwent constant remodeling processes, the vegetation was structurally stable. In other words, although this dynamic environment changed all the time, the nature of the landscape remained the same.

Secondly, another point to consider is that quite large sedentary human groups dwelled along the coast for thousands of years and engaged in food production activities (cf. Scheel-Ybert et al., 2003; Boyadjian et al., 2016a, 2016b; Scheel-Ybert, 2018; Pezo-Lanfranco et al., 2018). Cultivation leads to the creation of anthropogenic environments, stimulating the introduction of foreign plants and management of native ones. The combination of anthracological, phytosociological, and ethnobotanical data provide indications of landscape

domestication – a concept that is understood here as “the process by which human manipulation results in changes in landscape ecology and in the demographics of its plant and animal populations, resulting in a landscape more productive and congenial for humans” (Clement, 1999: 190).

For instance, *Sideroxylon obtusifolium* (Sapotaceae) charcoal is prevalent in many Southeastern sites. These shrubs/trees are relatively common in the extant *restinga*, but a remarkable feature is that they frequently grow upon or around the shellmounds themselves, to the point of being considered as “mound-markers”. This association attests to a long-standing relationship. Their importance in the past may be related to their edible fruits, medicinal properties, and/or good quality wood – which is presently praised by traditional fishermen and largely used for boat frames, repairs, and battens (Scheel-Ybert, 2001, 2018; Fonseca-Kruel et al., 2009).

Myrtaceae charcoal presents high diversity and is extremely prevalent, if not largely dominant, in the anthracological record of all sites studied heretofore, attesting to the high value of these plants (Scheel-Ybert, 2014, 2018). Bianchini (2008) suggested that *sambaqui* people might have fostered Myrtaceae plants in their surroundings. Presently, this family is among the most important in the extant *restinga* vegetation (e.g. Araujo and Henriques, 1984; Pereira and Assis, 2000; Araujo et al., 2009). Many phytosociological analyses carried out in Southern and Southeastern Brazil point to the dominance of Myrtaceae both in the number of species (c. 15–30% of the total) and in the number of individuals (c. 15–35% of the total) in forest and shrubby *restinga* formations (Scheel-Ybert, unpublished bibliographic survey). Ethnobotanical studies in *restinga* areas attest Myrtaceae is among the most important of plant families in all utility categories, documenting their importance as food, medicine, technology, and building material (Kelecom et al., 2002; Fonseca-Kruel and Peixoto, 2004; Fonseca-Kruel et al., 2009). The diversity and importance of their tasty and nutritional fruits are given prominence (Fonseca-Kruel and Peixoto, 2004). Myrtaceae is a large taxonomic group, but Kelecom and colleagues (2002) demonstrated that half of the species that they studied are presently used or useful, predominantly for food and medicine.

In Southeastern Brazil, a quantitative ethnobotanical/phytosociological study in a *restinga* forest pointed to the high importance of *S. obtusifolium* and of Myrtaceae species (among others) and demonstrated that the dominant species are those with the highest usage values (Fonseca-Kruel et al., 2009). Traditional fishing communities make intense use of *restinga* plants for food, medicine, wood, fibers, needles (to sew fishing nets), boats, utensils, and soap, among others. As an example, they produce fishing nets from palm (*Bactris setosa*) fibers that are said to last for 50 years or so (Fonseca-Kruel and Peixoto, 2004; Fonseca-Kruel et al., 2009).

The distribution and abundance of plant species in the *restinga* are certainly influenced by ecological and edaphic processes (Scheel-Ybert, 2000). Nevertheless, past usage patterns may have also defined the present vegetation structure. *Sambaqui* builders have employed countless plants for a variety of uses and may have deliberated or incidentally manipulated the environment in many ways, through management, displacement, and multiplication of chosen species. This might have not only involved the taxa mentioned above, but possibly several other useful plants, many of which are recorded in archaeobotanical analyses as well (Scheel-Ybert, 2000, 2013, 2018). Besides, they have altered their landscape through the creation of home gardens (Boyadjian et al., 2016a), and through the establishment of permanent settlements and monumental constructions. Human settlements induce the creation of areas of secondary vegetation that not only alter the natural environment but also tend to create meaningful spaces bearing social significance (Scheel-Ybert et al., 2016).

In Amazonia, the effects of past human intervention in the structuration of the present vegetation and the formation of anthropogenic forests is well documented (e.g. Denevan, 1992; Balée and Erickson, 2006; Clement and Junqueira, 2010; Arroyo-Kalin, 2016). Recent

studies have attributed species hyperdominance to pre-1492 human management/cultivation practices which resulted in the creation of oligarchic forests dominated by useful trees (Ter Steege et al., 2013; Levis et al., 2017). We believe that similar processes may have operated in coastal Brazil. However, further studies are still necessary to investigate whether, or to what extent, the *restinga* vegetation has been durably modified by human agency.

#### 4. Food plants

Food plants have been documented in different contexts from Southern/Southeastern *sambaquis* (Table 1).

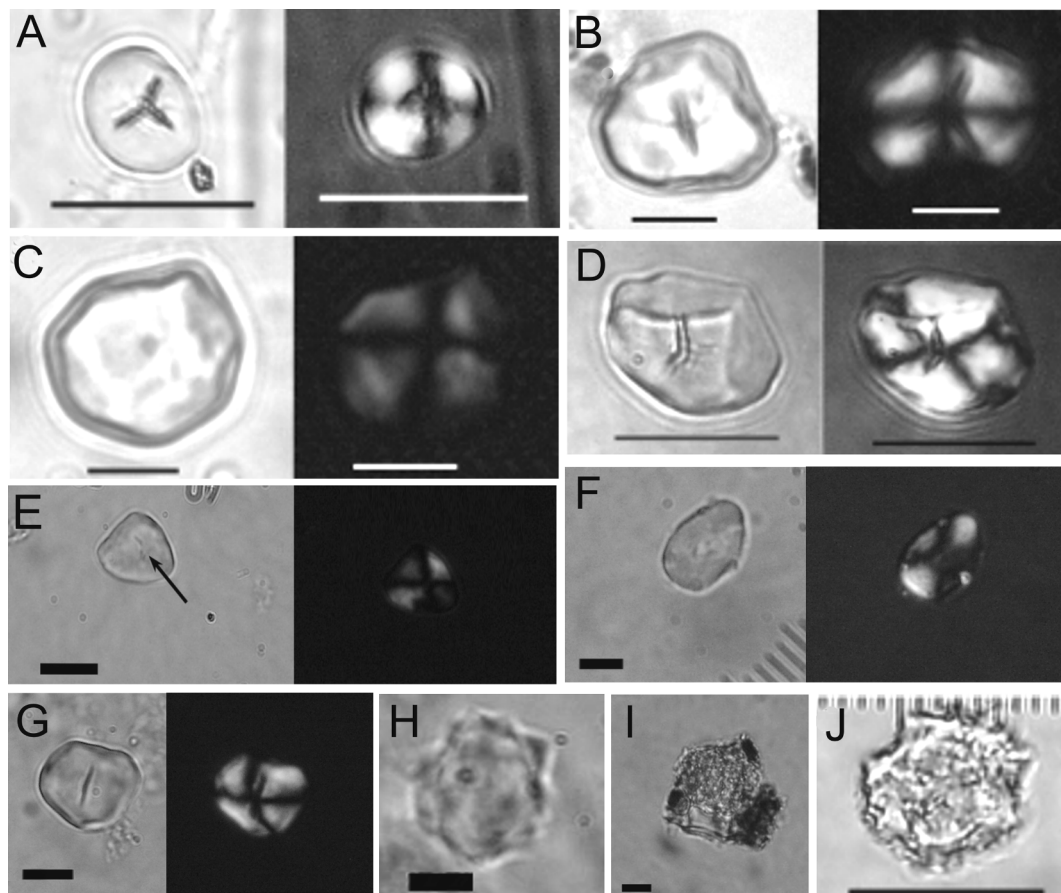
Microarchaeobotanical studies in dental calculus have provided essential direct evidence to these people's diet. A great diversity of phytoliths and starch grains, some of the latter modified (which points to cooking or processing), were documented in human dental remains from *sambaquis* of the Babitonga Bay: Morro do Ouro (4030 ± 40 yrs BP or 4511–4243 cal yrs BP), Forte Marechal Luz (1110 ± 100 to 850 ± 100 yrs BP or 1258–762 to 924–563 cal yrs BP), Enseada (1390 ± 40 yrs BP or 1282–1093 cal yrs BP), and Itacoara (550 ± 55 yrs BP/TL) (Wesolowski, 2007; Wesolowski et al., 2010). Sweet potato (*Ipomoea batatas*), Araceae (the taro family), and Poaceae (grasses) remains occur in all sites; yam (*Dioscorea* sp.), palms, and Araucaria pine nuts (*Araucaria angustifolia*) in most of them; and possibly Marantaceae (the arrowroot and leren family) and bromeliads in some. Possible maize (*Zea mays*) remains were found in the more recent sites, Enseada and Itacoara (Fig. 3).

