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Archaeological Evidence of the Development of a Regional Society in Santarém (AD 1000–1600), Lower Amazon: A Path to Understanding Social Complexity

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Abstract

This article sets out to broaden our knowledge of the sociopolitical dynamics of Santarém (AD 1000–1600), a regional society in the Lower Amazon, by synthesizing the existing archaeological data relating to settlement patterns, ritual ceramics, prestige goods and chronology, as well as exploring aspects linked to the technology of ceramic production at the Carapanari site, a small-scale community located in the region during the late precolonial period. Using an integrated approach, the research combines a techno-functional analysis of a sample basically composed of ceramic fragments, providing information on the original forms and possible uses, with microscopy and compositional analyses of fragments based on instrumental neutron activation analysis. This enables the identification of technological choices, processes of innovation and behavioral changes, also present at other sites in the region that are expressed over time. The set of information presented here engages with recent debates on the emergence of complex societies, providing some insight into the historical development of this polity in Amazonia during the late precolonial period.

Keywords Amazonian archaeology · Complex societies · Santarém phase · Ceramic analysis · INAA · Technological innovation

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Introduction

Archaeological research in Amazonia has been notable for its demonstration of the relationship between anthropic alterations in the landscape and the cultural development of human societies from the late precolonial period, highlighting the emergence of complex social formations. Examples include the anthropogenic soils interpreted as a correlate of large sites (Arroyo-Kalin, 2014; Woods & McCann, 1999); earthwork fishing structures (Erickson, 2000); raised fields (Rostain, 2017); the existence of extensive networks of paths linking different classes of settlements (Heckenberger, 2005; Heckenberger et al., 2008; Saunaluoma et al., 2021); geometric earthworks (Schaan et al., 2013; de Souza et al., 2018; Iriarte et al., 2020a); the construction of funerary and habitational mounds (Prümers, 2017; Roosevelt, 1991; Schaan, 2008); stilt house settlements (Navarro, 2018); megalithic structures composed of granite slabs (Saldanha, 2022); and civic-ceremonial architecture including pyramids (Prümers et al., 2022), which comprise significant forms of landscape intervention. Based on this evidence, scholars have described the existence of late precolonial polities in Amazonia, established on the floodplains of the major rivers, but also along the southern tributaries of the Amazon.

Heckenberger (2005) described the emergence of regional societies in *terra firme* forest of the Upper Xingu basin, Southern Amazonia, between AD 1200 and 1500. This involved a complex pattern of land use for cultivation and planned settlements with central plazas, including villages up to 50 ha in size, connected by a network of paths and roads that integrated peer polities covering an area of around 250 km^2. These multi-centric settlements were hierarchically organized and gravitated around a political and ceremonial center; many of them were surrounded by defensive ditches, whose central plazas testify to the importance of the public rituals and comprise the main distinguishing feature of these precolonial polities.

Another important example is found on Marajó Island, where Schaan (2008) concentrated her research on a hierarchical cluster of 32 residential and ceremonial mounds. Extending for ten kilometers along the Camutins creek, these contained highly elaborate funerary urns and ceramic artifacts related to festivities, ancestor worship and women's rituals. The author's interpretative model proposes the existence of a non-agricultural chiefdom, based on centralized control of a hydraulic water management system composed of canals, wells and dams located next to the mounds, constructed in the region between AD 700 and 1000.

Between the sixteenth and eighteenth centuries, the ethnohistorical chronicles pertaining to the Santarém region mention the existence of an indigenous group called the Tapajó, whose main village was located at the confluence of the eponymous river and the Amazon (Fig. 1). From the voyage undertaken by Carvajal, who journeyed along the Amazon river in 1542, we know that this village was densely populated (Carvajal, 1941). According to Maurício de Heriarte (1874), who visited the locality in 1639, it was capable of assembling 60,000 warriors from all over the region, much feared by other tribes. The same chronicler

Fig. 1 Map of the research area

emphasizes that the smaller villages possessed between 20 and 30 communal houses. Each village had a chief and above them all a supreme chief. The Tapajó planted maize and manioc in the floodlands, harvested wild rice, fished, and hunted game. They manufactured ceramics and made green stone artifacts in the shape of birds, frogs and other figures. Also mentioned are collective rituals, funerary ceremonies that included the ingestion of calcinated bones mixed with beverages, and the worship of idols deposited in sanctuaries. During the missionary occupation in Santarém, between AD 1631 and 1759, the priests Felipe Betendorf and João Daniel reported destroying the bodies of chiefs and ancestors that had been mummified and conserved in specific structures (Betendorf, 1910; Daniel, 1976).

Despite rejecting the possibility that precolonial complex societies could have developed, due to the limitations imposed by the Amazonian environment, Meggers (1971) cites ethnohistorical references to affirm that floodplain societies like the Tapajó in Santarém presented a higher level of cultural development than those of the *terra firme* forest. Along with Marajó, Santarém was classified by Roosevelt as a chiefdom, or a regional formation, densely populated, with large habitational sites, social stratification, and political centralization (Roosevelt,

1980, 1987, 1993). Years later, influenced by the concept of heterarchy, the same author considered Santarém as 'a complex chiefdom with moderate centralization' (Roosevelt, 1999). A consensus nonetheless exists among the researchers about the absence of a more precise definition, based on empirical data, for the type of social formation that developed in Santarém (Gomes, 2017; Stenborg et al., 2018).

This article synthesizes the existing archaeological evidence pointing to the emergence of a regional society in Santarém during the late precolonial period (AD 1000–1600). It considers the hierarchical settlement patterns, the existence of highly elaborate ceremonial ceramics found in specific disposal structures, and the manufacture of green stone ornaments that comprised prestige goods in long-distance exchange networks linking the Lower Amazon, the Guianas and the Caribbean (Boomert, 1987; Rostain, 2010; Wassén, 1934), as well as the Maranhão Lowlands (Navarro, 2017) and other regions of Amazonia. The available regional chronology allowed the historical reconstruction of the trajectory of this society, initially seen from the perspective of the large central villages (Aldeia and Porto sites). However, the information on smaller villages has proven indispensable to the broader understanding of the power strategies operating regionally.

Taking this cue, our focus here is on the Carapanari site (AD 1440–1690). Our goal is to obtain a better understanding of the lifeways of communities located in the Santarém area, evaluating both the local ceramic production and the degree of autonomy of these communities in relation to the large villages located in the same region. We adopt an integrated methodological approach, conducting a technofunctional study of the ceramics recovered from the Carapanari site combined with instrumental neutron activation analysis (INAA), which consists of a nuclear technique to determine the elemental composition of ceramics, exposing small samples of materials to the field generated by a nuclear reactor that activates the radioactive isotopes of the elements present (Minc & Sterba, 2017, p. 424). This technique was important to define technological choices at this site beyond visual analysis of the ceramics. The ceramic assemblages from the Carapanari site have also been analyzed in terms of their technological, decorative, morphological and functional aspects, based on performance characteristics, focusing not only on ritual artifacts, but especially on artifacts of domestic use that are still seldom explored in the existing literature.

At a theoretical level, this article draws from recent debates that reassess the concept of chiefdom as a category that extends far beyond the typological vision typical of processual archaeology, recognizing instead its variability and multidimensionality (Carneiro, 2017; Earle, 2021). We also consider the existence of social forms analogous to chiefdoms (Grinin & Korotayev, 2017), as well as the possibility of distinguishing between horizontal chieftains and centralized chiefdoms (Earle, 2021).

We conclude that a regional society developed in Santarém, in the Lower Amazon, during the late precolonial period (AD 1000–1600), beginning with a densely populated habitational and religious nucleus composed of two large contemporaneous villages. This society was characterized by the existence of ideological chieftains, who succeeded each other over time, based on the importance of shamans as

spiritual leaders. From 1300 AD a process of demographic fission began that gave rise to villages, like the Carapanari site, which resisted political centralization and were autonomous in terms of subsistence and ceramic production, although united by a cultural and religious affinity. Attempts at greater centralization of power and social stratification can be materially inferred from the establishment of a long-distance network of producing and exchanging goods, which seems to dissolve at a determined moment, giving way to the local production of adornments from less prestigious materials. This suggests a historical process of forming a horizontally integrated regional polity.

Theoretical Background

Carneiro (1970) brings to light the existence of chiefdoms, also present in pre-colonial times on the Amazon floodplains. Defined by the author as an autonomous political unit, comprising several communities under the permanent control of a supreme chief, the political genesis of the chiefdom is associated with population increases and with the warfare resulting from disputes over agricultural lands, circumscribed to specific environments. Among the archaeological indicators for the identification of chiefdoms found in various parts of the world are monumental architecture, ceremonial centers, burials with signs of social differentiation, the distribution of prestigious goods, and a hierarchy of settlements. The latter, considered by the author as the most efficient means to recognize a chiefdom, presupposes the existence of small communities subordinated to large central settlements (Carneiro, 1981).

Since then, the debate on using this analytic category as a socio-evolutionary model for theorizing human development has advanced, emphasizing both the great variability of chiefdoms and the distinct ways of accessing power (Drennan & Uribe, 1987; Earle, 1997; Feinman & Neitzel, 1984; Yoffee, 1993, 2005). More recently, a strong criticism of the study of complex societies has been formulated, pointing out the inability of the concept of chiefdom to recognize the plurality of social organizations, forms of regional integration, political structures and historical experiences, especially when the concept is used as an explanatory device (Pauketat, 2007, p. 81).

This questioning has cleared the way for consideration of other forms of conceptualizing complex societies, which may also be non-hierarchical or even retain heterogeneous aspects (Ross & Steadman, 2017, p. 4). Responding to Pauketat's critique, Carneiro (2017) argues that the process of sociocultural complexity is multidimensional and multilinear. He insists on the contemporary relevance of the concept of the chiefdom as an essentially political entity with a heuristic value for both anthropology and archaeology, serving in formulations that attempt to explain the transition from simple sociopolitical systems to those of greater complexity. Grinin and Korotayev (2017) propose a distinction between the classic concept of chiefdom and chiefdom analogues, which encompasses different social morphologies (mono-settlements, horizontally integrated poly-settlements and corporate formations).

Based on an approach that foregrounds the potential of anthropological archaeology as a comparative social science, Earle (2021) revisits the discussion of chiefdoms by incorporating contemporary questions such as the considerable variability

in regional polities compared to the typological vision, the role of individual agency, and the importance of apprehending long-term historical processes. Classic ethnographies like those of the Tikopia of the Pacific (Firth, 1936), the Kachin of South East Asia (Leach, 1965), the Nuer of the African continent (Evans-Prichard, 1940) and the historical accounts of the Panamá chiefdoms, are consulted in detail along with the data from archaeological research conducted by Earle in Hawai'i (AD 800–1824), at Thy (2300–1000 BC) in Denmark, and at Wanka (AD 500–1534) in the Mantaro Valley, Peru. This material enabled the author to identify different modes of production of chiefdoms—ritual, corporative (defensive), hydraulic and predatory (economy of prestige goods)—which possess their own archaeological signatures. Encompassing an ample spectrum of social formations that spans from strongly centralized classical chiefdoms like those of Hawai'i to more egalitarian chieftains, Earle's fundamental contribution allowed us to identify characteristics essential for comprehending the historical trajectory of the society that developed in Santarém during the late precolonial period.

