Radiocarbon, Vol 65, Nr 4, 2023, p 930–952 DOI:10.1017/RDC.2023.67

REASSESSING THE CHRONOLOGY OF TOPARÁ EMERGENCE AND PARACAS DECLINE ON THE PERUVIAN SOUTH COAST: A BAYESIAN APPROACH

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ABSTRACT. Through Bayesian analysis of new radiocarbon dates, this paper demonstrates that the Topará tradition did not emerge until after Paracas monumental sites were ritually closed in the Chincha Valley of the Peruvian south coast. These findings controvert a long-held hypothesis of Topará as a foreign tradition which intruded into the Paracas heartland and initiated the period of transformation known as the Paracas-Nasca transition. We present the first radiocarbon dates from Jahuay, the earliest accepted Topará site. These dates are compared with new analyses of published radiocarbon dates from three other sites associated with this transitional period: a Late Paracas politico-ceremonial site in the Chincha Valley, a Late Paracas settlement in the Palpa Valley in the Río Grande de Nasca Drainage, and an Initial Nasca site in the same valley. This work shows Paracas site closures began earlier than has previously been appreciated and demonstrates that the first appearance of the Topará ceramic style post-dates the onset of Paracas decline in the region's northern valleys. This analysis represents a successful attempt to develop a radiocarbon-based chronology across a calibration plateau by incorporating stratigraphic data into a Bayesian model.

KEYWORDS: Bayesian chronology, calibration plateaus, Paracas-Nasca transition, Topará.

INTRODUCTION

Paracas was an autochthonous archaeological culture on the Peruvian south coast, which spanned from the Chincha Valley to the Nasca Drainage (Figure 1). Independent Paracas communities were linked by economic relationships and a shared religious ideology (Tantaleán 2021a, 2021b). By the Late Paracas phase (ca. 390–120 BC; Unkel et al. 2012), local leaders asserted influence at a multi-community level through manipulation of social, economic, political, and religious systems. Although at no point was Paracas ever a single unified entity, there is evidence for local integration within subregions of the larger Paracas sphere, such as in the Chincha Valley (Tantaleán 2016, 2021a), the lower Ica Valley in the Callango Basin (Massey 1991; Cook 1999; Bachir Bacha and Llanos Jacinto 2013), and in the Palpa Valley of the Río Grande de Nasca drainage (Reindel and Isla Cuadrado 2013; Isla Cuadrado and Reindel 2018).

During the final centuries BC on the Peruvian south coast, the various manifestations of the Paracas phenomenon across the region's several valleys began a protracted process of "disintegration" and reformation (Unkel et al. 2012; Tantaleán 2021a, 2021b). This period of major social and cultural transformation has been referred to as the "Paracas-Nasca Transition" (Peters 2018; Peters and Tomasto-Cagigao 2018), or the "Necropolis Era" (Carmichael 2016, 2019). Since the 1960s and into the present, Paracas decline and the subsequent development of the Nasca culture has generally been understood to have been influenced by the incursion of a "foreign" group from the north, known as Topará, into the Paracas heartland (Lanning 1960; Wallace 1985, 1986). This hypothesis was developed largely based on the identification of Topará ceramics on top of Paracas-associated sites (Wallace 1972, 1986) and the observation that the Topará ceramic style influenced Late Paracas (Ocucaje 10) and Initial Nasca ceramics in the Ica Valley and Nasca Drainage (Menzel et al.

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Figure 1 Map showing the location of significant Late Paracas, Early Nasca, and Topará sites on the Peruvian south coast. The four sites modeled in this paper are differentiated with white markers (Map by J. Osborn).

1964; Silverman 1993). Indeed, Topará as an archaeological culture was defined based on its unique monochromatic ceramic style, and it remains unclear whether the people who made and used the Topará style were united by a shared ethnicity, political affiliation, religious worldview, or some other commonality. To address this question, it is first necessary to accurately define this ceramic tradition's chronological relationship with other regional styles. As a first step in this process, our investigation focuses on dating the emergence and spread of the Topará ceramic style across the Peruvian south coast.

Recent work in the Chincha Valley has problematized existing models of the Topará tradition's emergence and expansion. There, excavations at several sites across the valley have demonstrated

https://doi.org/10.1017/RDC.2023.67 Published online by Cambridge University Press

Table 1 The Lanning-Wallace Model's proposed relationships between Paracas, Nasca, and Topará ceramic phases. Note that several of the Paracas and Nasca phases are now understood to overlap significantly (see Carmichael 2019); for instance, Ocucaje 10 and Nasca 1 are considered almost entirely contemporaneous.

Epoch (Rowe Master Sequence)	Paracas or Nasca Ceramic Phase (Ica Valley)	Topará Ceramic Phase	
Early Intermediate Period 2	Nasca 2	Quebrada B Quebrada A	Campana
Early Intermediate Period 1	Nasca 1	Chongos B Chongos A	
Early Horizon 10	Ocucaje 10	Jahuay 3	
Early Horizon 9	Ocucaje 9	Jahuay 2	
Early Horizon 8	Ocucaje 8	Jahuay 1	
Early Horizon 7	Ocucaje 5-7	*Patos**	

Based on Wallace (1986) and Silverman (1991).
*Although considered a Topará ceramic style by Lanning and Wallace, we suggest Patos is in fact associated with the Paracas tradition, based on its resemblance to Paracas quotidian ceramics in the Chincha Valley (Tantaleán et al. 2020; Osborn 2022:54).

that Chincha was an important Paracas ritual landscape (Tantaleán 2016). This work has also provided crucial data on the closure of Paracas politico-ceremonial sites across the valley during the Late Paracas phase; all identified Topará occupations post-date the Paracas occupation of the valley (Stanish et al. 2014; Tantaleán 2016; Tantaleán et al. 2016, 2020). Their findings conflict with previous expectations and invite new examination into the emergence of the Topará style and its influence throughout the south coast during the Paracas-Nasca transition.

With this article we aim to reopen the debate regarding the role of Topará-affiliated groups in this transition, beginning with a new examination of one of the basic tenets of the model: the chronological relationship of the Topará tradition's emergence to Paracas decline. It is generally believed that the earliest Topará ceramic phase, Jahuay 1, was contemporary with Late Paracas styles (Table 1). Jahuay 1 ceramics have only ever been identified at the Topará type-site, also called Jahuay. Here, we present the first radiocarbon data from Jahuay along with a new Bayesian analysis of existing radiocarbon dates from the Chincha and Palpa Valleys that have been previously published by other researchers. Our findings open the door to a reassessment of the Topará style's origins, as well as reconsideration of its chronological relationship to the decline of the Paracas phenomenon and the transformations which took place across multiple generations during the Paracas-Nasca transition.

BACKGROUND

The Lanning-Wallace Model of Topará Expansion

Topará ceramics were first identified on the Paracas Peninsula by Julio C. Tello, where they were included in burials at the Necropolis of Wari Kayan (Tello and Mejía Xesspe 1979). As a result, this ceramic style is sometimes referred to as Paracas Necropolis. It became known as Topará after it was isolated at the site of Jahuay near the Topará Quebrada by Edward Lanning (1960), and was further elaborated by Dwight Wallace (1985, 1986). Lanning conceptualized Topará as a foreign invasive state which originated in the Cañete or Topará Valleys, contemporary with Late Paracas (Lanning 1960:427) and over time came to control

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the Cañete, Topará, Chincha, Pisco and Upper Ica Valleys. Wallace further developed this hypothesis, arguing that Topará quickly advanced through the Chincha, Pisco, and upper Ica Valleys during the Jahuay 3 phase of the Topará ceramic sequence (Table 1), and proposing that this invasion had an "obviously devastating effect" on Paracas communities in Ica (Wallace 1985:92; see also Massey 1986; Wallace 1986).