Boyadjian and colleagues (2016a, 2016b) had similar results from the Jabuticabeira-II shellmound (Santa Marta region, 2880 ± 75 to

1805 ± 65 yrs BP or 3163–2779 to 1832–1537 cal yrs BP). More than 30 starch grains and phytolith morphotypes were identified from human teeth, among them sweet potato, yams, leren, Myrtaceae (possibly Surinam cherry), Araceae, palms, and maize, attesting to a very diversified diet (Fig. 3). Damaged starches indicated food processing. Grass phytoliths suggest grass leaves might be used for non-food purposes or as kindling. Microcharcoal remains were associated with the roasting of tubers in open hearths or earth ovens. Lacustrine diatoms reasserted the use of lagoonal resources.

The few systematic studies concerning plant macroremains were based upon charred material. In Southeastern Brazil (Lagos region), evidence of food plants was found within all the archaeological levels of *sambaquis* Forte, Salinas Peroano, Boca da Barra, Ponta da Cabeça, Beirada, and Pontinha (dated from 6190–5760 to 1380–1180 cal yrs BP), each of them commencing at the beginning of the occupation. Palm nuts, mostly from *Syagrus* sp., are by far the most abundant plant remains from these sites. *Dioscorea* sp. (yam) tuber remains, along with different morphotypes of monocotyledonous tubers and seeds were also retrieved (Scheel-Ybert, 2001, 2013). Yams appear for the first time in *sambaqui* do Forte at 4910 ± 55 yrs BP (5720–5480 cal yrs BP); that is, to our knowledge, the earliest record of the use of yam in South America to date.

Charred plant remains were also documented in the southern *sambaqui* Jabuticabeira-II, on a funerary context dated at 2880 ± 80 yrs BP (3048–2694 cal yrs BP). Among them, *Cucurbita* (squash), Myrtaceae (the guava/surinam cherry family), and Annonaceae (the sweetsop family) seeds, as well as palm nuts (*Syagrus* sp., *Butia* sp.) were identified (Fig. 4). These remains were interpreted as funerary offerings, but they



**Fig. 3.** Examples of microremains retrieved from Brazilian Southern and Southeastern shellmounds. (A): *Zea mays*/maize starch grain; (B) *Ipomoea batatas*/sweet potato starch grain; (C) Araceae (taro family) starch grain; (D) Araucaria pine nuts starch grain; (E) *Dioscorea* starch grain; (F) *Eugenia*/Surinam cherry seed starch grain; (G) Poaceae starch grain; (H) Araceae/palm phytolith; (I) *Calathea* rhizome phytolith; (J) cf. Marantaceae phytolith (A-D,J: Wesolowski, 2007 – A,D: Enseada; B,C,J: Forte Marechal Luz; E-I: Boyadjian, 2012 – sambaqui Jabuticabeira-II).

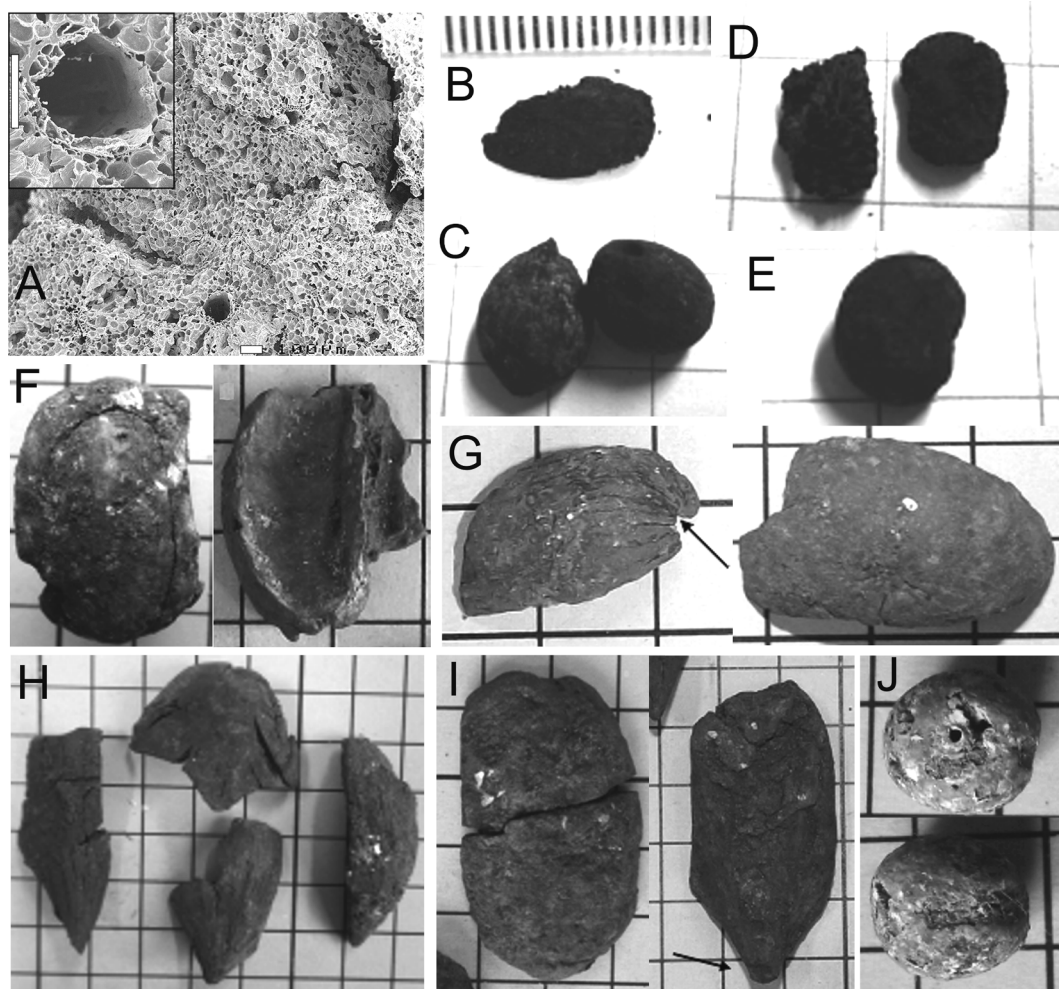


could also be related to ceremonial feasts (Bianchini and Scheel-Ybert, 2012).

Occasional uncharred remains also point to the importance of a large diversity of food plants (Fig. 4). Waterlogged fruits from Chrysobalanaceae (the coco-plum family), Humiriaceae (*Sacoglottis*/axuá), Lecythidaceae (cf. *Lecythis pisonis*/monkey pot), Myrtaceae (cf. *Psidium*/guava), and palms (*Acrocomia* sp., *Astrocaryum* sp., *Attalea* sp., *Bactris* spp., *Euterpe* sp., *Syagrus* sp.) were recorded in Sernambetiba site (Guanabara bay) and dated to  $1920 \pm 70$  yrs BP (2000–1616 cal yrs BP) (Heredia and Beltrão, 1980; Farias and Scheel-Ybert, 2012). Desiccated and charred remains from Myrtaceae (*Psidium* sp., *Eugenia* sp.) and palms (*Astrocaryum* sp., *Bactris* sp.) were reported in Corodó site (Cabo Frio region,  $4260 \pm 65$  to  $3010 \pm 80$  yrs BP or 4865–4529 to

3346–2921 cal yrs BP) (Carvalho, 1984).