Research Background

In an ecologically diverse region of floodplain areas and dense *terra firme* forest between the Amazon and Tapajós rivers in Pará state, Brazil, are located precolonial archaeological sites of the Santarém culture. Late phase pottery from this culture has been known since the nineteenth century as a result of collections and excavations conducted by travelers and naturalists (Barbosa Rodrigues, 1875; Hartt, 1885). From 1923 to 1926, the German ethnologist Curt Nimuendajú gathered a ceramic and lithic collection for the Gothenburg Museum in Sweden, and undertook an important survey of sites in the Santarém region, identifying 65 sites and enabling the dispersion area of this culture to be delimited in an ample region of 23,000 km^2.This area was characterized by a consistent ceramic style that the author associated with the Tapajó—an indigenous group first mentioned by ethnohistorical chronicles from the sixteenth century (Nimuendajú, 1949, 2004).

As well as establishing that the largest anthropogenic dark earth (ADE) settlements were found where the city of Santarém is located today, Nimuendajú highlighted the existence of artificial wells used for water storage and paths linking the sites in the plateau area to the area south of Santarém. However, it was through the Swedish archaeologist Erland Nordenskiöld (1930) and his book *L'archéologie du bassin de l'Amazone* that the ceramic forms of Santarém became known worldwide.

In the 1930s, studies began of museological collections in both Europe and the United States holding ceramic artifacts from the Santarém phase. Highly relevant are the analyses conducted by Palmatary (1939, 1960) and Barata (1950, 1953a, 1953b), which describe and photographically document the variability of ceramic vessels from Santarém. Barata is responsible for the classification of three types of ritual forms—the globular, necked and caryatid vessels—as well as plates and different types of anthropomorphic figurines.

These ritual vessels are notable for their complex forms, including three-dimensional appendages of tropical forest animals that realistically depict

species like jaguars, king vultures, wild dogs, toads, caimans and so on, along with hybrid, anthropozoomorphic beings. These artifacts probably had a mnemonic function, associated with Amazonian mytho-cosmologies and shamanism. Equally elaborate are the female figurines and the large seated male figurines, whose attributes, including their body ornaments and musical instruments, refer to shamans. Studies of collections are still being produced, with an interest in iconographic analyses continuing in the present (Corrêa, 1965; Gomes, 2002, 2007, 2012, 2017, 2022; Guapindaia, 1993; McDonald, 1972; Roosevelt, 1988). Found at large sites (Aldeia and Porto) and also at smaller sites, the ritual pottery of the late phase has drawn the attention of researchers to the archaeological importance of the Santarém region.

It is worth emphasizing that scientific archaeological research only began in Santarém in the 1980s. Roosevelt was responsible for compiling a regional chronology that demonstrated the time depth of human presence in Amazonia, beginning with the hunter-gatherers of the tropical rainforest who inhabited the Pedra Pintada cave in Monte Alegre from 9250 to 8050 BC (Table 1). The antiquity of the ceramics was also documented to the east of Santarém, in the freshwater shell midden of Taperinha, previously excavated by the geologist Charles Frederic Hartt in the nineteenth century, showing an occupation of fisher-gatherers dated between 5130 and 3755 BC (Quinn, 2004; Roosevelt, 1995; Roosevelt et al., 1991). Other occupations by pottery-making populations associated with semi-sedentary lifestyles were identified at diverse sites in the region with dates ranging between 1850 BC and AD 150 (Gomes, 2008, 2011, 2017; Quinn, 2004; Roosevelt, 1995). Permanent villages were also recorded on the Lower Tapajós between AD 630 and 1040, with a large artifactual variability, linked to the Parauá ceramics of the Incised-Punctate tradition (Gomes, 2008).

The Porto site, located in a relatively well-preserved area within the urban zone of the modern city of Santarém, was chosen by Roosevelt to provide evidence of the final period of the region's cultural sequence, associated with the emergence of complex societies. Reading through ethno-historical sources from the seventeenth and eighteenth centuries that mention the presence of the Tapajó, Roosevelt identified textual references to indigenous settlements with large population densities, the presence of powerful chiefs with supralocal power, and indicators of social hierarchy and ancestor veneration ceremonies. Along with the elaborate material culture, these elements were taken by the author to indicate a social formation of the complex chiefdom type. Combined with the apparent hierarchy of sites, given by the comparison between the areas of larger sites (Aldeia and Porto) and smaller sites, identified by Roosevelt as satellite communities, this material contributed to the idea of political centralization (Roosevelt, 1987, 1993, 1999). Systemic research on the regional settlement patterns was not conducted by Roosevelt to conform this hypothesis.

Fieldwork conducted by Roosevelt and colleagues at the Porto site in Santarém provided a chronology with dates between 960 and 320 BC, related by the researchers to the pottery of the formative period, and AD 1286–1570 for the late phase of Santarém ceramics. At this site, structures associated with collective habitations were found, as well as domestic and ritual ceramics deposited in bell-shaped pits. However, these studies were inconclusive in terms of providing

Table 1 Chronological periods of Santarém Region, Lower Amazon, Brazil

Chronological periods	Sites	Dates	References
Ancient hunter-gathers	Pedra Pintada Cave, Monte Alegre	9250–8050 BC	Roosevelt et al. (1996)
Ancient ceramist fisher-collectors	Shell-mound at Taperinha, east of Santarém, Amazon River	5130–3755 BC	Roosevelt et al. (1991)
Sparse occupations of ceramists	Parauá, Lower Tapajós, Santarém (Incised Rim Tradition)	1850 BC–AD110	Gomes (2008)
	Aroxi, Monte Alegre	1650–1290 BC	Quinn (2004)
	Porto Site, Santarém (Pocó Phase)	1310–320 BC	Alves (2015), Quinn (2004)
	Aldeia Site, Santarém (Pocó Phase)	1050 BC–AD 150	Gomes (2011, 2017)
Permanent settlements	Parauá, Lower Tapajós, Santarém (Incised Punctate Tradition)	AD 630–1040	Gomes (2008)
Initial ocupation of late phase	Porto Site, Santarém (Santarém Phase)	AD 990	Alves (2015)
Development of complex society	Porto Site, Santarém (Santarém Phase)	AD1286–1570	Quinn (2004)
	Aldeia Site, Santarém (Santarém Phase)	AD 1300–1540	Gomes (2017)
Late expansion	Bom Futuro, Amapá and Cedro sites, Belterra Plateau (Santarém Phase)	AD 1320–1710	Schaan (2016)
	Carapanari site, Santarém (Santarém Phase)	AD 1440–1690	Gomes (2017)

material evidence to support the debate on hierarchical and stratified social formations (Quinn, 2004, p. 237).

The excavations conducted at the Porto site by Schaan, relating to the late-precolonial period, also revealed evidence of habitational floors and bell-shaped pits for depositing the waste from domestic and ritual activities (Schaan, 2015, 2016). Around 108 sites were located in the region. Research on the Belterra plateau, revealing dates between AD 1320 and 1710, suggests that an earlier period of occupation at the Aldeia and Porto sites was followed by an expansion during the Santarém phase, which in the case of the Cedro, Bom Futuro and Amapá sites continued until the colonial period (Schaan, 2016). The villages contained facilities like water storage ponds and paths linking the settlements (Stenborg, 2016). Use of LIDAR technology enabled these ponds to be identified remotely at sites far from the shores of the main rivers, permitting the Santarém culture's area of occurrence to be projected much further south of the Tapajós river—around 160 km south of the modern city of Santarém (Stenborg et al., 2018).

Through a survey of 31 sites and contextual excavations in the Santarém region, Gomes (2017) obtained data that confirmed the existence of large and densely populated habitational sites (Aldeia and Porto), whose populations began fissioning into smaller units from about AD 1300, giving rise to other communities in the region that show signs of autonomy. Based on an archaeological approach highlighting the role performed by relational ontologies, artifactual studies proved extremely valuable. Along with figurines of shamans, the distribution of ritual artifacts bearing a mytho-cosmological symbolism related to shamanism, found across a broad geographical area in which Santarém ceramics occur, suggests a flow of relations, esoteric knowledge, exchanges of objects, cults and the presence of spiritual leaders. Taken as a whole, this information led the author to reject the hypothesis of a politically centralized sociopolitical organization and conclude that, along with the processes of population increase followed by fissioning, ritual activity was the most prominent aspect in Santarém's archaeological record and seems to have structured the region at a political level.

Research in the urban area of Santarém city delimited two large sites—Aldeia (120 ha) and Porto (89 ha)—separated by a seasonal lake (Fig. 2). These sites were also found to be contemporary during the most intense phase of late occupation, although a single older date of AD 990 had been recorded at the Porto site by Schaan and colleagues (Alves, 2015). Excavations conducted at the Aldeia site (AD 1300–1540), and Porto site (AD 1286–1570) have demonstrated the existence of a complex stratigraphy of dense layers of ADE, extending up to 2.5 m in depth, with the depositing of domestic ceramics and the existence of bell-shaped pits (Fig. 3). The latter contained various highly elaborate artifacts of ritual use, some of them utilized for storing and containing liquids, and others to serve solid foods. These exhibit iconographic themes associated with shamanism and predatory mytho-cosmologies, with an emphasis on images of body transformation (Gomes, 2017). Additionally, a survey undertaken on the right bank of the Tapajós river, across a 500 km^2 area, revealed evidence of 29 ADE sites containing domestic and ritual pottery associated with the Santarém late phase (Gomes, 2017; Gomes et al., 2018).

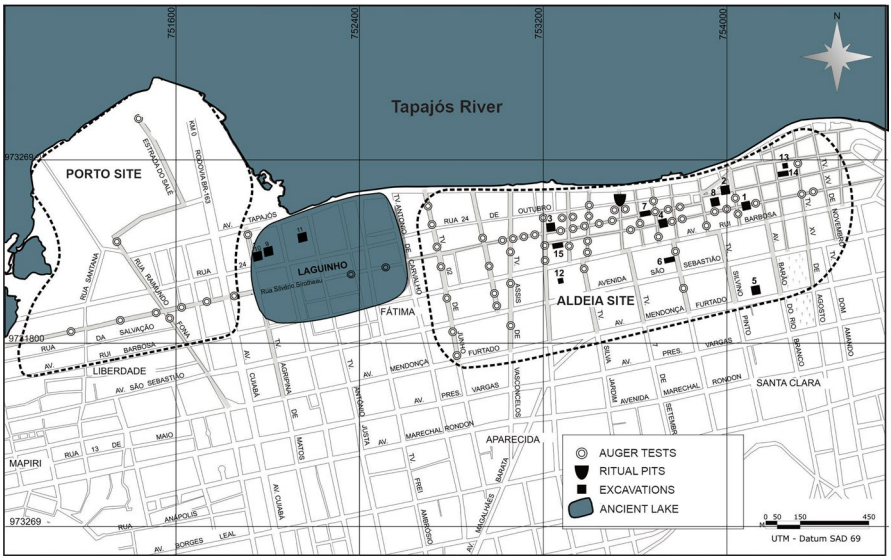


Fig. 2 Map showing the Aldeia and Porto sites, located in the urban area of Santarém, Pará, Lower Amazon, Brazil

Fig. 3 Excavation of unit 14, showing the depth of the anthropogenic dark earth (ADE) layer. Aldeia site, Santarém, PA. Photo: Author

Systematization of the Archaeological Information

The large villages (Aldeia and Porto sites) are located at the confluence of the Tapajós and Amazon rivers, at a topographical location favorable in terms of ecology and resource availability. Although both sites are today located in an urbanized area, the Aldeia site shows a greater impact, being completely covered in tarmac, which precludes reaching any precise conclusions about the distribution and layout of houses and so on. Excavations at this site were conducted in residential backyards, commercial establishments, school yards and common land (Gomes, 2011, 2017), revealing a complex stratigraphy. Other smaller sites were established close to river shores, but also at different localities in the landscape, next to lakes, inland close to small creeks, on steep hillsides and in the plateau region. Compiling the data from all the surveys already conducted in the Santarém region, from Nimuendajú in the 1920s (1949, 2004) to Schaan (2016), Gomes (2017), Gomes et al. (2018), Stenborg (2016), Stenborg et al. (2018) and Figueiredo (2019), gave a total of 190 sites.