In the Chincha, Pisco, and Ica Valleys, populations bearing Topará style ceramics established domestic settlements at former Paracas monumental ritual centers (Fernández et al. 2017; Nigra 2017; Tantaleán et al. 2017) and "urban" habitational sites (Wallace 1972, 1986; Massey 1986; Peters 1987). Topará "influence" is widely cited as a catalyst for the various transformations which took place during the Paracas-Nasca Transition (Menzel et al. 1964; Sawyer 1966; Wallace 1985, 1986; Massey 1986, 1991:229; Silverman 1993:257; Peters 1997, 2018; Cook 1999; Van Gijseghem 2006; Vaughn and Van Gijseghem 2007; Isla Cuadrado and Reindel 2018). The emergent Topará style also profoundly influenced Late Paracas and Early Nasca artistic styles (Menzel et al. 1964; Silverman 1993). Interactions between these three groups are most famously observed at the Necropolis of Wari Kayan on the Paracas Peninsula, where Ann Peters has proposed that communities affiliated with the Paracas, Topará, and Early Nasca traditions participated in an ancestral cult. She suggests that they recognized certain ancestors through renewed mortuary offerings while also exchanging goods and information, engaging in ritual combat, intermarrying, and negotiating alliances (Peters 2016, 2018; Peters and Tomasto-Cagigao 2017).

The conceptualization of Topará as a foreign group has been questioned by some researchers, who have instead suggested it may have been a local manifestation of Paracas (Dwyer 1971; Tinteroff Gil 2008; Nigra 2017). Other scholars have rejected this proposal, arguing that the stylistic differences between Paracas polychrome and Topará monochrome fineware ceramic styles are too great (Wallace 1986; Silverman 1991:411). Ultimately, although sometimes framed as a population migration rather than an invasion, today most scholars continue to echo Lanning and Wallace's suggestion that Topará was non-local and originated north of the Paracas heartland, somewhere between the Cañete and Chincha Valleys (Menzel et al. 1964; Engel 1981:11; Massey 1986; Silverman 1996; Peters 1997; Van Gijseghem 2006; Proulx 2008; Isla Cuadrado and Reindel 2018; Makowski and Kołomański 2018).

Recent Research on Paracas in the Chincha Valley

Extensive excavations conducted throughout the Chincha Valley over the past decade have brought to light new challenges to the Lanning-Wallace model of Topará. There are three key findings from this work to emphasize here.

First, while it was previously seen as peripheral to the Paracas phenomenon, we now recognize that the Chincha Valley was a major Paracas landscape throughout the final millennia BC. Paracas leaders in Chincha managed a nexus of roads, astronomically-aligned geoglyphs, irrigation canals, and monumental centers that drew groups from coastal and highland communities to participate in ritual events at specific times of year (Stanish et al. 2014, 2018; Tantaleán 2016; Stanish and Tantaleán 2018). This "ritualized landscape," which reached its pinnacle during the Late Paracas phase, served as a means of social, political, and economic integration while creating opportunities for the exchange of both goods and information (Stanish et al. 2014; Tantaleán 2016).

Second, excavations have provided new information about the end of Paracas in Chincha through documentation of the ritual closure and abandonment of Late Paracas politico-ceremonial sites across the valley (Tantaleán et al. 2016, 2022; Tantaleán and Rodríguez 2021). One of the primary events associated with the decommissioning of ritual sites was feasting. These elaborate final feasting events were drawn out over the course of weeks or even months (Tantaleán et al. 2016:12).

Finally, recent investigations have shown that after the closure of major Paracas sites in Chincha, local populations continued to live in the valley and reused at least one former politico-ceremonial site, La Cumbe, for domestic occupation (Tantaleán et al. 2022). While fineware ceramic styles (Cavernas and Pinta) fell out of use, Paracas utilitarian ceramics continued to be used in association with this "Epi-Paracas" phase (Tantaleán et al. 2020, 2022). Although not addressed here, elsewhere we have drawn comparisons between Late and Epi-Paracas utilitarian wares and the quotidian Topará ceramics identified at Jahuay (Osborn 2022). These comparisons suggest a possible continuity between Paracas and Topará-affiliated populations in this region which will be the subject of future studies.

Other Paracas ritual and domestic sites in Chincha were later reused as Topará settlements (Wallace 1972; Fernández et al. 2017; Nigra 2017; Tantaleán et al. 2017; Orccosupa Ccapcha et al. 2022). A similar pattern of reoccupation was identified at Paracas and Topará sites in the Pisco Valley (Peters 1997, 2013). Based on observation of Topará ceramics at these sites, Wallace concluded that the Paracas monumental sites in the Chincha Valley were Topará-built temples (Wallace 1972, 1986). While we now recognize that these were Paracas ritual centers, it is unclear how groups associated with the Topará style came to occupy this region. If a Topará invasion into the Chincha Valley had taken place with no warning, Paracas-affiliated populations would not have had time to ritually seal their sacred spaces through ceremonies which lasted several weeks, at minimum (Tantaleán et al. 2016). Alternatively, if the Paracas population had advanced warning that invasion was imminent, providing time to close their ritual centers, we would also expect to see some evidence of resistance, such as relocating settlements to defensive locations, but this was not the case. Paracas-affiliated populations did not flee but continued living in Chincha at sites like La Cumbe. Furthermore, there is no evidence of defensive or fortified sites in Chincha, or in the neighboring Pisco Valley. We might ask whether Topará-affiliated groups migrated peacefully into this region. If that were the case, why were the Late Paracas ritual centers closed? The data from Late Paracas sites within the hypothetically contested area simply do not support the theory of a Topará invasion, violent or otherwise.

The work completed in Chincha in recent years makes it clear that our understanding of Paracas decline and the emergence of the Topará style is incomplete. Building on these foundations, beginning in 2017 the Proyecto de Investigación Arqueológica Jahuay (PIA Jahuay) initiated excavations which explored the roots of the Topará tradition (Osborn 2022). Here, we present the first radiocarbon dates from the Topará type site of Jahuay. Comparing these dates with dates from Paracas and Initial Nasca sites in the Chincha and Palpa Valleys allows us to reevaluate the timing of the Topará style's emergence and the spread of Topará stylistic influence throughout the Peruvian south coast during the Paracas-Nasca transition.

Andean Chronologies and the Issue of Calibration Plateaus

Dependable chronologies are fundamental to our ability to address anthropological questions using archaeological data. Answering practically any question you can pose about past societies will require that you first define the relevant temporal relationships. In the Central Andes, the work of John H. Rowe set the groundwork for the regions' s archaeological chronologies. Rowe's Ica Valley Master Sequence (Rowe 1960, 1962) was developed based on ceramic seriations he and his students developed in the Ica Valley. Rowe also oversaw the doctoral work of an entire generation of influential Andean archaeologists, including Wallace and Lanning, and his Master Sequence still underpins the way most Andeanists talk about chronology. Among other features, Rowe's Master Sequence assumed continuity between epochs and phases, and this underlying assumption was embedded into many early Andean chronologies. As more data accumulates, however, scholars have recognized that the boundaries between archaeological stages and phases can be rather fuzzy. People did not simply switch overnight from one ceramic style to another. Some stylistic phases overlap (Carmichael 2013, 2019; Koons and Alex 2014) while other scholars have identified gaps in local chronologies (Unkel et al. 2012; Marsh et al. 2019). Refining chronologies is an ongoing project which will continue to improve our ability to address anthropological questions in the Central Andes.

Absolute dating, especially the use of AMS radiocarbon dating, has greatly enhanced Andeanists' capacity for constructing more accurate chronologies (Contreras 2022). However, calibration plateaus complicate these efforts. One calibration plateau in particular affects dates between 800–400 BC. This plateau is referred to as the Hallstatt Plateau in European archaeology, or more fancifully, "the 1st millennium BC radiocarbon disaster" (Baillie and Pilcher 1983); this latter name provides some idea of the global impact this plateau has on radiocarbon calibration. Calibrated dates which fall within this plateau will result in probabilities spanning multiple centuries. An additional, smaller wiggle between 400–200 BC has a similar effect (Hamilton et al. 2015).

