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Sambaquis from the Southern Brazilian Coast: Landscape Building and Enduring Heterarchical Societies throughout the Holocene

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Abstract: This paper presents a heterarchical model for the regional occupation of the *sambaqui* (shellmound) societies settled in the southern coast of Santa Catarina, Brazil. Interdisciplinary approaches articulate the geographical scope and environmental dynamics of the Quaternary with human occupation patterns that took place therein between the middle and late Holocene (approximately 7.5 to 1.5 ky BP). The *longue durée* perspective on natural and social processes, as well as landscape construction, evince stable, integrated, and territorially organized communities around the lagoon setting. Funerary patterns, as well as mound distribution in the landscape, indicate a rather equalitarian society, sharing the economic use of coastal resources in cooperative ways. This interpretation is reinforced by a common ideological background involving the cult of the ancestors, which seems widespread all over the southern Brazilian shores along that period of time. Such a long-lived cultural tradition has endured until the arrival of fully agricultural Je and Tupi speaking societies in the southern shores.

Keywords: sambaquis; shellmounds; heterarchy; southern Brazilian coast

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This paper presents a regional occupation model for the *sambaqui* (shellmound) societies settled in the southern coast of Santa Catarina, Brazil. In this peculiar lagoonal region, interdisciplinary approaches have focused on the geographical scope and environmental dynamics of the Quaternary, as well as on the human occupation patterns that took place in that peculiar coastal setting between the middle and late Holocene (approximately 7.5 to 1.5 ky BP). This brings an extensive time-length perspective on natural and social processes and landscape construction. Human occupation dynamics have revealed an enduring pattern of integrated and organized communities around a rich, patchy aquatic, and terrestrial territory [1–3].

Within that perspective, after summarizing the basic characteristics of the sambaqui cultural tradition, the central idea of this paper is to propose a heterarchical model of social evolution for this coastal-adapted culture. This model has been developed for the Santa Marta (Camacho) area, in the southern shores of Brazil, where the sambaqui settlement system greatly expanded between 6 and 3 ky cal BP approximately, when the construction of monumental sambaquis (or shellmounds) increased. To this day, these giant mounds that loom over extensive horizons in the open, flat surrounding landscape remain as remarkable and outstanding landmarks of that long-gone culture (Figure 1).

Figure 1. Large and outstanding sambaquis in the open coastal landscape from the Santa Marta/Camacho area, Santa Catarina, southern Brazil. Above, Figueirinha and Cigana; below, the twin-mounds Encantada I and II and Santa Marta I (photos Sambaquis and Paisagem Project, MAE-USP).

1. The Sambaquis

Sambaqui (from the native Tupi language, literally meaning "shellmound", or *conchero*) is an archaeological mounded site type found all over the Brazilian coast. They occupy mostly ecological patchy zones involving brackish waters, mangrove, and forests, clustering in lagoon, bay, and estuarine and coastal island areas [4–8] (Figure 2).

Figure 2. Brazilian coast showing locations where clusters of sambaquis have been described. The Santa Marta/Camacho (Santa Catarina) and Saquarema (Rio de Janeiro) research areas, cited in the text, are highlighted.

These sites achieve impressive dimensions especially in the southern Atlantic shores, where they may reach up to 70 m high and 500 m wide. It is also towards the southern shores that they reach larger aggregates, with hundreds of mounds clustered into the bay and estuarine and coastal island areas, ecologically diverse and very productive coastal niches.

As an example, a comparison among the two better studied areas, that is, along the Brazilian coast in the Santa Marta Bay area in Santa Catarina [1], and the Saquarema Lake district at the northern coast of Rio de Janeiro [9–11], is shown below. These areas display a very distinctive ratio of sites per area, 0.34 and 0.18, respectively, in similar proportions of firm ground and aquatic environments (Figure 3).

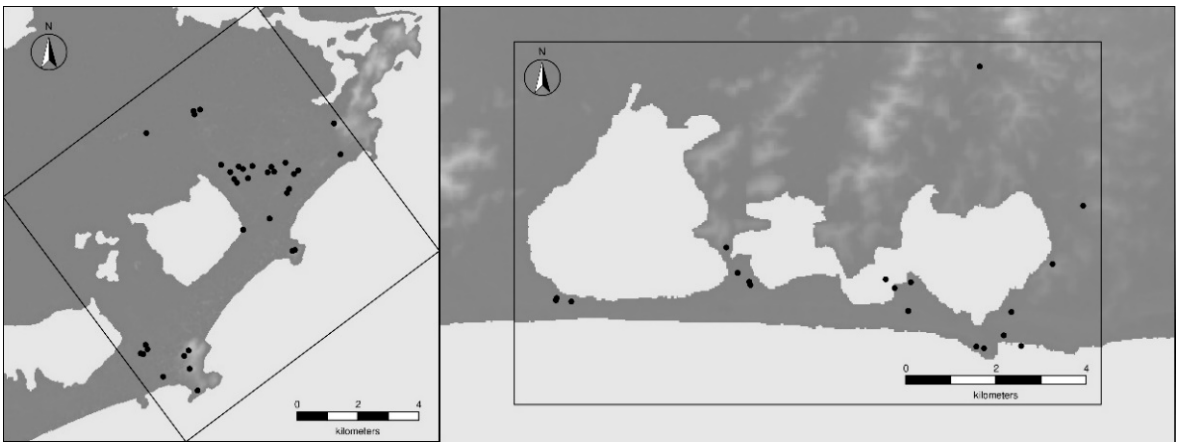

Figure 3. Santa Marta (on the left) and Saquarema Lake district mound clusters. Density has been calculated from a section of 104 km^2 encompassing as many sites as possible in both areas. In Santa Marta it covers 64% of land and 38% of water and accounts 35 sites, while in Saquarema, 57% of land and 43% water, 19 sites have been recorded.

Sambaquis, especially the bigger ones, typically exhibit heterogeneous stratigraphic sequences, with packs of light-colored shell interspersed with darker strata rich of organic materials. These last ones are composed mostly of charcoal, burnt fishbone, and smashed soft shell into a sandy substrate, and into them a variety of stone and bone tools can be found, and a great deal of fire-cracked rocks [12]. These dark layers frequently include as well abundant burial structures, configuring a sequence of specially prepared funerary areas located on former mound platform surfaces [13,14]. Eventually, from time to time, these funerary areas are closed and covered by packs of clean shell, setting the place for new burials, at a higher platform ground.

In fact, several burials, usually tightly flexed and disposed in shallow pits, are reported in most sambaqui descriptions. The dead are carefully, ceremonially lain down into these prepared places, accompanied by adornments and artifacts, food offerings, and hearths [7,15,16]. Remains of wooden tumular structures and palisades (postholes) have also been described [14,17]. In sum, most of the sambaquis, especially the large ones, are collective funerary structures (Figure 4).

In some excavated larger mounds, dozens of burials have been documented, such as Cabeçuda (337 individuals; [18–22]), Congonhas (22 individuals; [23]), Armação do Sul (86 burials, [24,25]), Jaboticabeira II (204 burials; [21,22,26,27]), and Morro do Ouro (some 100 burials; [28]). Several other mounds are reported as having a large number of burials, such as Carniça [29] and Jaboticabeira I [17], but they have never been studied or accounted properly. Small interventions (such as test-pits and small-scale profiling) at some mounds have disclosed a few burials, suggesting a much bigger number of them (e.g., [2,13,23,30], among many others).

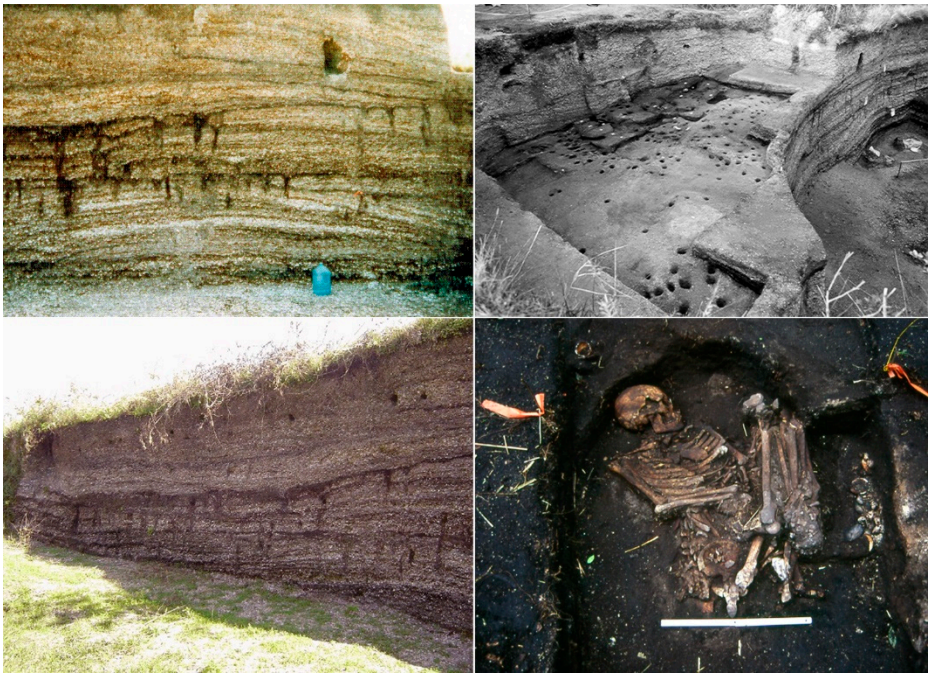

Figure 4. On the left, typical stratigraphic profiles from large mounds (sambaqui Jaboticabeira II). On the right, funerary area (above) and a single burial at the same site (photos Sambaquis and Paisagem Project, MAE-USP).

