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RADIOCARBON CHRONOLOGY OF THE OCCUPATION OF THE SOUTHERN COAST OF NAYARIT, MEXICO

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ABSTRACT. Despite chronicles from the 16th century describing fertile alluvial plains and densely populated wetlands, archaeology in western Mexico has been little studied. The Directorate of Archaeological Salvage (DSA) of National Institute of Anthropology and History (INAH) has initiated a study of two sites in Costa Canuva, at the southern part of Nayarit state: Becerros and Naranjos. Thirty charcoal and shell samples were radiocarbon (^{14}C) dated to determine occupation history. A Bayesian approach was used to build a chronological modeling from charcoal samples. Charcoal and shell samples found in the same context allowed us to calculate the ΔR values of marine offset for this period. In general, the archaeological sites of this area are divided into three major periods: Formative, Classic, and Postclassic. The ^{14}C dating of Becerros recovered materials provided a chronological framework for the site's occupation, from cal AD 169–1025, corroborating the ceramic studies in the sense that human settlement activities date from the Formative (300 BC–AD 600) to the Early Postclassic (AD 900–1200). Naranjos started in the Classic period and reached its occupancy peak in the Late Classic. The site's occupation may have persisted for at least two centuries after the conquest of the Altiplano in 1521. The comparison of charcoal dates and associated shell samples from the Naranjos Unit gave a probability distribution for ΔR, that ranged from 118.5 to 199.5 with a mean value of 159 ± 4, slightly higher than other values obtained at nearby sites.

KEYWORDS: Mexico, marine reservoir effect, Pre-Columbian.

INTRODUCTION

The area of Western Mexico is occupied by the states of Jalisco, Colima, and Nayarit. Nayarit´s chronology as that for Mesoamerica, is divided into three major periods: Formative (Early Formative 2000–300 BC and Late Formative 300 BC–AD 300); Classic: (Early Classic AD 300–500 and Late Classic AD 500–850/900), and Postclassic (Early Postclassic AD 850/900–1200, and Late Postclassic AD 1200–1521). In Nayarit, important changes mark the temporalities: shaft tombs characterize the Late Formative; in the Classic, a change in ceramics is observed, with a wider variety of decorative techniques; finally, during the Postclassic period, metallurgy begins.

At the arrival of the Spaniards, the region was densely populated. Despite the scarcity of archaeological research in this area, it is known that the coastal populations had a complex social and political organization and a highly diversified mixed economy based on the exploitation of tropical coastal wetlands, brackish water lagoons, and estuaries of high biodiversity, as well as a wide availability of crustaceans and mollusks (Gámez Eternod, 2004; Garduño 2021).

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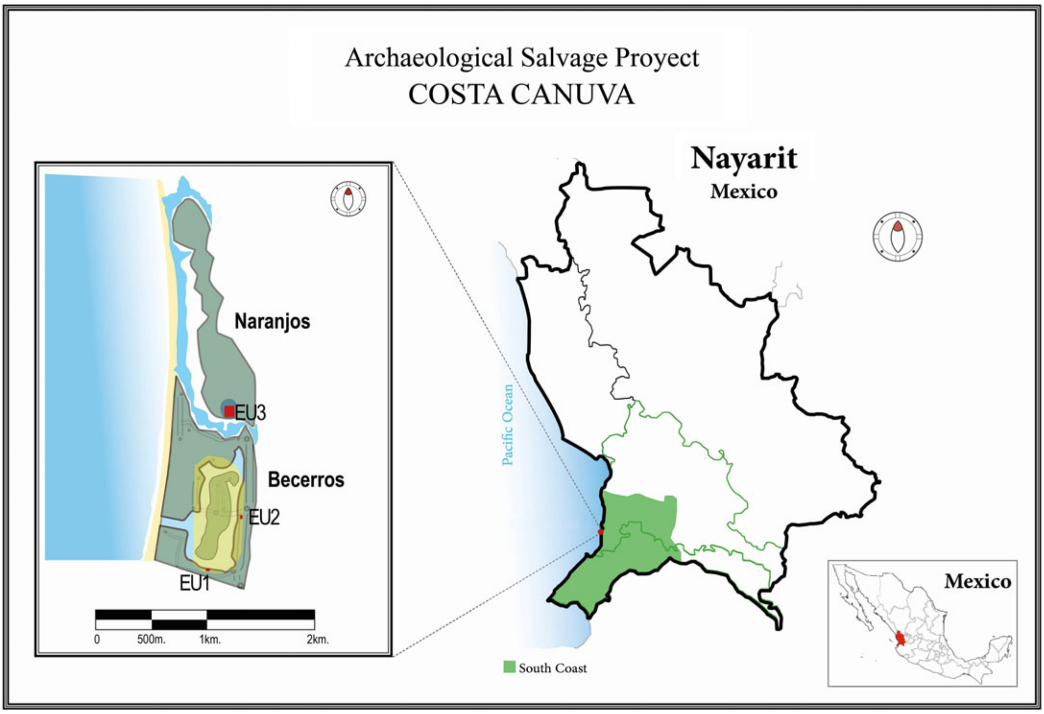