Bayesian sequencing can be used to calibrate dates more precisely across a plateau. Bayesian approaches to chronological modeling across calibration plateaus have been applied in contexts around the globe, including Britain (Hamilton et al. 2015; Waddington et al. 2019), Bronze Age China (Yu et al. 2021), Iron Age Germany (Rose et al. 2022), and the Early Horizon Central Andes (Contreras 2023). This paper contributes to this growing body of literature by presenting a successful attempt to build a chronology across a calibration plateau through the incorporation of stratigraphic data within a Bayesian model.

DATING THE DECLINE OF PARACAS AND EMERGENCE OF TOPARÁ IN THE CHINCHA PROVINCE—MATERIALS AND METHODS

Jahuay, Quebrada de Topará

Jahuay is located at the mouth of the Topará Quebrada approximately 15 km north of the modern town of Chincha Alta, Chincha Province, Department of Ica (13°19'24.87"S, 76°14'31.62"W). Jahuay is the type site for the Topará tradition (Lanning 1960), and as the only site where Jahuay 1 ceramics have been identified (Wallace 1986), it is also the earliest accepted Topará site.[1]

Between 2017 and 2019, PIA Jahuay conducted new excavations which documented nearly 4 m of stratified Topará production contexts (Osborn 2022). Our work shows that Jahuay was a

[1]For Lanning (1960) and Wallace (1986), the earliest Topará site was Los Patos, an unexcavated and now destroyed site in the middle Cañete Valley. We disagree, and echo previous arguments that Los Patos was more likely associated with the Paracas tradition (Silverman 1991; Tantaleán 2021a, 2021b). The Patos assemblage contained no obviously Topará ceramics; it did, however, include sherds incised with designs bearing strong resemblance to Paracas wares (Silverman 1991:380). Excluding Patos from the Topará tradition makes Jahuay the earliest Topará site.

https://doi.org/10.1017/RDC.2023.67 Published online by Cambridge University Press

permanently occupied settlement of maritime specialists who fished, hunted marine birds and mammals, and collected shellfish, while also practicing limited horticulture to grow gourds and cotton. Maritime products were preserved through drying so that they could be traded with nearby sites in exchange for agricultural food products and ceramics goods (Osborn 2022; Weinberg et al. 2022; Weinberg 2023). In contrast with nearby Topará sites in the Chincha Valley (Wallace 1972; Fernández et al. 2017; Nigra 2017; Orccosupa Ccapcha et al. 2022), we do not identify evidence of a pre-Topará occupation at Jahuay.

Initially, 17 radiocarbon samples were collected from various Topará contexts throughout the site. These samples were submitted to DirectAMS in Bothell, Washington, where they were portioned for pretreatment. A routine ABA protocol was applied to the charcoal samples consisting of treatments in 6M hydrochloric acid (65ºC, 12 min), 0.1M potassium hydroxide (65ºC 12 min), and 0.05M HCl with deionized water washes following each step. The samples were then graphitized and analyzed using the NEC 1.5 SDH Compact Pelletron Accelerator Mass Spectrometer. The ^{14}C concentrations in graphite produced from the unknown samples, Oxalic Acid II standards, and process blanks have been measured and reported by the DirectAMS laboratory.

The resulting radiocarbon ages were calibrated with OxCal v.4.4.4 (Bronk Ramsey 2009a) using the Southern Hemisphere calibration curve (SHCal20, Hogg et al. 2020). The choice to use SHCal20 rather than a mixed curve was determined based on Marsh and colleagues' (2018) recommendation for sites located along the Pacific coast of South America. Calibration of some of these dates was affected by a radiocarbon calibration curve plateau found between approximately 2400–2100 BP, resulting in calibrated ages which spanned multiple centuries (Osborn 2022:352–354). To address this issue we employed Bayesian sequencing, which can significantly narrow the range for each date and improve overall dating precision (Cowgill 2015), including when calibration is affected by fluctuations on the calibration curve (Bayliss 2009; Hamilton and Krus 2018).

We focused on 9 radiocarbon samples which were collected from stratified contexts excavated in Jahuay's Sector B, referred to as the Production Zone. In this area, residents processed and stored maritime products, prepared and repaired fishing nets, and engaged in other communal economic activities (Osborn 2022). The area was frequently remodeled by burying earlier levels and building new walls in new configurations, resulting in nearly four meters of stratified walls, floors, and fill. The dated samples are charcoal specimens of an undetermined species; unfortunately, samples of annual plant species such as maize were not available from these contexts. Although this potentially introduces complications due to the old wood problem, by using charcoal samples rather than bone or marine shell we avoid the uncertainty of the marine reservoir effect, a significant concern at a littoral site like Jahuay. With charcoal dates, it is generally understood that the dated event is earlier than the deposition event. This is acceptable given the aims of this study.

The two deepest samples (D-AMS 040505 and D-AMS 040506) were collected from near-sterile strata and were found in association with Jahuay 1 ceramics (Osborn 2022: 136); therefore, we are confident that the resulting dates are associated with the early phase of the Topará occupation.

The stratigraphic relationships between levels were recorded in the site Harris matrix during excavation. This provided information about the relative depositional order of each sample,

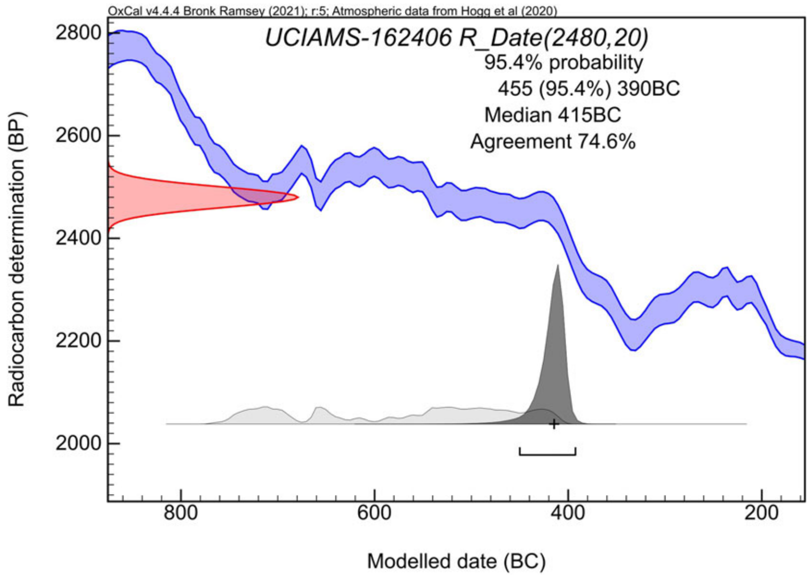

Figure 2 Plot of UCIAMS-162406 (2840±20) from Cerro del Gentil, illustrating how the calibration curve plateau (in blue) affects this date without modeling (light gray) and after modeling (dark gray).

allowing us to create a Bayesian model for these nine dates. Details of this model are described below ("Bayesian Modeling of Dates").

New Analysis of Published Radiocarbon Dates

Our goal with this paper is not simply to date the occupation of Jahuay, but also to assess the chronological relationship between Paracas decline and the Topará style's emergence and contextualize these dates within the Paracas-Nasca transition. To this end, we also selected three sites with sets of published radiocarbon dates which were suitable to Bayesian analysis. These data sets were reanalyzed in OxCal and compared with results from Jahuay.