Habitation areas of the sambaqui people have never been acknowledged. Smaller mounds and other discreet features, without burials, often surround larger funerary mounds, but there is no undisputable evidence of habitational debris on them [1,31,32]. It might be that the bulk of debris from living areas located at the sandy terraces, not far from the mounds, has been remobilized into them, perhaps on a regular basis (funerary occasions, for instance). This behavior would generate low visibility for habitational contexts in such a plastic, unconsolidated environment, such as the discreet activity traces described by Attorre [33] surrounding larger mounds.

Moreover, there is very scanty evidence that moundbuilders might have lived on palafittes (stilt-houses), wooden constructions located in the shifting fringes of the ever-changing lake borders [34]. Such structures have been reported towards northern coastal lacustrine contexts, in the southeastern border of the Amazon area [35]. However, if such structures really existed along the southern shores, they have long disappeared due to Holocene dynamic coastal landscape reshaping by sea level fluctuations [3,36]. The chance of finding them seems very elusive, but some might have survived at low-energy filling-in patches of the old lagoon borders.

Though recognition and analysis of the relationship between sambaquis and the dynamic quaternary coastal environment appear in early studies, ecological approaches remain rare. Krone [37,38] and Guerra [39] pointed out the connection of older mounds to former coastal lines, as well as paleo beach strands which, sometimes, are located well back from the coast today. Hurt [29], Bigarella [40,41], Emperaire and Laming [42], and Kneip [43], among others, explored mound distribution as related to former regional landscapes, noting the significant difference between past and present coastline and island configurations along Holocene sea-level fluctuations and associated sedimentary processes [3,36].

Indeed, sambaqui chronology throughout the Brazilian coast [44] coincides with the maximum sea level oscillation and the following regressive processes, along the middle and lower Holocene (approx. 7000 to 1500 years BP). Nevertheless, as pointed out by Kneip et al. [1], the principal characteristics of the sambaqui culture (moundbuilding related to funerary activities, technological and stylistic patterns of lithic and bone industries, the

close connection to large bodies of water, among others) are already tied together in the oldest known sites (around 8 to 6 kya), strongly suggesting that it is a much older culture, probably deriving from coastal migrations by the end of the Pleistocene. Mounded sites even older than that have survived into inland riverine locations [45], but ancient coastal ones seem to have been mostly wiped out by coastline remodeling along the early and middle Holocene.

Bone and lithic technology is similar across the southern and southeastern coast, where cutting, carving, drilling, and polishing techniques have been used for manufacturing a variety of tools such as points, spatulas, and even sculpted effigies. The presence of spindle disks strongly suggests the practice of some kind of weaving among sambaqui societies. Several authors (e.g., [21,46–48]) point out that most burials of the southern shores have been tightly disposed, probably enveloped by some kind of tissue or straw mat (see [49] for evidence in another interesting Pacific coast context). This artefactual similarity reinforces the hypothesis of a common origin for these sambaqui societies from the southern and southwestern coast, and maybe also from the northern shores.

2. Theoretical Background

Shellmounds from the Brazilian coast have long been considered remains of successive campsite locations of mobile mollusk gathering and fishing bands [15,16,50]. Only recently have the sambaquis been recognized as intentionally constructed structures, full of symbolic signification to their builders [7,27,51]. Our first theoretical scenario for studying the sambaquis has been the debate concerning "complex hunter-gatherers", frequent in American archaeology since the 1980s ([52–55], among others). In a rather similar way to other Archaic coastal and lowland cultures all over Americas (e.g., [11,56,57], among others), DeBlasis et al. [2,58] and Gaspar [5,6] have argued that the sambaqui culture displays aspects of social and economic organization far more complex than formerly expected—sedentary life, expressive demography, and construction of monumental structures included.

Since the beginning, our investigations in the sambaquis from the southern shores have developed an adequate balance between understanding ecological and environmental factors, on one side, and sociocultural adaptation on the other. This perspective eventually evolved towards the understanding of demographic and economic intensification on coastal resources and the emergence of a long-lived integrative, heterarchical social organization around the lagoon and its ecological patches along the Holocene [1]. Indeed, gradually, the idea of "adapting to nature" has given place to the perception of the influence of cultural behavior as regards landscape constitution and shaping—that is, "adapting the nature" to human purposes (e.g., [59–61]). Ultimately, we have been committed to understanding the evolution of the landscape and social environment as a whole, integrated phenomena.

Most studies of Archaic and Formative societies link the development of social and economic complexity to the emergence of hierarchical social differentiation. This sort of evolutive thinking has been a kind of rule of thumb since the XIX century, becoming common sense after the influential models from the 1960s. Alternative perspectives on social evolution (e.g., [62]) argue that many past societies maintained and even expanded social organization without the emergence of structured or formal social stratification or any kind of statutory political leadership. Proposed models where politically equivalent communities share specific territories into a network structure are starting to appear (see 68 and 9 for examples in very different contexts). As we shall see in this paper, sambaqui societies from Brazilian southern Atlantic shores seem to provide a pretty good case for such an interpretive perspective.

This approach is not a new one. Indeed, the conception of "primitive communism", first elaborated by Engels [63], has gained wide influence on social sciences since the late 19th century. Throughout the 20th century, both European and American archaeologies have drawn deep into materialistic and techno-economical perspectives of investigation. In Latin America, a strong line of research in Social Archaeology has appeared and acquired wide influence, especially across Spanish-speaking research groups.

Some 20th century ethnographies of South American indigenous peoples argue that several societies from different environments developed mechanisms inhibiting aggrandizement and social differentiation based on the accumulation of material goods. In such societies, social prestige achieved by non-material means corresponds with individuals' social status, but do not imply in rigid hierarchical structuring (see, particularly, [64]). Viveiros de Castro [65–67] has noted a deep-rooted ecological worldview, characteristic of Amerindian societies, connecting culture and nature, including transfiguring, interchangeable perspectives across these worlds. Complementary, Vilaça [68], among others, has pointed out the deep connection of the living with the dead. Her study among the Wari people from southwestern Amazonia evinces how funerary events have this powerful capability of creating strong bounds among people from villages across a wide territory.

Following these lines, the model delineated further on in this paper can be summarized by this: Initial communities spread all over the area, always keeping close contact among themselves. Working in cooperative ways, they expand demographically and intensify the management of the landscape. Local community identities, probably based on familiar bonds (tribes or tribelets) remain strong, expressed as they are in the architecture of the mounds. This thriving expansion, in due time, develops new systems of social organization at a regional scope, with the development of an overall religious ideology regulating and mediating relationships among communities. Apparently, this religious apparel has never acquired a structured political dimension; sambaqui communities remain integrated in a rather equalitarian, heterarchical way.

Thus, this paper makes a case for the sambaqui societies of the southern Brazilian coast, focusing on moundbuilders' heterarchical behavioral patterns. Available economical, ideological, and organizational evidence for it is summarized below, in order to contextualize the sambaqui society's endurance in living into these affluent coastal settings throughout several millennia. As most of the information herein discussed comes from the southern Santa Catarina coast, natural characteristics and ecological changes of the shoreline environment of this area throughout the Holocene are also shortly reviewed below.

3. The Research Area and Methodological Approaches

The Santa Marta lagoon area, in the southern shores of Brazil, Santa Catarina State (Figure 2, detail), encompasses an expansive, mostly flat, and open lagoonal system infilled with recent (quaternary) sedimentary deposits. Interspersed rocky promontories and small isolated outcrops, that once formed a string of islands at the mouth of an open bay, today anchor elongated sand strips and dune fields enclosing several lakes of brackish water. Canals connect these remnant lakes throughout this complex and dynamic mosaic of inter-related marine, lagoon, and aeolian deposits, where the Tubarão river, running from the scarped mountains at the hinterland, configures one of the largest inner deltas of the world [12,69–71].