The results show that the area of regional dispersal of the late sites, associated with the Santarém phase, presents a higher density on the Lower Tapajós, with few sites located on the Middle Tapajós, which represents an expansion of the southern limit of the Santarém culture (Fig. 4). Significant differences exist in the size of the sites bordering rivers, those located in *terra firme* forest inland, in the plateau region of Belterra and other localities less attractive to the establishment of new villages, suggesting the relevance of political factors in the implantation of these sites. These factors appear to explain the choice of locations distant from the large villages for

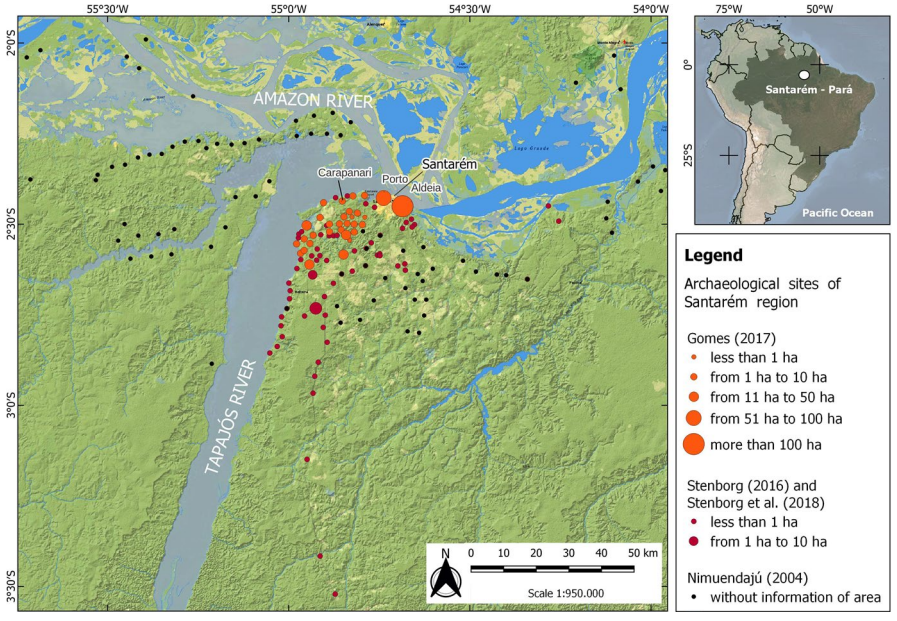


Fig. 4 Map showing the distribution of the archaeological sites of the Santarém region and their hierarchy

the founding of new settlements. The impression given is that diverse parts of the landscape were occupied in an endeavor to move away from the center of power.

The regional settlement patterns clearly indicate a hierarchy of localities in which the Aldeia and Porto sites stand out with 120 ha and 89 ha respectively. Both are long-term habitational sites close to a river where their occupants conducted activities associated with food preparation and the production of utilitarian pottery artifacts, lithic artifacts and, no less important, objects related to shamanic practices, along with structures for disposing of artifacts used in everyday and ceremonial contexts. These reveal an intense ritual activity over the course of three centuries. Although the dimensions of the Aldeia and Porto sites are indicative of massive settlements, the material evidence suggests more heterarchic patterns, without any notable differences in the distribution of objects among people. However, the prominence of these sites in the regional space is undeniable, comprising centers with a higher population density and sociopolitical influence, the latter inferred from the shamanic ritual activities whose relevance is demonstrated by the ceremonial artifacts and ritual disposal structures.

Most of the smaller sites are between 1 and 10 ha in size. Only a few sites over 10 ha in size are found far from the main river, one example being the Cedro site (20 ha), located in the Belterra plateau region, in an area distant from the main river but where wells were dug to obtain water. Evaluated in combination with the available datings, these findings are indeed evidence of a process of regional expansion with the establishment of new villages that originated from the large villages. The regional chronology indicates three moments: the first related to the start of the late occupation of the Santarém phase at the Porto site in AD 990; the second between AD 1298 and 1570, which demonstrates the contemporaneity of the Aldeia and Porto sites, as well as the regional expansion through the establishment of other villages; and finally the third period, dated between AD 1660 and 1710,which shows the historical resilience of peripheral sites during the colonial period (Table 2 and Fig. 5).

This expansion began around AD 1320 with the occupation of the Belterra plateau region, including the Cedro site, followed by the Bom Sucesso site in AD 1364, and around a century later by the Carapanari site in AD 1440. Along with the domestic-use pottery, encountered in high densities at all the habitational sites, the same kinds of ritual artifacts found at Aldeia and Porto were unearthed at these smaller sites, indicating that shamanic practices extended across a vast area, a fact confirmed by other surveys (Figueiredo, 2019; Gomes, 2017; Schaan, 2015). A stylistic flexibility was also observed, though, which reinforces the idea of the autonomy of these communities vis-à-vis larger sites (Gomes, 2017; Gomes et al., 2018).

The ritual ceramic artifacts, found in large villages, show considerable uniformity in design: complex compositions and details reveal the animation of beings and also refer to cosmological concepts relating to the structure of the cosmos (Gomes, 2010, pp. 219–220). Specific combinations of predatory animals (jaguar, harpy eagles, caimans), prey animals (pacas, agoutis) and an infinitude of non-human beings suggest an association with mythological narratives, forming what Severi (2012) describes as ‘arts of memory.’ There are also stylized female figurines, others of hybrid beings in a state of bodily transformation, and large realist figurines of shamans. The latter

Table 2 Late Chronology of Central Sites of Santarém (Porto and Aldeia), Plateau Sites (Cedro, Bom Futuro, Amapá) and Carapanari

Laboratory data	Site	Unity of excavation	Depth	Radiocarbon age BP	Radiocarbon age AD	Calibrated age range BP (2∂) 95% confidence	Calibrated age range AD (2∂) 95% confidence	References
Beta 322202	Porto	N240/6L150	63 cm	960 ± 30	990	920–780	1020–1170	Alves (2015)
WK6844	Porto	20/5N	–	664 ± 57	1286	680–540	1270–1410	Quinn (2004)
WK6837	Porto	11/4B	–	652 ± 56	1298	670–540	1280–1410	Quinn (2004)
WK6843	Porto	18	–	650 ± 59	1300	670–540	1270–1410	Quinn (2004)
Beta 248483	Aldeia	2/3	80 cm	650 ± 40	1300	670–550	1280–1400	Gomes (2017)
ICA 16C/0747	Cedro	6	94 cm	630 ± 30	1320	650–550	1300–1400	Troufflard and Alves (2019)
Beta 248484	Aldeia	2/3	100 cm	600 ± 40	1350	650–530	1300–1420	Gomes (2017)
ICA 16C/0749	Cedro	7	43 cm	600 ± 20	1350	640–540	1310–1410	Troufflard and Alves (2019)
WK6839	Porto	12	–	586 ± 56	1364	650–510	1300–1440	Quinn, (2004)
Ua46306	Bom Futuro	–	68 cm	586 ± 30	1364	640–520	1310–1430	Stenborg (2016)
WK6833	Porto	8	–	583 ± 57	1367	650–510	1300–1440	Quinn, 2004
ICA 16C/0748	Cedro	7	26 cm	580 ± 20	1370	630–530	1320–1420	Troufflard and Alves (2019)
Beta 391786	Aldeia	15/1	70 cm	570 ± 30	1380	640–520	1310–1430	Gomes (2017)
Beta 248487	Aldeia	4/3	160 cm	550 ± 40	1400	630–500	1310–1450	Gomes (2017)
Beta 324192	Cedro	1	18 cm	550 ± 30	1400	630–510	1320–1440	Schaan (2016)
Ua46305	Bom Futuro	–	58 cm	540 ± 30	1410	620–510	1320–1440	Stenborg (2016)
WK6840	Porto	12	–	537 ± 58	1413	650–480	1300–1470	Quinn (2004)
ICA 16C/0746	Cedro	6	52 cm	530 ± 20	1420	550–510	1400–1440	Troufflard and Alves (2019)
WK6846	Porto	25	–	512 ± 60	1438	650–350	1310–1510	Quinn (2004)
ICA 16C/0751	Cedro	13	48 cm	510 ± 20	1440	540–500	1410–1450	Troufflard and Alves (2019)
Beta 234474	Carapanari	4/3	60 cm	510 ± 60	1440	650–330	1310–1510	Gomes (2017)
Ua46304	Bom Futuro	–	47 cm	497 ± 30	1453	550–490	1400–1450	Stenborg (2016)

Table 2 (continued)

Laboratory data	Site	Unity of excavation	Depth	Radiocarbon age BP	Radiocarbon age AD	Calibrated age range BP (2∂) 95% confidence	Calibrated age range AD (2∂) 95% confidence	References
ICA 16C/0745	Cedro	6	24 cm	460 ± 20	1490	530–480	1420–1470	Troufflard and Alves (2019)
WK6845	Porto	25	–	455 ± 63	1495	620–320	1330–1630	Quinn (2004)
WK6837	Porto	11/4B	–	452 ± 57	1498	550–320	1400–1630	Quinn (2004)
Beta 234473	Carapanari	4/2	50 cm	450 ± 50	1500	550–320	1410–1630	Gomes (2017)
Beta 248489	Aldeia	4/4	150 cm	450 ± 40	1500	540–330	1410–1620	Gomes (2017)
WK6841	Porto	13	–	425 ± 56	1525	530–320	1420–1630	Quinn (2004)
Beta 248486	Aldeia	4/4	130 cm	420 ± 40	1530	520–320	1430–1630	Gomes (2017)
WK6842	Porto	15C	–	418 ± 59	1532	530–320	1420–1630	Quinn (2004)
WK6838	Porto	11/4B	–	413 ± 56	1537	520–320	1420–1630	Quinn (2004)
Beta 248488	Aldeia	4/3	190 cm	410 ± 40	1540	520–320	1430–1630	Gomes (2017)
Beta 234472	Carapanari	4/2	20 cm	390 ± 50	1560	510–310	1440–1630	Gomes (2017)
WK6832	Porto	5	–	386 ± 62	1564	510–310	1440–1640	Quinn, 2004
WK6835	Porto	9B	–	380 ± 64	1570	510–300	1440–1650	Quinn (2004)
Beta 324178	Bom Futuro	1	20–25 cm	350 ± 30	1600	480–310	1470–1640	Schaan (2016)
Beta 234470	Carapanari	1/6	150 cm	340 ± 80	1610	520–150	1430–1800	Gomes (2017)
Beta 234468	Carapanari	1/6	130 cm	330 ± 70	1640	510–150	1440–1800	Gomes (2017)
Beta 324176	Amapá	AMP 001	70–80 cm	300 ± 30	1650	450–290	1500–1660	Schaan (2016)
Beta 234471	Carapanari	3/1	40 cm	260 ± 40	1690	450–150	1500–1800	Gomes (2017)
Beta 324193	Cedro	T1	23 cm	240 ± 30	1710	420–240	1630–1810	Schaan (2016)