There is therefore strong evidence of the use of various wild and domesticated food plants, besides many as yet unidentified micro- and macroremains (Table 1). Botanical macroremains, only retrieved charred or from rare sites that exhibit special conditions of preservation (such as waterlogged contexts), are never abundant, but indubitably constitute a significant part of the archaeological record. Considering the many biases in the preservation of plant remains, archaeobotanical findings in *sambaquis* are particularly diversified and extremely relevant. They attest that wild and domesticated plants were widely used and contributed on a large scale to these people's subsistence and rituals.



**Fig. 4.** Examples of macroremains retrieved from Brazilian Southern and Southeastern shellmounds. (A): *Dioscorea* tuber (SEM image); (B) Cucurbitaceae seed; (C) *Syagrus* sp. (Palmae) endocarp; (D) Annonaceae (cf. *Rollinia* sp.) seeds; (E) Myrtaceae seed; (F) *Sacoglottis* sp. seeds; (G) *Astrocaryum* sp. endocarps; (H) *Attalea* sp. endocarps; (I) Chrysobalanaceae seeds; (J) *Euterpe edulis* endocarps (A: Scheel-Ybert, 2001 – sambaqui do Forte; B-E: Bianchini and Scheel-Ybert, 2012 – sambaqui Jaboticabeira-II; F-J: Farias and Scheel-Ybert, 2012 – sambaqui Sernambetiba).

**Table 1**

Summary of the plant remains retrieved from Brazilian Southern and Southeastern shellmounds and mentioned in the text. The evidence/proxy, geographical region (numbered according to the codes for the *sambaqui* areas presented in Fig. 1), and chronology associated with each taxon are informed. The earliest context studied for archaeobotanical material is dated at 6190–5760 cal yrs BP; micro and macrobotanical plant remains (several of which unidentified) occur in all studied contexts.

Family	Species	Common name	Proxy	Site/region*	Chronology
<i>Domesticates/possible domesticates/exotic</i>					
Araceae	?	(the taro family)	Starch <sup>(1)</sup>	1	3163–2779 to 1832–1537 cal BP
	cf. <i>Alocasia</i>		Starch <sup>(2)</sup>	3	4511–4243 to 924–563 cal BP
Convolvulaceae	<i>Ipomoea batatas</i>	Sweet potato	Starch <sup>(1)</sup>	1	3163–2779 to 1832–1537 cal BP
			Starch <sup>(2)</sup>	3	4511–4243 to 1282–1093 cal BP
Cucurbitaceae	<i>Cucurbita</i> sp.	Squash	Charred seeds <sup>(3)</sup>	1	3048–2694 cal BP
Dioscoreaceae	<i>Dioscorea</i> sp.	Yam	Starch <sup>(1)</sup>	1	3163–2779 to 1832–1537 cal BP
			Starch <sup>(2)</sup>	3	4511–4243 cal BP
			Charred tubers <sup>(4)</sup>	8/9	5720–5480 to 1380–1180 cal BP
Marantaceae	cf. <i>Calathea</i> sp.	(Leren)	Phytolith <sup>(1)</sup>	1	3163–2779 to 1832–1537 cal BP
	?		Phytolith <sup>(2)</sup>	3	4511–4243 to 924–563 cal BP
Poaceae	<i>Zea mays</i>	Maize	Starch <sup>(1)</sup>	1	3163–2779 to 1832–1537 cal BP
			Starch <sup>(2)</sup>	3	1282–1093 to 924–563 cal BP
Araucariaceae	<i>Araucaria angustifolia</i>	Araucaria pine nuts	Starch, phytolith <sup>(2)</sup>	3	1258–762 to 924–563 cal BP
<i>Fruits/seeds (wild or managed)</i>					
Annonaceae	cf. <i>Rollinia</i>	(the sweetsop family)	Charred seeds <sup>(3)</sup>	1	3048–2694 cal BP
Myrtaceae	?	(consistent with Surinam cherry and related)	Charred seeds <sup>(3)</sup>	1	3048–2694 cal BP
	cf. <i>Eugenia</i>	(possibly Surinam cherry)	Starch <sup>(1)</sup>	1	3163–2779 to 1832–1537 cal BP
	<i>Eugenia</i> sp.	(Surinam cherry or related)	Desiccated/charred seeds <sup>(7)</sup>	9	4865–4529 to 3346–2921 cal BP
	cf. <i>Psidium</i>	(guava or related)	Waterlogged fruits <sup>(5)</sup>	7	2000–1616 cal BP
	<i>Psidium</i> sp.	(guava or related)	Desiccated/charred seeds <sup>(7)</sup>	9	4865–4529 to 3346–2921 cal BP
Chrysobalanaceae	?	(the coco-plum family)	Waterlogged fruits <sup>(6)</sup>	7	2000–1616 cal BP
Humiriaceae	<i>Sacoglottis</i> sp.	axuá	Waterlogged fruits <sup>(6)</sup>	7	
Lecythidaceae	cf. <i>Lecythis pisonis</i>	Monkey pot	Waterlogged fruits <sup>(5)</sup>	7	
Arecaceae	<i>Acrocomia</i> sp.	Palms	Waterlogged <sup>(5,6)</sup>	7	2000–1616 cal BP
	<i>Astrocaryum</i> sp.		Waterlogged <sup>(6)</sup>	7	2000–1616 cal BP
			Charred nuts <sup>(7)</sup>	9	4865–4529 to 3346–2921 cal BP
	<i>Attalea</i> sp.		Waterlogged <sup>(6)</sup>	7	2000–1616 cal BP
	<i>Bactris</i> spp.		Waterlogged <sup>(6)</sup>	7	2000–1616 cal BP
			Charred nuts <sup>(7)</sup>	9	4865–4529 to 3346–2921 cal BP
	<i>Butia</i> sp.		Charred nuts <sup>(3)</sup>	1	3048–2694 cal BP
	<i>Euterpe</i> sp.		Waterlogged <sup>(6)</sup>	7	2000–1616 cal BP
	<i>Syagrus</i> sp.		Charred nuts <sup>(3)</sup>	1	3048–2694 cal BP
			Waterlogged <sup>(6)</sup>	7	2000–1616 cal BP
			Charred nuts <sup>(4)</sup>	8/9	6190–5760 to 1380–1180 cal BP
	Unidentified palms		Phytolith <sup>(1)</sup>	1	3163–2779 to 1832–1537 cal BP
			Phytolith <sup>(2)</sup>	3	4511–4243 cal BP to 550 ± 55 BP
			Waterlogged <sup>(5)</sup>	7	2000–1616 cal BP
			Charred nuts <sup>(4)</sup>	8/9	6190–5760 to 1380–1180 cal BP
<i>Indeterminate/unconfirmed food items (tubers are probable food; bromeliads might be; grasses are probably not)</i>					
Poaceae	Panicoideae	Grasses	Phytolith, starch <sup>(1)</sup>	1	3163–2779 to 1832–1537 cal BP
	Pooideae				
	Chloridoideae				
	?		Phytolith <sup>(2)</sup>	3	4511–4243 to 924–563 cal BP
cf. Poaceae/ Cyperaceae	?	Tuber	Charred tuber <sup>(4)</sup>	9	1820–1570 cal BP
Bromeliaceae	?	Bromeliads	Phytolith <sup>(2)</sup>	3	4511–4243 to 924–563 cal BP
?	Unidentified tubers	Tubers	Charred tubers <sup>(4)</sup>	8/9	6190–5760 to 1380–1180 cal BP

\* Regions code numbers according to Fig. 1.

(1) Boyadjian et al. (2016a, 2016b).

(2) Wesolowski (2007); Wesolowski et al. (2010).

