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Brushing Off the Dust: Transitionary Diet at the site of Cerro del Oro

Brittany Hundman

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TRANSITIONARY DIETS AT THE SITE OF CERRO DEL ORO

by

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Under the Direction of Dr. Nicola Sharratt, PhD

ABSTRACT

Dietary practice during the transition from Early Intermediate Period (200 BC-AD 600) to the Middle Horizon (AD 600-1000) is crucial to understanding Pre-Hispanic life on the southern coast of Peru. The Cerro Del Oro material was excavated in 1925 by Alfred Kroeber and since been biochemically unstudied for almost ninety years; left dormant at The Field Museum in Chicago. Through bioarchaeological reconstruction of diet and health at the site of Cerro Del Oro from a cemetery sample (N=35) in the Cañete Valley, the effects of demographic and subsistence changes can be examined through a combined analysis of osteological and light isotopic data. Stable carbon ($^{13}C/^{12}C$, or $\delta^{13}C$) and oxygen ($^{18}O/^{16}O$, or $\delta^{18}O$) isotopic values from tooth enamel carbonate are utilized to reconstruct diet during early childhood of each individual. Results indicate that the majority of the population were consuming a moderately variable terrestrial protein or C_3 diet. This is significant due to the close proximity to marine resources.

INDEX WORDS: Bioarchaeology, Stable isotope analysis, Paleopathology, Diet, Health, Nasca, Wari, Cañete, Peru, Museum Collections

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1 INTRODUCTION

At various places and times in Andean South America, state expansion was enacted by complex societies through a variety of strategies including trade agreements, formation of administrative centers in distant regions, and the forging of political alliances through the manufacturing of elite ideologies (Jennings, 2006). Sites located on the periphery of major cultural groups play an important role in understanding the ways in which those strategies were utilized and the nature of social and political interactions with the heartland (Jennings, 2006; Moseley, 2001). Such state strategies can affect access to resources, the introduction of new pathogens, alterations to subsistence patterns, and changes to the population composition.

As cultural practices are disseminated and rearticulated across the landscape, relationships between heartlands and peripheries are developed and negotiated. Cultural practices regarding food production and consumption are an example of this. The ways that populations select consumable options from the available landscape are based on economic, social, and religious perceptions of what is food. These perceptions are based on variables such as taste, value, taboo, and means of preparation. The result of social and environmental pressures on a population, access to resources is mitigated by a number of additional factors. Gender, ethnicity, ideology, and status can also affect the repertoire of foods available to groups within a population.

Additionally, the physical act of eating is an individual performance of identity. When examined demographically, isotopic data for both diet and mobility can shed light on the social groups that people participated in, both locally and in a larger region. Moreover, analysis of dietary composition at population levels can elucidate potential social differentiation such as status, gender differences, and age differences and therefore provides an opportunity to examine social variation within populations on the edge of expansive polities.

Health in the archaeological past is analyzed by the examination of human skeletal remains through the identification of pathological markers. Because not all diseases leave markers in bony tissue it can be difficult to know exactly what caused an individual to die. Stress related insults such as cribra orbitalia, porotic hyperostosis, and linear enamel hypoplasias are indicative of reduced access to nutritionally rich foods, severe illness, contaminated water sources, etc. In combination with other data this information can inform on discussion on demographic differences, i.e. sex or age or status.

Examined temporally, changes in both dietary composition and disease prevalence can elucidate changes resulting from sociopolitical transformation, such as the imposition of an imperial state across the landscape. Changes in social composition, access to resources, and movement of peoples are indicative of changes to the human landscape.

This thesis examines diet and migration in a mortuary population from the site of Cerro del Oro located in the Cañete Valley, Peru. The site's location in space and time make it an ideal case study for examining the ways in which one peripheral community's choices about food were impacted by multiple processes of cultural influence and state expansion. Cerro del Oro was located on the periphery of the Nasca polity (AD1- 600). Current interpretations of the Nasca is that it consisted of a confederation of valleys along the south coast of Peru that were bound together through cultural practices (Moseley, 2001). Communities living in these valleys shared ideologies, ways of life and material styles. Shared identity and social ties were periodically reinforced by groups coming together at pilgrimage sites and engaging in ceremonial activities. Nasca's core territory was in the Nazca (location of Cahuachi, the largest known Nasca site) and Ica valleys, but Nasca materials and its assumed sphere of influence stretch 200 miles from the Yauca Valley (south of the Nasca valley) to the Caňete Valley (north of the Nasca valley). That influence is evident at Cerro del Oro where ceramics with Nasca iconography have been recovered.

However, Cañete, as well as other valleys within the Nasca sphere of influence, were also subject to Wari influence. Dating after the fluorescence and decline of the Nasca confederacy (AD 600-1000) the Wari culture was an imperial power that controlled the landscape from the central hub of the Ayacucho Valley in the Andean highlands. There is continued debate about the nature of the Wari imperial power. This debate can be characterized as expansionist vs node-core models. The expansionist model depicts the Wari as exerting complete control over the entire landscape between the heartland to its most distant provinces, such as that in the Moquegua Valley (Williams, 2001, 2005; Finucane, Agurto, & Isbell, 2006). In contrast, a model proposed principally by Jennings (2006) understands Wari as utilizing a node system instead of a blanket of influence spread universally across the landscape. This system allowed the heartland to access and influence specific sites without having to control all of the land in between. These models rely on a multifactorial data set of ceramic materials, human skeletal remains, and architectural styles, to name a few. The presence of ceramic materials or individuals from distant lands is indicative of cultural exchange.

Therefore, because it is located in a valley that was influenced first by the Nasca and then by the Wari and because it is a site from which pottery with Nasca iconography and pottery with Wari iconography has been recovered, Cerro del Oro presents a critical case study for examining the variety of ways in which the complex societies of Nasca and Wari interacted with distant valleys and how these valleys dealt with their cultural influence.

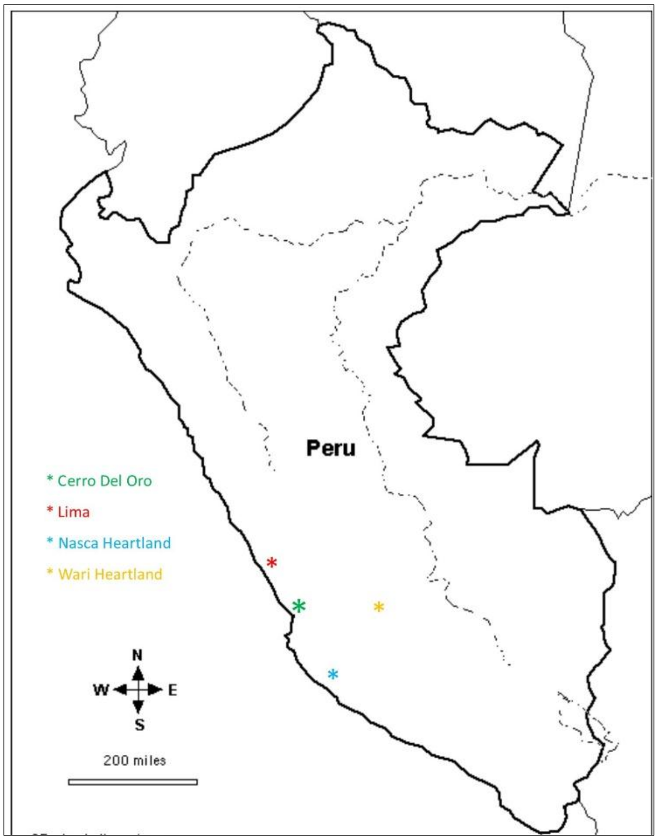


Figure 1: Map of Peru

Through the reconstruction of diet at Cerro del Oro, this thesis examines food choice and resource access at the site in order to both investigate the influences of Nasca and Wari cultural practices on the population and to attempt to reconstruct social difference within the population through differential access to foods.

Isotopic analysis also examines whether there were non-local individuals within the population. Shifts in population also occur during times of state expansion and cultural interaction; as people move from the heartland into the periphery and vice versa. Human skeletal evidence is fundamental to the examination of human movement across the landscape. Through isotopic analysis it is possible to determine residential patterns in early life to compare with the years leading up to death to see if individuals had left their natal community. There is evidence for individuals moving from the Wari heartland into the periphery and taking up residence there (Knudson, Tung 2007).

The examination of health, also through the analysis of the skeletal remains, can further provide information about social stratification and identity in this valley. These sets of data can suggest lifeways in the past. Understanding the indices of pathology within the population in the Cañete Valley can help in the reconstruction of how its inhabitants experienced life and disease (Waldron, 2008). Changes in dietary consumption and disease prevalence over the course of the occupation phases may represent the imposition of foreign influence or the preferential maintenance of local dietary practices as a means of resistance to the presence of foreign materials and individuals.

1.1 Research Questions

Through its examination of archaeological and bioarchaeological data from Cerro del Oro, this thesis examines the influence of Nasca and Wari on the population of this peripheral site. Specifically, it asks:

1. What are the demographics of sampled population from the Cerro del Oro cemetery?
2. Is there variation in diet between the individuals represented by the thirty-five individuals analyzed from the Cerro del Oro population?
3. Are biogeochemical analyses useful in elucidating residential origins and modeling paleomigration in the Cañete valley? If so, can the current study be modified and expanded for future research? What are the limitations of such a study?
4. What, if any, does the diet and health suggest for non-local influence on the population?

1.2 Chapter Overview

Chapter 2 of this thesis presents the cultural context and background information for this research. It provides the reader with an overview of the cultural practices of both the Nasca polity and Wari state. It considers regional variation in dietary consumption throughout the Nasca confederacy and Wari Empire. This chapter also summarizes the cultural background of the south coast of Peru, the Cañete Valley, and the site of Cerro del Oro. It reviews the history of work at the site, and briefly presents the collection that I analyzed for this thesis.

Chapter 3 presents the methodological framework by which this thesis was constructed. It examines both isotopic analyses as well as paleopathological indicators found in ancient populations. This chapter discusses the ways in which these indicators are interpreted and used to reconstruct past dietary and mobility patterns within a population.