Early Holocene sea-level rise drowned older marine terraces and dune formations before stabilizing ca. 5.7 ky ago [36]. The slow and regular lowering of the sea level since the middle Holocene has allowed the development of sandy barriers that gradually isolated the former bay area into the almost closed lagoon system we see today [2,3,43]. Open dune fields frequently intersperse with archaeological deposits, creating intricate depositional contexts.

This area displays a large aggregate of sambaquis, reinforcing the perception that great and productive bodies of brackish water are fundamental environmental references for the adaptive patterns of sambaqui communities [6,7]. Indeed, this open and mostly flat landscape congregates nearby environments including shallow aquatic settings, mangrove, and rain forest patches on the fringe of surrounding hills, making it truly an ecological (sub) tropical paradise, with abundant and diversified resources from sea and ground.

Minor climatic oscillations along the middle and recent Holocene, particularly as regards humidity, temperature, and water salinity [72–74], have made of it an ever-changing scenario, especially in terms of the small-scale distribution of vegetation patches (such

as mangrove) and spots of fish and shellfish concentration. In spite of these variations, landscape structural and environmental characteristics have changed at a rather moderate pace and scale, providing stable and reliable conditions for human adaptation.

Into such a very productive landscape, as well as at several others along the Atlantic Brazilian coast (see Figure 2), sambaqui-making people clustered and built mounds over many millennia [4,15,16,44,75]. This southern area has been chosen as strategical for archaeological research due to its optimal combination of environmental diversity and the presence of a large number of mounds still preserved, including some of the biggest ever recorded anywhere in the world.

Since the middle 1990s, our research group has systematically explored this portion of the southern shores of Santa Catarina, with an international team of interdisciplinary investigators from different institutions [76]. Such a setting provided for an approach focusing on regional understanding of territorial patterns and settlement evolution [1–3], as well as mound formation processes and architectural design, with special attention to the interrelationship of natural and cultural phenomena into site and off-site formation processes. This research project, generically named *Sambaquis and Paisagem* (1995–2020), has produced a considerable amount of literature, especially as academic works such as theses and dissertations. (For a review of its main results, please see [1–3,5–7,17,26,27,46,77], among others). For the investigation of moundbuilding processes, the strategy has been systematically profiling into some large mounds, taking advantage of extensive walls left on them by intensive mining for shell materials in the past. This approach has allowed us to explore stratigraphic sequences across the whole mound, mapping the distribution of burials and other structures therein, as well as sampling for dating and zooarchaeological and sedimentological analyses. Some mounds, especially Jaboticabeira II (JabII), have been studied in greater detail, including trenching and small-scale excavations ([12,13,17,26,27, 46,78,79], among others).

In order to acquire a regional perspective, the whole area has been surveyed for shellmounds and other sites, including sampling for dating and sediment analysis. Several smaller mounds have been examined in a rather similar way [2,31,33,80]. Spatial analyses have been performed using GIS software [1,2,33,43].

4. Results: Sambaqui Archaeology in Santa Marta, Southern Coast of Brazil

4.1. Chronology and Settlement Evolution

More than 120 sambaquis have been recorded so far in the Santa Marta study area, and, surely, other mounds have succumbed facing intensive mining and recent urban development. Almost three hundred radiocarbon dates provide a fairly well distributed sample for a regional chronology (Table A1; see Appendix A). Intra mound dating into large sambaquis shows coherent and uniform sequences, usually without important interruptions for centuries—indeed, some larger funerary mounds have been continuously built throughout more than two thousand years [2,17,81].

On a regional perspective, dating indicates that sambaqui occupation in this area has no important interruption throughout at least five thousand years [1,3]. It starts around 7.5 ky BP, showing an expansion of active funerary sites up to approximately 3000 BP, decaying after that, but with sites still active until 1000 years BP approximately (Figure 5).

During the "classic" sambaqui period (between 5 and 3 kya approximately), small mounds and other discreet peri-sambaqui structures appear, frequently with a single stratigraphic horizon [1,31–33]. Although the compositional and functional variability of these smaller sites/events are still poorly explored, most of them seem to gravitate around the bigger mounds, being functionally related to them. Moreover, several sambaquis constituted by twin-mounds, frequently sharing the same basal platform, appear around this period.

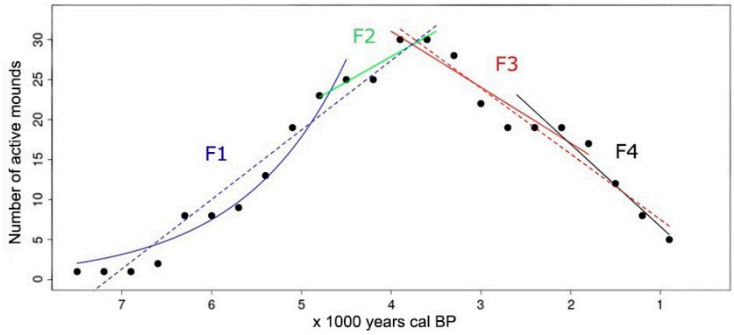

Figure 5. Number of active mounds between 7.5 and 0.9 ky BP in the Santa Marta area, distributed in 300-year slots (after 75). This long trajectory exhibits two ascending and two descending phases (F), with a turning point around 3 kya.

Similar concomitant funerary moundbuilding processes at different locales across the area, and along several generations, point to stable and enduring cultural patterns towards the dead, shared by all communities around the lagoon [1,2]. Such a homogeneous architectural design (and its endurance) finds resonance into the long permanence of lithic and bone technological and stylistic patterns all through this area, and well beyond [15,82].

Sites located up to 10 km away from the actual seashore indicate that the sambaqui occupation of this paleo bay/lagoonal system was already flourishing on its inner and most sheltered portion by at least 7.5 ky BP—that is, well before the medium sea level reached its maximum, about 2.3 m above actual sea level [36]. These small older mounds are rare and rather difficult to find—and, usually, very disturbed by modern land use. Nevertheless, they already display a well-defined trace association pattern, featuring typical characteristics of the later ("classic") sambaqui culture. It includes settling at the border of large water bodies (lakes, bays, estuaries), shell-mounding formation processes involving funerary use, and the presence of peculiar votive sculptures (see ahead).

These deep-lagoonal mounds, once located at the very bottom of the paleo bay area, reveal that sambaqui adaptive patterns to coastal environments, already present and active by the early/middle Holocene, are even older, probably of Pleistocene origins. Deep inland shell-mounded funerary sites found further to the north (at the São Paulo state), settled at lowland riverine environments and dated from the end of Pleistocene [45], make a strong case for this argument.

Available estimates for demography are in the order of a few thousands of people living together around the lakes around 3.5 to 2.5 ky BP [17,27]. Sedentary life and population increase are also reinforced by available paleopathological data on the skeletal population of the sambaquis Cabeçuda and Jaboticabeira II [21,83–85]. This demographic expansion, however, apparently does not bring perceptible changes or disruption on the homogeneous cultural and economic patterns of the sambaqui society along its enduring existence. There is almost no evidence of violent death among the buried population [86,87], and, as far as we can see, economic and organizational solutions for conflicting situations were "socially orchestrated" [6]: p. 26, in order to support population growth and the intensification of social interaction in the area. This orchestration, as already pointed out, involves free-flow and cooperation at a regional scale among several communities, and an ideological/religious "superstructure" promoting (or stimulating) integration and social isonomy.

Mound distribution into long-lasting clusters (Figure 6) evinces that, throughout the middle and late Holocene, the large body of brackish water was the epicenter of the sambaqui social sphere [2]. It became a shared and communal territory, vital space for economic and social interaction [1]. Eventually, this has led to an increase in territorial circumscription in the lagoon area, and intensification upon available resources, drawing on the abundance, stability, and reliability of environmental conditions. Social flexibility and interaction among sambaqui communities around the lagoon are indicated by their

similarity (that is, cultural homogeneity), concomitance, and the evenness of their spatial distribution.