(3) Bianchini and Scheel-Ybert (2012).

(4) Scheel-Ybert (2001, 2013).

(5) Heredia and Beltrão (1980).

(6) Farias and Scheel-Ybert (2012).

(7) Carvalho (1984).

Of the plants described above, we believe that palms, Chrysobalanaceae, Humiriaceae, and Lecythidaceae species were probably wild, but may have been managed. Charred palm nuts stand out as the most frequent and the most diverse plant item in *sambaquis* along the entire Brazilian coast. They are repeatedly mentioned by archaeologists and are common on most sites from the earlier known occupations (cf. Scheel-Ybert et al., 2003; Scheel-Ybert, 2013, 2018). Palms are widely known for providing edible fruits and seeds that are tasty and rich in oils and carbohydrates; they also provide starch, buds (hearts of palm), fibers, leaves, thorns, and wood. Due to the multiplicity of the important resources that they offer, palms are high-value

plants for most neotropical traditional populations and indigenous groups. There is no doubt they were extremely important for *sambaqui* people as well, used both in domestic and ritual contexts.

*Araucaria angustifolia* is a native and major component of the mixed ombrophilous forest that only thrives in Southern Brazil in altitudes above 400–500 m. It is a heavily managed species of high importance to proto-Jê populations in the highlands. The mixed ombrophilous forest (or Araucaria forest) is considered to be an anthropogenic vegetation and as such part of a domesticated landscape (e.g. Copé, 2006; Bittencourt and Krauspenhar, 2006; Iriarte and Behling, 2007). This species could not occur naturally nor be cultivated near the coast. Its



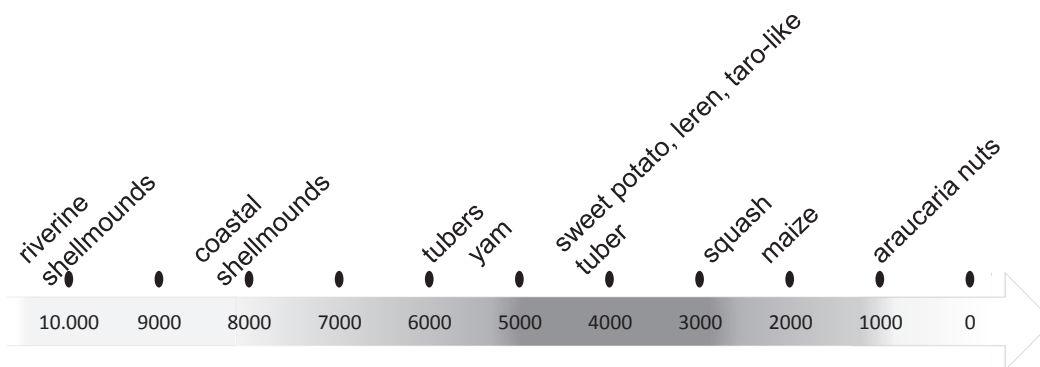


Fig. 5. Schematic timeline of archaeobotanical records in Brazilian Southern and Southeastern shellmounds. It shows the approximate time of the earliest records of riverine and coastal shellmounds and the earliest records of a selection of taxa, especially domesticates, possible domesticates, and exotic plant species (*Araucaria*). The darker shade in the arrow represents the period where these shellmounds are more frequent along the coast. The earliest site studied for archaeobotanical evidence is dated at c. 6000 cal yrs BP.

tasty and nutritious nuts were probably obtained from the highland populations – attesting, by these means, to intercultural contacts, interpopulational interactions, and exchanges (Wesolowski, 2007).

Annonaceae, Myrtaceae, Araceae, Dioscoreaceae, and Marantaceae families include both wild and domesticated species, yet we are unable to ascertain which ones, or if both, were used, especially because of the small samples that are available. Some of these remains may come from domesticates (especially *Dioscorea*/yam, *Calathea*/leren, and Araceae/‘taro’), but all those are large families in which many wild species may produce edible fruits/tubers. Therefore, even if some are domesticates, wild plants might also have been gathered, and possibly managed.

Sweet potato and squash are probably domesticated species, whilst maize is definitely domesticated. Wesolowski (2007) and Boyadjian and colleagues (2016a) proposed that, similarly to *Araucaria* pines, the presence of maize in *sambaquis* might result from exchanges with inland populations. However, the identification of maize remains in various sites from different regions suggests it is a part of this horticultural system and as such locally cultivated.

Although archaeologists frequently expect maize to be indicative of extensive agriculture, it is now recognized that it was largely used by generalist groups as well. After its domestication in Central America at c. 9000 yrs BP, maize rapidly spread across the continent, reaching Uruguay by at least 4500 yrs BP (Iriarte et al., 2004; Iriarte, 2007; Piperno et al., 2009). In many cases, it was not used as staple food, but mostly associated with recreational or religious consumption (Neves, 2019).

Thus, domesticates are recorded after c. 4000 cal yrs BP (sweet potato) or c. 3000–2000 cal yrs BP (squash, maize); possibly domesticated yams are present from at least 5500 cal yrs BP (Fig. 5, Table 1); many archaeobotanical remains are still unidentified. The accumulated evidence attests that various plant products were regularly consumed and used in ceremonial feasts. Vestiges of wild and domesticated plants retrieved in the same contexts, at different sites, and from different proxies suggest the practice of both plant gathering and horticulture concomitantly. The importance of a variety of tuberous species (yams, sweet potato, leren, some taro-related species, and several unidentified tubers) is documented from the earlier studied contexts (c. 6000 cal yrs BP), corroborating previous studies that demonstrate the major importance of root and tuber crops for tropical indigenous societies (Harlan, 1992; Piperno and Pearsall, 1998; Iriarte, 2007; Watling et al., 2018).

A much greater investment in archaeobotanical studies is still needed. Nevertheless, the diversity of plant micro- and macroremains and the evidence of consumption of both domesticated and wild plants by these groups consistently points to economic and subsistence spectra much larger than formerly believed. *Sambaqui* builders were not only foragers, nor were they strictly fishers, but rather they lived in a system

of mixed economy, where fishing and gathering were associated with horticulture (Boyadjian et al., 2016a).

## 5. Discussion

The picture that emerges from archaeobotanical research is that coastal Brazilian populations, far from depending essentially on fishing and mollusk gathering, greatly relied on plant gathering and gardening to assure both their basic subsistence and the performance of elaborated feasts and mortuary rites. In addition to the construction of monumental shellmounds that permanently and profoundly transformed the landscape, these people probably modified their landscape persistently in more subtle ways: through the establishment of permanent settlements, the creation of home gardens, and the manipulation of wild and domesticated plants. Activities such as tending wild plants to increase their production; deliberately carrying fruits/seeds, cuttings or rootstocks to place plants nearer to where they were required; deliberately or unintentionally discarding wild seeds near their homes, at campsites or along their paths; exchanging fruits and plants from their gardens; and many others, have been repeated for generations over thousands of years and have possibly left traces in the environment.

The practice of horticulture by these populations was first suggested in the early 2000s, through the combination of archaeological, palaeoepitaphological, and lithic industry data from Southern/Southeastern sites (Scheel-Ybert et al., 2003). Later, microarchaeobotanical data strengthened this claim (Wesolowski, 2007; Boyadjian, 2007, 2012; Wesolowski et al., 2010). Yet, in spite of numerous lines of evidence, remains of starchy plants and domesticates in these shellmounds have frequently been treated either as episodic findings (if not “anomalous” or “uncertain”), as fruits of exchanges with “more developed” agriculturalist societies or as evidence of “incipient forms of tending and harvesting” (cf. Wesolowski, 2007; Bianchini and Scheel-Ybert, 2012; Gaspar, 2014). Subsidiary to these interpretations is the idea that we did not have enough information to demonstrate, or even to verify, a possible transition between foraging and agriculture.