Chapter 4 outlines the research design of this thesis. The preparation of enamel carbonate is outlined in this chapter. Paleopathological identification criteria for cribra orbitalia and trauma are also outlined in the chapter. This is used to frame the later discussions on diet and mobility in the past. This chapter also addresses this study's objectives and goals. Outlining the foundational hypotheses of the research establishes the parameters by which this study was conducted. The research questions discussed in this chapter informed the overall theoretical and methodological framework of the analysis.

Chapter 5 discusses the isotopic results from the sample collection. It outlines the variability seen in the isotopic signatures and discusses the interpretation of these results. The variability between categories such as age-at-death and biological sex are also presented and discussed. The presence of cribra orbitalia in a number of these specimens is analyzed in this chapter and interpreted in concordance with the isotopic data to examine early life health insults and their potential causes

Chapter 6 concludes this thesis. It addresses each of the five research questions in turn and discusses limitations of the existing collection and future plans associated with this material. It also discusses future research proposed for this collection.

2 CULTURAL BACKGROUND & ARCHAEOLOGICAL CONTEXT

The transition from the Early Intermediate Period (BC 200-AD 600) (EIP) to the Middle Horizon (AD 600-1000) was a period in Andean pre-history that saw the rise of empires and major changes to sociopolitical organization (Moseley, 2001). This time period is characterized by substantial changes in administrative practices, population increases, and the spread of imperial styles and ideology. Of the various Early Intermediate Period polities, the Nasca (BC 100- AD 800), a confederation of valleys on the south coast of modern Peru, and the Moche (AD1-750), considered by some to be a state level society on the north coast of Peru, are the most extensively studied (Silverman, 2002; Valdez, 1994; Donnan, 2014; Toyne et al, 2014). In the Middle Horizon, two large expansive states flourished: the Wari (AD 600-1000) and Tiwanaku (AD 300-1100). From the Wari heartland in the Ayacucho Valley, the imperial state implemented strategies of expansion across the central highlands of modern day Peru (Schreiber, 1992; Williams, 2001, 2005; Jennings, 2006). Tiwanaku coalesced from the region surrounding Lake Titicaca and expanded to cover the areas of southern Peru and Bolivia (Kolata, 1986; Janusek, 1986; Goldstein, 1993a, 1993b). Early Intermediate Period Nasca and Middle Horizon Wari are the foci of this thesis.

Influenced by both the Nasca and the Wari, the Cañete Valley presents an opportunity to examine expansion and interaction during both the EIP and the Middle Horizon. The peripheral and temporal location of this valley between these two major culture groups in ancient Peru are invaluable for understanding imperial control methodologies, trade networks, and population movement. Situated between two expansive cultures, the Cañete Valley provides an opportunity to examine local responses to external influences of sociopolitical organization, craft production, and resource acquisition (i.e. diet) of each polities.

2.1 Establishing Chronologies

Although critiqued and revised several times, scholarship on the pre-Hispanic Andes still relies heavily on Rowe's (1962) master chronology. At the core of this chronology is the concept of ¨horizons¨ versus ¨intermediate periods". Horizons are temporal phases where there is considerable stylistic uniformity across the landscape while an intermediate period is a temporal phase with great stylistic diversity (Stone Miller, 1990.) During the Early Intermediate Period there were a number of stylistic phases in forms across the Andes, i.e. Nasca phases I through VIII. In the Middle Horizon there were the stylistic forms of Wari and Tiwanaku which although distinct, shared elements.

While this pervasive chronology is maintained throughout the Andes and utilized in the construction of this thesis, absolute dating as well as a growth in excavation has problematized this temporal framework. Of particular relevance for this thesis, recent research conducted by Dr. Fernandini found discrepancies in the established chronology on the southern coast of Peru, particularly as regards the end of the EIP (ca AD 500-600) and the beginning of the Middle Horizon (AD 600-800) (Fernandini, 2015). There is evidence for a much more fluid temporal range than the categories imply (Fernandini, 2015). For the Cañete Valley, chronology must be considered to be more of a continuous cultural period rather than a definitively defined period.

2.2 The Nasca

Nasca, as it is understood today, was a confederation of valleys bound together by religious ideology (Moseley, 2001; Vaughn, 2006). Temporally spanning from approximately AD 1-700, this cultural group spread across the southern coast of modern day Peru. Nasca influenced not only the coastal regions, their material culture also reached into the higher altitudes (Vaughn, 2006). Comprised of self-sufficient rural villages, the Nasca were linked by communal ceremonies and ideologies centered on the socio-religious center of Cahuachi rather than through imposed imperial administrative controls (Vaughn, 2006). A large ceremonial center, Cahuachi reached significance during Nasca Phase 3 (AD 50-170) (Valdez, 1994). Though there is evidence of domestic-like structures at the site there is no concordant domestic refuse to indicate a large permanent occupation during the Early Nasca Phases (AD 1-450) (Silverman, 1993; Vaughn, 2006). Located in the lower portion of the Nasca Valley this site was likely a major pilgrimage center for what is considered today to be the Nasca confederacy. Production of the famous polychrome pottery was centered at this site during the Early Nasca Phases (Silverman 2002; Vaughn, 2006). This served as a means of production control for Nasca religious elites. The centralized production of this early material is an excellent indicator of interaction between the heartland and its periphery by tracking the appearance of early polychrome ceramics in distant regions of the south coast.

Due to the large temporal span of Nasca polychrome pottery an eight phase chronology was established to better account for the 800 plus years of its presence in the archaeological record (Kroeber, 1998; Silverman, 2002; Vaughn 2004, 2006). Understanding the position of a ceramic assemblage on this temporal spectrum allows for relative dating of materials, sites, and burials. As new analyses of ceramic composition come to light and dating techniques are improved these chronological phases continue to be redefined (Vaughn, 2006; Proulx, 1994; Hecht, 2009). These improvements provide more definite intervals of time in which to situate the material. This is especially important for research where C^{14} data are absent and absolute dates are not available. The ceramic chronology can provide a relative dating method with which to contextualize material and to examine topics such as resource acquisition, ideological dialogue, and socio-political structures (Sinopoli, 1991). Ideological dialogue refers to the transmission, negotiation, and maintenance of ideological iconography across all stratum of the population.

During the later Nasca Phases (5-8) (AD 550-1000) there was increased heterogeneity in both the composition of pottery slips and decoration (Vaughn, 2006). Changes in slips indicate that ceremonial polychrome pottery was now being made from resources local to each site. Decorations became less reliant on the elite iconography of the previous phases, and increasingly abstract motifs were introduced into the designs (Vaughn, 2004 & 2006).

During the Early Nasca Phase, i.e. the beginning Early Intermediate Period (AD 200-350) the Nasca saw a decrease in the physical expression of warfare, i.e. non-defensible settlement distributions, from the more defensible village settlement patterns of the proto-Nasca phase (Paracas) at the end of the Early Horizon and an increase in violent iconography in the thematic expressions of trophy heads, warriors, and combat (Vaughn, 2004, 2009; Unkel et al, 2012). Nasca ceramics are used as a relative dating method and are representative of the use of ceramics in the construction of chronologies in archaeological contexts. While transitions between ceramic phases are not temporally discrete they can shed light on changing socio-political, religious, and domestic life. In regards to the iconography on ceramic vessels, when examined with skeletal material a broader picture of the interactions between people and their world is drawn. The presence of violent images concurrent with the physical expressions of violence, skeletal trauma, are representative of growing interpersonal violence (Tung, 2012).

The term trophy head refers to an isolated cranium that has been imbued with social or religious importance (Tung, 2012). In the Late Nasca Period there was a shift toward larger villages and increases in skeletal evidence of violence (Unkel et al, 2012). Men and women now had similar rates of cranial trauma indicative of inter-group violence, likely resulting from raiding behaviors (Tung & Knudson, 2010). There was also a spike in trophy head taking during this time (Tung, 2012; Tung & Knudson, 2010). Such shifts in trauma may be the result of increased instability as the Nasca cultural group's influence began to wane during the Late Nasca period (AD 500-600).

2.2.1 Diet in Nasca Region

Diet in the Nasca heartland during the Early Intermediate Period (BC 100-AD 600) relied primarily upon terrestrial agricultural products (Carmichael, 2014; Webb, White, & Longstaffe, 2013). Though this culture is found in a coastal region, marine resources played only a small part in the larger subsistence patterns of the EIP. Due to the agricultural limitations of the Nasca southern area and the seasonally unreliable water sources there are high degrees of variability seen in the diet of the Nasca people (Webb, White, & Longstaffe, 2013). The terrestrial resources vary across the landscape and were differentially selected throughout the Nasca Valley (Webb, White, & Longstaffe, 2013; Carmichael, 2014). The resources consumed by the Nasca included peanuts, jack beans, squash, potatoes, aji, avocado, guava, huarango pods, and maize. The variability in subsistence patterns and the depiction of these resources in Nasca art suggest that no one resources was preferentially consumed (Silverman & Proulx, 2002) The consistent consumption of terrestrial plants and animals is markedly different from the iconographic evidence which is heavily reliant on marine resources and aquatic activities, i.e. fishing (Carmichael, 2014; Buzon et al, 2008). The disconnect between iconographic depictions of marine resources and the consumption of terrestrial diet may be representative prestige foods. If marine resources are to be considered an elite food resource and one that is consumed only rarely then it is possible that the sporadic consumption would not appear in the isotopic signature of the elites and therefore only leave evidence in middens and the iconographic record.

2.3 The Wari

The Wari state was a novel creation in the Ayacucho Valley, and had no imperial template to follow. The capital of Huari was the center of the Wari imperial state and was located in the Andean highlands. Emerging around AD 600 the urban center of Huari spanned between 200 and 300 ha at its center with several square kilometers surrounding it of residential settlements. At the urban core there is evidence for craft specialization, elite compounds, and royal tombs; indicative of a complex and hierarchical social system. This centralized imperial state was based on a hierarchical settlement pattern, a political economy based on agriculture and a complex religion (Moseley, 2001; Covey et al, 2013).