Figure 1 Location of Costa Canuva, in the municipality of Compostela, Nayarit, Mexico. (Artwork by Eric N. Amador).

Due to touristic and economic development, there has been an increasing demand from construction companies on the Mexican coasts in the last few decades. Tourist interest in lands with beautiful beaches and landscapes should pass through archaeological inspection and research before getting the authorization to build hotels or resorts. Such is the case of Canuva Coast, located on the Pacific coast, in southern Nayarit (Figure 1). The area, approximately 300 hectares, contains archaeological sites that had never been explored. This research started in 2020 as an archaeological salvage project performed by the Archaeological Rescue Directorate (DSA-Dirección de Salvamento Arqueológico) of the National Institute of Anthropology and History (INAH-Instituto Nacional de Antropología e Historia). The pursuit of this Directorate is oriented to preserve the cultural heritage before a new construction project takes place.

This cooperation between the DSA and construction companies has facilitated research in remote areas of Mexico that have been explored very little or not at all. Another goal of this project is to avoid the loss of crucial objects and learn about the pre-Hispanic past of the southern coast of Nayarit (Flores-Montes de Oca and Amador-Garcia 2021). Several structures were found along numerous ceramic objects with associated charcoal, wood and bones during the excavation. The South Coast of Nayarit, where the sites studied are located, has been studied previously by several archaeologists (Bordaz 1964; Mountjoy 1970; Beltrán 1998, 2005; Garduño 2013, 2014), who have proposed a ceramic typology, with its corresponding chronology.

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The objective of this study was to apply, for the first time, radiocarbon (^{14}C) dating of these archaeological materials to establish the chronology of occupation of the cultures that settled in the Canuva Coast. The ages obtained by ^{14}C dating with those previously estimated by the site's ceramics were also compared as well as, anthropomorphic figurines, and rock ornaments. We can assess the consistency and accuracy of both methods by comparing the obtained ^{14}C ages from organic materials with the typo-chronological dating derived from ceramics and other archaeological materials. The comparison can help to establish correlations between the absolute ages obtained through ^{14}C dating and the relative typological sequences. This correlation is valuable for archaeological dating objects without organic material suitable for ^{14}C dating.

In the domestic contexts of the Naranjos archaeological site, various common use objects were found, including seashells from bivalves used as a food resource. The presence of these items in this site is attributed to human intervention and showed no signs of having been used to make ornaments or tools. Having marine shells and contemporary terrestrial organic samples offered the opportunity to study the ^{14}C marine reservoir effect (R) (Stuiver et al. 1986). Therefore, an additional goal of this study was to estimate the local marine reservoir variation (ΔR) in this region. The use of contemporary marine and terrestrial samples is a common approach to estimate ΔR (Cooper and Thomas 2012; Dettman et al. 2015; Zazzo et al. 2016; Alves et al. 2018).

MATERIALS AND METHODS

Study Sites

Canuva Coast, an under construction touristic complex, belongs to Compostela, a municipality located in the southern of Nayarit state located on the Pacific coast (Figure 1). As part of an archaeological rescue project, two locations in Canuva Coast were excavated: Becerros and Naranjos. Becerros is a well-preserved site, with no apparent recent human disturbance, located on a flat area between the mountains and the beach, favorable for human settlement. Its architecture made of rock slabs indicates a residential use, associated with large pots assemblage with fragments of grinding stones and rocks of various sizes. At the Becerros site, extensive periods of human occupation have been observed. In the southeastern region, there is a notable concentration of material from the Late Formative period, characterized by a circular offering (EU2 in Figure 1). In contrast, towards the northern area, 500 m away, there is evidence of a habitation zone with artifacts from the Classic Period, referred to as EU1 in Figure 1. Despite the temporality difference for the EU1 and EU2, both sites were established in Becerros geographic area.