Calibrated by OxCal 4.4 online with IntCal13 atmospheric curve

OxCal v.4.4.4 Bronk Ramsey (2021), r.5; Atmospheric data from Reimer et al. (2020)

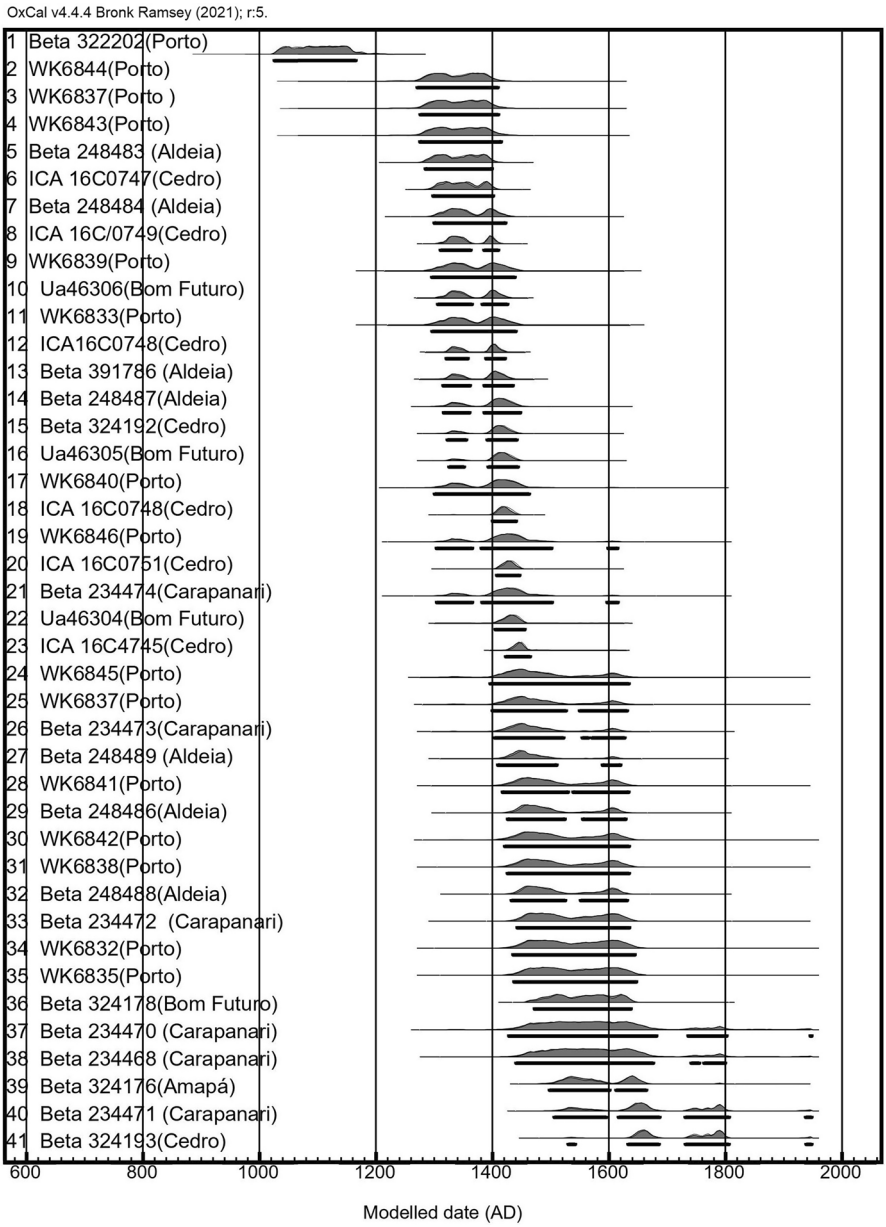


Fig. 5 Distribution of the C14 dates associated with the Santarém phase

show corpulent men sat on stools or seated with their legs crossed, male genitalia, and body ornaments like bracelets, earplugs and jaguar tooth necklaces. These artifacts point to the personification of shamans as individuals with considerable prestige (Fig. 6).

Fig. 6 Figurines and ritual paraphernalia from the Santarém phase: **a** Male figurine holding a gourd rattle; **b** Male figurine wearing various body adornments in a position suggestive of a shaman; **c** Figurine of a hybrid being, half snake, half shaman, in a state of bodily transformation; **d** Cup with a depiction of a harpy eagle superimposed on an anthropomorphic face; **e** Globular vessel with a hybrid being, half man, half animal, in a state of bodily transformation; f. Caryatid vessel synthesizing the 3 cosmic layers; g. Globular vessel with a caiman head and a shaman sat on the animal's tail; h. Necked vessel with the figures of a caiman, a wild dog and a king vulture. MAE-USP (Adapted from Gomes, 2002)

Taken as a whole, these objects have been considered part of an American aesthetics (Gomes, 2012, 2022), aligned with cosmological conceptions known through Amazonian ethnology, especially the concept of Amerindian perspectivism, which implies the different and alternating perspectives that humans and non-humans can assume as subjects, along with the possibility of bodily transformation (Viveiros de Castro, 1996, 2002). Along with the male figurines, indicative of the importance of shamanism as an institution, are objects with a mnemonic function and others that allude to the instability of forms. These objects were involved in politically important collective ceremonies, considered here to be events that permit the condensation of paradoxical situations, communicating distinct realities in synthetic form (Lagrou, 2007, p. 149).

Alongside ritual ceramics there exist small adornments of green stones (~3 cm in length) in the shape of frogs and more rarely other animals found in the region. The former were generally manufactured from tremolite-actinolite (Costa et al., 2002), as well as other raw materials like jade-jadeite not found in Amazonia (Fig. 7). The available literature associates the existence of these artifacts, known as *muiraquitãs*, with an extensive exchange network of prestige goods, involving chiefdoms of the Lower Amazon, Guianas and Caribbean (Boomert, 1987; Rostain, 2010; Wassen, 1934), as well as the Maranhão Lowlands (Navarro, 2017). These objects are pendants with holes on the side. Made by specialists, these items of jewelry were

Fig. 7 Green stone adornment in the form of a frog (3.4×2.0 cm),with lateral holes, made from tremolite-actinolite. Museu Nacional-UFRJ. Photo: author

symbolic artifacts whose existence in this exchange network, Earle (2021) argues, is an indication of a mode of predatory production typical of individual chiefdoms, marked by a non-institutionalized power. Tools such as awls and drills related to the manufacture of *muiraquitãs* were found in stone workshops at the Porto site, pointing to their local production (Moraes et al., 2014). Another significant aspect is the emulation of these adornments, which at some point began to be fabricated in the Lower Tapajós using less high-quality materials, such as basalt, with which stone ax blades are made. This suggests a connection with cyclical political processes involving alternations in power (Fig. 8).

Finally, we can highlight the lengthy duration of the Cedro, Bom Futuro, Amapá and Carapanari sites, occupied until the colonial period (AD 1600–1710). Records of the presence of European explorers in the Santarém region begin in 1542 with the

Fig. 8 Adornment in the shape of a frog (5.0 × 4.0 cm), with lateral holes, made from basalt, a raw material commonly used to make polished ax blades. Private collection, Santarém, PA. Photo: Author

Spanish expedition of Francisco de Orellana, who was the first to travel down the Amazon river. Carvajal (1941), the chronicler of this expedition, passing through a region whose geographic description closely matches the Tapajós river, reported the existence of large settlements with population densities similar to towns, governed by chiefs. However, he records that they had no direct contact with the indigenous population of this region: the expedition was merely observed by a large number of people from their canoes. In 1637, during the expedition of Portuguese explorer Pedro Teixeira, who left Belém heading towards Quito, the accounts show that contacts were made with the region's indigenous population, who welcomed the travelers, although the latter saw human remains and the weapons of Dutch soldiers killed by the Tapajó (Rojas, 1941).

On the return journey of the same expedition, which set out from Quito in 1639, both the chronicler Acuña (1941), a Jesuit priest, and Heriarte (1874) produced reports with detailed ethnographic information on Tapajó customs, their hierarchical form of government, collective religious ceremonies and funerary rites involving the ingestion of calcinated bones of dead kin mixed with drinks. During this period, judging by Acuña's testimony, the contacts between Portuguese and Amerindians became more intense and no less violent, including episodes such as the one involving Bento Maciel's troop, who ended up raiding villages and enslaving groups of Tapajó. This can be considered a pivotal event in the region's chronology, signaling the more permanent presence of the European colonizers.

In 1661, religious missions began to be established in the region with a base in Santarém and diverse mission villages on the Tapajós and Arapiuns rivers, which would remain in operation until 1759. The missionaries were themselves agents in the cultural disintegration of the Tapajó. This broad set of information enables us to evaluate the effects of colonization on these indigenous populations at different moments in time and also to reflect on their resistance strategies in continuing to occupy the Cedro, Bom Futuro, Amapá and Carapanari sites until a late period contemporaneous with the religious missions.

Fieldwork at the Carapanari Site

The Carapanari site (2° 25′25.85″S, 54° 50′46.57″W) is situated on the right shore of the Tapajós—a long clearwater river (840 km in length), which rises in Central Brazil and flows into the Amazon. The site occupies the top of a 60 m hill with gullied slopes, covered in dense secondary vegetation. Invisible from the river itself, the site's conditions were favorable in defensive terms, concealing the settlement from potential rival groups but above all from the European presence during later periods. The site is located about 12 km south of the present-day city of Santarém, in Pará state. Fieldwork studies were focused on the delimitation, mapping, and intensive excavation of the area, allowing characterization of the intra-site space and contextualization of its ritual activities, associated with Santarém late phase ceramics. The site was mapped with the assistance of a total station (Leica TPS 1201) and a geodetic GPS (Fig. 9).