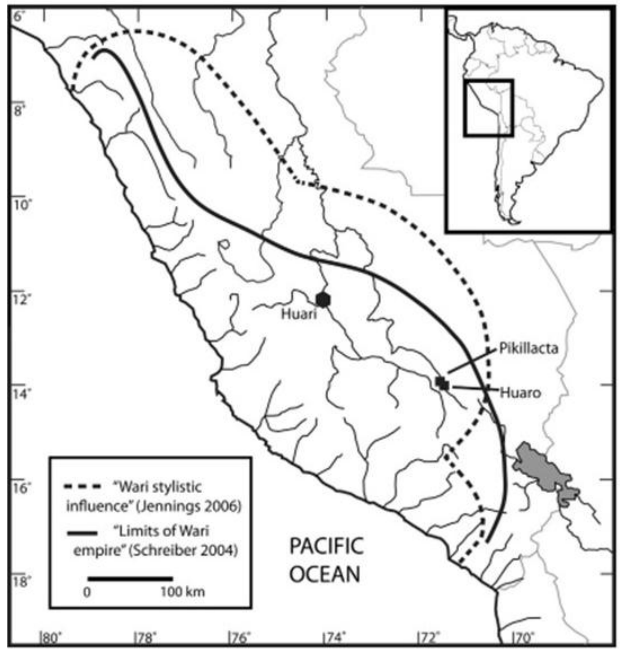


Figure 2: Map of Ayacucho Valley (Covey et al, 2013)

Heartland elites constructed an empire founded on the elaboration of wealth finance through the creative implementation of influence in the periphery (Earle & Jennings, 2012; Schreiber, 2004). Wealth finance, as defined by Earle and Jennings (2012), is the controlled distribution of high quality prestige items whose production is managed by the ruling elites and used to display status. Materials such as textiles, polychrome pottery, and metal artifacts were the primary objects of elite exchange (Earle & Jennings, 2012). Elites did not control the production and distribution of staple goods in the distant regions their territory, and instead relied on the exchange of prestige goods and ideologically significant materials. Locations such as

Conchopata (Figure 2) were centers for the production of Wari fine-ware ceramics (Earle and Jennings, 2012).

For the Wari, the production and distribution of prestige materials allowed the state to exert a measure of control over local elites, as well as to consolidate an ideological foundation of authority in those regions. Resulting in an ideologically legitimated authoritative position in many regions, e.g. the Sondondo and Nasca Valleys, the Wari constructed administrative centers to monitor the production of items such as textiles and pottery (Earle & Jennings, 2012; Edwards & Schreiber, 2014; Castillo, Fernandini, & Muro, 2012). They were able to construct these exchange networks by tapping into the preexisting needs of local elites for foreign goods (Earle & Jennings, 2012).

Ideology played a crucial role in the negotiation of power during and after the introduction of the Wari state (Schreiber, 2004). The Wari state employed a number of strategies to deal with local ideology: incorporation, elimination, and concordance. Ideologies such as the Nasca cult became incorporated into the Wari ideological structure because it allowed them to lay claim to the indigenous ritual centers and affirm an ideological basis of power that legitimated their occupation of the villages and valleys (Vaughn, 2004). Wari iconography allowed the empire to communicate both sacred and secular information through transportable media such as textiles and ceramic vessels which extended far beyond the loci of physical presence. These materials spread across the landscape marking boundaries of political influence and social and ritual hierarchies (Schreiber, 2004). Through the accumulation of foreign prestige goods, local elites could legitimate their power within the local through expressions of access and establish the novelty and importance of materials in the Wari style. In addition to transportable materials, the architecture the Wari imposed upon landscapes in the periphery was another strategy of legitimization and control (Edwards, 2013; Schreiber; 2004; Edwards & Schreiber, 2014).

Wari ceramic styles such as Chakipampa and Viñaque, appear in the northern valley of Jequetepeque which was home to the Moche. By the beginning of the Middle Horizon the Moche had begun to decline due to increased socio-political fragmentation, incorporation of foreign prestige goods, and lack of iconographic homogeneity (Castillo, Fernandini, & Muro, 2012). The impermeability of the Early Moche (AD 100-300) was broken by the presence of these foreign ceramic types in the high elite tombs such as the Priestess of San Jose de Moro (Castillo, Fernandini, & Muro, 2012). The changes in Moche ceramic styles in the Late Moche (AD 700-800) are linked to the appearance of the Wari Chakipampa style. The influence of Wari styles indicates that the elites of the site at San José de Moro were less able to restrict the incorporation of new techniques and also that the Wari were able to exert more influence in the northern region of the Wari empire (Castillo, Fernandini, Muro, 2012). The presence of Nasca and Cajamarca ceramics at the Wari administrative center of Pikillacta in the Cuzco Valley indicates the spread of foreign elite materials from the areas it conquered into the Wari heartland as well as into other Wari provinces (McEwan, 1996, 2004; Moseley et al, 2005).

2.3.1 Trauma in Transition

The Middle Horizon saw the fluorescence of the Wari state and an increase in the variability of cranial trauma rates with a possible preferential selection towards elites (Arkush & Tung, 2013; Arkush, 2005). It has been suggested by Arkush and Tung (2013) that this was the result of elite members of the Wari state leading soldiers into combat and returned to the Wari heartland after death. Though only one type of imperial acquisition strategy enacted by the Wari, the use of violence to obtain and maintain control had potential repercussions for both the local elites and administrative elites from the Wari heartland. Iconographically, there was thematic reinforcement of militaristic and violent behavior inscribed in a ceramic medium. Caches of non-local trophy heads lend credence to the possibility of raiding and violent behaviors enacted in daily life. Children were often taken for the creation of trophy heads (Tung & Knudson, 2010).

Strontium isotopes suggest that some of the children whose skulls would become trophy heads were abducted from outside the local geological region to serve a sacrificial purpose (Tung & Knudson, 2010). The social implication of head taking is one of conquest. Captive taking was likely the primary way of producing individuals for sacrifice. By taking prisoners and ritually sacrificing them, rather than killing them during a battle, the state was provided the opportunity to demonstrate its prowess and authority couched in both militarism and religiosity (Tung & Knudson, 2010). The actual process of making the heads into trophies was undertaken by ritual specialists who would have received their own level of authority and agency through the creation of these ritual mediums (Tung & Knudson, 2010; Tung, 2007).

2.3.2 Wari Diet

Maize was a foundational agricultural product for the Wari Empire (Finucane, 2007; Kellner & Schoeninger, 2008). In the Wari heartland and surrounding areas, such as the Sondondo Valley, diet consisted primarily of maize and maize consuming terrestrial animals such as guinea pigs and camelids. Terraces were constructed during the Middle Horizon in the Ayacucho Valley and Sondondo Valley to accommodate the population growth that coincided with the imperial growth (Kellner & Schoeninger, 2008).

During the Middle Horizon, the site of Ancon was under the Wari influence. Due to its location along the central coast the population consumed large quantities of marine resources as expressed in the isotopic signatures of the populations. Slovak and colleagues (2009) utilize strontium isotopes to delineate between terrestrial and marine signatures. Corroborated by material evidence in the form of fishing gear, fish and shellfish refuse a heavily marine oriented diet is suggested by the isotope data (Slovak, Paytan, Wiegand, 2009). There does not appear to be a change in marine investiture during the expansion of the Wari Empire into this region. Local individuals continued to exploit the natural resources in much the same way as before (Slovak, Paytan, Wiegand, 2009).

2.3.3 Wari Migration

The presence of Wari ceramics across the Andes during the Middle Horizon was important for connecting peripheral locations with the heartland; but not the only way to do so. As material culture is able to move across the landscape so can people. Human migration from the heartland to the periphery and vice versa assists in the transmission of culture. At the site of La Tiza, Nasca Valley, there non-local individuals were buried during the Middle Horizon. Buzon et al (2012) suggests that this was the result of foreigners marrying into the community. Strontium and oxygen isotopic signatures inform on the migration and mobility of populations. Changes in dietary patterns or access to foreign resources can also be indicative of changes in mobility, exchange, and influence.

2.4 The Nasca Region in Transition

During the transition from the Early Intermediate Period to the Middle Horizon the people in the Nasca region experienced many changes to daily life. Their peripheral location to the Wari heartland allowed for a variety of localized responses to imperial influence (Buzon et al 2012; Edwards, 2013). Reaching its florescence during the Middle Horizon (600-1000 AD) the Wari state began to expand outward from its highland inception and began a process of integration and subordination that would last almost 400 years (Buzon et al, 2012; Edwards, 2013; Edwards & Schreiber, 2014; Jennings, 2006). As discussed above, the Wari Empire did not express uniform investment across the Andes likely relying on ideological and social exchanges to control distant regions (Jennings, 2006; Kellner & Schoeninger, 2008). This set in motion a time of change and socio-political adaptation for populations across southern Peru.

2.4.1 Wari Architectural Influence

The Nasca region provides excellent evidence for the imposition of Wari material culture and political influence (Buzon et al, 2012; Edwards, 2013; Edwards & Schreiber, 2014). The skeletal and material remains reflect transition and incorporation as individuals endured shifts in the political and social environment. Variability in local response provides interesting insight into the strategies employed by the state institutions (Buzon et al 2012; Edwards, 2013; Edwards and Schreiber, 2014). For example, the population at the site of La Tiza, Nasca Valley, maintained a variable diet throughout Wari influence (Buzon et al, 2012) while populations in the Sondondo Valley experienced an increased agricultural focus on maize production (Schreiber, 2004; Kellner & Schoeninger, 2008). The lack of uniform investment across the Andes indicates that territorial acquisition, alone, was not the primary driving force behind the expansion (Edwards, 2013).