The mere idea of cultivation among *sambaqui* builders is most controversial. Low caries prevalence, traditionally found among these people, have always been related to the consumption of low carbohydrates, and therefore to foraging (Mendonça de Souza, 1995). However, high levels of dental caries and evidence of carbohydrate-rich diets were occasionally documented (Messias, 1977; Wesolowski, 2007; Pezo-Lanfranco et al., 2018). Central to the problem is the conceptual dichotomy in which past human societies must be categorized as either hunter-gatherers or agriculturalists, with no intervening options, that has been almost unrestrictedly applied in previous studies.

Recently, Boyadjian and colleagues (2016a) proposed that *sambaqui* builders lived in a system of mixed economy, opening the debate that

situates these populations as middle ground societies engaged in low-impact food production with domesticates. They were followed by Pezo-Lanfranco and colleagues (2018), who presented oral pathology and stable isotope evidence for carbohydrate-rich diets in Southern sites from the Babitonga Bay dated to ca 4500 cal BP and proposed that the studied populations subsisted on a mixed economy.

We now know that long-term nonagricultural societies that practiced food production at some level existed over long time periods. They were not simply extensions of hunter-gatherers, nor a brief transitional phase between two steady states, nor an incipient lead up to full agriculture. Conversely, they represent a rich and diverse array of extremely variable, successful long-term sociopolitical-economical solutions, fine-tuned to a wide range of cultural and environmental contexts (Smith, 2001).

Many low-impact food production societies are found in coastal areas, for instance, in the American Northwest Coast (Deur, 2002), the Southern Gulf Coast Lowlands of Mexico (VanDerwarker and Kruger, 2012; Killion, 2013), coastal Ecuador, coastal Peru (Pearsall, 1995, 2003, 2009), and the central (Shady et al., 2001; Shady, 2014) and southern coasts of Peru (Moseley, 1975; Beresford-Jones et al., 2018).

Middle ground societies were also identified in several eastern South American contexts. In southeastern Uruguay, coastal earthmound complexes dating from c. 5000–2700 cal yrs BP provided evidence of sedentary people who subsisted on a mixed economy and adopted major crop plants long before previously thought; micro-archaeobotanical analyses documented plants such as maize, squash, palms, beans, and achira (Iriarte et al., 2004).

Amazonian riverine shellmounds were also associated with mixed subsistence strategies. In southwestern Amazonia, maize and squash were recorded from at least 5300 cal yrs BP onwards, along with wild resources such as palms, soursop (*Annona* sp.), and wild rice; the domestication of *Oryza* sp. wild rice was documented at approximately 4000 cal yrs BP (Hilbert et al., 2017). In eastern Amazonia (Marajó island), maize and squash were documented from c. 4400 cal yrs BP (Hilbert, 2017).

A site bearing Amazonian Dark Earth contexts in southwestern Amazonia provided evidence of early food production and landscape domestication dating from at least c. 6500–5500 cal yrs BP. Phytoliths and macrobotanical analyses recorded domesticates such as manioc, squash, beans, and possibly leren, alongside wild fruits such as pequiá, guava, and Brazil nuts (Watling et al., 2018).

Later populations have also been involved in mixed economic systems, such as ceramists from Central Amazonia (Caromano et al., 2013) and from the southern Brazilian highlands (Corteletti et al., 2015), respectively dated to c. 2250–400 and c. 1650–250 cal yrs BP.

Therefore, it seems that Southern/Southeastern Brazilian coastal *sambaqui* populations were engaged in a pattern of food production that was widespread in the South American lowlands and beyond during the Holocene. They were not “incipient agriculturalists” nor “complex hunter-gatherers”, but they made use of wild and domesticated environmental resources by their own measure. Archaeological research attests that *sambaqui* builders exhibited sedentary residence, population growth, large communities, and monumental constructions in what seems to have been a heterarchical society that persisted for thousands of years (cf. DeBlasis et al., 2007; Fish et al., 2013; Kneip et al., 2018). Archaeobotanical research completes this picture by demonstrating that people were closely interacting with the landscape and constantly changing it in subtle but decisive ways that may have influenced the vegetation until the present day.

It becomes clear by now that these *sambaqui* builders were not merely “people of the lagoon” nor did they have a primarily aquatic territory, as previously proposed (Kneip et al., 2018; Gaspar et al., 2019). Rather, they were “people of the *restinga*”. Restricting the importance of their territory to its aquatic portion means falling once again into the trap of overestimating the value of more visible and better preserved archaeological remains (fish bones, shells, etc.) and of

supposedly masculine activities (fishing, canoeing, etc.) over the poorly preserved plant remains and the myriad of other activities performed daily upon the land. Lagoons and similar waterbodies, with their surroundings, have certainly been the focus of their settlement system while also being essential vectors of social networking. Nonetheless, they are intrinsic parts of a larger environmental context, the *restinga* ecosystem, in which *sambaqui* people were actually thriving. And it was the *restinga* that defined *sambaqui* territory and landscape and was at the center of the social sphere and subsistence activities.

The various facies of the *restinga* ecosystem provided most of the wild plants used by *sambaqui* builders with a variety of purposes, such as food, condiments, medicine, mystical/religious, hallucinogen, technology (such as dyes or soap), tools, timber, firewood, and others. Some of these plants might have been regularly displaced nearer to their dwellings, to be cultivated along local paths or in home gardens. Home gardens would also contain exotic and domesticated plants, acquired by exchange or through heritage. Perhaps they also comprised some beautiful/pleasant species. The cultivated plants were not all domesticated, but they were all equally nurtured and cared for. As argued by Hastorf (1998) and Descola (2016), for most Amerindian traditional societies, plants were/are not just useful, they are kin.

Environmental manipulation and plant experimentation were constantly performed by women and men that sought to improve their diet, health, technological resources, and way of life. At most times and in most places, however, it was almost certainly women who were not only collecting and cultivating plants, but also actively channeling the consumption of food in their households (Hastorf, 1998; Descola, 2016). The role of women among *sambaqui* people, therefore, deserves to be reconsidered.

For many traditional societies, especially in lowland South America, plants are part of the family – they represent lineages and define clan identities (Hastorf, 1998; Descola, 2016). They are also essential actors in social life and ritual. Feasts play a central part in the *sambaqui* social dynamics. While the importance of fish in these ceremonies is indisputable (Klokler, 2017; Klokler et al., 2018), plants have certainly played a prominent role as well, as archaeobotanical studies have already pointed out (Bianchini and Scheel-Ybert, 2012). Plants provided the firewood that fueled food preparation and ritual fires, but above all plant foods were actively consumed, either fresh, in special preparations, or in fermented beverages.

Feasts and mortuary rituals were the occasions to ceremonially share plant and animal foods. However, food sharing might also occur in the domestic sphere, through foodstuffs given as gifts or exchanged between neighbors or with members of other communities, or through the exchange of food plants in the form of seeds, cuttings or rootstocks. In many ways, group relations and social networks were marked by solidarity and cooperation, and not competition, from the construction and maintenance of the sites themselves to the sharing of food.

## 6. Conclusions

Extensive and solid data point to the importance of plants, to food production, and to the central role of the *restinga* in *sambaqui* people's way of life, especially in the Southern/Southeastern Brazilian coast. *Sambaquis*, and the landscape in which they are situated, associated with the *restinga* environment, are the result of intense social processes that produced a highly domesticated landscape, marked by cognitive, sensorial, sentimental, and emotional references.

Over thousands of years, people moved along the coast between the land and the water, lived in organized settlements, constructed impressive mounds, performed elaborate ceremonies and feasts, walked and canoed from one place to another, produced various artifacts from stone, wood and more, made large fires, gathered multiple resources, fished, hunted, managed and cultivated plants. Meanwhile, they modified and signified the landscape. The dynamic *restinga* environment, its sands, soils, waters, and plants, established the territories in which this

remarkable society developed.

Plants are part of this history. As such, their importance must be reinstated as central to all aspects of *sambaqui* people's life, not only on the domestic and economic levels, but also with regard to ceremony, religion, society, and politics.