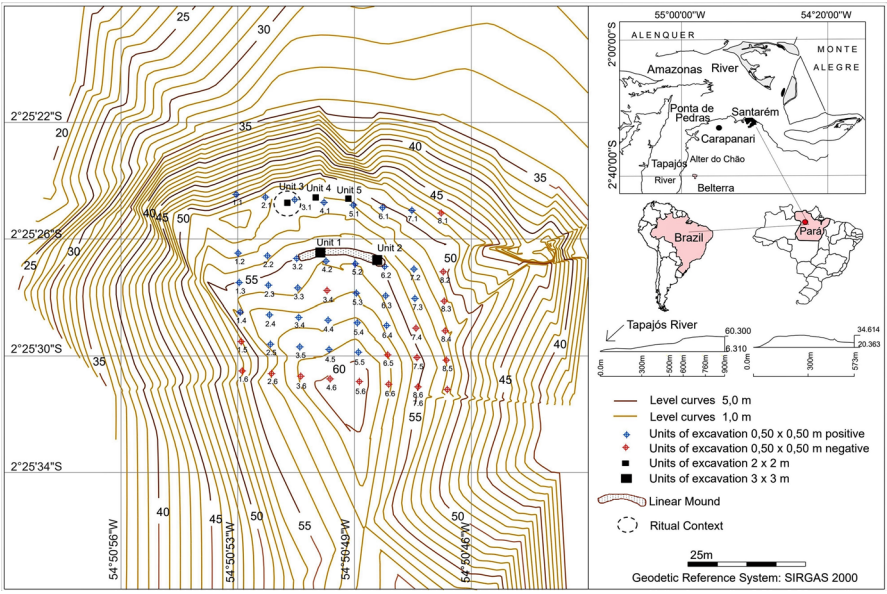


Fig. 9 Topographical map of the Carapanari Site, Santarém, Lower Amazon, Brazil. Survey: Jordan Bezerra Galvão

The excavation of 48 test pits distributed at 20 m intervals revealed a site with pottery fragments distributed over an area 150 m × 175 m (26,250 m^2) in size, located at the top of a hill whose highest point is 900 m from the shores of the Tapajós river. This data enabled the elaboration of a topographic map of the site. Five large excavation units were plotted in different areas of the site. The dimensions of the units varied between 9 m^2 and 4 m^2, with an average depth of 2.0 m. A total of 30 m^2 was excavated at artificial 5 cm levels. The results allowed an understanding of intrasite variability with waste disposal areas and ceremonial sectors (Fig. 10).

The first two units of 9 m^2 were excavated in areas containing linear mounds. The artificial origin of these features was identified by their structure, soil texture and composition, associated with intentional soil movements, modifications, and the accumulation of artifacts to keep the main area clear, eventually forming these ridges of waste. Below these mounds was a horizon of ADE (10YR 1.7/1) of sandy texture containing ceramics and lithics (Fig. 11).

Unit 3 unearthed a diagnostic artifact from the Santarém phase (a globular vessel with a caiman head), surrounded by concentrations of ashes, suggesting a ritual context possibly involving the ingestion of calcinated human bone ashes mixed with fermented drink, as documented by ethnohistorical chronicles (Fig. 12). The dating obtained for this context (AD 1690) points to fairly late activity at the Carapanari site, subsequent to occupation of the Amazon region by the Portuguese.

In sum, the Carapanari corresponds to an ADE site of a late precolonial occupation that extended to the colonial period (AD 1440–1690) (see Table 2). Bell-shaped pit structures used to store domestic or ritual artifacts, encountered at the Aldeia (Gomes, 2017), Porto (Gomes & Luiz, 2013; Quinn, 2004), and Cedro (Troufflard & Alves, 2019) sites, were absent here. Ritual waste appears mixed with domestic waste. Furthermore, the stylistic variability observed in the zoomorphic and

Fig. 10 Fieldwork at the Carapanari site: **a** Bank close to the site where clay samples were collected on the shores of the Tapajós river; **b** Topographic survey; **c** Excavation of test pits; **d**, **e** Excavation of unit 1; **f** Excavation of unit 2. Photos: Author

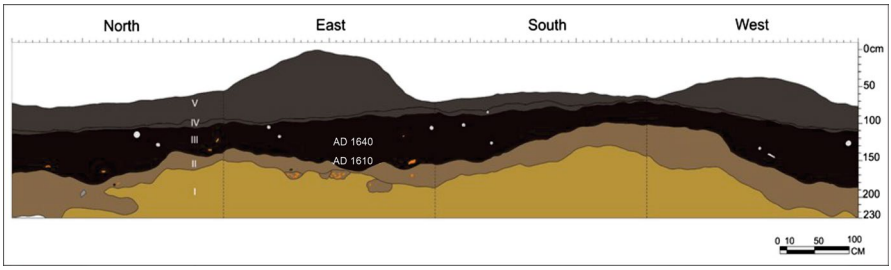


Fig. 11 Profile of excavation unit 1. Carapanari site, Santarém, PA. I—Horizon of bright yellowish-brown color (10 YR 6/6), sandy texture. Sterile layer. II—Horizon of transition brown color (10 YR 4/4), mixed with brownish gray (10 YR 5/1), sandy texture. Presence of ceramic concentrations in the eastern profile. III—Anthropogenic dark earth (ADE) horizon of black color (10 YR 1.7/1), sandy texture. High density of ceramics and charcoal. IV—Layer with high amounts of organic material (dry seeds), land snails and roots, brownish gray color (10 YR 6/1), sandy texture. V—Artificial mound. Presents a brownish gray color (10 YR 4/1), sandy texture, with presence of ceramics

Fig. 12 Excavation of unit 3, Carapanari site, showing a globular vessel with a caiman head in a ritual context. Photo: Author

anthropomorphic appendages provides an insight into the variability of ceramics produced in communities situated in the Santarém regional space.

As mentioned earlier, some ritual artifacts from the Carapanari site and other sites across the region differ morphologically, as in the example of the globular vessel

Fig. 13 Morphological variability of ritual paraphernalia from Aldeia and Carapanari sites. **a** Globular vessel from the MAE-USP collection, possibly originating from the Aldeia site, Santarém, PA. (Adapted from Gomes, 2002); **b** Globular vessel excavated at unit 3, Carapanari site, which demonstrates morphological variability of the artefact, whose body is composed of 2 parts. Photo: Author

Fig. 14 Iconographic variability of ritual paraphernalia from Aldeia and Carapanari sites. Caryatid vessel belonging to the MAE-USP, originating from the Aldeia site, Santarém, PA. (Adapted from Gomes, 2002). **a** Fragment of a caryatid vessel found at the Carapanari site, showing iconographic variability; **b** fragment of a medial flange associated with a caryatid vessel. Museu Nacional-UFRJ. Photo: Author

with the caiman appendage found in a ceremonial context, whose body is formed from two connected parts made separately. By contrast, in the examples originating from the Aldeia site, found in museological collections, this kind of vessel is made from a single spherical form (Fig. 13). Iconographic variability was also observed in diverse modelled appendages, whose figurations are absent from the vessels held in museological collections and those found at the Aldeia site (Fig. 14). Samples of the

well-known caryatid vessel, collected from 30 archaeological sites, also document this intense variability (Gomes et al., 2018). This fact thus constitutes one of the material indicators suggesting the autonomy of the communities in this region.

However, the dating of AD 1690, associated with the context of the globular vessel described above, points to the persistence of Tapajó cultural patterns, at the same time as it reinforces the continuity of the practices of modifying the stylistic canons of the ritual pottery associated with shamanism, identified across more than two centuries of occupation of this site. This was a moment of major impact of European colonization in Amazonia with the arrival of religious missions, the headquarters of which were situated in Santarém just a few kilometers away from the Carapanari site. A techno-functional analysis, combined with an analysis of composition from the Carapanari site, will enable us to broaden our understanding of the different ceramic production processes and activities undertaken by the people who occupied it.

The Methodology of Techno-Functional Analysis

Analysis of the ceramics from the Carapanari site was based on a techno-functional approach, which set out to determine the relationship between their technological and formal attributes and the use-alteration traces associated with performance, thus suggesting different uses of the artifacts. This methodology is inspired by the proposals of both Skibo (1992, 1999, 2013, 2015), who emphasizes the importance of use-alteration traces for comprehending performance characteristics, and Rice (1987, pp. 238–240), who highlights techno-functional criteria based on ethnographic analogies in order to propose models of functional classes.

In this article, we present a techno-functional analysis with a description of performance attributes, along with stylistic characteristics, which combined distinguish the pottery of the Carapanari site. The correlation established between the reconstructions of forms and the use-alteration traces enabled identification of different cooking and storage behaviors, associated with the content of the vessels. According to Skibo (2015), although the intended functions may be ambiguous, the use-alteration analyses provide unambiguous evidence. Additionally, functional classes were established that allowed inferences to be drawn about the kind of activities undertaken by people in the village space over time. Contextual information concerning the content of the primary and secondary deposits adds further weight to our conclusions.

Description of the Ceramic Sample

The excavations conducted at the Carapanari site enabled the recovery of a ceramic assemblage consisting of a total of 8988 fragments and a single entire artifact. Along with this ritual artifact (a globular vessel with a caiman appendage and a pedestal base, found in a ritual context), 1298 diagnostic fragments– rims, bases, decorated walls, flanges, zoomorphic appendages, anthropomorphic appendages, unidentified appendages, and fragments of figurines, most of these pertaining to domestic-use

artifacts—were selected for a non-hierarchical analysis of attributes. We compiled a numerical database with 14 nominal variables presenting diverse sublevels—relating to the artifact class, paste color, temper, construction techniques, surface finish, firing, use-alteration traces, plastic decoration, painted decoration, and morphology of rims and bases—as well as two measurable variables: thickness and diameter.

Classification of the paste color according to the Munsel code revealed that the sample could be subdivided into two sets. The first of these was the most numerous (N = 1200), formed by ceramic fragments with a light yellowy beige coloring (10 YR 7/2 dull yellow orange to 7.5 YR 8/1 light gray) and the second (N = 98) by red-colored fragments (2.5 YR 4/6 reddish brown to 2.5 YR 6/6 orange).

The pottery recovered in the excavations of the 15 units at the Aldeia site is predominantly light-colored with no artifacts made from red-colored clay (Gomes, 2017). The same observation was made at the Porto site, whose ceramics presented a beige coloring (7.5YR 8/2 pinkish white and 7.5 YR 8/3 pink) and gray (7.5YR 7/2 pinkish gray and 7.5 YRR 6/1 Gy) (Alves, 2015, p. 76). Current findings thus suggest that the use of this red-colored clay is limited to the Carapanari site.

This division into two sets of samples from the Carapanari site initially led us to hypothesize either the local collection of two clay types for ceramic manufacture or, alternatively, the local production of light-colored pottery and the introduction of red pottery through exchanges. The existence of these two different sets justified a study of the ceramic composition via INAA analysis in order to investigate production relations in communities located around the large villages. The type of manufacture of the Carapanari site provides an indication of the level of ceramic production. This suggests the local production of items of everyday use for the performance of activities connected to food and subsistence, along with objects related to shamanic technology, which were employed in diverse ceremonial events. Consequently, as well as the stylistic variability, the introduction of the red paste at this site poses additional technological questions.

Technology

The artifacts from the two sets were fabricated using a coil technique, combined with clay modelling to produce externally reinforced rims, ring and pedestal bases, lip flanges, rounded, flat and undulating lips, and figurative appendages. All the pottery was smoothed, and some artifacts were carefully polished. Most of the samples show evidence of firing with a dark core in the assemblage associated with light paste (N = 853–71%) and also in the assemblage associated with the red paste (N = 70–69%), indicating not only the firing of the pottery in an open space, but also, perhaps, the existence of clays with a considerable amount of organic material.