Sites such as Patayara are representative of the ideological control exerted on distant populations (Kellner, Edwards, & Schreiber, 2013). The site of Patayara is nestled in the southern tributary of the Nasca drainage. A transition zone between the coast and the highlands, this region has little rainfall and dry river beds during the year necessitating the use of irrigation (Edwards & Schreiber, 2014). The *puquio* irrigation systems was the most efficient way of moving water around the valleys but were already in place by the end of the Early Intermediate

Period (200-600 AD) (Edwards & Schreiber, 2014). Wari influence is evident at this site in the form of Wari style architecture (Edwards & Schreiber, 2014; Edwards 2013). A small site, it has the rectangular enclosure and segregated activity patterns indicative of a Wari site. Due to its size, Edwards and Shreiber (2013) suggest that this was not an administrative center but rather a way station for Wari elites as they moved between the Wari heartland and the larger sites in the Valley, i.e. Incawasi. The architecture at the site suggests Wari influence and a possible location for Wari elites to reside as they moved between the heartland and larger sites in the Nasca Valley (Edwards & Schreiber, 2013).

On the other hand, the site of Incawasi is considered to be the regional administrative seat for the Wari in the Nasca Valley (Edwards, 2013). A much larger adaptation of the Wari architectural model, Incawasi, was likely the seat of regional Wari expression in the southern Nasca tributary. The scalability of the Wari architectural model made its localized application easier as it was possible to construct from an architectural canon that linked it to the state level infrastructure but was able to respond to the needs of those at the site (Edwards & Schreiber, 2014; Edwards 2013). This identifiable architecture of the Wari in the Nasca landscape provided a visual connection to the heartland as well as allowed for a localized response from administrative elites.

Interestingly, the skeletal material from La Tiza exhibits less influence than the built space (Buzon et al 2012; Conlee, 2009). Throughout the Wari empire there was a drastic intensification of maize production but there is no noticeable increase in consumption in La Tiza in the Nasca Valley. In areas of intensification there arises a marked difference between male and female consumption of maize (Buzon, 2012). This is attributed to the male practice of consuming chicha, corn beer, either ritually or domestically. The lack of difference indicates that male and females who lived in the Nasca drainage consumed maize equally and likely in the same fashion (Buzon et al 2012). The people may have benefited from their interactions with the Wari polity through increased access to diverse food resources. Buzon and colleagues (2012) discovered that during the Middle Horizon the population, both elite and non-elite, exhibit a greater dietary diversity than those from the preceding time period. Access to a state level infrastructure such as long distance trade would have increased the valley population's reach well beyond the efficient resources of surrounding areas.

The Wari expansion affected agricultural production in valleys closer to the heartland, i.e. the Sondondo Valley while in others there was little agricultural interruption, such as the Southern Nasca Region. Wari elite ceramics appear across the landscape and indicate a connection between the locations. Tung (2007) suggests that there was an overall increase in violence during the Wari Empire's influence but that it was selective and not universally applied. At the site of La Real in the Sondondo Valley there is little evidence of physical violence but Tung (2007) suggests structural violence at play rather than active warfare behaviors.

2.4.2 Dietary Changes

Architecture was not the only practice changing during this time; mortuary traditions also began to incorporate novel foreign practices. This is not to say that the traditional Nasca practice of domestic burials was discontinued but rather that elite burials began to incorporate imperial prestige practices as a means of connecting themselves to the reigning power structure (Buzon et al, 2012). While there are a number of burial practices performed by the Nasca, the domestic burial practice continues throughout the Early Intermediate Period (Conlee, 2009). Isotopic evidence from cemeteries around Cahuachi shows a high degree of dietary and water resource variability during the early (AD 1-450) and middle (AD 450-550) Nasca phases (Webb, White, & Longstaffe, 2013).

The Nasca drainage did not see an increase in maize production in the Middle Horizon. The site of La Tiza, in the Southern Nasca Region, does not express a marked difference between male and female consumption of maize. For the Wari, maize and the resulting product of chicha was both a ritually and domestically important resource and was predominantly consumed by males during the Middle Horizon (Buzon et al, 2012) The lack of difference in Nasca indicates the equal consumption of maize between males and females of all status levels. This is not to say that the Wari had no effect on diet in the Nasca drainage. Instead, there was an increase in dietary diversity during this time period. The ability of elites and non-elites to interact with state level infrastructure provided them access to resources beyond the confines of the Valley (Buzon et al, 2012).

Corroborated by the isotopic data collected by Kellner and Schoeninger (2008), the diet in the Southern Nasca Region saw no drastic change during the Middle Horizon. This study did not identify significant differences between individuals buried with local ceramics and those buried with Wari ceramics. This indicates that there was an equitable consumption of maize across all social strata of the populations. The variable consumption of wild and domesticated C_3 and C_4 plants were inter-individually significant but lacked any clear social, sex, or age corollary. These variations were present before the appearance of the Wari and indicated a diet with a mixture of C_3 and C_4 plants as well consumption of meat resources such as *cuy*, guinea pigs, and camelids (Kellner & Schoeninger, 2008; Finucane, Argurto & Isbell 2006). The nitrogen values of the local populations are lower than the heartland indicating fewer marine resources and reduced consumption of animal proteins. The archaeological evidence cited by

Kellner and Schoeninger (2008) supports the consumption of a variety of wild and domesticated plants such as potatoes, legumes, maize, squash and huarango (Kellner & Schoeninger, 2008).

2.4.3 Burial Practices

Mortuary practices were in a state of transition during the Middle Horizon in the Nasca Valley. While there was an increasing incorporation of novel practices; the traditional burials within the domestic structure were also maintained. Buzon and colleagues (2012) suggest that this is a delineation between elites and the common people. Because elites likely interacted with the Wari state and collected prestige goods associated with them the subsequent burials reflected their position on a higher social tier as well as their attempt to emulate state level elites. The site of La Tiza is relatively small but had multiple Middle Horizon burials types such as domestic and tomb burials. This separation between people in death indicates a level of social stratification and hierarchy in the Nasca valley. The introduction of above ground stone tombs that were plastered and painted would have signaled to the population that this individual was different than those who were buried in pits inside their house. As new ideology was enacted within the population the variability increased but as the Wari influence began to wane there is a clear shift back to the "traditional" burial practices (Buzon, et al 2012). This regression to tradition emphasizes the lack of control the Wari polity was able to exert. Instead of abandonment, such as that documented at Pataraya (Edwards and Schreiber, 2014), populations continued to live their lives as they had before the imposition of Wari influence (Buzon et al 2012). It is unlikely that, due to the lack of consistent burial practice and subsequent return to previous practice, the Wari were able to exert total social, political, and ideological control over the region. Incorporation and manipulation of established ideology and infrastructure were the primary strategies in this region (Buzon et al, 2012; Jennings 2006).

2.5 Cañete Valley

The Cañete Valley is a river valley on the southern coast of Peru. The Caňete river runs 220 km from its source at Ticllacicha Lake (5255 masl) to the Pacific Ocean (marked by a green arrow in Figure 3). The river basin consists of three zones: the high mountain zone, the middle mountain zone, and the alluvial plain. The alluvial plain is in the lower region of the river basin and is comprised of minor elevations with few hills. Though the region receives low annual rainfall, the river runs consistently and provides a year round water source. The site of Cerro del Oro is located approximately 13 km from the Caňete River in the Quilmana Rocky Spurs. This location makes it an ideal location to exploit the fertile landscape of the alluvial plane.

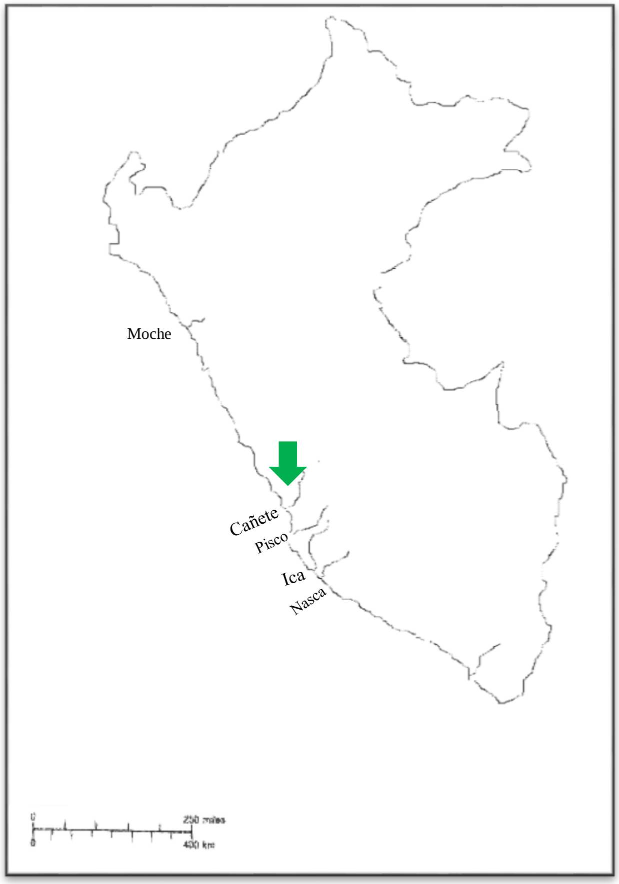


Figure 3: Map of Cañete River Valley

Located approximately 5 km from the modern city of Cañete, in the provinces of Caňete, and 150 km south of Lima, Cerro Del Oro was considered by Alfred Kroeber to be the site of a large cemetery (Kroeber, 1937). Kroeber and Antonio Hurtado noted no residential structures on the hill and posited that associated residences were in the valley below the hill (Kroeber, 1937). In 1925, Kroeber and Hurtado excavated at Cerro del Oro and identified two temporal occupations: the Middle Cañete and the Late Cañete/Late Chincha. Although Kroeber could not date the site absolutely, his monograph indicates that Cerro del Oro may occupy a temporal range between the Nasca and the Wari. Kroeber supports this claim by reference to the pottery from the site which contains elements of the terminal Early Intermediate Period as well as anticipatory elements of the Late Intermediate Period. The Middle Cañete pottery was influenced by the Nasca though it lacks the clear influence of Wari. It should be noted that Kroeber referred to this influence as Tiahuanaco. It was not until the mid-20th century before there was a distinction drawn between Tiwanaku and Wari. Previously the Wari cultural material had been considered a coastal version of the Tiwanaku (Moseley, 2001).