#### CRedit authorship contribution statement

**Rita Scheel-Ybert:** Conceptualization, Methodology, Investigation, Funding acquisition. **Célia Boyadjian:** Methodology, Investigation.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Acknowledgments

We thank Andrew Wyatt for inviting us to contribute to this special volume. We deeply acknowledge two anonymous reviewers and this volume guest editors for comments that much improved this paper. This work benefited from funding from the Coordination for the Improvement of Higher Education Personnel (CAPES), National Counsel of Technological and Scientific Development (CNPq), and Foundation Carlos Chagas Filho for Research Support of the State of Rio de Janeiro (FAPERJ). R. Scheel-Ybert is a CNPq fellowship holder and a Senior Scientist from FAPERJ.

#### References

- Angulo, R.J., Lessa, G.C., Souza, M.C., 2006. A critical review of mid- to late-Holocene sea-level fluctuations on the eastern Brazilian coastline. *Quaternary Sci. Rev.* 25, 486–506.
- Araujo, D.S.D., Henriques, R.P.B., 1984. Análise florística das restingas do Estado do Rio de Janeiro. In: Lacerda, L.D., Araujo, D.S.D., Cerqueira, R., Turcq, B. (Eds.), *Restingas: Origem, Estrutura, Processos*. Niterói, CEUFF, pp. 159–194.
- Araujo, D.S.D., Sá, C.F.C., Fontella-Pereira, J., Garcia, D.S., Ferreira, M.V., Paixão, R.J., Schneider, S.M., Fonseca-Kruel, V.S., 2009. Área de Proteção Ambiental de Massambaba, Rio de Janeiro: caracterização fitofisionômica e florística. *Rodriguésia* 60 (1), 67–96.
- Arroyo-Kalin, M., 2016. Landscaping, landscape legacies, and landesque capital in pre-Columbian Amazonia. In: Isendahl, C., Stump, D. (Eds.), *The Oxford Handbook of Historical Ecology and Applied Archaeology*. Oxford Univ. Press, Oxford, pp. 1–24.
- Balée, W., Erickson, C.L., 2006. *Time and Complexity in Historical Ecology*. Studies in the Neotropical Lowlands. Columbia Univ. Press, New York.
- Bandeira, A.M., 2011. O povoamento da América visto a partir dos sambaquis do litoral equatorial amazônico do Brasil. *FUMDHAMENTOS* 7, 430–468.
- Beresford-Jones, D., Pullen, A., Chacua, G., Cadwallader, L., García, M., Salvatierra, I., Whaley, O., Vásquez, V., Arce, S., Lane, K., French, C., 2018. Refining the maritime foundations of andean civilization: how plant fiber technology drove social complexity during the preceramic period. *J. Archaeological Method Theory* 25 (2), 393–425.
- Bianchini, G.F., 2008. Fogo e paisagem: evidências de práticas rituais e construção do ambiente a partir da análise antracológica de um sambaqui no litoral sul de Santa Catarina. unpublished M.Sc. dissertation. Rio de Janeiro: Museu Nacional, Universidade Federal do Rio de Janeiro.
- Bianchini, G.F., Scheel-Ybert, R., 2012. Plants in a funerary context at the Jabuticabeira-II shellmound (Santa Catarina, Brazil) – feasting or ritual offerings? In: Badal, E., Carrión, Y., Macías, M., Ntinou, M. (Eds.), *Wood and Charcoal: Evidence for Human and Natural History*. Valencia, Sagvintv Extra, pp. 253–258.
- Bianchini, G.F., Gaspar, M.D., DeBlasis, P., Scheel-Ybert, R., 2011. Processos de formação do sambaqui Jabuticabeira-II: interpretações através da análise estratigráfica de vestígios vegetais carbonizados. *Revista do Museu de Arqueologia e Etnologia, São Paulo* 21, 51–69.
- Bitencourt, A.L.V., Krauspenhar, P.M., 2006. Possible prehistoric anthropogenic effect on *Araucaria angustifolia* (Bert.) O. Kuntze expansion during the Late Holocene. *Revista Brasileira de Paleontologia* 9, 109–116.
- Boyadjian, C.H.C., 2007. Microfósseis contidos no cálculo dentário como evidência do uso de recursos vegetais nos sambaquis de Jabuticabeira II (SC) e Moraes (SP). unpublished M.Sc. dissertation. São Paulo: Universidade de São Paulo.
- Boyadjian, C.H.C., 2012. Identificação de microfósseis vegetais para a reconstrução de dieta sambaquieira. unpublished Ph.D. dissertation. São Paulo: Universidade de São Paulo.
- Boyadjian, C.H.C., Eggers, S., Reinhard, K.J., Scheel-Ybert, R., 2016a. Dieta no sambaqui Jabuticabeira-II (SC): Consumo de plantas revelado por microvestígios provenientes de cálculo dentário. *Cadernos do LEPAARQ* 13, 131–161.
- Boyadjian, C.H.C., Eggers, S., Scheel-Ybert, R., 2016b. Evidence of plant foods obtained from the dental calculus of individuals from a Brazilian shellmound. In: Hardy, K., Martens, L.K. (Eds.), *Wild Harvest: Plants in the Hominin and Pre-agrarian Human Worlds*. Oxbow books, Oxford, pp. 215–240.
- Calippo, F.R., 2008. Os sambaquis submersos do Baixo Vale do Ribeira. *Revista de Arqueologia Americana* 26, 153–172.
- Caromano, C.F., Cascon, L.M., Neves, E.G., Scheel-Ybert, R., 2013. Revealing fires and rich diets: macro-and micro-archaeobotanical analysis at the Hatahara Site, Central Amazonia. *Tipiti* 11 (2), 40–51.
- Carvalho, E.T., 1984. Estudo arqueológico do sítio Coronó. Missão 1978. *Boletim do Instituto de Arqueologia Brasileira, ser. Monografias*, 2, pp. 1–243.