Naranjos, located 1.5 km away from Becerros is a jungle environment characterized by deciduous vegetation, near an estuary that meanders through the area and eventually reaches the beach, sharing the same name. An abode consisting of two rooms, constructed using an arrangement of rocks, was discovered (EU3 in Figure 1). Within this dwelling, a funerary space was identified alongside various objects associated with daily activities. These items included grinding stones, fishing tools, and anthropomorphic figurines.

Ceramic Typology and Stratigraphy

Material collected in Canuva Coast comes from excavation units 1 (EU1) and 2 (EU2) in Becerros and excavation unit 3 (EU3) in Naranjos. The oldest pottery typology was in EU2 at

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Becerros. It included different styles: chinesco black-on-cream, chinesco black-on-orange, and chinesco polychrome, associated with the Terminal Formative and Early Classic periods (300 BC–AD 500) (Beltrán 1998, 2005; Beltrán and González 2012; Garduño 2021). Other ceramic types were navy-red-sgraffito, red-on graffito buff, and polished-monochrome-buff. These are classified as local since they have not been reported from other archaeological sites. In EU1, ceramics with red borders with buff-colored stripes, black and white-on-red, amapa red-on-buff color, and amapa red-on-orange types were found, belonging to the Classic period (AD 300–850/900) (Beltrán 2005; Garduño 2013, 2014; Cid et al. 2014). Less frequent was the ceramic belonging to the Early Postclassic (AD 850/900–1200) whose styles were: brown-on-fine cream, smoothed orange monochrome, and fine cream monochrome. In EU3 at Naranjos, the ceramic types identified were the same as in EU1 at Becerros, plus others in the black and red-on-orange (Cid et al. 2014), and brushed brown styles, all of them belonging to the Classic period (Beltrán 2005). Ceramics of the otates polychrome type (Beltrán 2005; Beltrán-González 2012), late punzonada (Beltrán 1998), Banderas black-on-orange (Beltrán 1998, 2005), belonging to the Late Postclassic period (AD 1200–1521), were also found at this site.

The excavation at both sites was performed at intervals of 20 cm in depth, identifying and analyzing each natural stratigraphic layer. All recovered material were classified and grouped according to its location in the stratigraphic sequence during the analysis process (layer I, layer II, etc.), identifying the different cultural periods in each layer. Artifacts of different chronologies were not mixed throughout the stratigraphy, but some layers were so thick that contained material belonging to two cultural periods. Some charcoal samples were found in the interior of closed vessels, and others were found close to them. The charcoal provides an accurate proxy date for the deposition of the pottery.

^{14}C Dating Samples

At the Becerros site, seven charcoal samples associated with ceramic sherds and other elements were collected for radiocarbon dating. Charcoal samples were carefully collected from the soil and from within the ceramic vessels containing funerary materials, specifically incinerated bones found inside the pots. Samples were collected at different depths, as close as possible to the ceramic sherds, representing the time at which the objects were deposited. The occupations at the site were primarily determined through the analysis of ceramic connections. Certain types of ceramics aided in understanding the chronological sequence of deposition. Subsequently, these findings were further validated using ^{14}C dating techniques.

From Naranjos burial sites in EU3, 12 charcoal samples were collected. Additionally, 15 whole bivalve mollusk shells (mainly from *Ostrea* and *Crassostrea* genera), were recovered. All samples collected from Naranjos, including charcoal and malacological material, originate from the same stratigraphic layer (II). Ten samples were obtained from a depth ranging between 20 to 60 cm, while two others were obtained at a depth of 80–100 cm. Given that Naranjos is located 500 m from the sea, it can be inferred that the malacological material's deposition resulted from human activity rather than natural processes.

^{14}C Dating

The ^{14}C concentrations were obtained by accelerator mass spectrometry (AMS) at LEMA, Instituto de Física, UNAM, Mexico. Chemical procedures followed for charcoal, and shell samples were previously reported (Hajdas 2008). Molars lacked enough collagen and were discarded. Samples were combusted at 950 degrees with oxygen injection in an elemental

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analyzer (Vario Microcube). The resultant CO_2 was then converted to graphite in an automatized equipment AGE III (Ion Plus). Shells (35–40 mg) were cleaned and treated with 3.4 mL hydrochloric acid (0.1 M) overnight to remove half of the outer layer (Díaz et al. 2017). They were then submitted to a digestion reaction with H_3PO_4 at 75°C to obtain CO_2 in a CHS Carbonate Handling System (Ion Plus). The obtained CO_2 was transferred with helium to a reactor and reduced to graphite on iron powder via hydrogen reduction. The ^{14}C concentration in pure graphite was measured with a 1MV AMS system (HVEE) and ^{14}C ages based on the $^{14}C/^{12}C$ and $^{13}C/^{12}C$ ratios were calculated following LEMA protocols (Solís et al. 2014). OxCal v 4.4.4 program (Bronk Ramsey 2009; Ramsey and Lee 2013) with IntCal20 curve (Reimer et al. 2020) was used to obtain calibrated ages (BC/AD) with confidence limits of 95%. A chronological modeling was undertaken using the program OxCal 4.4.4. by grouping the charcoal samples in phases.