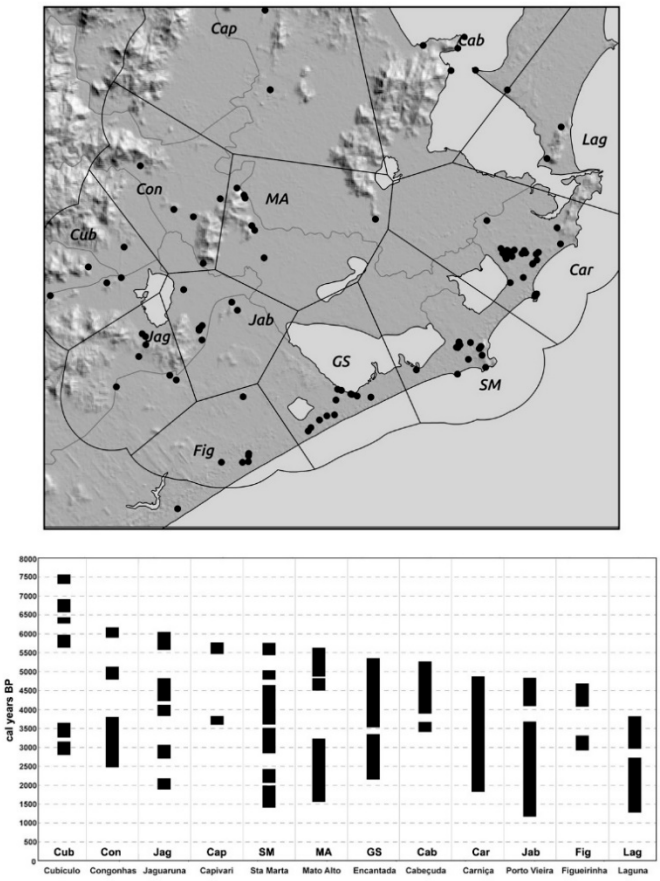

Figure 6. Chronology of the sambaqui clusters in the Santa Marta area, and their regional distribution (after [1]).

This evidence points to an articulated social network and territorial sharing as fundamental aspects of the systemic integration among these communities. It suggests that each of these clusters represent, in both social and economic perspectives, a nuclear focus of occupation with its own social—and, to some degree, also territorial—identity, as represented by each unique (and long-lived) funerary locale. However, as regional chronology clearly shows, they are never alone, living among other analogous communities distributed around the lagoon, involved in a "face-to-face" (frequent, quotidian) network interaction [1,2,88–90].

An apparently abrupt change in depositional patterns occurs around 2100 to 1800 years ago. By this time, darker organic sediments rich in fish remains and charcoal replace the fore predominant shell accumulation [17,26,27,46,77]. This "upper black horizon"—that, in some mounds, may reach more than two meters thick—is related to carefully disposed burials and assorted structures. Associated lithic and bone industries, also similar to previous phases, exhibit consistent functional, technological, and locational persistence. Depositional patterns involve remobilization of faunal (mostly fishbone) materials, charcoal, and burnt stone fragments within and above the burial ground [12,26,77]. Despite the low frequencies of shell, the funerary ritual is still the principal mounding up driving process, and the large amounts of food remains, remobilized and frequently burnt, have been interpreted as resulting from well-attended, community-bound feasting upon the dead [26,27,46,77].

Shortly after (around 1700 years BP), discreet dark-earthen mounded sites start to appear along the coast and nearby areas. Some of them are clearly funerary [2], while

others look to be fishing shoreline campsites or aggregation places [80]. The features and structures appearing in these sites, particularly as regards faunal composition, burial inception (including cremation, never present in the mounds before this period), and accompaniments, are rather distinct from earlier sambaquis. Differences also include the introduction of ceramics, around twelve hundred years ago. These events indicate significant cultural changes taking place around the lagoon, leading to the end of a long period of stability and cultural continuity of the sambaqui culture.

The characteristic ceramic styles occasionally found in these smaller "late sambaquis" are related to the ethnographically known Je speaking societies that have occupied most of the southern Brazilian coast since around seven hundred years before the arrival of European settlers [1,7,15,91–95]. These later sites display higher evidence of violence among buried people [86,87], and also some evidence of changes in post-marital residence patterns [96].

No archaeological settlement typically related to the coastal sambaqui culture has ever been found deeper into the mainland, outside the lagoon area and its surroundings—except for some scanty evidence of artifact circulation in a few large open valleys located to the northern shores, in Santa Catarina and São Paulo [45]. Settlement distribution and sambaqui life center in the lagoon area; large bodies of water constitute the focal interaction sphere as regards social and economic relations among these circum-lacunar communities.

4.2. Technology and Economy

The most conspicuous element found in the sambaquis is shell, a paramount feature of mound architecture. Shellfish used for moundbuilding comes mostly from bay areas and rocky coastal shores around the lakes. These resources were abundant in the lagoon but do not seem to be of dietary significance, as isotopic studies point to a diet based on fishing and hunting on high-level trophic species [46,97]. Nevertheless, shellfish resources were fundamentally important in funerary rituals taking place at the mounds. Together with fish remains, they are ever-present in the layers associated with feasting events.

Whatever symbolic meaning shells might have possessed, it is clear that they have acted as excellent architectural materials—notably the *berbigão* (*Anomalocardia flexuosa*), preferred for the thicker layers that frequently cover the funerary areas. These layers aggregate volume and monumentality to the built structures, and usually constitute the basal surface for new funerary ground surfaces. Moreover, shell packs provide "ventilation" and important alkalinity, thus increasing bone preservation—effects that, arguably, may have been intentional [30]. Some species are more than food, such as the nice-looking *Lucina pectinata* and a variety of sea snails, as well as whale and dolphin parts, although not so common, that certainly have symbolic value, as they are frequently found as offerings, or even accompaniments, in quite a few funerary contexts.

Anthracological data point to the presence of patches of mollusk-rich mangrove by 5 to 3 ky BP [82]. Large packs with an impressive amount of oyster shells, found in most of the older and larger sambaquis, also reinforce this assumption. The lagoon has functioned as ambience for economic intensification, involving management of some species of fish, shrimp, and oysters, as observed nowadays [98]. If remains of fish and oyster abound in sambaquis, shrimp, though abundant and economically important in the lagoon today, apparently leaves no trace in the archaeological record.

Abundant fish remains in the mounds display moh as fishnets and canoeing [82,99,100]. Stly lagoon-bound and near-coastal maritime species, captured with both hooks and nets [99,100]. Nevertheless, larger species such as whales, dolphins, sharks, and sea-wolves, although not so frequent, are highly valuated, not only for food: their teeth, tympanum, and vertebrae are used for tools, collars, and other adornments [6,15,16]. Typological characteristics of bone artifacts (points, hooks, spatulas) also indicate an economy predominantly based on fishing and sea-hunting activities, endowed with technological assets suc.

The frequent and abundant presence of seabird flocks has to be remembered, since this significant resource is still available in the lagoon, and its remains are easily found in the sambaqui faunal record, both as food remains and for tool making [50,101]. Finally, yet importantly, the presence of terrestrial game among faunal remains: parts (almost never whole individuals) of tapirs, boars, rodents, and monkeys, among other species, are frequently found above or next to burials [14,46]. Their teeth and vertebrae are used for making exquisite personal adornments carefully disposed as accompaniments for the deceased [15].

These species' inception in ritual contexts and funerary areas is quite significant, and trace-element analyses of human bone indicate that they are more important to diet than zooarchaeological studies suggest [46]. The presence of terrestrial game indicates that nearby *restinga* (stable and forested coastal sandy terraces), as well as the luxuriant rain forest at the hilly surrounding areas around the lagoon, wholly integrate the sambaquis' territory and played an important role in their economy and everyday living. This assumption is reinforced by characteristic forest-bound wood species detected in anthracological studies [102].

Lithic technology includes artifacts decisive for adapting to aquatic environments (such as axes and wedges used for canoe making), and artifacts for processing plant food, such as mortars, pestles, and groundstone tools of various sizes and shapes, found in a great number in these sites, frequently as funerary accompaniments [15,99,100,103]. Indeed, there is growing evidence for the importance of vegetal resources management in the sambaqui economy, including horticultural activities [104–108].

Organic residues in dental calculus from human remains indicate the presence of several plant families in the diet. These include Araceae (*inhame*) Arecaceae (palms), Convolvulaceae (sweet potato), Dioscoreaceae (*cará*), Maranthaceae (*ariá*), Myrtaceae (wild fruits such as *pitanga*), and Poaceae (including maize), among others. Starch grains also indicate food processing, reinforced by the variety of lithic grinding and pounding tools found in these mounds [109–111]. Scheel-Ybert and Boyadjian [108] argue that, besides lagoon resources, wild plants and fruits from nearby *restinga* and rain forest were currently collected, and that garden cultivation of tuberous plants and other species rich in carbohydrates (such as maize) was also an important part of the everyday diet.