At the time of his work at Cerro del Oro Kroeber was in Peru on an expedition for the Field Museum in Chicago, Illinois. He was charged with learning about South America and collecting museum collections (Kroeber, 1998). His excavations at Cerro del Oro were to contribute to this mission. His primary focus was on the material culture in tombs at the site. The time period of this excavation, 1925, predates the archaeological understanding of the importance of bioarchaeology and the human skeleton as a fundamental component of archaeological investigation. This lack of knowledge resulted in many skeletal elements being left behind during excavations in the early 20th Century. The primary focus for the collection were human cranial elements and mummified remains.

Since its arrival at the Field Museum, the skeletal material has had relatively little academic attention. This legacy collection has experienced further taphonomic alterations to the remains as the materials have become increasingly frail and many of the teeth have been lost postmortem due to increased drying of the remains and the increased fragility of the skeletal material. The term legacy collection is defined by the author as a museum collection that was the result of a single, or small group, effort in collection of artifacts and materials either explicitly for the museum or later given to a museum. In this context, the Cerro del Oro collection is considered to be a legacy collection as it was excavated and curated by Dr. Alfred Kroeber explicitly for the Field Museum on a Marshall Field Expedition in 1925.

More recent research in the Cañete Valley by Dr. Fernandini (2015) has established a chronology that confirms Kroeber's temporal hypothesis. She orients the site at Cerro del Oro in a temporal period spanning the Early Intermediate Period and the Middle Horizon. Her chronology considers these temporal periods to be more fluid in this region. This is especially the case during the transition from the EIP to the Middle Horizon (Fernandini, 2015).

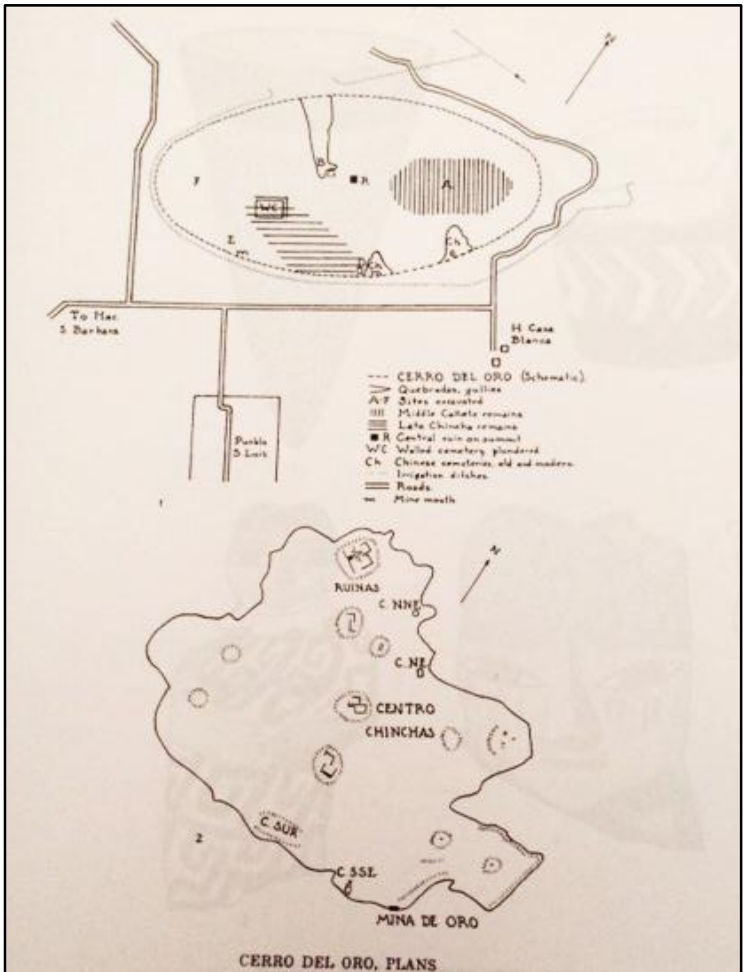


Figure 4: Map of Cerro del Oro (Kroeber 1937)

The modern excavations at the site revealed several occupation phases at the site that spanned 300-400 years. A variety of ceramic types, local and non-local, were found across the site. Botanical evidence suggests a diet based on crops such as lima beans, beans, and maize. There is some evidence of mollusks at the site (Fernandini, 2015).

Area A, where most of the tombs were found was on the Northeastern side of the hill. The Middle Cañete burials, early occupation phase, were predominantly undisturbed. This is likely due to the lack of precious metals in the burial goods. The materials from the earlier component of the cemetery contained ceramics, textiles, wooden bowls, and faunal bones but no precious metals. The relative poverty of materials perhaps saved these burials from the ravages of looting. Constructed out of small adobe bricks the tombs ranged in size from 30 x 30 cm to 100 x 150 cm and were built into the base of the terrace walls (Kroeber, 1937). While the size of the tomb is not proportional to the number of individuals it contains it does dictate the position in which the bodies are oriented. A seated and flexed position with the head between the knees appears to be the most common.

In Kroeber's monograph (1937) he mentions the skeletal materials and notes when elements are missing but does not provide drawings or complete inventories for each of the burials. Descriptions such as "*Tomb 7*- Adjoining 5 on S; 90 cm deep. Body, with bowl laid on head; also fragments of baby's skull" and the tomb contents list are the only information provided about the burials. There are no burial sketches or consistent information on burial orientation or type. Descriptions of tomb contents lists the number of individuals with the burial material but again lack description and identification.

The skeletal collection that was brought back to the United States consisted of 56 individuals with varying amounts of osteological material. In a number of cases the only elements to be recovered were cranial elements, i.e. cranium and mandible. Some of the remains were mummified and those were brought back as intact as possible. The mummified individuals were excluded from the potential sampling set. These were excluded at the Field Museum's request due to their inclusion in an exhibit on human mummies and the museum's preference to keep those individuals whole.

2.6 Summary

The Nasca were a confederacy of valleys that interacted in a socio-ideological realm but were self-reliant politically and agriculturally. Diet in the EIP was highly variable and consisted of a combination of wild and domesticated plant materials and terrestrial and marine resources and was site dependent. On the other hand, the Wari was a centralized hierarchical empire that relied on a complex political and religious structure that commanded influence across a large and varied landscape. Wari influence, in the form of ceramics, textiles, and architecture, is evident on the landscape.

The site of Cerro del Oro was within both spheres of influence. In this thesis, I utilize a bioarchaeological approach to examine diet and migration among the population interred at the cemetery on Cerro del Oro. Ceramics and textiles indicate both Nasca and Wari influence during the large temporal span of the cemetery's use. Biochemical analysis of the human remains will inform on the migration of the individuals and their diet patterns in early life.

3 METHODOLOGY

Serving to bridge the gap between archaeological and biological anthropological investigations of the past, bioarchaeology combines the study of material culture with that of human remains from archaeological contexts. By contextualizing human remains within a past cultural group's social processes bioarchaeologists can move beyond the descriptive nature of archaeology (Buikstra, 1977; Buikstra & Beck, 2006, Larsen, 1997: pg 3). Bioarchaeological approaches endeavor to not only describe the effects of diet and disease upon the human skeleton but reach beyond it to question the ways in which those processes could affect daily life. Rooted in the study of human skeletal remains this sub-discipline of archaeology combines the scientific methodologies of physical anthropology with the theory and contextual analysis of archaeology (Larsen, 2002).

The interdisciplinary nature of this sub-discipline provides multiple data sets for examining the historical and cultural processes that condition human lived experiences. The intersection between these data sets provides evidence for addressing questions of life quality, population frailty, and the mechanisms by which the population and the individual dealt with those issues (Zuckerman et al, 2012). This field allows researchers to step beyond the biological constraints on understanding humans and begin to articulate the means by which biological processes can affect culture. This interdisciplinary understanding allows for the reconstruction of a more nuanced understanding of past populations (Larsen, 1997: pg 5). While this approach is centered on the analysis of human skeletal remains, it is not separated from the need to understand the cultural conditions that shape life, i.e. economics, politics, diet, and conceptualizations of health.

3.1 Bioarchaeology

A fundamental component of bioarchaeological investigations is osteological analysis. In recent decades, archaeology as a whole, driven by the newer discipline of bioarchaeology, has moved beyond the realm of cataloguing remains as archaeological items. Human remains have left the footnotes of archaeological reports and are now a major component for reconstructions of the past (Larsen, 1997: pg 333; Buikstra, 1977). Prior to the 1970s, osteological analysis was considered to be a technique occasionally employed by an archaeologist. However, in part connected with the emergence of scholarship often defined as “post-processual,” which addresses topics including identity and agency (Wylie, 1991; Dobres & Robb, 2000), osteological analyses have been integrated more thoroughly into reconstructions of social process in the archaeological record.

Moreover, the addition of chemical analysis to the osteological repertoire of visual identification and osteometrics expanded the application of osteology in interpretations of culture (Larsen, 1997: pg 270). The “biological profile” is the result of osteological analysis of both metric and nonmetric data sets and include estimates of age, sex, stature, pathology, cultural affiliation, trauma, diet, nutritional status, and mobility. Age and sex categorizations are reconstructed from the analysis of suites of nonmetric features (White et al, 2012).

The study of paleopathology has especially benefited from the transition to a more scientific methodology. Early attempts at diagnosing disease in the past were the result of descriptive analysis of osteological markers. While this is still an element of paleopathological analysis the discipline has incorporated a number new techniques to further understand disease in the past. These techniques include DNA analysis of mummified tissues, measurement of growth insults such as linear enamel hypoplasia (LEH), the reconstruction of clinical expressions of disease, and more (Zuckerman et al, 2012).

3.1.1 Theory

The reconstruction of lived experience in the past is accomplished through the combined efforts of archaeological interpretations of material culture and biological interpretations of organic materials such as the human skeleton. The interactions between humans and their surrounding are key elements in the construction of what it means to be human. The examination of skeletal remains represents a bottom-up model for reconstructing social process as opposed to the top-down models associated with the study of documentation or iconography. The physical body affects and is affected by its surrounding culture (Soafer, 2006). Society is constructed and negotiated through the interplay between the forces of individual agency and cultural influence.