To estimate ΔR we used a similar approach as in Carvalho et al. (2015) and Diaz et al. (2017). With the OxCal software, each charcoal sample was grouped with theirs closer archaeological paired shells under the same phase. Inside the phase, the charcoal is calibrated using IntCal20 while the shells are calibrated using the marine curve Marine20, leaving the ΔR undefined in the interval of −250 to 250 ^{14}C yr. Each group/phase is placed in independent sequences but considering ΔR the same for all phases. The complete code is presented in Table 1 in the supplementary material.

RESULTS

Results for ^{14}C ages obtained from charcoal samples from the excavation units EU1 and EU2 at Becerros and unit EU3 at Naranjos are presented in Table 1. Calibrated dates were obtained with OxCal v 4.4.4. We subjected the two sets of dates to a Bayesian chronological modeling process. Figure 2 shows the condensed the Bayesian models of the two sites. Each phase in the figure corresponds to one layer of Table 1. The code of the model is shown in the supplementary material section. The outputs of the model indicate a good overall agreement (Figure 2).

For Becerros, the ^{14}C dates ranged from 1807 ± 25 to 1073 ± 30 BP, which fell into the 169–1025 cal AD (modeled 603–1021 cal AD) interval. The only charcoal sample from EU2 (LEMA 1697) from layer V, discovered beneath a large polychromatic vessel, showed a date of 1807 BP (168–335 cal AD), and corresponds to the oldest value, in the Formative period. Since it is a single sample from this unit, it was excluded from the Bayesian model in Figure 2. This area within EU2, with very little datable material, is the sole location where Terminal Formative material was found.

Charcoal samples from excavation unit EU1 were collected as follows: LEMA 1701, from inside a funerary urn closed with a lid with charred human remains in the northern part (layer VII); LEMA 1712 and 1704, from layer III in the northern part, above two large pots; LEMA 1698, also from layer III, near green obsidian objects and a human figurine. LEMA 1700 from layer III, was in the southwestern part of EU1, and LEMA 1702 from layer II in the northwestern part of EU1, atop a large pot, yielded the youngest ages among the samples.

This sample was found close to a globular rattle made of copper; a material considered from the Early Postclassic period.

Table 1 Radiocarbon data for charcoal samples from Becerros and Naranjos. The associated occupation period refers to that inferred from the pottery. The layer of each Excavation Unit (EU) is in parenthesis. Average carbon content was 60%. AMS-δ^{13}C varied from –23 to –28‰.

Lab code	Occupation period	EU (layer)	Depth (m)	^{14}C age (BP)	Calibrated date range (cal AD) (95% prob.)	Posterior density estimate (cal AD) (95% prob.)
Becerros						
LEMA 1701	Late Classic	1 (VII)	1.8–2	1380 ± 30	601–758	605–680
LEMA 1697	Terminal Formative	2 (V)	1.1	1807 ± 25	169–335	168–335
LEMA 1712	Late Classic	1 (III)	0.8–1	1285 ± 25	665–775	689–770
LEMA 1704	Late Classic	1 (III)	0.8–1	1302 ± 25	660–775	689–770
LEMA 1698	Late Classic	1 (III)	0.8–1	1332 ± 25	650–774	740–775
LEMA 1700	Late Classic	1 (III)	0.8–1	1209 ± 30	702–893	679–741
LEMA 1702	Early Postclassic	1(II)	0.6–0.8	1073 ± 30	892–1025	763–1021
Naranjos						
LEMA 1703	Late Classic	3 (II)	0.8–1	1240 ± 30	681–879	675–862
LEMA 1692	Late Classic	3 (II)	0.8–1	1232 ± 30	686–882	710–889
LEMA 1757	Late Postclassic and colonial	3 (II)	0.2–0.4	395 ± 30	1438–1631	1441–1608
LEMA 1748	Late Postclassic and colonial	3 (II)	0.4–0.6	385 ± 35	1441–1634	1456–1625
LEMA 1768	Late Postclassic and colonial	3 (II)	0.4–0.6	366 ± 35	1451–1635	1456–1625
LEMA 1760	Late Postclassic and colonial	3 (II)	0.2–0.4	356 ± 35	1457–1636	1441–1608
LEMA 1766	Late Postclassic and colonial	3 (II)	0.4–0.6	417 ± 27	1432–1618	1456–1625
LEMA 1762		3 (II)	0.4–0.6	235 ± 26	1529–1936	
LEMA 1764		3 (II)	0.2–0.4	157 ± 35	1664–1903	
LEMA 1770		3 (II)	0.2–0.4	138 ± 35	1671–1945	
LEMA 1754		3(II)	0.2–0.4	109 ± 27	1683–1936	
LEMA 1744		3(II)	0.4–0.6	53 ± 27	1694–1917	