Rare animal-shaped lithic effigies or sculptures with a ventral cavity, splendidly crafted following very rigid and enduring stylistic rules, have been found in association with a few specific burials, pointing to some kind of social distinction (e.g., [112]). Indeed, small lithic tools, such as spatulas, awls, and burins, frequently displaying intense use-wear, reinforce the amazing sculptural craftsmanship and artistry of the sambaqui people (Figure 7) Some pieces are so perfectly carved that it has been possible to identify the precise species depicted in the sculpture [113]. First described in detail by Prous [114], these artifacts (usually called zooliths) have been interpreted as part of the ritual paraphernalia linking specific animal species and mythological entities, related to a religious ideology of an animistic nature [115].

Although only a small number (around three hundred pieces) of these sculptures has ever been found, based on its distribution [114], it might be inferred that such a religious ideology has an ample regional dispersion and endurance, widespread among sambaqui societies from the southern and southeastern Brazilian shores. In fact, although shellmounds are conspicuous throughout the Atlantic coast of Brazil, these lithic sculptures have never been found to the north of the Tropic of Capricorn. Thus, this is a typically southern sambaqui cultural trace.

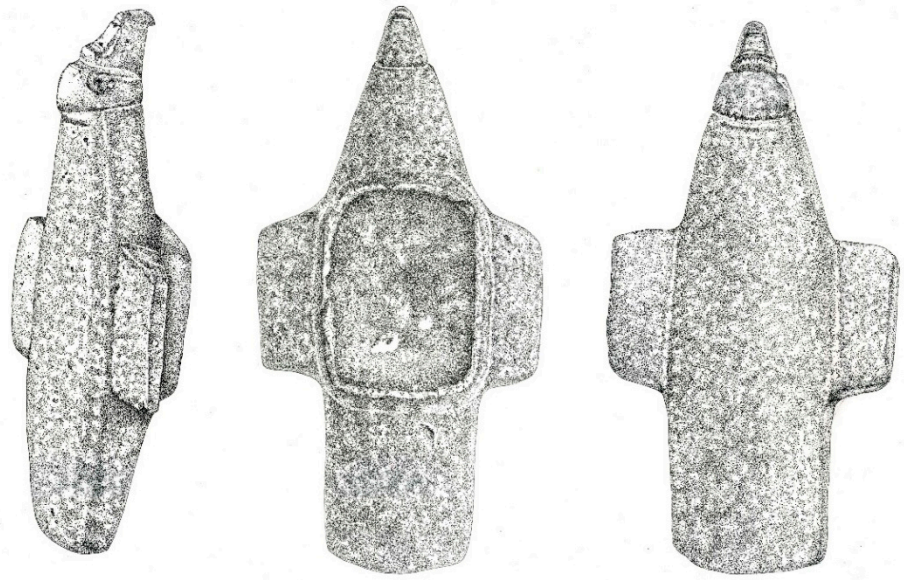

Figure 7. Zoolith (animal-carved sculpture) typical of the sambaqui culture from the southern shores. This piece depicts, with amazing accuracy and elegance, an eagle-like species (Artifact x.551, Museu de Arqueologia e Etnologia, University of São Paulo. Art by Taciana Ottowitz).

Such technical refinement and aesthetic taste are also evident in bone and teeth artifact production. A variety of items have been described, including fine tools such as needles and spinning implements, small-scale sculpted effigies and a variety of spatulas and adornments [116,117]. Bone, teeth, and vertebrae from sea, land, and bird species have been used to manufacture exquisite, sophisticated collars and other adornments, frequently incorporated into the burials [6,46]. Wooden tools did not preserve, but the typology of lithic implements, such as a variety of axes and wedges, although not yet specifically accessed in functional terms, leaves no doubt of intense wood use as raw material [15,118].

It is important to call attention to the fact that the sambaqui culture is very much related to large bodies of water, living on the fringe of bay, lagoon, and estuarine environments among coastal islands and promontories. Aquatic environments and canoeing were essential to their way of life and subsistence [2]. Marks on large bones and the auricular structure of human skeletal remains indicate that rowing and underwater activities were practiced regularly [20,84].

In summary, the circum-lagoonal settlement distribution, as well as the bulk of evidence described above, points to cooperative strategies of economic organization towards aquatic (and nearby) resources, sharing these "fields of production" and, likely, finding ways of intensifying it. In fact, exploratory ground radar investigations suggest management of the unconsolidated aquatic landscape and the making of canals, dikes, platforms, and assorted structures aside and around the mounds [33,119–121]. As stated above, some of them might be related to habitational locations.

4.3. Funerary Ritual

Most of the knowledge on mound formation processes comes from the Santa Marta area in the southern shores, where these funerary locales are enduring occupation places, actively used along several centuries. At Jaboticabeira II (3300 to 1200 BP approximately) and Cabeçuda (circa 4800 to 1500 BP), for instance, stratigraphically controlled radiocarbon dating shows an uninterrupted activity for more than two thousand years. These sites display an impressive volume (estimated 32,000 and 53,000 m^3, respectively), reflecting this continuous and intensive building-up occupation for a long period of time [1,81]: p. 192.

Ultimately, the succession of funerary areas, continuously reenacted throughout many generations (indeed, bigger mounds are millenarian), contributes to the incremental architecture and massive proportions of these sambaquis. This social phenomenon demonstrates

a deep-rooted and enduring worldview based on the cult of the ancestors, where ritualized funerary ceremonies play a very important role [7]. The impressive amounts of food consumption on such occasions, as well as the progressive monumentality achieved through continuous reenactment of feasting parties [26], indicate that funerary ceremonies were important occasions, socially meaningful events incorporating and integrating local people as well as from surrounding communities.

As already stated, exceptional, rare burials with distinctive and peculiar accompaniments such as lithic finely carved effigies and burial decor, seem to be related to some kind of religious leadership, given the association with votive effigies and some other occasional signs of prestige. In rare documented cases [23,112,122], these finely appareled burials are located at the base of the mounds, suggesting that a few socially influential personas might be the founding reference for brand new funerary areas—that is, the very starting up of new sambaquis, or new funerary locales at higher ground, accreting volume to the mounds.

The presence of iron oxide (ochre) in mortuary contexts is recurrent (although not imperative) in sambaqui burial descriptions, usually dyeing, more or less intensely, bone, shell, and lithics associated with mortuary contexts. It is unclear if it was sprinkled over the body during burial inception, or eventually placed directly over the defleshed bones [15,30,46]. On several sambaquis, a large amount of ochre, rendering the soil red, appears in some funerary features [10,15]. In a dramatically suggestive way, Rohr ([123]: pp. 8–9) describes some burials as drenched "in blood-red mud". It does not seem to be related to any specific social category, though; its occurrence contemplates indistinctly both sexes and aged burials alike.

Shell and bone adornments are common accompaniments in sambaqui burials. Collars made of modified shark and monkey teeth, shell, and carp beads are not rare, although these items are not featured in most of the burials [23,124]. As said, zoomorphic sculptures appear as rare and peculiar funerary accompaniments (e.g., [124]), and large bone pieces, such as whale ribs and big tortoise casks, have been described as funerary accompaniments in several sites ([15,112,116,122,123], among others). Occasionally, sophisticated burial paraphernalia have been found, such as whale ribs arranged as a "coffin", encircled by large amounts of ochre and hearths [123]. Painted terracotta coverings and carved bone vessels have also been described [15,23,125]. Gaspar et al. [7] point out that there are several records of child burials with rich accompaniments, such as ochre, collars, special rare shells, and large animal bones.

Upon and surrounding these funerary structures, thin deposits of charcoal, burnt shellfish, and fishbone form small heaps, interpreted as residues of feasting on the deceased, carefully disposed over and around the burials [26,27,30,46,48,126]. Evidence of burial revisiting has also been reported, as well as manipulation of former burials, with bone parts of older ancestors incorporated into new burials [30].

5. Sambaqui Social Organization: A Heterarchical Model

The initial evolution of the sambaqui occupation in the southern shores of Santa Catarina seems to follow what has been described as a "ideal free distribution" pattern, that is, as succinctly stated by Bettinger ([127]: p. 224), "the movement of individuals and families from places where conditions were worse to places where they were better, in a way that equalizes fitness". It has developed among early focal and well-located communities evenly distributed around former bay/lagoon borders and nearby coastal islands, exploring its rich resources in cooperative ways, mainly as organized fishing and sea hunting parties. Cooperation in these tasks must have been of adaptive significance, enhancing productivity and sharing of staple marine and also dryland resources.