3.2 Osteological Analysis

Skeletal remains are indispensable sources of data for archaeological interpretations of cultural practices such as mortuary rituals, residential patterns, diet, migration, health, trauma, and paleodemography. Demographic analysis can shed light on lifestyles and group construction in archaeological contexts (Larsen, 1997: pg 338; Soafer, 2006). Paleodemographic reconstructions are based on demographic variables such as age-at-death and biological sex, and are fundamental to the study of population structures and cultural behaviors. These two variables can then be used to infer culturally-constructed processes related to gender and identity (Soafer, 2006; Buikstra & Beck, 2006). The identification of pathological elements on human remains can be used to infer access (or lack thereof) to necessary resources, and thereby contribute to reconstructions of health, well-being, social stratification, and disease management (Larsen et al, 1991; Soafer, 2006; Weston, 2012).

3.2.1 Pathological Identification

Identifications of disease and disease processes can shed light on quality of life in the past. Prevalence of disease in the archaeological record informs on the effects of dietary and social choices on the individual. Ascertaining the type and degree of pathological insults on the human body can indicate the susceptibility of the living population to disease, the potential disease load for a region, and how those populations may have responded to such pressures. Expressions of stress and disease insults such as caries, linear enamel hypoplasia (LEH), rickets, Harris Lines, and osteomyelitis are excellent indicators of bodily responses to different types of stress (Waldron, 2009; Ortner, 2003; White et al 2012). There are many issues with the utilization of visual analyses in the archaeological record, including multifactorial causes, non-diagnostic expression, and lack of expression of disease on the skeletal material. Chronic pathologies such as dental caries, periosteal reactions, and developmental interruptions are excellent indicators of illness in the past when diseases often killed their hosts before manifesting on the skeleton.

Inflammatory responses of the periosteum, a thin membrane protecting the outside of the bone, can have multiple causes such as a bacterial infection or trauma (White et al , 2012; Ortner, 2003; Waldron, 2009). Expression ranges from a slight elevation of the bony surface to drastic expansions and malformations of the bone shaft. These varying responses make causality difficult to specify. This is not to say that pathological responses on bony tissues are not useful indicators of lifeways. Increased frequencies of periosteal reactions have been linked to increased population sizes and subsequent expansions in sedentary occupations (Larsen, 1997: pg 85; 2002). Changes in such frequencies could provide information for when a population in a region began to live sedentary lives or had population increases that resulted in more crowded living arrangements (Larsen, 2002).

Periosteal reactions such as cribra orbitalia and porotic hyperostosis are considered to be evidence for nutritional deficiencies. The cause of these bony expressions has been debated for numerous years and is still contested to this day. The disputes over the causality of cribra orbitalia have lasted decades (Walker et al 2009; Naveed et al, 2012; Turner et al, 1999; Stodder, 2006). What is known is that it is caused by some form of anemia. The type of anemia is still under investigation. Iron-deficiency, hemolytic, or megaloblastic anemia are possible causal factors for this pathology (Walker et al, 2009). Cribra orbitalia is considered by some to be a megaloblastic anemic response with a variety of potential causal factors. Though arguments for a single cause will likely continue, it is more beneficial to consider the possible mechanisms that can result in the expression of cribra orbitalia and porotic hyperostosis (Turner, Kingston & Armelagos, 2012). Unsanitary living conditions, unequal access to food resources and/or parasitically contaminated water sources are all potential causal mechanisms (Walker et al, 2009). Cribra orbitalia is defined as a localized response of pitting and porosity on the orbital roof. The orbital roof extends laterally to the greater wing of the sphenoid and medially to the frontal process of the maxilla. A calvarial bone, the orbital roof is comprised on endocranial and ectocranial laminae with a layer of cancellous

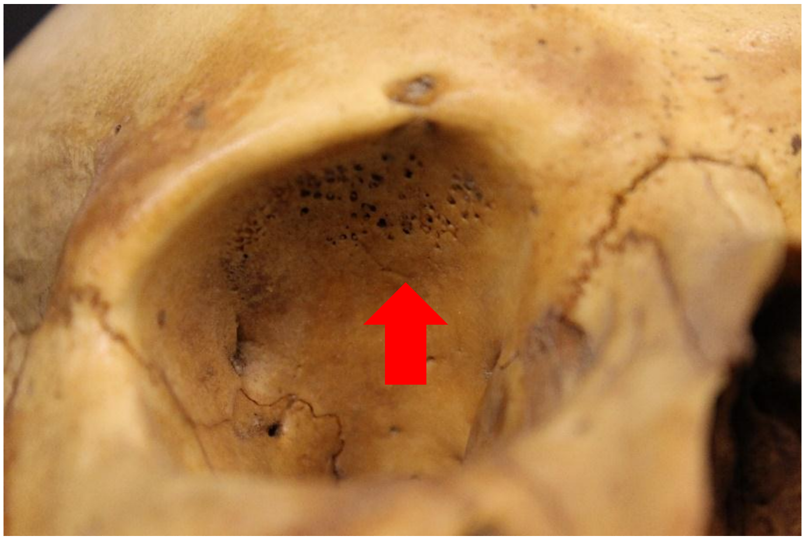


Figure 5: Cribra Orbitalia Example (1925.1588.169609)

bone (marrow producing) or diploe between them (Naveed et al, 2012; White et al, 2012). The three criteria for establishing the presence of cribra orbitalia are a reduction in bone density, increased porosity of medullary bone, and thickening of orbital roof.

3.3 Biochemical Analysis

3.3.1 Isotopic Analysis

The analysis of carbon and oxygen isotopes provides evidence for the types of resources being consumed and the food choices that populations were making as well as, and where these resources were located (Ambrose, 1993, 1990; Hedges & Reynard, 2007; Katzenberg, 2008). Distinctions between plant and animal proteins as well as the types of plant material being consumed are the results of such isotopic analysis (Ambrose, 1993). Isotopic analysis shows the ways in which a community utilized the local environment and/or interacted with other communities to gain non-local goods and resources.

Bones and teeth develop concurrently, but are affected by stress at different points in human growth and are imprinted with indicators of various indices of imbalance. Human dentition occurs in two stage: deciduous (or baby teeth) and adult teeth. Tooth formation begins in utero and continues through the eruption process. Deciduous teeth are the first set to form (Larsen, 1997:pg 23). Eventually, these teeth are lost and subsequently replaced by adult dentition. While tooth formation begins in utero, tooth eruption does not begin until approximately 9 months after birth. By the third year of life all of the deciduous teeth have erupted. Adult crown calcification begins at birth with the first molars and continues through age 8 when the completion of crown formation in the second molars. Starting around the age of six the adult dentition begins to erupt. All of the deciduous teeth are lost by 11 years of age, at which time all of the permanent dentition is in place, except for the highly variable third molar which does not completely erupt until approximately 18 years (White, 2012; Bass, 2005).

3.3.2 Understanding Diet in the Past

Rather than examining population level dynamics from site distributions and midden analysis of available foods, stable isotopes look at the individual level of dietary choice and what was actually consumed (Schoeninger & Moore, 1992; Cuellar, 2013). Isotopic analysis is especially helpful in the creation of more nuanced understandings of dietary composition and food choice (Schoeninger & Moore, 1992; Larsen, 2002; Ambrose, 1993; Katzenberg, 2008; Kellner & Schoeninger, 2007; Reynard & Hedges, 2008). Analyses of isotopic values extracted from bones and teeth in the carbonate fraction of hydroxyapatite have proliferated in the past several decades. Carbon in the bone carbonate is much more resistant to diagenetic processes than bone collagen (Wang & Cerling, 1994; Klinken 1999). Diagenesis is a physical or chemical change to the bony tissues of the skeleton. In archaeological contexts, diagenesis is the result of soil or ground water contamination (Ambrose, 1993; 1990).

Carbonate, from tooth enamel, is a metabolically inactive inorganic material that reflects the dietary carbon isotopic signal (Ambrose, 1993). Bone carbonate is metabolically active inorganic material that is remodeled throughout life. Due to its inactivity, enamel carbonate is not replaced after formation has been completed. Structural carbonate is suspended within the crystal lattice of hydroxyapatite – a type of calcium phosphate that forms the inorganic phase of bones, dentin, and enamel. The inorganic component of these tissues accounts for approximately 70% of the mass of bones, 80% of the mass of dentin, and 99% of the mass of enamel (Ambrose, 1993). Collagen is the primary component of the organic phase of bones and dentin. The organic phase comprises approximately 30% of the mass of bones and 20% of the mass of dentin. The carbon compositions of bone collagen and carbonate reflect the diets of individuals in slightly different ways because of underlying differences in their respective synthetic and metabolic pathways. Collagen derives a large portion of its carbon from dietary proteins while structural carbonate is primarily representative of the macronutrients, such as carboydrates, lipids, and proteins in the entire diet (Ambrose, 1993).

There are a number of elements with more than one isotope that are of bioarchaeological significance. The most commonly utilized in bioarchaeological research are carbon, nitrogen, oxygen, hydrogen, sulfur, and strontium. The most commonly used isotopes for dietary analyses are carbon and nitrogen, while oxygen and strontium are used in understanding mobility and migration. Carbon and nitrogen isotopes are used to estimate the relative proportions of resources in an individual's overall diet. This includes the types of plants consumed based on differences in their photosynthetic pathways (C_3 or C_4), and the types of terrestrial animal, vegetable, and marine proteins consumed. Stable carbon isotopes (^{13}C and ^{12}C) are metabolized into plants and animals by animals that consume them, and cycle through food webs with predictable changes in isotope ratios through a process known as fractionation ratios (Ambrose, 1993; Larsen, 2002: Schoeninger & Moore, 1992; Sealy et al, 2004). Expressed by the symbol δ or ‰ the ratios of carbon isotopes ($\delta^{13}C$) are what was expressed in plant tissue then consumed by other animals or humans (Larsen, 2002: Schoeninger & Moore, 1992; Sealy et al, 2004). The absolute differences between these carbon isotopes is very small, they are expressed as permil (‰) using delta notation (δ) relative to a geological standard, PeeDee Belemite or PDB (Schoeninger, 1995; Schwarcz and Schoeninger, 1991).