Of the samples collected in EU 3 at Naranjos, all correspond to layer II. Of these, samples LEMA 1703 and LEMA 1692 were modeled separately because although they are in layer II, they were found in the lowest level at 0.8–1 m depth, while the rest of the samples of the layer were found in a level above 0.2–0.6 m depth. This means that in the layer II of Naranjos, there were at least two occupational stages. The chronology of Naranjos occupation was obtained from the charcoal samples, found in layer II of the EU3. The dates obtained are also listed in Table 1 and the Bayesian model is shown in Figure 2. The oldest two samples found, LEMA 1703 and LEMA 1692, had ^{14}C dates of 1240 ± 30 and 1232 ± 30 BP (681 to 882 cal AD, modeled 675–889 cal AD). They were modeled separately because they were found in the lowest level of layer II, at 0.8–1m depth, corresponding to the Late Classic period for the South and North coasts of Nayarit, which varies from 500–850/900 AD. Five charcoal samples, found in a level above 0.2–0.6 m depth, had later dates, from 417 ± 27 to 356 ± 35 BP (1432 to

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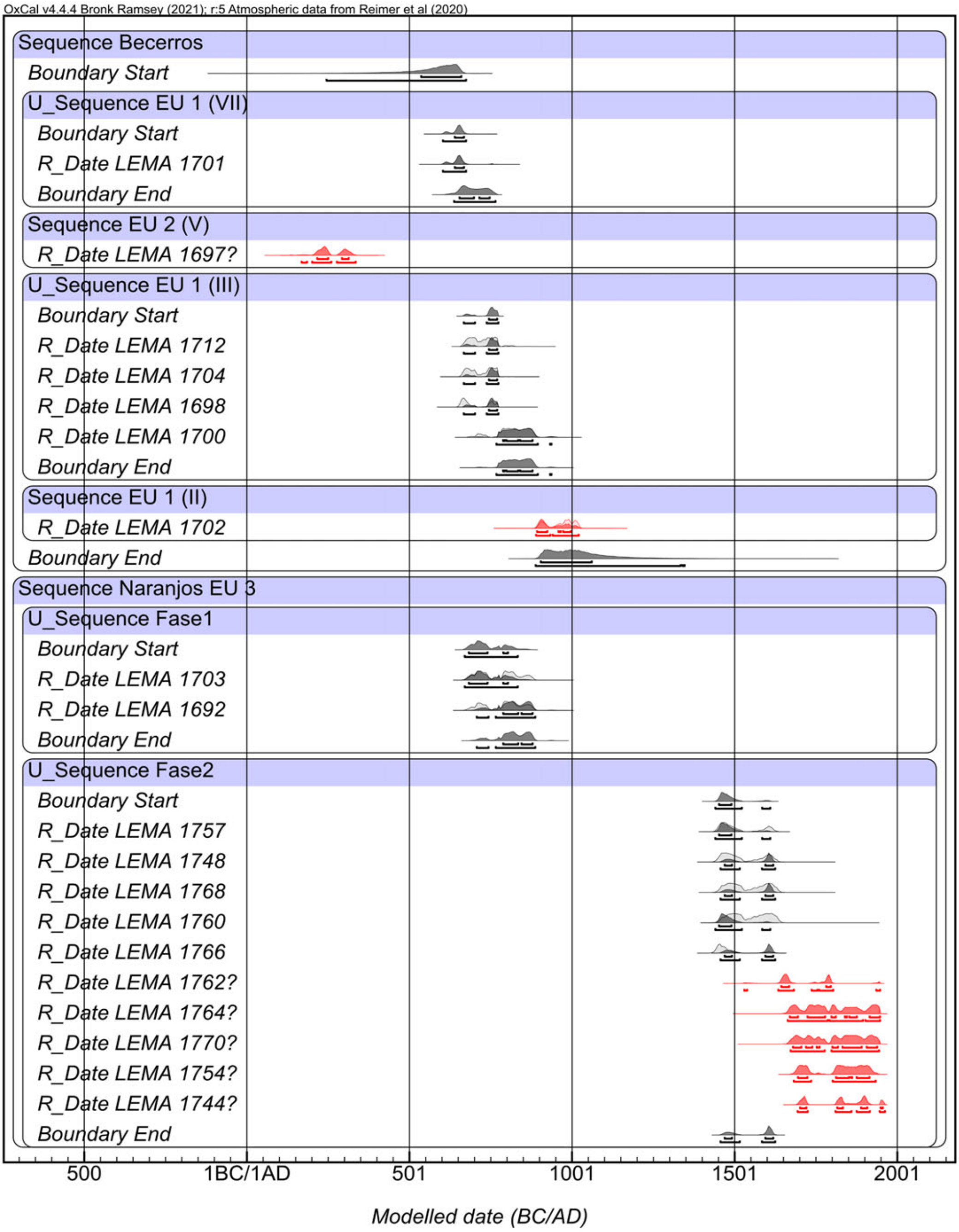