- Castro, J.W.A., Suguio, K., Seoane, J.C.S., Cunha, A.M., Dias, F.F., 2014. Sea-level fluctuations and coastal evolution in the state of Rio de Janeiro, southeastern Brazil. *Anais da Academia Brasileira de Ciências* 86 (2), 671–683.
- Clement, C.R., 1999. 1492 and the loss of Amazonian crop genetic resources. I. The relation between domestication and human population decline. *Econ. Bot.* 53 (2), 188–202.
- Clement, C.R., Junqueira, A., 2010. Between a pristine myth and an impoverished future. *Biotropica* 42 (5), 534–536.
- Colonese, A.C., Collins, M., Lucquin, A., Eustace, M., Hancock, Y., Ponzoni, R.D.A.R., Mora, A., Smith, C., DeBlasis, P., Figuti, L., Wesolowski, V., Plens, C.R., Eggers, S., Fariás, D.S.E., Gledhill, A., Craig, O.E., 2014. Long-term resilience of late Holocene coastal subsistence system in southeastern South America. *PLoS ONE* 9 (4) e93854.
- Copé, S.M., 2006. Les grands constructeurs précoloniaux du sud Brésil: Etude de paysages archéologiques a Bom Jesus, Rio Grande do Sul, Brésil. unpublished Ph.D. dissertation. Paris: Paris I Panthéon-Sorbonne.
- Correa, I.C., 1996. Les variations du niveau de la mer durant les derniers 17.500 ans BP: L'exemple de la plate-forme continentale du Rio Grande do Sul, Brésil. *Mar. Geol.* 130, 163–178.
- Corteletti, R., Dickau, R., DeBlasis, P., Iriarte, J., 2015. Revisiting the economy and mobility of southern proto-Jê (Taquara-Itararé) groups in the southern Brazilian highlands: starch grain and phytoliths analyses from the Bonin site, Urubici, Brazil. *J. Archaeol. Sci.* 58, 46–61.
- De Masi, M.A.N., 2001. Pescadores coletores da costa sul do Brasil. *Pesquisas, ser. Antropologia* 57, 1–136.
- DeBlasis, P., Fish, S.K., Gaspar, M.D., Fish, P.R., 1998. Some references for the discussion of complexity among the sambaqui moundbuilders from the southern shores of Brazil. *Revista de Arqueologia Americana* 15, 75–105.
- DeBlasis, P., Kneip, A., Scheel-Ybert, R., Giannini, P.C., Gaspar, M.D., 2007. Sambaquis e Paisagem: Dinâmica natural e arqueologia regional no litoral do Sul do Brasil. *Arqueologia Suramericana* 3, 29–61.
- Denevan, W., 1992. The Pristine Myth: The Landscape of the Americas in 1492. *Ann. Assoc. Am. Geography* 82 (3), 369–385.
- Descola, P., 2016. Landscape as transfiguration. *Suomen antropologi* 41 (1), 3–14.
- Deur, D., 2002. Plant cultivation on the Northwest Coast: A reconsideration. *J. Cultural Geography* 19 (2), 9–35.
- Fariás, S.Q., Scheel-Ybert, R., 2012. Identificação de frutos e sementes do sambaqui Sernambetiba (Guanimirim, RJ): dieta e modos de vida de sambaquieiros do Recôncavo da Guanabara. unpublished report. Rio de Janeiro: CNPq/Museu Nacional, UFRJ.
- Figuti, L., 1993. O homem pré-histórico, o molusco e os sambaquis: considerações sobre a subsistência dos povos sambaquieiros. *Revista do Museu de Arqueologia e Etnologia, São Paulo* 3, 67–80.
- Figuti, L., Plens, C.R., DeBlasis, P., 2013. Small sambaquis and big chronologies: shell-mound building and hunter-gatherers in Neotropical highlands. *Radiocarbon* 55 (3), 1215–1221.
- Fish, P., Fish, S., DeBlasis, P., Gaspar, M.D., 2013. Monumental Shell Mounds as Persistent Places in Southern Coastal Brazil. In: Thompson, V.D., Waggoner, J.C. (orgs.) *The Archaeology and Historical Ecology of Small Scale Economies*. Gainesville: University Press of Florida, pp. 120–140.
- Fonseca-Kruel, V.S., Peixoto, A.L., 2004. Etnobotânica na Reserva Extrativista Marinha de Arraial do Cabo, RJ, Brasil. *Acta botânica brasileira* 18 (1), 177–190.
- Fonseca-Kruel, V.S., Araujo, D.S.D., Sá, C.F.C., Peixoto, A.L., 2009. Quantitative ethnobotany of a restinga forest fragment in Rio de Janeiro, Brazil. *Rodriguésia* 60 (1), 187–202.
- Gaspar, M.D., 1998. Considerations of the sambaquis of the Brazilian coast. *Antiquity* 72, 592–615.
- Gaspar, M.D., 2014. Sambaquis shell mounds. In: Smith, C. (Ed.), *Encyclopedia of Global Archaeology*. Springer, New York, pp. 6449–6454.
- Gaspar, M.D., Heilborn, M.L., Escorcio, E., 2011. A sociedade sambaquieira vista através de sexo e gênero. *Revista do Museu de Arqueologia e Etnologia, São Paulo* 21, 17–30.
- Gaspar, M.D., Klokler, D., Scheel-Ybert, R., Bianchini, G.F., 2013. Sambaqui de Amourins: mesmo sítio, perspectivas diferentes. *Arqueologia de um sambaqui 30 anos depois*. *Revista do Museu de Antropologia* 6, 7–20.
- Gaspar, M.D., Bianchini, G.F., Berredo, A.L., Lopes, M.S., 2019. A ocupação sambaquieira no entorno da Baía de Guanabara. *Revista de Arqueologia* 32 (2), 36–60.
- Harlan, J.R., 1992. *Crops and Man*, second ed. American Society of Agronomy, Madison.
- Harstorf, C.A., 1998. The cultural life of early domestic plant use. *Antiquity* 7 (2), 773–782.
- Heredia, O.R., Beltrão, M.C., 1980. Mariscadores e pescadores pré-históricos do litoral centro-sul brasileiro. *Pesquisas* 31, 101–119.
- Heredia, O.R., Tenório, M.C., Gaspar, M.D., Buarque, A., 1989. Environment exploitation by prehistorical population of Rio de Janeiro. In: Neves, C. (Ed.), *Coastlines of Brazil*. American Society of Civil Engineers, New York, pp. 230–239.
- Hilbert, L.M., 2017. Investigating Plant Management in the Monte Castelo (Rondônia-