Chincha Valley: Cerro del Gentil

The Lanning-Wallace model for Topará emergence suggests that the development of the Topará tradition (Jahuay 1 and 2 ceramic phases) was concurrent with Late Paracas ceramic phases (e.g., Ocucaje 8 and 9). To test this hypothesis, we compared the new radiocarbon dates from Jahuay to published dates from a Paracas site in the Chincha Valley. Multiple Middle and Late Paracas sites in Chincha have been systematically excavated and dated in recent years using non-Bayesian methods (Tantaleán et al. 2013, 2016; Nigra 2017; Tantaleán and Stanish 2017; Tantaleán et al. 2022). Late Paracas sites closures have consistently dated around the second to third century BC (Tantaleán et al. 2020). However, calibration of these dates is severely impacted by a plateau in the calibration curve (Figure 2). Bayesian modeling is expected to narrow these ranges and result in more precise dates. Of the dated sites, Cerro del Gentil was selected as a focus for this analysis because 1) this site had the largest number of dated samples (n=15), and 2) the dated samples were collected from a stratified series of construction events which could be easily modeled as a Bayesian Sequence in OxCal.

https://doi.org/10.1017/RDC.2023.67 Published online by Cambridge University Press

Cerro del Gentil was a Middle and Late Paracas ceremonial site located 16 km inland in the Chincha Valley (13°29'41.36"S, 76°02'12.53"W; 30 km southeast of Jahuay). This important monumental platform mound drew visitors from both the coast and the highlands for feasting and ritual events (Tantaleán et al. 2016; Stanish et al. 2018). Dates are associated with three sequential construction phases, known as the Fase Amarilla, Fase Gris, and Fase Marrón (Yellow, Grey, and Brown phases) (Tantaleán et al. 2016; Tantaleán and Stanish 2017). During the Fase Amarilla, associated with Middle Paracas materials, the first clay-floored patio was built. This patio was remodeled and reduced in size during the Fase Gris and again in the Fase Marrón (Late Paracas). At the conclusion of this final phase, the entire space with covered with soil during a series of closure events, including elaborate feasts (Tantaleán et al. 2016:12). Samples from the Fase Marrón were collected from objects given as offerings during this ritual decommissioning, and therefore can be used to date the site's closure.

Palpa Valley: Jauranga and Estaquería

To situate the Jahuay data within the broader phenomenon of the Paracas-Nasca transition on the Peruvian south coast, we also incorporated new analysis of published dates from two sites at the far southern end of the region. Recent work in the Palpa Valley of the Río Grande de Nasca Drainage has emphasized the impact of the Topará tradition on local populations during this transition (Isla Cuadrado and Reindel 2018). In a recent paper describing the Paracas-Nasca transition in Palpa, Isla and Reindel proposed that the changes associated with this period can be attributed to a migration of Topará-affiliated populations into the valley (Isla Cuadrado and Reindel 2018).

One site associated with the Paracas-Nasca transition is the hillside settlement of Estaquería (14°32'57.22"S, 75°13'03.49"W). There, researchers recovered Ocucaje 10 and Nasca 1 ceramic materials, style phases influenced by the monochrome simplicity of Topará ceramics. This site is therefore understood to represent the spread of Topará into the Nasca Drainage (Isla Cuadrado and Reindel 2018).

Researchers in Palpa previously published a robust Bayesian chronology of local radiocarbon dates (Unkel et al. 2007, 2012), and estimated the range for the Paracas-Nasca transition (which they call "Initial Nasca") was *120 BC–AD 75 (SHCal20)*.[2] The authors' stated goal was to create a chronology which incorporated dates from the Archaic through the Late Intermediate Period, a span of nearly 5000 years. The model assumed continuity between phases, except in the case of two chronological gaps (one during the Archaic and Initial Period, and another between the Middle Horizon and Late Intermediate Period). While this was an appropriate assumption given their research goals, Unkel and colleagues point out that the onset of the Paracas-Nasca transition is a weak point of their model, as it is based on only 6 dates from one excavation unit at Estaquería in the Palpa Valley (Unkel et al. 2007:557). Coupled with the model's assumption of continuity, this has the potential to artificially extend the starting boundary of this phase. We attempted a different approach by creating a new model using the published dates from Estaquería.

[2]This range was derived by rerunning Unkel and colleagues' (2012) OxCal code using SHCal20. They originally presented two versions of their chronology, one calibrated using SHCal04, and another calibrated using IntCal09 with a Southern Hemisphere correction. The difference between these calibrations was negligible for most phases but resulted in drastically different dates for the Paracas-Nasca transition. They estimated this phase occurred between *120 BC–AD 90 (SHCal04)* or *260 BC–AD 80 (IntCal09 with an SH correction of 41±14).*

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We also aimed to compare data from Chincha and Jahuay with Late Paracas contexts in Palpa. The site of Jauranga (14°32'44.12"S, 75°12'36.57"W) was a Middle and Late Paracas settlement located roughly 1.5 km northeast of Estaquería and associated with Ocucaje 5- Ocucaje 9 ceramics (Reindel and Isla Cuadrado 2013). 27 radiocarbon samples from stratified archaeological contexts have been previously published (Unkel 2006; Unkel et al. 2007, 2012), making Jauranga an excellent candidate for Bayesian chronological modeling.

Bayesian Modeling of Dates

The model used for this analysis was created in OxCal v.4.4 (Bronk Ramsey 2009a); the code is provided as Supplemental Data 1. Although coded as a single plot, the four sites were modeled independently. For each site, we plotted the dates as a Kernel Density Estimation plot (KDE_Plot command) (Bronk Ramsey 2017) embedded within a Sequence command. The order of the dates was based on stratigraphic relationships between excavation contexts and samples. These stratigraphic data are detailed in greater depth in Supplemental Data 2. A General outlier model (Bronk Ramsey 2009b) was integrated to down-weight dates with low agreement indices. Lastly, several Difference commands were incorporated to query the gaps between start and end boundaries at different sites. OxCal's formatting tools were used to round the dates by 5 years. The results of these analyses are presented in Tables 2, 3, and 4, and summarized in Figure 3.

Cerro del Gentil

Fifteen published AMS radiocarbon dates are associated with the Paracas occupation of Cerro del Gentil (Tantaleán et al. 2016; Tantaleán and Stanish 2017). The fifteen dates were sorted into three Phases ("Amarilla", "Gris", and "Marrón") based on their corresponding construction phases (Tantaleán and Stanish 2017). Within these construction phases, dates were horizontally distributed rather than selected from a vertical column, so we were unable to incorporate intraphase stratigraphic relationships into our model. The samples from the Marrón phase were derived from materials given as final offerings as part of a site closure ceremony. They are therefore assumed to date to the end of the site's use.

Jahuay

9 charcoal samples were AMS dated as part of this analysis. These samples were collected from a stratified series of informal construction levels and stamped earth floors (*apisonados*) near the intersection of Units 35, 40, and 41 in Sector B at Jahuay. This area is interpreted as a communal area for processing marine resources procured by the fisherfolk at the settlement. The dates were organized into a single sequence based on stratigraphic relationships between excavated contexts. Three of these dates were collected from a single excavated locus, and therefore were grouped into one Phase ("Locus 317") within the Sequence.

Jauranga

Jauranga was a Middle and Late Paracas settlement site (Unkel 2006; Reindel and Isla Cuadrado 2013). There are 27 published dates from Jauranga stemming from two excavation areas, referred to as Units 1 & 4 and Unit 2 (Unkel 2006:66–71). The dated charcoal and soil were collected primarily from hearths, graves, and walls. They are mostly AMS dates, but 5 are gas proportional dates. The two excavation areas were treated independently by embedding them in a Phase within the site Sequence. The dates were ordered based on published

Table 2 Radiocarbon dates from Cerro del Gentil, Jahuay, Estaquería, and Jauranga. Dates from Cerro del Gentil were published by Tantaleán and Stanish (2017), while dates from Estaquería and Jauranga were first published by Unkel (2006). The SHCal20 calibrations presented here differ slightly from previous publications of these dates, which used earlier versions of the same calibration curve (SHCal13 and SHCal04, respectively). Unmodeled calibrations are expressed as whole ranges.