Figure 2 Bayesian Sequence Model of the Becerros and Naranjos in Costa Canuva. Horizontal bars under the distributions are at 1σ and 2σ probability ranges. The agreement values of the model are shown. Distributions followed by a "?" were excluded from the analysis. Having access to modern shells and charcoal samples from Naranjos provided us with the chance to assess the marine reservoir effect in that location. Therefore, we determined the local reservoir offset ΔR by comparing the ages of contemporary charcoal and their associated marine shells collected from the same stratigraphic layer from Naranjos.

1636 cal AD, modeled 1441–1625 cal AD) (LEMA 1766, LEMA 1760, LEMA1768, LEMA1748 and LEMA1757) corresponding to the Late Postclassic period. Five charcoal samples fell in long intervals up to modern ages: 53 ± 27 to 235 ± 26 BP (1529 to 1945 cal AD) (LEMA 1744, LEMA 1754, LEMA 1770, LEMA1764 and LEMA 1762). These dates were identified as outliers and were excluded from the Bayesian model in Figure 2. They are shown in the figure because although they could provide insight into the timing of that occupation, they could not be associated with a single phase. As Naranjos sits on sandy soil, easily subject to disturbance by water or bioturbation, we interpret that these charcoals are intrusive that moved to deeper levels. The absence of modern artifacts such as plastic bags, bricks, nails, as well as ceramics with Spanish influence (glazed), is the main argument supporting this hypothesis.

The 15 marine shells from Naranjos displayed ^{14}C ages with a more delimited time frame: from 1144 ± 28 to 962 ± 26 BP, centered in an average of 1007 ± 72 BP, while the charcoal samples were distributed between very early and very late dates. With the aim of estimate the reservoir effect at the time of occupation, we selected only those charcoals corresponding to Postclassic period (LEMA 1748, LEMA 1757, LEMA 1760, LEMA 1766, and LEMA 1768). Figure 3 shows the distribution of charcoal and shells in excavation unit EU3 of Naranjos.

Table 2 shows ^{14}C dates of bivalve shells and their associated charcoal samples. The pairs were selected considering position and closeness of samples in the stratigraphic layer (Figure 3). Since most of the bivalves correspond to shallow layers and because of their sizes are difficult to move down, they would mark the end of the site's occupation.

With this set of samples, we determine the ΔR using the Bayesian methods described above (Reimer & Reimer 2001), with groups formed as it is shown in Figure 3 and Table 2. The resulted probability distribution is shown in Figure 4.

The value of 159 ± 41 for ΔR is slightly higher than other values obtained from sites close to the southern coast of Nayarit. Berger et al. (1966) reported values of 3 ± 50 for Banderas Bay Jalisco, 85 ± 50 for Isabel Island, and 59 ± 48 for Nayarit and Mazatlán Sinaloa, located at 26, 129, and 226 km respectively. However, these values were calculated using pre-bomb known-age shells for a different time, so it is hard to make a comparison. These are the Berger et al. values corrected for the Marine20 chronology. Anyway, this new positive value helps to confirm the influence of upwelling in the Mexican West coast as pointed out by Berger et al. (1966).