Analysis of the clay temper was made using a 4 × binocular magnifying glass in conjunction with a Leica M205C stereoscopic microscope. Both sets of ceramics from the Carapanari site mostly used a mixture of ground potsherds as temper, obtained by recycling pottery fragments, ground into a powder, and *cauixi*—spicules

of freshwater sponges, which were burnt and also ground. These are described by Rye (1981, p. 34) as bio-silicas. In the two samples selected to illustrate the use of *cauixi*, the clear-paste fragment presents *cauixi* and ground red-paste potsherds also mixed with *cauixi*. This constitutes a unique find rather than a more general pattern in the set of analyzed fragments. Red-paste pottery thus appears to have been seldom used in the process of recycling artifacts for the manufacture of clear-paste ceramics (Fig. 15).

Other tempers, less frequent and probably associated with functional choices, were made from a combination of elements like ground potsherds and quartz; *caraipé* (siliceous ashes made from tree bark); minerals and ground potsherds; *cauixi*, *caraipé* and minerals; *cauixi* and quartz. The latter element seems to occur naturally in the clay.

Freshwater sponges are found among the fauna of the main rivers of the Amazon region. Like the Aldeia and Porto sites, the Carapanari site is also very close to the shores of the Tapajós river (900 m), making seasonal harvesting of these sponges very easy. While use of *cauixi* made the ceramic artifacts lighter and less liable to break (Skibo et al., 1989), enhancing the thermal conduction properties of the sand naturally present in the clay (Rice, 1987, p. 87), addition of ground potsherds is a method used to avoid thermal shock, since these inclusions are stable and possess coefficients similar to those of the clays (Rice, 1987, p. 230; Rye, 1981, p. 33).

This association of elements comprises a long-term technological choice, employed in the ceramic industries associated with the Incised and Punctate tradition (Meggers & Evans, 1961) and in the Santarém region since at least 1850 BC (Gomes, 2008, p. 114). This cultural pattern for the preparation of ceramic pastes during the Santarém late phase was already identified in previous studies of museum collections (Gomes, 2002; Guapindaia, 1993; Palmatary, 1960) and in recent studies of pottery from the Aldeia site (Gomes, 2017) and Porto site (Quinn, 2004; Schaan,

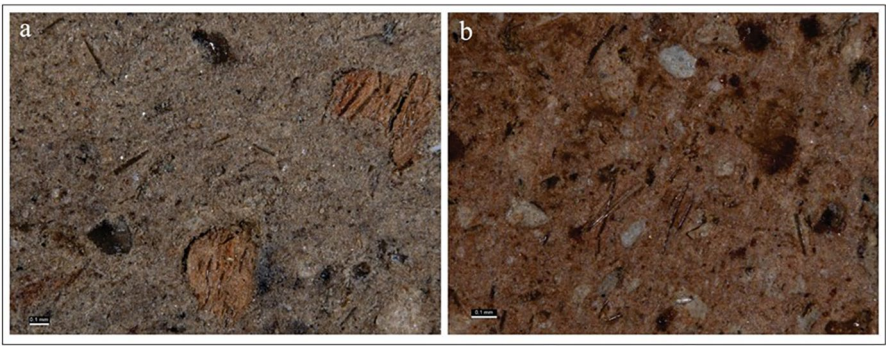


Fig. 15 Light paste showing the use of *cauixi* and ground potsherds as tempers, with sherd particles containing spicules of freshwater sponges (6.3 × magnification); **b** – red paste with the same elements (8 × magnification). Leica M205C stereomicroscope coupled to a Leica DFC 45P camera. Photo: Manoela Woitovicz

2015, 2016). In the case of the Carapanari site sample, preparation of this most frequently used paste recipe also included a temper made from the same mixture of recycled pottery and ground freshwater sponges, irrespective of the type of clay involved.

Decoration

The red painting is a type of chromatic decoration more frequently found on artifacts intended for domestic use, applied both in bands and over the entire surface of the artifacts made from both types of paste, although those fabricated from light paste are more numerous (Fig. 16). Parallel incisions are present on the rims and lips of the vessels and constitute the type of plastic decoration most frequently encountered on the pottery for domestic use, made from both kinds of paste (Figs. 17 and 18). Along with the parallel incisions, elongated punctates, sometimes combined with short incisions, constitute a distinctive way of decorating the lips of utilitarian artifacts from the Santarém late-phase pottery, which allows them to be correlated with the Incised and Punctate tradition (Meggers & Evans, 1961).

In the ritual artifacts, all made from light paste, the following types of plastic decoration are present: incisions, fillets, fillets with incisions, fillets with punctates, excisions, and notches. These decorations are found on the anthropomorphic figurines and three ceremonial vessels typical of Santarém culture—caryatid, necked and globular vessels—which comprise complex forms with numerous anthropomorphic and zoomorphic appendages, known in the literature through studies of museum collections (Barata, 1953a, 1953b; Gomes, 2001, 2002, 2017, 2022; Guapindaia, 1993; Palmatary, 1960). The ritual artifacts related to the red paste also display associated incisions and excisions, as well as fillets with and without incisions, which appear on the necks of the globular vessels.

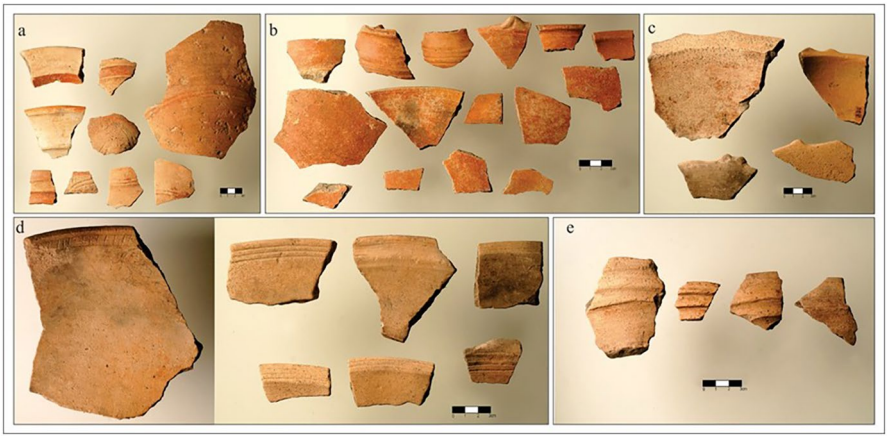


Fig. 16 Fragments of the set of light paste pottery with red painted bands; **b** red paint over the entire surface; **c** waves; **d** parallel incisions; **e** fillets. Carapanari site, Santarém, PA. Photos: Wagner Souza e Silva

Fig. 17 Ceramic fragments of rims with lips decorated with elongated punctates, light paste. Carapanari site, Santarém, PA. Photo: Wagner Souza e Silva

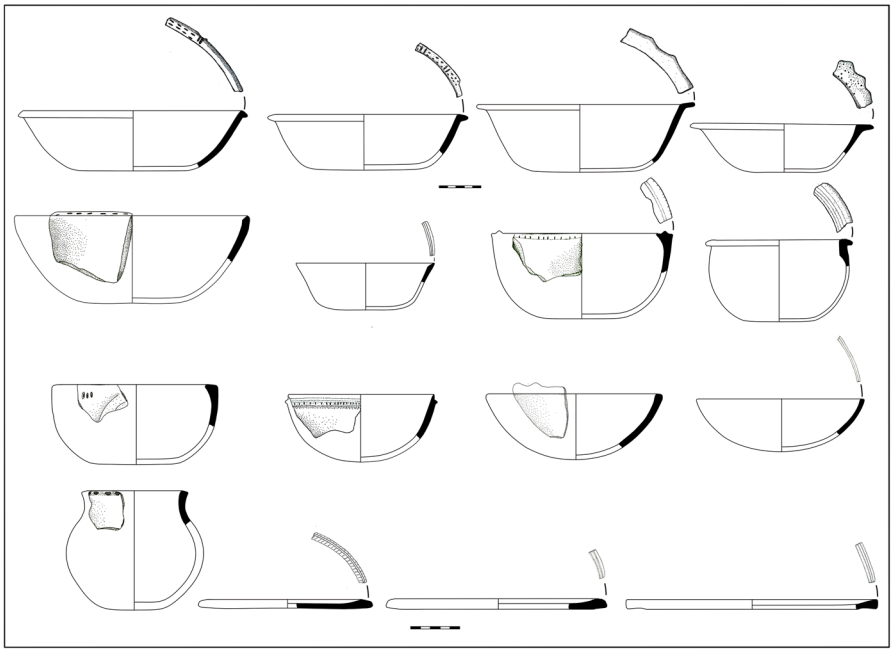


Fig. 18 Graphic reconstruction of utilitarian forms with incised and punctate decoration, Carapanari site, Santarém, PA. Author

Form and Function

In terms of morphological attributes, direct and everted rims are more frequent in both assemblages, followed by the externally reinforced direct rims. Rounded lips predominate, followed by flat lips, many of them with incised and punctate decoration. Generally, flat, gently sloping bases predominate. There are also convex, pedestal and ring bases. The flat, pedestal and ring bases are entirely stable, while the convex bases are unstable (Rice, 1987, p. 224).

The assemblage made with light paste provided a significant sample of graphically reconstructed forms (N = 146). Based on the rim fragments, whose diameters were measured with an abacus, the profiles of the rims were drawn (Sheppard, 1985 [1957]) and digitalized in Corel Draw. The same procedure was employed with the bases. Fragments were also reassembled, which, along with the single entire artifact recovered from the site, enabled identification of 13 different morphologies. The thickness of the artifacts was measured with a pachymeter, showing that the average thickness of the walls of the light paste set is 0.6–0.8 cm. Thin walls provide efficient resistance to thermal shock (Rice, 1987).

Next, we calculated the volumetric capacities using the Rhinoceros program. This works with 3D images of the vessels, generated through graphic reconstructions of their forms, with their respective dimensions. Based on this data, the program calculates volumetric capacities. Sinopoli (1999, p. 120) highlights the importance of morphological attributes, including volume, in the differentiation of consumption activities. Hence, the volume variable provides key information for identification of the use patterns of the vessels.

Consequently, the information on the morphology of the vessels, surface treatments, rim diameters, volumetric capacities, and the use-alteration traces (carbonization, attrition, and spalling) supports the advancement of hypotheses concerning the performance of the artifacts from the Carapanari site, indicative of different domestic and ritual functions. Although entire vessels, or vessels capable of being reassembled, are ideally used to observe the use-alteration traces, Skibo (2013, p. 192) accepts that this type of analysis is still possible with assemblages formed mostly from fragments, thanks to the 'long scientific tradition of technical drawing in archaeology', which records ceramic variability. These characteristics can be examined, therefore, with the aim of reconstructing a life story of the artifacts (Skibo, 2015, p. 7).

Although the light paste assemblage contained 44 fragments with use-alteration traces, only 14 could be associated with reconstructed forms. The red paste assemblage contained 6 fragments with use-alteration traces, 2 of which allowed reconstruction of their form. This procedure allowed us to suggest with greater confidence the functions associated with the morphologies produced through graphic reconstructions.