Site	Laboratory ID	Material	Radiocarbon age years BP ± error	δ^{13}C%	Calibrated age (95.4%)[a]	Modeled age (95.4% hpd)	Median	Agreement
Cerro del Gentil	Cerro del Gentil Start Boundary					*480–395 BC*	*425 BC*	
	UCIAMS-162403	Maize leaf	2395±20	–10.6	720–230 BC	*445–385 BC*	*405 BC*	169.3
	UCIAMS-162406	Plant material	2480±20	–10	755–405 BC	*455–390 BC*	*415 BC*	74.6
	UCIAMS-162415	Charcoal	2360±20	–25.4	460–200 BC	*420–385 BC*	*400 BC*	145
	UCIAMS-162404	Plant material	2370±20	–11.1	515–200 BC	*405–365 BC*	*390 BC*	149.9
	UCIAMS-137882	Textile	2340±20	[b]	410–200 BC	*405–365 BC*	*385 BC*	137.5
	UCIAMS-162414	Charcoal	2350±20	–24.8	410–200 BC	*405–365 BC*	*390 BC*	150
	UCIAMS-162413	Plant fiber cord	2270±20	–22.7	385–190 BC	*390–265 BC*	*345 BC*	96.7
	UCIAMS-162410	Textile	2330±20	[b]	405–200 BC	*395–340 BC (72.6%)* *320–240 BC (22.8%)*	*365 BC*	89.7
	UCIAMS-137884	Textile	2260±20	[b]	385–185 BC	*390–265 BC*	*340 BC*	100.1
	UCIAMS-137885	Textile	2230±20	[b]	375–150 BC	*380–280 BC*	*335 BC*	108.9
	UCIAMS-131979	Textile	2220±15	–25.6	365–150 BC	*370–265 BC*	*335 BC*	103.2
	UCIAMS-162412	Mate gourd	2265±20	–23.7	385–185 BC	*390-265 BC*	*345 BC*	98.4
	UCIAMS-162407	Textile	2255±20	–22	385–185 BC	*385–270 BC*	*340 BC*	102
	UCIAMS-162408	Textile	2220±20	–22.3	370–145 BC	*370–280 BC*	*335 BC*	105.5
	UCIAMS-162409	Textile	2255±20	–28.5	385–185 BC	*385–270 BC*	*340 BC*	102
	Cerro del Gentil End Boundary					*350–205 BC (92.9%)* *200–175 BC (2.5%)*	*295 BC*	
Jahuay	Jahuay Start Boundary					*220–65 BC*	*130 BC*	
	D-AMS 040506	Charcoal	2107±23	–19.45	150 BC–AD 20	*150–65 BC*	*105 BC*	99.4
	D-AMS 040505	Charcoal	2116±23	–23.81	155 BC–AD 15	*135–60 BC*	*90 BC*	115.4
	D-AMS 033289	Charcoal	2125±28	–17.07	180 BC–AD 15	*120–40 BC (93.1%)* *AD 1-15 (2.3%)*	*70 BC*	102.4
	D-AMS 033293	Charcoal	2035±35	–31.63	90 BC–AD 115	*90–80 BC (0.7%)* *70 BC–AD 20 (94.7%)*	*35 BC*	107
	D-AMS 040504	Charcoal	2121±27	–16.59	180–50 BC	*120–45 BC (94.6%)* *AD 5–15 (0.8%)*	*70 BC*	98.9
	D-AMS 040503	Charcoal	2030±25	–12.17	55 BC–AD 65	*50 BC–AD 50*	*AD 5*	105.1
	D-AMS 040501	Charcoal	1972±23	–23.86	40 BC–AD 195	*45–15 BC (10.9%)* *AD 15–75 (84.5%)*	*AD 35*	72.1

Table 2 (*Continued*)

Site	Laboratory ID	Material	Radiocarbon age years BP ± error	δ13C%	Calibrated age (95.4%)[a]	Modeled age (95.4% hpd)	Median	Agreement
	D-AMS 040502	Charcoal	2022±21	–23.22	50 BC–AD 70	*40–15 BC (5.2%)* *AD 15-85 (88.9%)* *AD 100-115 (1.3%)*	*AD 50*	85
	D-AMS 033290	Charcoal	1940±28	–20.87	AD 25–205	*30–15 BC (3.2%)* *AD 25–135 (92.2%)*	*AD 80*	98.2
		Jahuay End Boundary				*30–15 BC (1.2%)* *AD 30–220 (94.3%)*	*AD 100*	
Jauranga		Jauranga Start Boundary				*510–400 BC*	*440 BC*	
	HD24264	Charcoal	2458±31 c	–22.55	750–230 BC	*485–360 BC (94.9%)* *245–235 BC (0.5%)*	*410 BC*	124.6
	ET466	Charcoal	2290±54	–31.9	760–205 BC	*485–350 BC (85.3%)* *290–210 BC (10.1%)*	*405 BC*	109.8
	ET379	Charcoal	2450±45	–24	760–390 BC	*490–365 BC*	*415 BC*	103.1
	ET463	Charcoal	2220±54	–26.8	385–70 BC	*395–215 BC (92.4%)* *210–185 BC (3.0%)*	*330 BC*	102.8
	ET378	Soil	2335±49	–26.3	390–190 BC	*395–335 BC (47.4%)* *325–200 BC (48.0%)*	*325 BC*	96
	HD-24209	Charcoal	2324±20 c	–26.09	400–200 BC	*405–345 BC (56.9%)* *305–205 BC (38.5%)*	*360 BC*	99.8
	HD-24234	Charcoal	2283±22 c	–25.22	390–190 BC	*395–335 BC (47.4%)* *325–200 BC (48.0%)*	*325 BC*	96
	ET462	Charcoal	2255±49	–24.4	395–150 BC	*400–195 BC*	*330 BC*	104.2
	ET376	Charcoal	2160±49	–25.6	360 BC–AD 20	*390–245 BC (87.7%)* *230–220 BC (0.5%)* *205–155 BC (7.2%)*	*330 BC*	52.6
	ET377	Charcoal	2195±49	–27	375–55 BC	*395–240 BC (88.6%)* *235–215 BC (1.6%)* *205–170 BC (5.2%)*	*330 BC*	86.4
	HD24232	Charcoal	2284±22 c	–24.84	390–190 BC	*395–240 BC (48.3%)* *325–200 BC (47.1%)* *Combined Date - Sample 289*	*335 BC*	96
	ET438	Charcoal	2325±54	–28.2	405–160 BC			
	ET454	Charcoal	2420±54	–24.1	760–210 BC	*485–350 BC (86.6%)* *290–225 BC (8.3%)* *220–210 BC (0.4%)*	*405 BC*	110.5
	ET457	Charcoal	2485±54	–21.1	765–204 BC	*490–365 BC*	*415 BC*	78.4
	ET446	Charcoal	2290±54	–31.9	405–165 BC	*405–205 BC*	*340 BC*	101.7
	ET447	Charcoal	2285±54	–30.6	405–165 BC	*405–205 BC*	*335 BC*	102
	ET448	Charcoal	2330±54	–26.7	515-185 BC	*415–200 BC*	*355 BC*	106.8
	ET449	Charcoal	2190±54	–26.7	375–50 BC	*395–240 BC (88.4%)* *235–215 BC (1.9%)* *210–170 BC (5.1%)*	*330 BC*	83.3

(*Continued*)

Table 2 (*Continued*)