CONCLUSION

This study has allowed us to set a more solid chronology framework of one of the archaeological zones in western Mexico. The ^{14}C dating of charcoal LEMA 1697 recovered at Becerros provided an absolute date for the site's earliest occupation at cal AD 169–335, corresponding to the Late Formative period. The date of this material could be due to the old wood effect. However, we dismiss this possibility because we found ceramic material in the same excavation unit with chinesco-style typology, which is characteristic of that period. The charcoal dated simply ratifies the occupation previously indicated by the ceramic typology. The archaeological evidence provided by the ceramic materials and a copper rattle found in Becerros, indicates that the human settlement in this site reached its peak during the Classic period, and continued until the Early Postclassic period. This assumption is confirmed by the

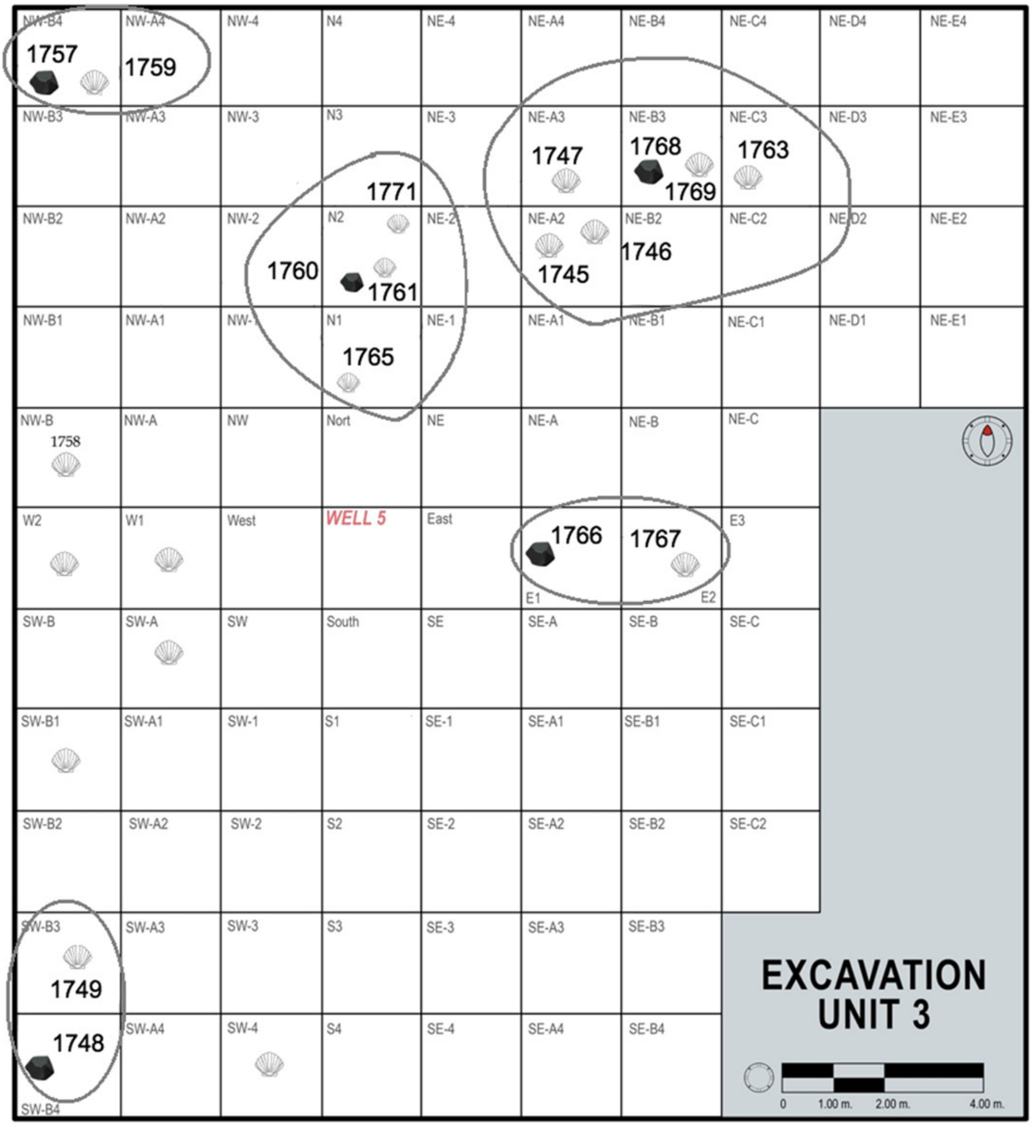

Figure 3 Calibration data for charcoal and associated shell samples from Naranjos.

results of ^{14}C dating associated with these materials, whose dates fall within the Early Postclassic period.