- Brazil) and Tucumã (Pará-Brazil) Shell Mound Using Phytoliths Analysis. unpublished Ph.D. dissertation. Exeter: University of Exeter.
- Hilbert, L., Neves, E.G., Pugliese, F., Whitney, B.S., Shock, M., Veasey, E., Zimpel, C.A., Iriarte, J., 2017. Evidence for mid-Holocene rice domestication in the Americas. *Nat. Ecol. Evol.* 1 (11), 1693.
- Iriarte, J., 2007. New perspectives on plant domestication and the development of agriculture in the New World. In: Denham, T.P., Iriarte, J., Vrydaghs, L. (Eds.), *Rethinking Agriculture: Archaeological and Ethnoarchaeological Perspectives*. Routledge, New York, pp. 167–188.
- Iriarte, J., Behling, H., 2007. The expansion of Araucaria forest in the southern Brazilian highlands during the last 4000 years and its implications for the development of the Taquara/Itararé Tradition. *Environ. Archaeol.* 12 (2), 115–127.
- Iriarte, J., Holst, I., Marozzi, O., Listopad, C., Alonso, E., Rinderknecht, A., Montaña, J., 2004. Evidence for cultivar adoption and emerging complexity during the mid-Holocene in the La Plata basin. *Nature* 432, 614–617.
- Kelecom, A., Reis, G.L., Fervereiro, P.C.A., Silva, J.G., Santos, M.G., Mello, C.B., Gonzalez, M.S., Gouvea, R.C.S., Almeida, G.S.S., 2002. A multidisciplinary approach to the study of the fluminense vegetation. *Anais da Academia Brasileira de Ciências* 74 (1), 171–181.
- Killion, T., 2013. Nonagricultural cultivation and social complexity: the Olmec, their ancestors, and Mexico's southern Gulf Coast lowlands. *Curr. Anthropol.* 54 (5), 569–606.
- Klokler, D., 2017. Shelly coast: constructed seascapes in southern Brazil. *Hunter Gatherer Res.* 3 (1), 87–105.
- Klokler, D., Villagrán, X.S., Giannini, P.C., Peixoto, S., DeBlasis, P., 2010. Juntos na costa: zooarqueologia e geoarqueologia de sambaquis do litoral sul catarinense. *Revista do Museu de Arqueologia e Etnologia, São Paulo* 20, 53–75.
- Klokler, D., Gaspar, M.D., Scheel-Ybert, R., 2018. Why clam? Why clams? Shell Mound construction in Southern Brazil. *J. Archaeol. Sci.: Rep.* 20, 856–863.
- Kneip, A., Farias, D.S., DeBlasis, P., 2018. Longa duração e territorialidade da ocupação sambaquieira na laguna de Santa Marta, Santa Catarina. *Revista de Arqueologia* 31 (1), 25–51.
- Lessa, A., Gaspar, M.D., 2014. Estratégias de subsistência, complexidade social e violência entre grupos sambaquieiros do litoral brasileiro. In: Mazz, J.M.L., Berón, M.A. (Eds.), *Indicadores arqueológicos de violência, guerra y conflicto en Sudamérica*. CSIC/Universidad de la República, Montevideo, pp. 55–80.
- Levis, C., Costa, F.R.C., Bongers, F., and 150 more authors, 2017. Persistent effects of pre-Columbian plant domestication on Amazonian forest composition. *Science* 355(6328): 925–931.
- Lima, T.A., Mazz, J.M.L., 1999–2000. La emergencia de complejidad entre los cazadores recolectores de la costa atlántica meridional sudamericana. *Revista de Arqueologia Americana* 17 (18/19), 129–175.
- Martin, L., Dominguez, J.M.L., Bittencourt, A.C.S.P., 2003. Fluctuating Holocene Sea Levels in Eastern and Southeastern Brazil. *J. Coastal Res.* 19 (1), 101–124.
- Mendonça de Souza, S.M.F., 1995. Estresse, doença e adaptabilidade: estudo comparativo de dois grupos pré-históricos. unpublished Ph.D. dissertation. Rio de Janeiro: ENSP/FIOCRUZ.
- Messias, T.T., 1977. Estudo morfológico da população do Sambaqui do Forte. In: Kneip, L. M. (ed.) *Pescadores e coletores pré-históricos do litoral de Cabo Frio, RJ. Anexo C. Coleção Museu Paulista, sér. Arqueol.*, 5: 165–167.
- Moseley, M.E., 1975. *The Maritime Foundations of Andean Civilization*. Cummings Publishing Company, Menlo Park, CA.
- Neves, E.G., 2019. O rio Amazonas: fonte de diversidade. *Revista del Museo de La Plata* 4 (2), 385–400.
- Pearsall, D.M., 1995. Domestication and agriculture in the New World tropics. In: Price, T.D., Gebauer, A.B., (Eds.) *Last hunters, first farmers: new perspectives on the pre-historic transition to agriculture*. Santa Fe: School of American Research, pp. 157–192.
- Pearsall, D.M., 2003. Plant food resources of the Ecuadorian Formative: an overview and comparison to the Central Andes. In: Raymond, J.S., Burger, R.L. (Eds.), *Archaeology of Formative Ecuador: A Symposium at Dumbarton Oaks*. Dumbarton Oaks Research Library, Washington, DC, pp. 213–257.
- Pearsall, D.M., 2009. Investigating the transition to agriculture. *Curr. Anthropology* 50 (5), 609–613.
- Pereira, G.L., 2013. *Ocupação pré-histórica do litoral norte gaúcho: um olhar sobre o invisível*. unpublished M.Sc. dissertation. Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre.
- Pereira, O.J., Assis, A.M., 2000. Florística da restinga de Camburi, Vitória, ES. *Acta botanica brasílica* 14 (1), 99–111.
- Pezo-Lanfranco, L., Eggers, S., Petronilho, C., Toso, A., Bandeira, D.R., Von Tersch, M., Santos, A.M.P., Costa, B.R., Meyer, B., Colonese, A.C., 2018. Middle Holocene plant cultivation on the Atlantic Forest coast of Brazil? *R. Soc. Open Sci.* 5 (9) 180432.
- Piperno, D.R., Pearsall, D.M., 1998. *The Origins of Agriculture in the Lowland Neotropics*. Academic Press, San Diego.
- Piperno, D.R., Ranere, A.J., Holst, I., Iriarte, J., Dickau, R., 2009. Starch grain and phytolith evidence for early ninth millennium BP maize from the Central Balsas River Valley, Mexico. *Proc. Natl. Acad. Sci.* 106 (13), 5019–5024.
- Pugliese, F.A., Zimpel, C.A., Neves, E.G., 2018. What do Amazonian Shellmounds tell us about the long-term indigenous history of South America. In: Smith, C. (Ed.), *Encyclopedia of Global Archaeology*. Springer, New York.
- Scheel-Ybert, R., 2000. Vegetation stability in the Southeastern Brazilian coastal area from 5500–1400 yr BP deduced from charcoal analysis. *Rev. Palaeobot. Palynol.* 110, 111–138.
- Scheel-Ybert, R., 2001. Man and vegetation in the Southeastern Brazil during the Late Holocene. *J. Archaeol. Sci.* 28, 471–480.
- Scheel-Ybert, R., 2013. Preliminary data on nonwood plant remains at sambaquis from the Southern and Southeastern Brazilian coast: considerations on diet, ritual, and site particularities. *Cuadernos del Instituto Nacional de Antropología* 1, 60–72.
- Scheel-Ybert, R., 2014. Landscape and use of plants by Southern and Southeastern Brazilian shell mound builders. In: Roksandic, M., Mendonça de Souza, S.M.F., Eggers, S., Burchell, M., Klokler, D. (Eds.), *The Cultural Dynamics of Shell-matrix Sites*. University of New Mexico Press, Albuquerque, pp. 289–300.
- Scheel-Ybert, R., 2018. Landscape and plants use in Brazilian shell mounds. In: Smith, C. (Ed.), *Encyclopedia of Global Archaeology*. Springer, New York.
- Scheel-Ybert, R., Dias, O.F., 2007. Coronó: Palaeoenvironmental reconstruction and palaeoethnobotanical considerations in a probable locus of early plant cultivation (South-Eastern Brazil). *Environ. Archaeol.* 12, 129–138.
- Scheel-Ybert, R., Eggers, S., Wesolowski, V., Petronilho, C.C., Boyadjian, C.H.C., DeBlasis, P.A.D., Barbosa-Guimarães, M., Gaspar, M.D., 2003. Novas perspectivas na reconstituição do modo de vida dos sambaquieiros. *Revista de Arqueologia* 16 (1), 109–137.
- Scheel-Ybert, R., Bianchini, G.F., DeBlasis, P., 2009a. Registro de mangue em um sambaqui de pequeno porte do litoral sul de Santa Catarina, Brasil, a cerca de 4900 anos cal yrs BP, e considerações sobre o processo de ocupação do sítio Encantada-III. *Revista do Museu de Arqueologia e Etnologia, São Paulo* 19, 103–118.
- Scheel-Ybert, R., Afonso, M.C., Barbosa-Guimarães, M., Gaspar, M.D., Ybert, J.P., 2009b. Considerações sobre o papel dos sambaquis como indicadores do nível do mar. *Quaternary Environ. Geosci.* 1 (1), 3–9.
- Scheel-Ybert, R., Caromano, C.F., Azevedo, L.W., 2016. Of forests and gardens: landscape, environment, and cultural choices in Amazonia, southeastern and southern Brazil from c. 3000 to 300 cal yrs BP. *Cadernos do LEPAARQ* 13 (25), 425–458.
- Scheel-Ybert, R., Rodrigues-Carvalho, C., DeBlasis, P., Gaspar, M., Klokler, D.M., 2020. Mudanças e permanências no Sambaqui de Cabeçada (Laguna, SC). *Revista de Arqueologia* 33 (1), 169–197.
- Shady, R.S., 2014. Caral: The sacred city. In: Smith, C. (Ed.), *Encyclopedia of Global Archaeology*. Springer, New York, pp. 1152–1156.
- Shady, R.S., Haas, J., Creamer, W., 2001. Dating Caral, a preceramic site in the Supe Valley on the central coast of Peru. *Science* 292 (5517), 723–726.
- Smith, B.D., 2001. Low-level food production. *J. Archaeol. Res.* 9 (1), 1–43.
- Ter Steege, H., Pitman, N.C., Sabatier, D., and 117 more authors, 2013. Hyperdominance in the Amazonian tree flora. *Science* 342(6156), 1243092.
- VanDerwarker, A.M., Kruger, R.P., 2012. Regional variation in the importance and uses of maize in the Early and Middle Formative Olmec heartland. *Latin American Antiquity* 23 (4), 509–532.
- Villagrán, X.S., Klokler, D.M., Nishida, P., Gaspar, M.D., DeBlasis, P., 2010. Lecturas estratigráficas: Arquitectura funerária y deposición de residuos en el Sambaquí Jabuticabeira II. *Latin American Antiquity* 21, 195–227.
- Watling, J., Shock, M.P., Mongeló, G.Z., Almeida, F.O., Kater, T., Oliveira, P.E., Neves, E.G., 2018. Direct archaeological evidence for Southwestern Amazonia as an early plant domestication and food production centre. *PLoS ONE* 13 (7), 1–28.
- Wesolowski, V., 2007. Cáries, desgaste, cálculos dentários e micro-resíduos da dieta entre grupos pré-históricos do litoral norte de Santa Catarina. unpublished Ph.D. dissertation. Rio de Janeiro. ENSP/FIOCRUZ.
- Wesolowski, V., Mendonça de Souza, S.M.F., Reinhard, K.J., Ceccantini, G., 2010. Evaluating microfossil content of dental calculus from Brazilian sambaquis. *J. Archaeol. Sci.* 37 (6), 1326–1338.