The connection between these communities, possibly organized in sibs (or tribelets), seems to derive from common ancestors—real and/or mythical (totemic) ones. The archaeological perception of it is given by the regular and systematic construction, across several centuries, of funerary spaces at the same, permanent places, where *all* deceased group

members are ritually disposed. Flexible marriage rules probably provide mobility and integration among social compounds, stimulating fitness and social isonomy, while funerary rituals (and probably others) tighten their social bonds. Indeed, the impressive amount of food (mostly fish and shellfish) incorporated into funerary features strongly indicates that the scale of these events is well beyond the local level, enhancing the perception of a territorially wide ideological and cultural background, certainly also linguistic [14,46,48].

Gradually, such a pattern increases economic (and demographic) intensification at specific patches of the landscape, including the management of animal and vegetal species [1,110,128]. Intensification and management of resources in the lagoon and surrounding areas suggest the taking advantage of cooperation, maintaining a large regional network—that is, above the community level—of social integration. This tendency is favored by linguistic, parental, and ideological connections between these communities which, after all, have never been isolated. Their connectivity and interdependence persist towards later periods, expressed as they are on ceremonial occasions (funerary ritual is the most visible archaeologically), where common ancestors connected to an eschatology related to natural entities (as indicated by the votive effigies) seem to be of paramount, foundational importance.

As Bettinger [127] suggests for California hunter-gathering societies, this pattern promotes some degree of territorial compartment, always maintaining "mutually beneficial relations in trade, marriage, and ceremony". Spatial proximity allows for high levels of interaction between community members; daily interaction reinforces social relationships and a common worldview. Shared practices and communal landscapes lead to what has been called "practices of affiliation", conducting to the emergence, and maintenance, of community identity on a local/regional scope ([90]: p. 125). Eventually, sustained demographic growth has favored the establishment of moieties among these communities, as a way to minimize conflict and organize relationships inside and among them. These moieties would be expressed archaeologically as twin-mounds (Figure 1), which became common sometime after four thousand years ago.

Most burial patterns, which exhibit some variability through time, are always ritualized and widespread throughout mounds on a regional scope. Nevertheless, some differentiated ones, more appareled than most, suggest that eventual "principals" might have a role in starting new lineages, as represented by new funerary areas, or even new mounds (e.g., [15,23,50,112]). Characteristic animal and geometric lithic zoomorphic sculpted representations (described above), found in connection with such atypical burials, suggest that social coordination might have been structured by religious leaders who, by means of collective rituals, promoted pacific articulation, economic cooperation, and political balance among communities. The small number of these sculptures ever found into these mounds seems to indicate that they result from very rigid stylistic rules on making and using them, across several generations, with symbolic meanings encompassing a large, all-inclusive social outreach [8].

Again, ritual occasions (of which, funerary rites surely are among principals) have a paramount and decisive function in accomplishing social and economic balance at a regional level, acting as a "glue" into a rather isonomic, heterarchical system. Such religious leadership, however, does not seem to have a consistent, or permanent, political presence at a regional, pan-lagoonal scale.

As already pointed out, sambaqui clusters are evenly distributed around the bay/lagoon system of Santa Marta. They are not only concomitant, but also exhibit a high degree of cultural homogeneity. These characteristics indicate a social system in which the lagoon territory and its surroundings are shared by several communities, a regionally articulated pattern integrated within the scope of a greater pan-lagoonal organizational structure, as depicted in Figure 6.

Heterarchy is expressed, particularly, by the even territorial distribution of the mounds and assorted sites, as well as their chronological, formal, volumetric, and stylistic similarity (both in an architectural as well as a technological sense). Especially among larger mounds,

despite some variability in stratigraphic composition and internal distribution, structural characteristics of the formative processes are very similar. Mounds are equivalent; there is no evidence of central places, principal mounds, or the like. The lake is the center of the system, indicating that it is regularly used by the communities around it, a common "territory" that is shared by them all, in a network of social and economic relationships [1,2]. As one of us [43] once said, they are "the people of the lake".

Into the mounds, some variability among burials occurs, but, in general, nothing seems to indicate noticeable structured social differentiation [129,130]. For instance, distribution of bone and lithic artifacts among burials, even in the same mound or funerary area, is much diversified, with no clear distributive pattern. That is, although some differentiation among burials is evident (in terms of presence/absence and quantity of items), it does not appear to be particularly related to gender, age, or even some clear-cut, or well-defined, kind of social ranking [22,48].

Differentiated and exuberant treatment for children, as well as other rare outstanding and "out of the curve" cases, does not seem to mean the emergence of any formal, institutionalized, or structured socio-political hierarchy. More likely, these distinctions are related to specific circumstances and/or beliefs as regards death—newborn or child, aged, in the sea or at the forest, by disease or while hunting, and so on. South American ethnographic analogies are abundant (e.g., [68]) but not immediately applicable to the sambaqui context. In a careful examination, Gaspar et al. [130] have noticed but a small degree of sexual distinction as regards funerary accompaniments in the Saquarema Lake district, northern coast of Rio de Janeiro. They suggest the absence of well-defined gender roles among moundbuilders in that area, thus reinforcing the perception of a rather plastic society.

Occasional and exceptional, outstanding burials are found scattered in different mounds all over the southern and southeastern shores (e.g., [30,116]). In some situations, as already mentioned, it might well be related to prestigious personalities or lineage leaders, or religious paramount individuals related to deep-rooted beliefs regarding ancestors and mythic heroes. The occurrence of rare animal sculptures (zooliths, described above) within a number of these special burials reinforces this perspective. Perhaps the relationship with the ancestors (and other instances, as posed by Viveiros de Castro [65]) was intermediated by important shamanic authorities, who would usufruct of considerable social distinction, reflected in these exquisite burials. Definitely, this is not yet clear enough, and should be an object of future research. Both intra-site as well as regional distributions of these richly appareled burials, and their apparently foundational inception among several other burials, seem to indicate that they symptom local prestige, expressed in a widespread cultural pattern. They do not seem to represent the emergence of a higher-ranking political instance, related to a more stable political establishment at a regional level.

From a socio-economic point of view, some useful contemporary ethnographic analogies might help to understand the sambaquis society and their socio-economic characteristics. Today, among vanishing traditional fishing communities from the southern shores, net fishing in canoes or small boats is always performed by parties, whether in the lagoon or nearshore open sea. This social articulation around subsistence production is based on kinship as well as acquaintanceship (neighborhood relations). Besides, traditional communities around the lagoon are socially equivalent; they not only share mutual recognition but also intense social relations involving kinship, work parties, and festivities (patron saints, weddings, etc.). These relations imply great regional mobility, with people frequently moving from one locality to another. In an analogous way, the sambaqui settlement distribution indicates the lagoon as a privileged area for social interaction and an economic emphasis among concomitant and culturally homogeneous moundbuilding communities.

The understanding of the lagoon as the social-economic sphere that structured sambaqui subsistence and life leads to the perception of it as a highly socialized landscape. It is characterized by intense production, circulation, and interaction, a communal space sharing different management areas for fishing, shell fishing, hunting, and other activities. This organization is reflected in the circular, that is, "face-to-face" (following [131]; see [132]

for an example in another South American context) configuration of the settlements around a "territory" that, after all, is centered and focused on water, a water land.

As far as we can see at this point, sambaqui clusters seem to constitute heterarchical social nuclear entities of a larger territorial organization with loose political ties, but configuring a network of intense social and economic connections. Mounds appear as landmarks associated with specific social groups (perhaps extensive family clans, or lineages), with enough demographic and political expressiveness, or identity, justifying the incremental construction of the same sambaquis along many generations [17,27,30]. The construction of twin-mounds is reminiscent of the dual social organization of the historically known Je speaking societies from central [132] and southern Brazil [95,133], but the existence of dual (clan) organization among moundbuilders is still to be adequately demonstrated.

6. Final Remarks

The model hereby delineated—still too broad and filled with gaps, but consistently exploring available data—speaks of sedentary moundbuilding communities of fishers-hunters-gatherers and small-scale cultivators, socially articulated on a regional level and very well-adapted to the coastal environment. In such a water land, they have created a social landscape on their own. Their social organization patterns go far beyond the idea of small nomadic family bands that have guided archaeological interpretations about sambaquis in Brazil until recently. The persistence of ideological/religious traditions embodied in the mortuary program over several millennia is a hallmark of the sambaqui era. The scanty occurrence of the lithic zoomorphic sculptures and its association with specific burials evoke the emergence of early religious leadership; it strongly suggests that the cult of the ancestors has been the "glue" of the sambaqui society's cohesiveness.