3.3.3 Mobility in the Past

Oxygen isotopes are reflective of consumed regional water sources and the composition of the $\delta^{18}O$ is the result of variations in the hydrological, geographical and climatological factors exerted on the landscape (Toyne, 2014; Ambrose, 1993). These isotopic values can further clarify residential patterns and migration for populations as it is possible to locate the bodies of water that were accessed throughout life. If the values are different between the dental enamel and those of the bone, then it is possible that the individual moved away from their natal site (Buzon et al, 2012). For oxygen isotopes, the absolute differences between these isotopes is very small, they are expressed as permil (‰) using delta notation (δ) relative to a geological or environmental standard, Standard Mean Ocean Water or SMOW) (Schoeninger, 1995; Schwarcz & Schoeninger, 1991).

Interpetations for mobility in the Andes are difficult to reconstruct due to the extreme variety of environmental zones (Knudson, 2009). The different temperature, precipitation, and evaporation pressures on water sources across the Andes can make identifying mobility across a landscape difficult. The ratio of ^{18}O to ^{16}O varies due to the environmental factors impacting them as lighter isotope, ^{16}O, from water molecules evaporate more quickly (Knudson, 2009). In the Andes, the isotopic ratios of oxygen, (^{18}O), decrease with increasing altitude, increasing distance from the coast, increasing latitude, and decreasing temperature. The eight identified environmental zones in the Andes make identifying the location of these ratio changes difficult. A number of ratio changes can be occurring concurrently in this context such as increasing altitude and decreasing temperature without decreasing distance from the coast (Knudson, 2009).

Questions of mobility and migration are answered through the analysis of strontium and oxygen isotopes. Strontium isotopes correspond to the landscape’s bedrock values and indicate where the individual has lived. As strontium ratios ($^{87}Sr/^{86}Sr$) cycle through the food web without fractionation it is an excellent indicator for sourcing the relative location of individuals (Price et al, 2002). Assuming locally sourced food resources a researcher can postulate migration patterns (Buzon et al, 2012). If human values are different than regional values of "local" small omnivorous animals, such as rodents, then it is likely that the human comes from a different region or consumed imported strontium rich foods. When local foods are consumed, the strontium isotope ratios in human tissues will reflect a locally regional signature (Buzon et al, 2012; Buzon, 2011; Knudson et al, 2014; Larsen, 2002).

3.4 Summary

The methodological parameters of this research utilized carbon and oxygen isotopic signatures to better understand the effects of cultural transitions through changes to the subsistence, diet, and mobility of the population at Cerro del Oro. The combination of destructive and non-destructive methods was used to maximize the information that could be gathered from the skeletal material with a minimal amount of damage. These efforts were to maintain the integrity of the human remains as well as leave the potential for future research to be conducted.

4 RESEARCH DESIGN

4.1 Introduction

As previously discussed, isotopic studies have been used to reconstruct diet and mobility in past human populations. Understanding dietary construction within the constraints of the environment can inform on the ways in which the population interacted with their local environment. When there is evidence of variability in resources acquisition and access this can elucidate socially enacted processes such as status and identity. Additionally, this study serves to underline the applicability of museum legacy collections in providing valuable contributions to the larger understanding of sites and the region at large.

4.2 Study Objectives

The objectives of this research are to access the diet and residential origin of individuals from the Cerro del Oro cemetery in the Cañete Valley. This study employs light isotopes from enamel carbonate to determine variability in early life diet. Osteological analysis examines pathological indicators on the skeleton and demographic distributions of the sample population.

4.3 Research Questions and Hypotheses

The research questions are the overarching goals of this thesis while the hypotheses are the expected finding from the data. My hypotheses are preliminary interpretations from the existing analysis from the excavations conducted by Kroeber in 1925 and published in 1937.

Question 1: What are the demographics of the sampled population from the Cerro del Oro cemetery? Demographic information can provide biological profiles about the construction of the larger cemetery population at the site.

Question 2: Is there variation in diet between the individuals represented by the thirty-five individuals from the Cerro del Oro population? Potential variation could be congruent to demographic parameters and be representative of differential access. This underlines the necessity of accurate age-at-death and sex estimations when appropriate. In the Andes, both strontium and oxygen isotopic ratios can be distorted due to the marine resource availability and other aspects of high dietary capture levels. They can be further distorted due to water source type, e.g. well water vs river water (Knudson, 2009).

Question 3: Are biogeochemical analyses useful in elucidating residential origins in the Cañete valley? Do these values suggest that the remains are “local” or “non-local” individuals? Assessment of “local” or “non-local” signatures in isotopic values can be reflective of social interaction beyond the local valley. If so, can the current study be modified and expanded for future research? What are the limitations of such a study? Using oxygen isotopic ratios to determine the water resources available to a given population can determine where individuals were living during early life. Strontium isotopic ratios can be added to the investigation of residential origins and mobility in the Andes. While there is a body of lead isotopic data, at this time, there is a lack of concordant strontium research. When the strontium samples are run, they will be one of the few sample collections to be run in the Andes. This research will help to construct a strontium baseline for the southern coast of the Andes. This avenue of research will expand and refine the birth location of the individual.

Question 4: Do carbon and oxygen isotopic values vary by pathological, demographic, or osteological variables. Variation in dietary patterns can inform on potential factors for disease prevalence. Individuals who are nutrient deficient may be more likely to express diseases. Sex and age variations may represent differential access to resources based on social categories of gender and status.

4.3.1 Hypotheses

This research was predicated on two primary hypotheses which are discussed below. Subsequent sub-hypotheses in hypothesis 1 expand the considerations of this research. These hypotheses reflect the author's research and knowledge of the region and the parameters of study.

Hypothesis 1: Individuals interred at the Cerro del Oro cemetery will reflect non-local influence.

Hypothesis 1.a: Oxygen isotopic ratios will significantly vary among the study sample, indicating differential access to water sources.

Hypothesis 1.b: Carbon isotopic rations will significantly vary among the study sample, indicating differential diet composition.

Hypothesis 2: Presence of pathology will significantly vary according to estimated diet composition or water source. Differential access of resources may mitigate or exacerbate individual susceptibility to disease.

4.4 Osteological Analysis

Nondestructive, visual analysis was conducted on site at the Field Museum as well as through the author's photographic record. This includes photographs of the dental arcade and any cranial pathological marks. Standard osteological analysis included the reexamination of sex and age categorization, identification of pathological elements, and indices of trauma (White, 2012; Waldron, 2009; Pinhasi & Mays; 2008; Ortner, 2003). The osteological analysis was conducted using the established standards of Buikstra and Ubelaker (1994) and White et al (2012). It should be noted that many of the post-cranial elements were not present and could therefore not be included in the analyses. This limited age-at-death and biological sex determinations.

The pathological identification was conducted on crania only. Diseases such as cribra orbitalia and porotic hyperostosis were recorded as they are commonly found in Andean contexts (Turner, Kingston & Armelagos 2012; Tung & Knudson, 2010). Isotopic data are useful in elucidating potential nonspecific causal indictors of disease. Using this isotopic data set, not to pinpoint the actual causal mechanism of the disease, but to inform on the types of external stress factors that may have influenced the likelihood of disease expression suggest potential life experiences and concerns (Turner, Kingston, Armelagos, 2012). Indications of violence or other physical traumas were also noted. As isotopic signatures inform on dietary distributions across lines of age, sex, status, and gender, they can also suggest associated patterns of violence along similar lines.

4.4.1 Estimating Biological Sex

The established methods for sex estimation center on analyzing secondary sexual characteristics, including differences in the size and robusticity of anatomical elements between female and male skeletons in cranial features. By comparison, female skeletal remains have a more "gracile" appearance (smaller; less robust) than their male counterparts (White et al, 2012). It must be noted that sex estimation methods are population based and the established methods were constructed on reference collections with known individuals. The reliance on the identification of positive (or present) features in sex estimations tend to favor male identifications (Buikstra and Ubelaker, 1994). Observer error and biases must also be taken into account with regards to establishing accuracy. Juveniles lack the sexual dimorphism necessary for sex estimation and it therefore inadvisable to apply these methods to them.

4.4.2 Estimating Age-at-Death

Age-at-death estimations are fundamental to any osteological analysis but they are especially critical for demographics. Several methods are available for estimating age-at-death (Baker, 1984; Brooks & Suchey, 1990; Buikstra & Ubelaker, 1994; Katz & Suchey, 1986; Lovejoy et al, 1985) each with their own advantages and limitations. Due to the lack of demonstrable accuracy in a single method, a multifactorial suite of features and methods should be utilized to establish an age range representative of the individual's biological age (White et al, 2011; Buikstra & Beck, 2006; Buikstra & Ubelaker, 1994). A multifactorial approach minimizes the biases of a given method, reduces the potential for a skewed range estimation, and increases overall accuracy.

The use of cranial suture closure is one such method. The effectiveness of cranial suture closure as a method for determining age is a contested one (Garvin & Passalacqua, 2012). But due to the limitations of the sample this method was applied. Though highly variable, cranial sutures generally fuse increasingly with age and can therefore, serve as a skeletal age range proxy.

4.5 Sample Selection

The total number of the population was 56 and all were considered. Due to the destructive nature of isotopic analysis the number of individuals sampled was limited to 35. Previous isotopic sampling had been done on 12 of the individuals but the results were inconclusive and never published. Two individuals were selected from this set of 12 to be resampled. Individuals lacking dentition were excluded from the sampling process. A combination of adult and juvenile remains was sampled due to the small size of the population. Six juveniles and twenty-nine adults were sampled. Age estimates were limited to binary categories of ‘juvenile’ and ‘adult’ due to the lack of post cranial elements. The principal components for age estimation after complete dental eruption and epiphyseal union are changes to the pubic symphysis and the aricular surface. As an individual ages, the surface of both the pubic symphysis and the aricular surface exhibit identifiable alteration due to physical wear associated with mobility (Buikstra & Ubelaker, 1994; White et al, 2012). Of the adult individuals there were thirteen females and thirteen males. Three of the adult remains were not sexed due to the presence of only a mandible for each individual.