In Naranjos, the occupation period is posterior to Becerros. Although all the samples from Naranjos correspond to the same stratigraphic layer, their radiocarbon dates reveal an apparently extensive occupation that begins in the Late Classic period (500 AD–850/900) and extends beyond the Postclassic period (850/900 to 1521). While most of charcoal samples are consistent with the ceramic temporality (Classic and Postclassic), dates from five charcoal samples fall into broad calibrated date ranges beginning in the 1600s and reaching modernity.

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Table 2 Shells samples, species and ^{14}C dating results from Naranjos site used to estimate ΔR, with their corresponding paired charcoal samples.

Lab code	Species	^{14}C age (BP)	Paired charcoal	^{14}C age (BP)
LEMA 1767	*Ostrea iridescens*	977 ± 25	LEMA 1766	417 ± 27
LEMA 1745	*Ostrea fisheri Dall*	1144 ± 28	LEMA 1768	366 ± 35
LEMA 1746	*Crassostrea*	938 ± 28	LEMA 1768	366 ± 35
LEMA 1747	*Ostrea iridescens*	957 ± 26	LEMA 1768	366 ± 35
LEMA 1763	*Crasstrea*	1007 ± 26	LEMA 1768	366 ± 35
LEMA 1769	*Crassostrea angulata*	962 ± 26	LEMA 1768	366 ± 35
LEMA 1761	*Ostrea iridescens*	1139 ± 28	LEMA 1760	356 ± 35
LEMA 1765	*Ostrea iridescens*	1139 ± 28	LEMA 1760	356 ± 35
LEMA 1771	*Ostrea iridescens*	1139 ± 28	LEMA 1760	356 ± 35
LEMA 1749	*Ostrea iridescens*	987 ± 26	LEMA 1748	385 ± 35
LEMA 1759	*Ostrea iridescens*	1045 ± 26	LEMA 1757	395 ± 30

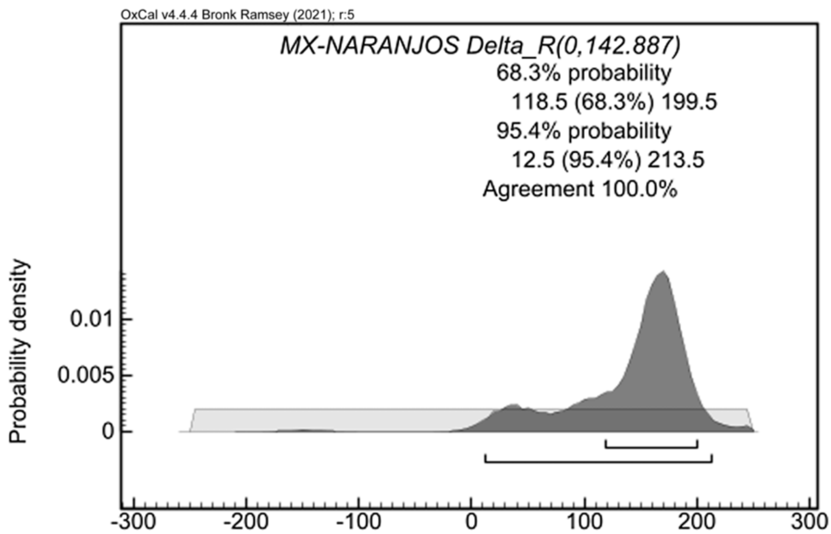

Figure 4 ΔR = 53±76 obtained for shells from Naranjos site.

The absence of materials such as bricks, nails, or ceramics with Spanish influence (glazed), indicators commonly found in colonial occupations, are the main argument supporting a possible intrusion. Especially considering that these are porous sandy soils easily subject to disturbance by water or bioturbation. However, the possibility exists that activities in the area continued long after the end of the Late Postclassic. Although historically the period ends in 1521 with the Spanish conquest, cultural changes did not occur simultaneously throughout the territory. Some regions of Mexico remained relatively isolated and self-sufficient until the mid-19th century. Due to their low population density and difficult terrain conditions, these regions were of no interest to the Spanish colonizers, which allowed many indigenous communities to maintain a certain degree of independence and continuity in their customs for a long time.

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The finding of shells associated with organic material was used to determine the local ΔR of Canuva Coast for that period giving a value of 159 ± 41 years.

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/RDC.2024.94

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