Funerary events would promote social integration of the communities across the lagoon by means of communal feasting, and recursive visiting afterwards [7,30,46]. The ritualized funerary character of these mounds makes them sacred ground, where the memory of the ancestors is ever-present in social life, and common to all its members. These bonds are recurrently reinforced by intentional, standardized ways of moundbuilding at the same (persistent) places for many generations [27]. Indeed, evidence shows that moundbuilding and recurrent visiting involve manipulation of former burials, reenacting the presence of the ancestors and the bonds they represent to the living [30]. Therefore, there are essential structural (in Levi-Strauss' sense) meanings linking the sambaqui society, their ancestors, and their (mostly aquatic) territory.

From that perspective, the highly visible shellmounds placed all around the lagoon create a rather culturally domesticated landscape, still visible to this day. The ever-present ancestors and their cosmological/ecological connections take part on the every-day life of the sambaqui builders' society. These meanings grow stronger every time ritual funerary moundbuilding takes place, reenacting communal conceptions of world and life and perpetuating specific territorial rights upon these monumental landmarks easily and extensively recognizable [1,7,56]. Such events offered opportunities for social negotiation and balance, reinforcing the integration among communities and their ideological/cultural homogeneity. Monumental building, and rituals that create them by means of connection to the ancestors, assign ancestral (mythic) belonging in the landscape, and the entities that take part on it. In addition, as sambaqui distribution evokes a sharing and cooperative manner in the exploitation and management of the lagoon and its surroundings, it becomes a central reference for the perception of social heterarchy in their organization on a regional level.

In conclusion, regional chronology and settlement organization indicate permanent and long-lasting moundbuilding occupation in this ever-changing bay/lagoon environment for at least 6000 years (about 7.5 to 1.5 ky BP). The sambaquis emerge as monumental representations of a long, stable, and well-adapted coastal occupation, evincing as well the strong symbolic relationships established between the sambaqui people and their mostly aquatic habitat. Such a landscape has been incorporated into their culture as much as their culture has remained incorporated into the landscape until today.

We argue that it is a case for a heterarchical model of social organization, with several politically equivalent communities integrated into a pan-lacunar social network, which has indeed endured for most of the Holocene. Such a pattern strongly highlights this successful long-lasting tradition connected to a lagoon-adapted life style—which would only change significantly after the arrival of the Je speaking, pottery-making, and plant-cultivating societies, from around 1.5 ky BP onwards. It is for no other reason that the sambaqui people from the southern shores have remained, for several millennia, rather introspected among themselves, with very scanty evidence of contacts with other, foreign cultures—the very "sovereigns of the coast".

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Appendix A

Table A1. Radiocarbon dating for the sambaquis from Santa Marta area. Except otherwise stated, the main reference is Kneip et al. [75], and references therein.

Site	Lab ID	CRA	sd	cal BP	Reference
Arroio da Cruz 1	Beta 209703	1080	60	532–744	
Arroio da Cruz 1	Beta 211732	1160	40	639–788	
Cabeçuda	Beta 280005	3640	50	3410–3677	Scheel-Ybert et al. 2020
Cabeçuda	Beta 280006	4180	60	4081–4417	Scheel-Ybert et al. 2020
Cabeçuda	Beta 280007	4020	50	3882–4195	Scheel-Ybert et al. 2020
Cabeçuda	Beta 280008	4180	60	4081–4417	Scheel-Ybert et al. 2020
Cabeçuda	Beta 280009	3870	40	3896–4147	Scheel-Ybert et al. 2020
Cabeçuda	Beta 297831	2030	30	1703–1860	Scheel-Ybert et al. 2020
Cabeçuda	Beta 297832	1990	30	1620–1665	Scheel-Ybert et al. 2020
Cabeçuda	Beta 297833	1800	40	1387–1393	Scheel-Ybert et al. 2020
Cabeçuda	Beta 297834	2290	30	1990–2161	Scheel-Ybert et al. 2020
Cabeçuda	Beta 383565	2990	30	2797–3003	Scheel-Ybert et al. 2020
Cabeçuda	Beta 383566	3030	30	2859–3065	Scheel-Ybert et al. 2020
Cabeçuda	Beta 383567	2920	30	2756–2895	Scheel-Ybert et al. 2020
Cabeçuda	Hannover 167	4120	220	3935–3936	Mello e Alvim, Soares & Cunha 1984
Caieira	Isotopes 2624	710	95	513–754	Hurt 1974
Caieira	Isotopes 2628C	3230	155	2990–3731	Hurt 1974
Caieira	Isotopes 2628S	2770	100	2283–2739	Hurt 1974

Table A1. *Cont.*

Site	Lab ID	CRA	sd	cal BP	Reference
Canto da Lagoa 1	Beta 209706	3370	70	3027–3397	
Canto da Lagoa 2	Beta 234200	3500	50	3243–3515	
Capivari 1	Beta 209705	3780	40	3599–3835	
Carniça 1	A 918	3370	150	2946–3884	
Carniça 1	A 919	3370	100	2946–3458	
Carniça 1	Az 883_2	3040	50	2719–2932	
Carniça 1	Az 884	2400	110	2153–2734	
Carniça 1	Az 912	3310	150	2770–3483	
Carniça 1	Az 914	2550	100	1945–2479	
Carniça 1	Az 917	3210	150	2708–3384	
Carniça 1A	Az 950	3275	125	3084–3088	
Carniça 1A	Az 959	2460	110	1831–2350	
Carniça 1A	Isotopes 2620	3350	110	2896–3454	Hurt 1974
Carniça 1A	Lamont 1164	3400	150	2862–3609	Hurt 1974
Carniça 1A	Lamont 1164B	3300	150	2763–3469	Hurt 1974
Carniça II	Beta 248566	3360	80	2984–3404	
Carniça III	Beta 248567	3360	50	3070–3351	
Carniça VI	Beta 248568	3800	80	3541–3964	
Carniça VII	Beta 253669	3440	50	3179–3436	
Carniça VII	Beta 253670	3510	50	3262–3534	
Carniça X	Beta 248569	2750	70	2317–2682	
Congonhas 1	Az 10650	3165	55	3179–3454	
Congonhas 1	Az 10651	3350	85	3360–3727	
Congonhas 1	desconhecido	3270	200	2896–3966	Beck 1972
Congonhas 2	Az 10647	2740	70	2716–2993	
Congonhas 2	Az 10648	2705	85	2489–2645	
Congonhas 2	Az 10649	2835	95	2748–3161	
Congonhas 3	Az 10646	2115	50	1914–2159	
Costa da Lagoa II	Beta 270316	4290	60	4223–4577	
Cubículo I	Beta 248575	3500	50	3243–3515	
Cubículo I	Beta 248576	3640	50	3410–3677	
Cubículo II	Beta 253676	3180	60	2813–3153	
Elisa	Beta 280843	3320	40	3041–3310	
Encantada I	Beta 262743	3930	60	3728–4085	
Encantada I	Beta 262744	4160	60	4066–4407	
Encantada I	Beta 276435	3940	50	3790–4085	
Encantada I	CENA LS-24	4290	70	4195–4614	
Encantada III	Az 10638	4420	50	4437–4772	
Encantada III	Beta 189712	740	40	560–609	
Encantada III	Beta 189713	4320	40	4651–4670	

Table A1. *Cont.*

Site	Lab ID	CRA	sd	cal BP	Reference
Encruzo	Beta 270327	2410	50	1892–2187	
Figueirinha I	Beta 276433	4370	50	4382–4694	
Figueirinha I	Beta 280844	4260	50	4219–4512	
Figueirinha II	Beta 384038	3720	30	3549–3750	
Figueirinha II	UGAMS 18540	3790	25	3639–3822	
Figueirinha III	desconhecido	4240	190	3836–4824	Martin, Suguio & Flexor 1988
Figueirinha III	UGAMS 18541	4190	25	4175–4386	
Figueirinha IV	Beta 280845	4140	40	4077–4351	
Figueirinha IV	Beta 384037	3870	30	3717–3938	
Figueirinha IV	UGAMS 18542	3850	25	3703–3895	
Figueirinha IV	UGAMS 18543	3990	25	3893–4084	
Figueirinha IV	UGAMS 18544	3960	25	3861–4059	
Figueirinha IV	UGAMS 18545	4010	25	3923–4121	
Figueirinha IV	UGAMS 18546	4000	25	3902–4098	
Figueirinha IV	UGAMS 18547	4000	25	3902–4098	
Figueirinha IV	UGAMS 18548	3920	25	4161–4168	
Figueirinha IV	UGAMS 18549	3990	25	3893–4084	
Figueirinha V	UGAMS 18550	1470	25	933–1098	
Formigão	Beta 280019	4690	60	4792–5132	
Formigão	Beta 280020	5620	60	5894–6172	
Galheta 1	Beta 209708	3090	70	2729–3050	
Galheta 2	Beta 209709	4400	60	4409–4771	
Galheta 2	CENA LS-10	4530	70	4513–4875	
Galheta IV	Beta 211734	980	40	647–767	
Galheta IV	Beta 280010	1360	40	967–1173	
Galheta IV	Beta 280011	1070	40	547–700	
Galheta IV	Beta 280012	950	40	570–591	
Garopaba do Sul	Az 10032	2705	240	2159–2266	
Garopaba do Sul	Az 9888	2840	70	2757–3077	
Garopaba do Sul	Beta 253666	3960	50	3816–4104	
Garopaba do Sul	CENA LS-25	3780	70	3540–3910	
Garopaba do Sul	CENA LS-27	3780	70	3540–3910	
Garopaba do Sul	CENA LS-28	4110	70	3964–4380	
Garopaba do Sul	desconhecido	3450	180	2853–3758	Martin, Suguio & Flexor 1988
Garopaba do Sul II	Beta 262747	3840	60	3627–3961	
Garopaba do Sul III	Beta 262748	4100	60	3967–4345	
Ilhota da Ponta do Morro	Beta 270325	2460	40	1989–2263	
Ilhotinha	Beta 209711	5270	60	5478–5775	
Ilhotinha	Beta 209712	5170	60	5350–5369	