Site	Laboratory ID	Material	Radiocarbon age years BP ± error	$\delta^{13}C$%	Calibrated age (95.4%)[a]	Modeled age (95.4% hpd)	Median	Agreement
	ET451	Charcoal	2300±54	–24	410–170 BC	*405–205 BC*	*345 BC*	101.6
	ET452	Charcoal	2305±49	–21.1	405–185 BC	*405–305 BC*	*345 BC*	100.1
	ET458	Charcoal	2380±49	–21.6	745–195 BC	*465–345 BC (72.8%)* *315–205 BC (22.6%)*	*390 BC*	132.1
	ET433	Charcoal	2230±49	–28.7	390–105 BC	*395–215 BC (92.6%)* *210–185 (2.8%)*	*330 BC*	104.7
	HD-24263	Charcoal	2247±23 c	–24.19	385–175 BC	*390–240 BC (90.0%)* *235–215 BC (2.1%)* *210-190 BC (3.3%)*	*325 BC*	98.9
	ET432	Soil	2325±49	–24.7	460–185 BC	*415–335 BC (54.6%)* *330–200 BC (40.8%)*	*355 BC*	103.1
	ET382	Soil	2305±45	–22.8	405–185 BC	*405–335 BC (51.7%)* *330–205 BC (43.7%)*	*345 BC*	99
	ET431	Soil	2375±49	–25.1	740–195 BC	*460–345 BC (70.7%)* *315–205 BC (24.7%)*	*385 BC*	131.2
	ET381	Charcoal	2290±45	–24.5	400–185 BC	*400–210 BC*	*340 BC*	99.1
		Jauranga End Boundary				*290–145 BC*	*225 BC*	
Estaquería		Estaquería Start Boundary				*95 BC–AD 60*	*40 BC*	
	HD24701	Wood	2047±24 [c]	–26.08	60 BC–AD 60	*55 BC–AD 5 (80.4%)* *AD 15–55 (15.1%)* *Combined Date - Sample 383*	*25 BC*	115.9
	ET366	Wood	1970±45	–28.5	50 BC–AD 205			
	HD24072	Wood	1992±16 [c]	–26.3	45 BC–AD 115	*45–5 BC (77.9%)* *AD 20–60 (17.5%)*	*25 BC*	58.1
	HD24073	Wood	2020±22 [c]	–25.88	55 BC–AD 70	*50 BC–AD 5 (80.3%)* *AD 15–55 (15.1%)*	*25 BC*	115.2
	HD24066	Wood	2086±29 [c]	–27.6	145 BC–AD 25	*40 BC–AD 60*	*1 BC*	86.9
	ET364	Charcoal	2005±45	–29.2	65 BC–200 AD	*40 BC–AD 65*	*5 BC*	108.7
		Estaquería End Boundary				*40 BC–AD 105*	*AD 15*	
Model Indices:			Amodel=123.2 Aoverall=122.3					

[a]Calibrated in OxCal 4.4 (Bronk Ramsey 2009a) using SHCal20 (Hogg et al. 2020).
[b]Tantaleán and colleagues report that the CO_2 yield was insufficient to measure $\delta^{13}C$.
[c]Gas proportional date.

Table 3 Comparison of site boundaries, showing medians as well as 95.4% probability ranges.

Boundary		Median	95.4% hpd	Number of dates
Cerro del Gentil	Start	*425 BC*	*480–395 BC*	14
	End	*295 BC*	*350–205 BC (92.9%)*	
			200–175 BC (2.5%)	
Jahuay	Start	*130 BC*	*220–65 BC*	9
	End	*AD 100*	*30–15 BC (1.2%)*	
			AD 30–220 (94.3%)	
Jauranga	Start	*440 BC*	*510–400 BC*	27
	End	*225 BC*	*290–145 BC*	
Estaquería	Start	*40 BC*	*95 BC–AD 60*	6
	End	*AD 15*	*40 BC–AD 105*	

Table 4 Results of difference queries for site boundaries. Note that some difference ranges include negative numbers, indicating a boundary overlap.

Boundaries	Difference range *(95.4%)*	Median difference
Start Jahuay v. End Gentil	*30–255 years*	*165 years*
Start Jahuay v. End Jauranga	*-30–195 years*	*90 years*
Start Estaquería v. Start Jahuay	*0–230 years*	*95 years*
Start Estaquería v. End Jauranga	*80–335 years*	*190 years*
End Gentil v. End Jauranga	*-60–185 years*	*65 years*

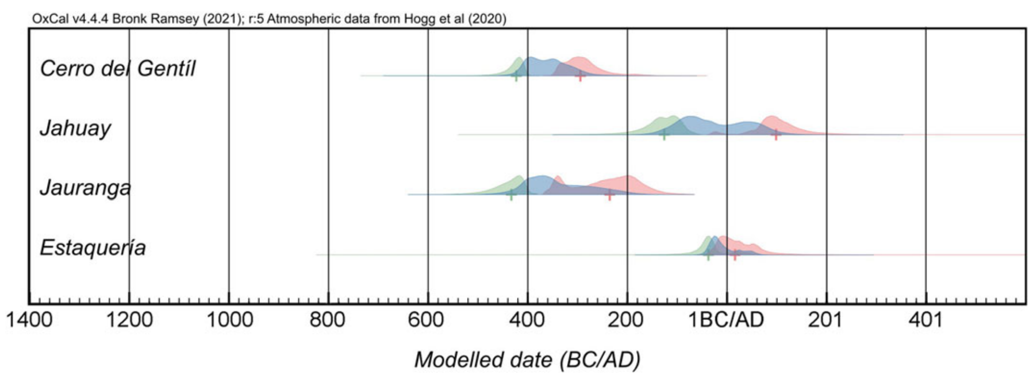

Figure 3 Modeled Kernel Density Estimate plots of ^{14}C dates from Cerro del Gentil, Jahuay, Jauranga, and Estaquería. KDE plots of modeled dates are shown in blue. Green and red curves indicate the starting and ending boundaries.

stratigraphic data (Unkel 2006:68–69). Dates sampled from the same stratigraphic level were embedded in Phases. An R_Combine command was used on two dates, HD24232 and ET438, which were derived from the same charcoal sample.

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Estaquería

There are 6 published Estaquería dates, sampled from two strata, Level I and Level D, within a single excavation unit, Unit 1 (Unkel 2006:73–74). All the samples were taken from wood posts identified within these two levels, with the exception of ET364, a charcoal sample collected from the floor of Level D. Four dates were produced using gas proportional counting, and the other two are AMS dates. Due to outstanding conditions for organic preservation, the old wood problem is a potential issue on the Peruvian coast. It is possible that the dated posts were older than the target event, the construction of these levels where Initial Nasca ceramics were identified, in which case the occupation would appear older than it truly was. Dates were organized within two sequential phases based on these levels. Two dates derived from the same sample (HD24701 and ET366) were combined using the R_Combine command.

RESULTS

The unmodeled calibrated dates from Cerro del Gentil suggest a long Paracas occupation which began in the fifth century BC and lasted approximately 250 years (Tantaleán et al. 2016; Tantaleán and Stanish 2017). This long span was an effect of the coincidence of the later dates from this occupation with a plateau on the calibration curve. Bayesian modeling indicates that Cerro del Gentil's occupation began slightly later and ended much sooner than was previously recognized. The ending boundary of the Cerro del Gentil model has a median end date of *~295 cal BC* (*350–205 92.9% hpd*).