In the light paste assemblage, forms could be identified that showed changes relating to carbonization. These vessels are unrestricted forms with a semispherical body; others, used for cooking, are restricted forms with a body in the shape of a spherical cap. There are also circular vessels, the griddles, used for processing food directly on the fire. Open artifacts with an ellipsoid body, allowing access to their contents, present attrition traces on the inner surface, indicating the occurrence of processing activities using tools to stir ingredients but without direct use of fire (Table 3).

Table 3 Vessel forms and use-alteration traces, light paste

Light paste

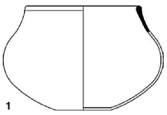
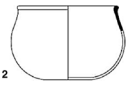
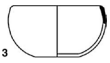
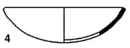
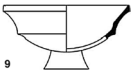
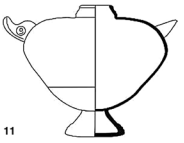
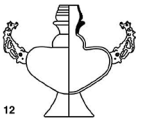
			Use-alteration traces			
Domestic vessel forms	Diameter (cm)	Volume (L)	Sooting/carbonization	Spalling	Attrition	Without alteration
 1	30–40	29.2–60				2
 2	14–24	1.8–7.6	1			7
	26–30	10.5–15.5				9
 3	18–24	2.1–18.0				4
	26–28	6.4–8.1				3
	34–36	15–18				3
 4	22–28	1.2–2.5				5
	30–36	3.3–5.5	2			3
 5	26	3.4				
	40	13.1	1	1	2	12
6	30–44	–	5			21
	38–50	–				20
 7	6–12	1.2–6.5				7
	14–18	14–18.5				6
 8	32–38	4.3–6.8		1		3
	42–46	9.6–12.6				2
 9	26	2.6				1
 10	8–12	0.16–0.6				3
	16–18	1.4–2				3
Ritual vessel forms						
 11	6–8	8.5		1		6
	10–12	8.5–11				6
 12	4–6	0.5–0.7				4

Table 3 (continued)

Light paste						
			Use-alteration traces			
Domestic vessel forms	Diameter (cm)	Volume (L)	Sooting/carbonization	Spalling	Attrition	Without alteration
 13	10	0.35				2
			8	3	2	133
Total						146

Internal spalling traces, meanwhile, were identified in the light paste assemblage on open and deep vessels with an ellipsoid shape and flat base, but also on narrow-necked globular vessels, allowing only limited access to their contents, one of them associated with the ritual excavation context (isolated and surrounded by concentrations of ashes). The spalling comprises a specific abrasive alteration (Skibo, 2015), which leaves no doubt about their correlation with the activities of preparing and storing fermented drinks.

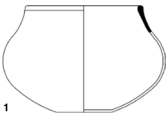
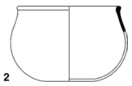
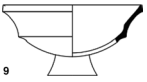
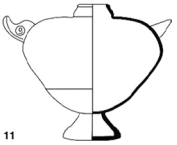
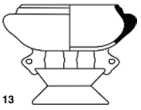
Overall, therefore, the set of morphological, technological, and decorative information, along with the use alteration traces, indicates that the ceramic vessels from the light paste assemblage can be associated with the following functions:

1. *Storing vessels*: closed forms with large capacities (form 1).
2. *Cooking vessels*: closed forms (forms 1, 2 and 3) and open vessels, which present soot traces (form 4).
3. *Processing vessels (without direct use of fire)*: open forms (forms 5 and 8). Attrition traces and spalling marks were also observed, indicating use of these vessels to prepare fermented drinks.
4. *Processing vessels (with direct use of fire)*: flat, circular forms presenting soot on the bases (form 6).
5. *Liquid transference/storage vessels*: closed forms with a well-defined neck constriction (form 7).
6. *Serving vessels*: open forms with a pedestal base (form 9); spherical cap shaped body for individual use (form 10).
7. *Ritual vessels*: globular vessels, with a narrow neck and zoomorphic appendages with a pedestal base, presenting spalling marks (form 11). Necked vessel, with an ovaloid body and multiple appendages, with a small volumetric capacity (form 12). Complex artifact formed by an open-mouthed vessel with a semispherical body and three female figures holding up the vessel, supported on a hyperboloid base (form 13). The performance characteristics indicate an artifact used to serve liquid or solid foods.

Graphic reconstructions of the red paste assemblage (N = 19) produced nine different forms. Although low in number relative to the diagnostic sample as a whole, red paste was observed to have been used in the manufacture of almost all

the artifact types identified at the site (except for forms 3, 8, 10 and 12) (Table 4). The average thickness of the walls of the red paste set is 0.6–0.8 cm, as found in the light paste set. These objects were spatially distributed across the entire area of the ancient village, present in the test pits and in the five excavation units.

Table 4 Vessel forms and use-alteration traces, red paste

Red paste						
			Use-alteration traces			
Domestic vessel forms	Diameter (cm)	Volume (L)	Sooting/carbonization	Spalling	Attrition	Without alteration
 1	38	52.8				1
 2	30	15.8				1
 4	16	0.48				1
 5	20–28	1.5–4.2	1			1
	30–36	5.2–9.2				2
 6	26	–	1			
	36	–				1
	50	–				1
 7	8–10	2.2–4.2				3
	16	16.8				1
 9	30	3.8				1
Ritual vessel forms						
 11	8	8.5				1
 13	14	1.0				3
			2			17
Total						19

Only the open ellipsoid vessel, preferentially used in processing activities (form 5) and a griddle (form 6), presented traces of carbonization, indicating the use of these artifacts in association with fire. Artifacts intended for the transference of liquids (form 7) stand out due to their higher relative frequency (N = 4) in this sample, as well as the care taken in their manufacture—exceptionally smoothed and polished, presenting fillets on the surface of the neck, and occasionally red paint. Finally, the occurrence of examples of three caryatid vessels, fabricated with red paste, also demonstrate the range in the use of the red paste.

Archaeometric Analysis

To test the hypothesis of the existence of two different pastes to fabricate the artifacts from the Carapanari site, samples were separated for archaeometric analysis: a set of fragments from red vessels (N = 24) and another set of fragments from light paste vessels (N = 33). The INAA nuclear analytical technique was employed, which involves neutron bombardment of the elements contained in the sample to produce artificial radioactive isotopes, which are then identified and measured. This analytic method presents a high degree of sensitivity, accuracy and precision since it can determine various chemical elements simultaneously, thus allowing a description of the elemental chemical composition of different clays (Munita et al., 2019). As mentioned, the aim of this analysis was to verify the existence of two different pastes.

The first statistical studies of the results were made by means of cluster analysis to verify the existence of homogeneous sample groups (Hair et al., 1998). Cluster analysis is typically used for the initial inspection of results as a fast and efficient way of evaluating relationships between samples. The cluster technique groups similar objects according to their characteristics. Analysis is based on the similarity/dissimilarity matrix where the distance between all pairs of samples is calculated using one of the many measured distances. In this research, the Ward method was used along with the squared Euclidean distance, since it exaggerates differences in the data and produces a clearly identifiable cluster dendrogram. The dendrogram of the cluster analysis shows the presence of two groups (Fig. 19).

Next, a discriminant analysis was carried out to confirm the number of groups defined by the cluster analysis. This technique identifies original variables (discriminant function), which explain the differences between the samples (Glascock et al., 2004), enabling new samples to be placed in one of the groups defined in the analysis. In this case, Stat Soft data software was used. The results confirm the existence of two groups formed by the different samples of pottery (Fig. 20). Group 1 is formed by the set of ceramics manufactured from red clay, and Group 2 by the set of light paste ceramics.

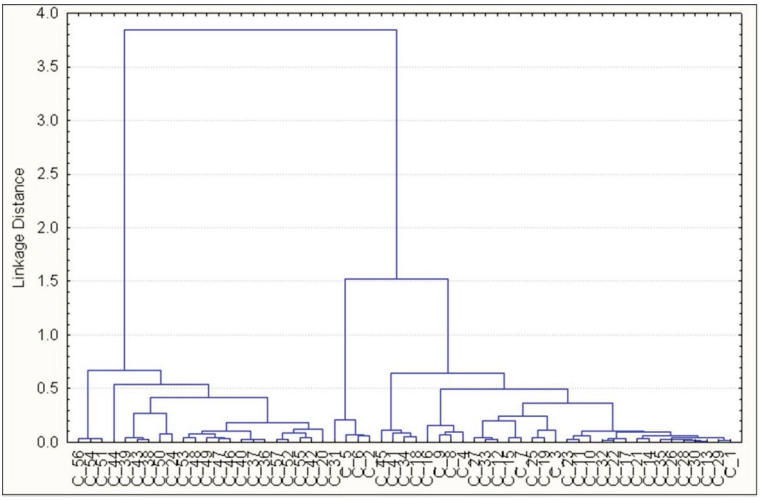


Fig. 19 Dendrogram of ceramic and clay samples using squared Euclidean distance and Ward's method, (n = 59)

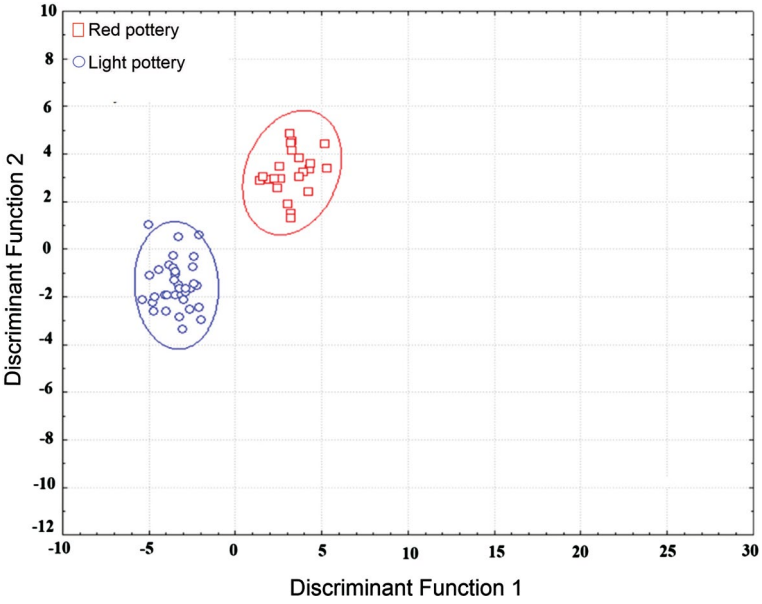


Fig. 20 Plot of the linear discriminant function 1 versus linear discriminant function 2 (Color figure online)

Discussion of the Results

Extrapolating from the sets of ritual artifacts with a mytho-cosmological symbolism deposited in specific structures at the Aldeia and Porto sites, and from the realist figurines of shamans indicative of the social importance of these individuals, we can deduce that an important ceremonial and ideological center was established in the large villages during the late precolonial period (AD 1000–1600). Religious leaders possibly acted alongside the political chiefs, whose authority was situational. From AD 1300, as the population density of the large villages increased, a process of demographic fissioning began with the emergence of smaller villages. Over time these came to occupy a region of 23,000 km^2 between the Amazon and Tapajós rivers.