Table A1. *Cont.*

Site	Lab ID	CRA	sd	cal BP	Reference
Ipoá	Beta 262746	4500	60	4520–4827	
Ipoá	Beta 276434	4420	50	4437–4772	
Jabuticabeira I	Az 10639	4185	90	4433–4853	
Jabuticabeira I	Az 10640	3995	85	4101–4113	
Jabuticabeira I	Az 10641	2655	110	2360–2929	
Jabuticabeira I	Az 10642	2430	125	2152–2749	
Jabuticabeira II	Az 10243	2365	45	1872–2113	
Jabuticabeira II	Az 10244	2490	35	2043–2284	
Jabuticabeira II	Az 10245	2370	35	1893–2104	
Jabuticabeira II	Az 10246	2335	35	1855–2063	
Jabuticabeira II	Az 10247	2795	35	2400–2683	
Jabuticabeira II	Az 10631	2855	105	2331–2820	
Jabuticabeira II	Az 10632	2310	70	2065–2066	
Jabuticabeira II	Az 10633	2890	55	2473–2768	
Jabuticabeira II	Az 10634	2280	80	2011–2381	
Jabuticabeira II	Az 10635	2180	105	1891–2348	
Jabuticabeira II	Az 10636	2655	105	2362–2895	
Jabuticabeira II	Az 10637	2165	75	1930–1976	
Jabuticabeira II	Az 9880	2880	75	2779–3163	
Jabuticabeira II	Az 9881	2075	65	1833–2155	
Jabuticabeira II	Az 9882	2470	55	2351–2621	
Jabuticabeira II	Az 9883	2240	170	1831–2623	
Jabuticabeira II	Az 9884	1805	65	1537–1832	
Jabuticabeira II	Az 9885a	1850	40	1611–1686	
Jabuticabeira II	Az 9889	2345	105	2063–2068	
Jabuticabeira II	Az 9890	2285	45	2153–2346	
Jabuticabeira II	Az 9891	2295	90	2008–2491	
Jabuticabeira II	Az 9892	1895	185	1371–2180	
Jabuticabeira II	Az 9893	2210	60	2016–2034	
Jabuticabeira II	Az 9894	2500	155	2118–2121	
Jabuticabeira II	Az 9895	2170	95	1913–2340	
Jabuticabeira II	Az 9896	2170	45	2004–2188	
Jabuticabeira II	Az 9897	2060	85	1747–1772	
Jabuticabeira II	Az 9898	2270	75	2016–2034	
Jabuticabeira II	Az 9899	2115	65	1888–2183	
Jabuticabeira II	Az 9900	1975	95	1613–1660	
Jabuticabeira II	Az AA77105	2004	44	1612–1844	
Jabuticabeira II	Az AA77106	2028	44	1625–1655	
Jabuticabeira II	Beta 188381	2340	50	2016–2302	
Jabuticabeira II	Beta 188382	2320	50	2001–2297	
Jabuticabeira II	Beta 195239	2070	60	1510–1806	

Table A1. *Cont.*

Site	Lab ID	CRA	sd	cal BP	Reference
Jabuticabeira II	Beta 195240	2020	40	1836–2009	
Jabuticabeira II	Beta 195249	1970	40	1748–1772	
Jabuticabeira II	Beta 195250	1950	70	1634–1640	
Jabuticabeira II	Beta 228506	1540	50	1305–1490	
Jabuticabeira II	Beta 228507	1910	60	1616–1655	
Jabuticabeira II	Beta 234201	1400	40	988–1194	
Jabuticabeira II	Beta 253672	3200	50	2856–3152	
Jabuticabeira II	Beta 270319	3400	40	3154–3370	
Jabuticabeira II	Beta 270320	3300	40	2991–3265	
Jabuticabeira II	Beta 270321	3470	50	3208–3469	
Jaguaruna I	Beta 209707	3080	80	2707–3066	
Jaguaruna II	Beta 270326	5320	60	5573–5846	
Jaguaruna III	Beta 280016	3980	50	3839–4130	
Jaguaruna III	Beta 280017	5510	60	5723–6049	
Lageado I	Beta 248577	5470	60	5692–5981	
Lagoa dos Bichos I	Beta 248572	4320	60	4258–4629	
Lagoa dos Bichos I	Beta 276437	4420	50	4437–4772	
Lagoa dos Bichos II	Beta 234204	4070	50	3948–4271	
Lagoa dos Bichos II	Beta 253671	2040	50	1488–1755	
Lagoa dos Bichos III	Beta 248573	4130	60	4008–4381	
Laguna (Peralta)	Beta 262749	3550	50	3327–3567	
Laguna (Peralta)	Beta 262750	1490	40	1108–1292	
Laranjal I	Beta 262745	4500	60	4520–4827	
Laranjal I	Beta 276436	4570	60	4586–4933	
Mato Alto 1	Az 10643	2245	60	2059–2074	
Mato Alto 1	Az 10644	2535	165	2153–2929	
Mato Alto 2	Az 10645	4685	160	4872–5650	
Monte Castelo	Beta 209715	3240	70	2853–3248	
Monte Castelo	Beta 209716	3360	70	3012–3384	
Morrinhos	Beta 209713	3230	70	2845–3235	
Morrinhos	Beta 209714	4480	60	4505–4820	
Morrote	Az 9886	2075	110	1746–1774	
Morrote	Az 9887	1975	115	1587–2155	
Pedra Chata	Beta 383570	2040	30	1525–1694	
Ponta das Laranjeiras II	Beta 270328	2010	50	1430–1705	

Table A1. *Cont.*

Site	Lab ID	CRA	sd	cal BP	Reference
Ponta do Costão do Ilhote	Beta 211733	980	40	765–927	
Ponta do Morro Azul	Beta 190468	4480	60	4505–4820	
Ponta do Morro I	Beta 270329	2500	50	2025–2302	
Porto Vieira 1	Beta 209710	3610	70	3348–3684	
Riachinho	Beta 280018	3250	50	2917–3218	
Ribeirão Pequeno	Beta 209704	2390	70	1851–2215	
Rio Caipora	Beta 234198	5410	60	5637–5907	
Rio Caipora	Beta 234199	6590	60	7325–7400	
Rio Caipora	Beta 270317	6290	70	6575–6930	
Rio Caipora	Beta 270318	5620	40	6035–6035	
Santa Marta I	Beta 195242	3200	60	2836–3175	
Santa Marta I	Beta 270322	3800	50	3602–3881	
Santa Marta II	Beta 270323	3390	40	3143–3361	
Santa Marta II	Beta 270324	4340	50	4326–4639	
Santa Marta III	Beta 276438	4090	50	3967–4295	
Santa Marta III	Beta 276439	4040	50	3908–4221	
Santa Marta III	Beta 276440	4000	50	3853–4152	
Santa Marta IIIA	Beta 195243	4110	50	3995–4334	
Santa Marta IIIB	Beta 262742	4040	60	3880–4242	
Santa Marta IV	Beta 234194	2620	50	2147–2438	
Santa Marta IV	Beta 234195	2530	50	2065–2320	
Santa Marta IX	Beta 248570	4670	50	4799–5035	
Santa Marta V	Beta 234196	2090	50	1541–1801	
Santa Marta V	Beta 234197	1990	40	1757–1762	
Santa Marta VI	Beta 253667	3510	40	3292–3515	
Santa Marta VIII	Beta 253668	1710	40	1316–1511	
Santa Marta X	Beta 248571	5240	70	5441–5762	

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