Even prior to modeling, comparison of radiocarbon dates from Jahuay and Cerro del Gentil reveals a temporal gap between their occupations. Previously, early Topará ceramic styles (Jahuay 1 and 2) were believed to be contemporary with the Late Paracas occupation of Chincha; if that were the case, Jahuay would be occupied by the fourth century BC. Instead, the unmodeled Jahuay radiocarbon dates indicate that the occupation of Jahuay post-dates the closure of the Late Paracas occupation at Cerro del Gentil. The addition of Bayesian modeling widens the chronological gap between Late Paracas in Chincha and Topará at Jahuay. We estimate that the median start occupation date for Jahuay was 130 BC (*220–65 cal BC, 95.4% hpd)*. The results of a Difference query comparing these two boundaries (Table 4; Figure 4) suggest that the end of Cerro del Gentil's occupation was around *165 years* prior to the start of the Jahuay occupation *(30–255 years, 95.4%, Start Jahuay v. End Gentil)*. These results indicate that the establishment of the earliest known Topará site post-dated the closure of Late Paracas ritual sites in the Chincha Valley. Assuming a generational interval of 25–32 years (Fenner 2005), these two events were likely separated by multiple generations.

New calibration and modeling of Late Paracas and Initial Nasca dates from Jauranga and Estaquería in the Palpa Valley resulted in considerably narrower probability distributions, and importantly, narrowed the estimated starting boundary for the Initial Nasca phase. The Palpa model (Unkel et al. 2012) suggested that the onset of the Initial Nasca phase, based on the dates from Estaquería, was *120 cal BC–cal AD 75 (95.4% hpd, SHCal20*). Considered in isolation rather than within a regional chronology, our estimated starting boundary of the Estaquería site occupation is *95 cal BC–cal AD 60 (95.4% hpd*) with a median of *40 cal BC*. A Difference query comparing the start boundaries of the two sites suggests that Estaquería was established *~95 years* after Jahuay *(0–230 years, 95.4%, Start Estaquería v. Start Jahuay)*. Broadly, these findings support the existing model of the Topará style having emerged north of the Ica Valley and Nasca Drainage, then gradually spreading to sites in the southern valleys. Of course, additional dates from this and other sites in the Nasca Drainage would strengthen these

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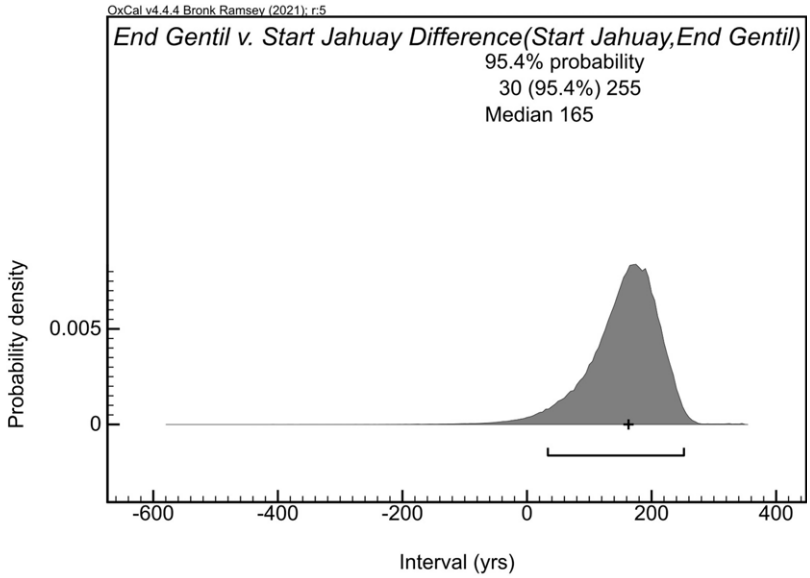

Figure 4 Plotted difference between the End Gentil and Start Jahuay boundaries.

findings, especially considering that the wood post samples from Estaquería could potentially be older than the site itself.

We should be cautious when comparing occupations at the two Late Paracas sites. Although a Difference query comparing the two suggests that Cerro del Gentil was closed *~65 years* prior to the end of Jauranga's occupation *(-60–185 years, 95.4%, End Gentil v. End Jauranga)*, the end boundaries for Cerro del Gentil and Jauranga have large areas of overlap. We cannot rule out the possibility that Jauranga's occupation ended first, or that both sites were abandoned at approximately the same time. Additionally, there is difficulty in comparing a monumental ritual center like Cerro del Gentil with a settlement like Jauranga. As recent work in the Chincha Valley has shown, even after major ritual centers were closed local populations continued to live in the area (Tantaleán et al. 2022). The impact of the Paracas-Nasca transition on different types of sites likely varied, and it would be useful to have dates from Palpa Valley ceremonial centers to directly compare with Cerro del Gentil.

Lastly, this analysis stands as a successful case of using Bayesian modeling to calibrate dates across a radiocarbon calibration plateau. By incorporating stratigraphic data into a Bayesian model, we were successful in narrowing calibrated dates with ranges spanning nearly five centuries down to a modeled range of a few decades. For instance, even though UCIAMS-162403 (2395±20) is a precise AMS date, its place on the calibration plateau produces a 95% calibrated range of 490 years (720–230 BC). The stratigraphic priors allowed us to drastically reduce the modeled range to just 60 years *(445–385 BC, 95.4% hpd)*. This work illustrates the potential utility of Bayesian approaches for any archaeologist interested in constructing chronologies on a calibration plateau.

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DISCUSSION

There are three principal findings based on this analysis regarding the decline of Paracas and the role of Topará during the Paracas-Nasca transition. First, the process of Paracas ritual site closures might have begun earlier than has previously been appreciated. Second, we find that the Topará tradition, long believed to have been a catalyst for Paracas decline, likely did not emerge until generations after the closure of one of the major Paracas ritual sites in the Chincha Valley; that is, until after Paracas decline was already well underway. Finally, although this work contradicts many of the tenets of the Lanning-Wallace model, it does appear to uphold one of the model's basic principles, which is that the Topará ceramic style spread from north to south through the valleys of the south coast, and likely did not become established in the southern valleys of the region until generations after its establishment in the northern valleys.

Based on analysis of unmodeled dates from Cerro del Gentil, Tantaleán and Stanish have previously proposed that the site was closed during the mid third century BC following a period of feasts and other ritual events (Tantaleán et al. 2016; Tantaleán and Stanish 2017). While this interpretation is still supported by our analysis, the ending probability range for Cerro del Gentil is estimated at *350–205 cal BC (92.9% hpd)* with a median end date of *295 BC*. In archaeological terms a chronological shift of a few decades is typically insignificant. It is important in this case, however, as understanding a brief yet complex period such as the Paracas-Nasca transition requires fine-grain, decadal-scale chronologies for each of the regions' several valleys.

As the only site to date where the Jahuay 1 ceramic style has been identified (Wallace 1986), Jahuay is the earliest accepted Topará site. Previous south coast chronologies have suggested that the early Topará ceramic phases were contemporary with Late Paracas. If Topará influence were a catalyst for Paracas disintegration in Chincha, then we would expect the earliest phases of Jahuay's occupation to predate the closure of Paracas ritual centers. Instead, comparison of radiocarbon dates from Jahuay and Cerro del Gentil indicates that the Topará ceramic style emerged generations after Cerro del Gentil site had been ritually closed *(30–255 years 95.4%, median 165 years, Start Jahuay v. End Gentil*). Although we focused this analysis on Cerro del Gentil, we note that these dates are relatively consistent with dates from other monumental sites throughout the Chincha Valley (Tantaleán et al. 2020:210). It is however conceivable that some still-unexcavated Paracas ritual centers sites in the Chincha Valley remained in use following Cerro del Gentil's closure, and may even have been loci where the Topará tradition was developed by local populations (Nigra 2017). Regardless, the evidence that the decline of Paracas and closure of its ritual sites had already begun prior to the development of the Topará style is sufficient to refute the hypothesis that an invasive Topará group was the catalyst for the Paracas tradition's downfall.