Despite the clear hierarchy among the settlements, political centralization cannot be inferred, given that this society developed on the basis of a precolonial Amazonian economy that has been taken as non-agricultural relative to Euro-Asian patterns (Fausto & Neves, 2018; Schaan, 2008). Rather, this Amazonian economy involved a mixed strategy based on fishing, gathering and polyculture associated with agroforestry systems (Iriarte et al., 2020b; Clement et al., 2021), whose resources were dispersed in the landscape, thus favoring the economic independence of the smaller villages.

Also noteworthy is the absence of material indices of the mobilization and control of collective labor, such as defensive structures, funerary mounds, agricultural earthworks and so on. On the other hand, the green stone adornments were involved in a long-distance exchange network of prestigious goods and can be seen as insignia of power or even markers of social hierarchy. The presence of artifacts manufactured in basalt that emulate the green stone *muiraquitãs*, also found in the Santarém region, indicates the cyclical nature of these power structures, possibly associated with the emergence of less powerful chieftains.

Post-processual critiques highlight the western and capitalist biases of archaeological interpretations that described complex societies primarily according to an economic vision (Dobres & Robb, 2000; Pauketat, 2007; Yoffee, 1993). Indeed, the economic emphasis seems to make little sense when it comes to comprehending the social formation that developed in Santarém, whose main political power strategy revolved around ideology and symbolism. Earle (2021) also stresses the importance of taking into account modern-day ethnographies. Although contemporary indigenous societies in Amazonia are marked by an egalitarian ethos, this same universe contains examples of societies with hierarchical dimensions, lineages of chiefs recognized as magnified persons, connected to elaborate ritual systems as in the Upper Xingu (Heckenberger, 2005, pp. 259–263). In Northwest Amazonia, among the Tukano, the notion of House societies involves tensions and hierarchical differences between segments of the same people, as well as a vertical shamanism associated with ancestrality (Hugh-Hones, 1994). This same group possesses historical accounts that mention the existence of priests (*kubu*), different from healing shamans, who acted as guardians of a mythological canon and worked in conjunction with chiefs as political leaders of large groupings (Hugh-Jones, 1993, p. 116),

already recognized earlier by Levi-Strauss (1973, p. 272) as testimony of a genuine civilization with a high level of religious and social organization.

As part of this conceptual imagination that conceives of hierarchical relations in tense relationship with the egalitarian Amazonian ethos, villages like the Carapanari site are taken to have maintained heterarchical relations with the large villages. Analysis of the sets of pottery from the latter suggests both an autonomous mode of production and a cultural-ideological connection with the large villages. At the other sites within the regional sphere, this can be inferred through the ritual pottery, which maintains the same types of ritual artifact, while simultaneously displaying significant formal and iconographic variations.

The functional analysis of ceramics from Carapanari site highlighted the performative use of 13 vessels related to various domestic activities: service, cooking, storing, processing, and ceremonial practices. Mostly decorated with parallel incisions and elongated punctates, the utilitarian forms identified at Carapanari are similar to other sites, which configures a technological and a regional pattern for the Santarém phase. The main difference is the employment of the red paste at the Carapanari site, not registered in the region before. Although most of the ceramics in the diagnostic sample were made using light or yellowish beige clay (N = 1.200), and the artifacts with red clay (n = 98) were less frequent, practically the same formal repertoire and respective functions were observed in both sets.

INAA indicates that the population living at the Carapanari site indeed used two chemically distinct clays, significant differences being identifiable in their elemental compositions. Hence the difference in paste color does not derive from alterations caused by the firing process, but from technological choices made by the potters. Although most of the ceramics in the diagnostic sample were made using light or yellowish beige paste (N = 1.200), and the artifacts with red paste (n = 98) were less frequent, practically the same formal repertoire and respective functions were observed in both sets (artifacts for serving, cooking, storing, processing and ceremonial use).

In terms of the production of the light pottery, both the ritual artifacts and those for domestic use display a higher technical quality in terms of the execution of the forms, surface finishing, and plastic decoration when compared to the ware fabricated with the red clay, the sole exception being the artifacts with a well-defined neck constriction (form 7) intended for transferring liquids, which were manufactured with more technical skill. According to Arnold (2000), based on the results of ethno-archaeological research in Peru and Mexico, the choice and selection of other ceramic pastes may be related to processes of experimentation. A similar case may have initially occurred with the production of the vessels for transference of liquids (form 7) fabricated with red paste, with this experiment later extended to other ceramic forms without the same successful outcome.

These observations suggest that the inhabitants of the ancient village may have been testing the red clay experimentally as an alternative material. The compositional studies undertaken with the ceramic fragments through INAA analysis enabled identification of the use of two different pastes in the pottery manufacture at the Carapanari site, employed in the fabrication of distinct types of utensils intended for domestic use and also for ritual/shamanic use.

Aiming to define a general model of transmission of techniques and knowhow associated with pottery making, Gosselain (2000, p. 192) argues that while the decorative techniques utilized in ceramic manufacture may be malleable, modifications to the patterns of choice of clays and other raw materials are more restricted. In the author's view, techniques related to the selection, extraction and processing of raw materials tend to be modified through post-apprenticeship interactions, involving a limited range of persons—companions, assistants, and neighbors of the potters. Consequently, the adoption of new raw materials tends to be infrequent, occurring principally when artisans move to new habitations or settlements, or set out to make a new kind of artifact. In the case of the Carapanari site, it may be that the motivation was precisely the latter, related to the attempt to produce another type of artifact (form 7), an experiment that later spread to other forms.

Concerning the understanding of lifeways and productive relations in the context of the sociopolitical system in the Santarém region of the Lower Amazon, which prompted this integrated ceramic analysis, we conclude that there indeed exists a ceramic style with a wide geographic dispersion, consistent in morphological, technological, decorative, and iconographic terms, although variations are observable. Undoubtedly, this ceramic technology was regional in scope, which relates to the existence of social boundaries in a regional society and the materialization of identities (Gosselain, 2000). At the Carapanari site, domestic ware presents the same forms and decorations (parallel incisions and elongated punctates on the lips) found in both the large villages and smaller sites, amounting to technological markers.

On the other hand, morphological variability of ritual artifacts was observed at this same site, along with the flexibilization of iconographic themes, and the existence of the red paste ceramic set, a technological feature not detected at other sites thus far. Through techno-functional and compositional analyses, the latter using INAA, it could be established that this technological choice involved a change in the ceramic production of the Carapanari site. This has implications for our understanding of the technology of community production during the late pre-colonial period, recorded in the archaeological context.

Based on the existing literature and on the recent excavations undertaken at the Aldeia and Porto sites, the latter are distinguished by a greater uniformization of their ritual ceramic artifacts and paste recipes (Gomes, 2001, 2002, 2017; Palmatary, 1960; Schaan, 2015, 2016). A relevant aspect identified by Arnold (2000) is the increase in the skill and routinization of ceramic production, which can lead to a high technological efficiency and may result in standardization of some ritual forms. This efficiency in the ceramic production of the Aldeia and Porto sites appears to coincide with the peak of development of this precolonial society between the thirteenth and sixteenth centuries AD, correlated with population growth in the large villages and the processes of demographic fissioning from the fourteenth century onward, which gave rise to new communities on the Belterra plateau (Schaan, 2016; Stenborg, 2016; Stenborg et al., 2018) and to others along the Tapajós river (Figueiredo, 2019; Gomes, 2017; Gomes et al., 2018).

In smaller communities like the Carapanari site, morphological and iconographic variations of the ritual ceramics were detected, an aspect highlighted by more recent

research that reflects a degree of sociopolitical autonomy (Gomes, 2017; Gomes et al., 2018). The information available seems to suggest a transition to more standardized forms of artifactual production of ritual forms at the Aldeia and Porto sites – the larger villages where the emergence of individual leadership would be plausible, while small-scale production of domestic and ritual pottery continued in the smaller villages until the seventeenth century AD, the moment of religious missionaries' arrival in Amazonia.

Research into aspects associated with the technology of ceramic production at the Carapanari site shows that the concomitant use of red ceramic paste with yellowish beige paste in the manufacture of pottery artifacts involved not just the environmental availability of the raw materials (clays and organic tempers), but also selections and choices intentionally made by the potters based on the performance characteristics of these pastes and the possibility of producing new artifacts—a change that represented an intra-community technological innovation, with consequences for our understanding of the regional sociopolitical dynamic.

Conclusion

The archaeological research data from Santarém (AD 1000–1600) shows a regional site hierarchy, highlighting the importance of Aldeia and Porto as large villages and as important religious and ideological centers where collective shamanic ceremonies were held. The latter featured artifacts with an iconography that materialized a relational ontological system of an animist and perspectivist type (Descolá, 2005; Viveiros de Castro, 1996, 2002), including references to cosmological concepts, prey animals and predators, as well as human and non-human beings in processes of bodily transformation, utilized for cosmopolitical ends. The realist images of shamans point to the importance of these specialists who acted alongside the chiefs. In ritual performances, the chiefs exerted leadership through the organization of religious ceremonies and also the control of the long-distance exchanges of prestigious goods, evincing a political system based on individual prestige and thus on a low level of institutionalization, as well as being subject to fluctuations.

The systematization of chronological information, in conjunction with the analysis of settlement patterns, shows a regional expansion with the emergence of new villages from AD 1300, whose genesis is explained through processes of population fission at the Aldeia and Porto sites (Gomes, 2017). The expansion identified here illustrates a particular form of agency of groups of people who sought to distance themselves from the authority of centralizing chiefs. This hypothesis converges with data on the size of sites and their different insertions in the landscape, some of them located in areas not ideal for dwellings. Also, these new villages shared a mixed economy associated with agroforestry systems, making it unlikely that this was a politically centralized society. The technological behavior of smaller villages like the Carapanari site (AD 1440–1690), marked by formal and iconographic variability and by choices of different raw materials, also points to a more fluid and decentralized regional formation, which is consistent with previous descriptions of Santarém as a heterarchical society, an idea advanced by Roosevelt (1999). In sum, we

conclude that in Santarém a horizontally integrated regional society developed over time with prestigious chiefs, whose power was based on ritual performance and with the large villages acting as ceremonial centers.

This conclusion is also compatible with the overall picture of precolonial societies in Amazonia that recognizes the diversity of social forms (Gomes, 2007; Heckenberger & Neves, 2009; Iriarte et al., 2020a; Neves & Petersen, 2006). Recent advances in archaeological theory also reveal alternative pathways to interpreting the archaeological record beyond the social evolutionary framework, related to regional systems (Grinin et al., 2017; Ross & Steadman, 2017; Earle, 2021) and to an understanding of how people experienced social practices through artifacts and landscapes. In this way, the synthesis of the archaeological information presented here and the analysis of the ceramic technology of the Carapanari site can help us recognize the historical trajectory of Santarém as a precolonial regional society that emerged in Amazonia.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10963-023-09177-3.

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Availability of Data Material The entire ceramic and lithic collection of 31 sites of Santarém region was lost during the huge fire that destroyed the Museu Nacional (UFRJ) in Rio de Janeiro, Brazil, on September 2, 2018. The documentation relating to these sites, in digital format, on which the present text is based, is under the responsibility of the first author.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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