Taking a broader look at the Peruvian south coast, however, it is apparent that Topará and Paracas populations *did* coexist and interact in other places, particularly the Paracas Peninsula (Peters 2016; Peters 2018), the Ica Valley (Menzel et al. 1964; Massey 1986), and the Río Grande de Nasca drainage (Isla Cuadrado and Reindel 2018; Carmichael 2019). While we echo Unkel and colleagues' caution that only 6 Initial Nasca dates have been published from the Palpa Valley (Unkel et al. 2012), comparison of those dates with the data from Jahuay suggests that the Topará ceramic style arrived in Palpa multiple generations after its appearance at Jahuay. A Difference query comparing the Jahuay and Estaquería Start Boundaries indicates that the settlement at Jahuay was establish around *95 years* prior to the settlement at Estaquería *(0–230 years 95.4%, Start Estaquería v. Start Jahuay)*. Similarly, the closure of

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Cerro del Gentil appears to predate the abandonment of Jauranga by about *65 years (-60–185 years, 95.4%, End Gentil v. End Jauranga)*. It is likely that the Paracas decline began earlier in the northern valleys of the region with the closure of Late Paracas sites like Cerro del Gentil, La Cumbe (Tantaleán et al. 2022), and El Mono (Tantaleán et al. 2013). Of course, there are very few absolute dates from intervening areas. Additional dating of Paracas and Topará contexts in the Pisco and Ica Valleys and on the Paracas Peninsula would provide greater insight, but initial comparison of dates from Jahuay and Palpa suggests that the fledgling Topará ceramic style did not introduce any discernable stylistic influence on ceramics in the Nasca drainage until several generations after it was developed in the region's northern valleys. This in turn suggests that Paracas decline across the entire south coast was perhaps more drawn out and exhibited more subregional variation than has previously been recognized.

A further question we have not explored here is how and when Topará ceramics reached highland Paracas settlements, and how those communities experienced the changes associated with the Paracas-Nasca transition. Reindel and Isla have recently reported possible Topará-influenced ceramics from the sites of Cutamalla and Huayuncalla in the highland Lucanas province (Reindel and Isla Cuadrado 2018). The vertical movement of goods, people, and ideas between the highlands and coastal valleys presents an additional layer of variability to be explored through future research.

In rejecting the hypothesis that a Topará invasion led to the Paracas decline, we also invite new examination of its causes. Within the Chincha Valley, the closure of Paracas ritual centers may represent a local collapse of Paracas social, economic, political, or religious systems. Perhaps a natural disaster, such as a severe earthquake or a drought, caused adherents of the Paracas religious system in Chincha to question local leaders' capacity to continue guiding their communities. Alternatively, in consideration of the evidence that Late Paracas communities were achieving new levels of political and economic integration, particularly in the Chincha Valley (Tantaleán 2016, 2021a), we might consider whether Paracas religious leaders in Chincha made an unsuccessful attempt to consolidate their power into a more permanent, ascribed status, and as a result lost the trust and allegiance of the communities they led. Nigra (2017:480–481) suggested the possibility that some ritual centers, including Cerro del Gentil, were out-competed by other ceremonial sites in the Chincha Valley; in this scenario, these latter sites were not abandoned but instead transitioned into politico-ceremonial centers for the emergent Topará tradition. Furthermore, the exact nature of the Topará tradition and its relationship to Late Paracas and Early Nasca styles is still an open question. Although in-depth exploration of this topic goes beyond the goals of this paper, we are intrigued by new data on Paracas and Topará domestic ceramics from Chincha and Jahuay (Tantaleán et al. 2020, 2022; Osborn 2022). These wares are nearly identical, a fact which potentially revives the argument that the Topará style, like Nasca, was developed by the descendants of south coast populations who had formerly been aligned with the Paracas phenomenon. Previously the Topará ceramic style was believed to appear too suddenly for it to have been an autochthonous development out of the Paracas Cavernas style. However, the evidence presented here suggesting the Topará style first appeared generations after the onset of Paracas decline indicates that there was sufficient time for communities of potters to experiment and develop the new ceramic technologies and decorative techniques which characterize Topará ceramics. Furthermore, the recent identification of an "Epi-Paracas" domestic occupation at La Cumbe after the site was decommissioned (Tantaleán et al. 2022) lends support to this theory by demonstrating that local populations continued to live in the Chincha Valley after regional politico-ceremonial centers were closed. We hope that future research focused on the Paracas-Nasca transition in

Chincha and surrounding valleys will target household contexts, as they can be a fruitful source of data for understanding how local populations experienced these transformations across multiple generations (see Van Gijseghem 2006; Bautista 2018).

In the future, additional Bayesian studies of dates from Paracas sites and their closure events could enable us to understand the rate at which they closed within the Chincha Valley and across the Peruvian south coast. Did all of the Paracas centers in Chincha close very rapidly, over a period of just a few months or years, or was this a more protracted process of gradual decline which unrolled over the course of decades? Understanding the rate of Paracas decline within a single valley, and then across the south coast, might offer hints as to its root causes. Similarly, Bayesian chronologies which incorporate foundational dates from Topará and Initial Nasca sites can help us track the spread of these two emergent ceramic styles with greater precision.

Ultimately, understanding the undoubtedly complex processes which contributed to the Paracas-Nasca transition will require much more work at both a regional and subregional level. Our work has reiterated that although fine-scale chronologies are sometimes complicated by calibration curve plateaus, Bayesian sequencing can help overcome these challenges and allow for more precise dating. Archaeologists working in contexts associated with calibration curve plateaus should consider Bayesian sequencing as a potential analytical method and select their samples appropriately, especially if they are working in stratified contexts which are well-suited to such methods.

CONCLUSION

The vaguely defined "foreign influence" of the Topará tradition has become a *deus ex machina* explanation for the transformation of south coast societies during the final centuries BC. Misattribution of the causes of Paracas disintegration and transformation to a supposedly external group continues to limit our ability to understand how this transitional period unfolded across the valleys of the Peruvian south coast. This is not simply a matter of correcting chronologies; it is also an anthropological issue relevant to studies of societal "collapse" and transformation. By demonstrating that the Topará style's development post-dated the onset of Paracas disintegration in Chincha, findings from Jahuay open the door for researchers to consider new causal explanations for this period of major social transformation. Future research should explore alternative explanations for the gradual demise of the Paracas religious system and should especially consider internal causes for this transition.

Our work has revealed that the chronology of this transition is more nuanced than previously understood, and merits deeper investigation. The developments which shaped population movements and cultural transformations during this period appear to have taken place relatively rapidly and across multiple valleys of the south coast. Understanding these processes will require extensive additional research and dating with decadal-scale resolution. In the past, archaeological chronologies at this scale have rarely been possible, especially when events corresponded with radiocarbon calibration plateaus. Bayesian chronological modeling can drastically improve chronological precision across calibration plateaus as we continue to explore this issue.

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/RDC.2023.67

ACKNOWLEDGMENTS

Our thanks to the PIA Jahuay team for all their hard work. We are grateful for the support of Jacob Bongers, Joyce Marcus, Charles Stanish, and Henry Tantaleán. We thank the Ministry of Culture for authorizing excavations at Jahuay [Resolución Directoral Nº 145-2017-DGPA-VMPCIC/MC and Nº 148-2018-DGPA-VMPCIC/MC] and especially appreciate support from Rubén García and Susana Arce of the DDC-Ica. We thank Kimberley Elliott for editorial support. Finally, thank you to two anonymous reviewers for their thoughtful and detailed feedback, which substantially improved this paper.

FUNDING

This work was supported by a Fulbright-Hays Doctoral Dissertation Research Abroad Fellowship [#P022A180037]; a Dumbarton Oaks Pre-Columbian Studies Fellowship; the University of Michigan Museum of Anthropological Archaeology; a National Geographic Young Explorers Grant [# CP-015ER-17]; the Rust Family Foundation Archaeology Grants Program; the American Philosophical Society's Lewis and Clark Fund for Exploration and Field Research; and the Department of Anthropology at the University of Texas at Austin.

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