4.5.1 Sample Context

A number of contextual parameters were considered for this analysis based on the available osteological material and the archaeological information from the original excavation (Kroeber, 1937). Contextual data including age, biological sex, skeletal inventory, and type of bone sampled for analysis were scored and recorded using established criteria (Buikstra & Ubelaker, 1994). Chronology and site context was acquired from Kroeber’s monograph. These contextual elements were included to examine intra-group comparisons of isotopic ratios to identify potential patterns within the sampled collection.

Table 1: Collection Demographics

Accession #	**Age Category**	**Sex Category**	**Tooth Sampled**
169609	Adult	M	LM_1
169610	Adult	M	LM^1
169611	Adult	M	LM_1
169625	Adult	I	LM_1
169633	Adult	I	RM_1
169641	Adult	M	LM_1
169647	Adult	F	RM_1

169653	Adult	I	RM_2
169657	Adult	F	LM_2
169664	Adult	M	RM_1
169665	Adult	M	LM_1
169670	Juvenile	NA	dM_1
169671	Adult	F	LM_1
169674	Adult	M	RM^1
169677	Juvenile	NA	RM^1
169680	Adult	M	LM_1
169696	Juvenile	NA	Molar Frag
169707	Adult	M	RM^2
169709	Adult	M	RM_1
169711	Adult	M	LM_1
169713	Adult	F	LM_1
169714	Adult	M	LPM^2
169724	Adult	F	LM^1
169729	Adult	PF	RM_1
169758	Adult	PF	RM^2
169759	Juvenile	NA	RM^2
169760	Adult	F	RM^2
169762	Adult	F	LM^1
169783	Adult	F	RM_1
169787	Adult	F	RM^2
169827	Juvenile	NA	RPm^1
169850	Older Adult	M	RM^1
170249	Adult	PF	RM^2
170287	Adult	F	RM_1
170280.a	Juvenile	NA	LM^1

First molars were preferentially selected for in order to facilitate a comprehensive isotopic reconstruction of the individuals' early life, between birth and approximately 13 years of age. Permanent dentition can be divided into three developmental windows: infancy/early childhood which is represented by the permanent first molar or first incisor, middle childhood, which is represented by permanent second molars, pre-molars, and canines, and adolescence, which is represented by the third molars (Turner, 2008; Hillson, 1996; White, 2012; Buikstra and Ubelaker, 1994). The developmental windows of the tooth crowns are summarized in Table 4.1. Using this sampling model maximizes the available sampling material and allows for consistent categorization for tooth development.

Table 2: Tooth Crown Development

Tooth Type	**Time Span of Crown Development**	**Development Window**
M3	8 years- 15 years	Adolescence
M2	2.5 years – 8 years	Middle Childhood
M1	Birth- 3.5 years	Infancy/Early Childhood
P2	2 years – 8.5 years	Middle Childhood
P1	1 year – 7.5 years	Middle Childhood
C	3 months – 7 years	Middle Childhood

However, as is common in museum collections, there was considerable post-mortem loss requiring deviations from this sampling model. Where possible, dental enamel was sampled from mandibular and maxillary permanent first molars. In two cases, maxillary pre-molars were utilized. While this was not an ideal situation it was necessary to make these adjustments when there were no other teeth available for selection.

4.5.2 Sample Processing

Sampling occurred both at the Field Museum in Chicago and at the Bioarchaeology Lab at Georgia State University, on the dates of November 16th-20th & December 1st & 2nd. Each tooth was assigned a catalog number and photographed, and impressions were taken using 3M ESPE ImprintTM II GarantTM Light Body vinyl polysiloxane impression material (ISO 4823 Type 3). This material creates a mold to produce casts of the teeth, thereby preserving the crown morphology and surface features to allow for potential dental wear analyses. The surface of each tooth was abraded using a Dremel 100 Series Single-Speed Rotary Tool equipped with a burr attachment in order to remove surface contaminants. A sample of approximately 10-30 milligrams of enamel, approximately the size of a grain of rice, was removed from the tooth (Ambrose, 1990). Damaged teeth were preferentially selected to minimize further intrusion into pristine teeth. Samples were cut from the cemento-enamel junction into the tooth, either to the occlusal margin or to the maximum height on the enamel in the case of worn teeth. Samples were then placed within 15mL tubes for transport back to the Bioarchaeology Lab. Photographs were taken to accompany the procedure for Field Museum documentation (Appendix C).

4.5.3 Preparation of Isotopic Samples

Sample preparation for isotopic analysis was conducted at the Georgia State University Bioarchaeology Lab under the supervision of Dr. Bethany Turner. Enamel samples were abraded clean using a dremel drill with a burr tip attachment to remove surface contaminants. The burr tip was cleaned with acetone and rinsed with ddH_2O between each sample to avoid cross-contamination. The enamel samples were then crushed into powder using an agate mortar and pestle. The mortar and pestle were cleaned with acetone and rinsed with ddH_2O to prevent contamination. After the samples were powdered, samples were soaked in a 3:1 solution of bleach (2% NaOCI) and ddH_20 for approximately 48 hours. Once the chemical reaction, in the form of off gassing and bubble production, had ceased, the samples were rinsed back to a neutral pH using ddH_2O. Samples were then soaked in acetic acid (2% solution) for 4 hours. Samples were the returned to neutral pH by rinsing them once again in ddH_2O. Once neutral, the samples were freeze-dried and stored in sterile centrifuge tubes for mass spectrometer analysis at the Department of Geological Sciences, University of Florida.

4.6 Limitations

There were a number of limitations in sampling this collection. Firstly, the original collection of the remains was a preferential collection of material for museum exhibition by Alfred Kroeber. Kroeber's selection of materials focused upon the mummified remains, interesting crania, and burial goods. Kroeber's selection process left behind numerous element of each individuals at the site. It had been my intention to also analyze the remains in tandem with the enamel samples but due to the lack of rib remains or bone fragments these samples were not obtained. While bone collagen and carbonate could have been obtained from the crania or mandible, the museum did not allow this due to the destructive nature of the procedure required to obtain the requisite sample size.

5 RESULTS

5.1 Osteological Results

The osteological analysis of this collection comprised of age-at-death analysis, sex estimation, and presence of pathology and trauma. The collection consisted of six juveniles and 29 adults. In the adult cohort there were 13 females, 13 males, and three indeterminates. The indeterminates category was created due to the lack of skeletal material with identifiable sex estimation markers. The skeletal components of the indeterminate individuals consisted of mandibular elements. While these components yield samples for testing the skeletal elements themselves did not provide sufficient marks for sex estimation.

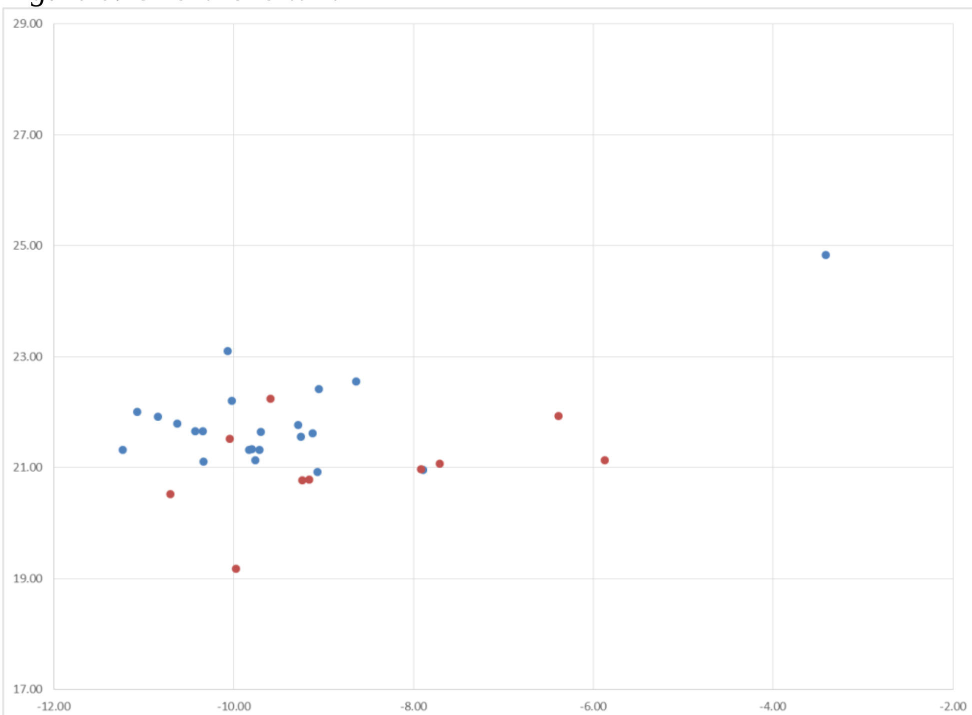
5.2 Cribra Orbitalia & Porotic Hyperostosis Results

The presence of cribra orbitalia on human remains results from a number of causes but is indicative of an anemic response in the individual. While the prevalence of such responses (N=11) in this population is statistically significant it is not necessarily interpretively significant. It is interesting to note the prevalence of this pathology within the population. For photographs of the individuals in the sampled collection see Appendix C. Figure 6 depicts the distribution of the presence of cribra orbitalia (red dots) in relation to the isotopic ratios of carbon and oxygen. The individuals with cribra orbitalia are predominantly clustered along the terrestrial dietary consumption. Two individuals trend toward a mixed diet of C_3 and C_4 plant material, or access to marine resources.

In the case of porotic hyperostosis there were two individuals who exhibited this pathology. Porotic hyperostosis is the result of anemic responses likely linked to a nutritional deficiency with a number of potential causes (Walker et al, 2009; Holland & O'Brien, 1997).

The lesions on these individuals' show evidence of healing and therefore not representative of an active disease expression. (APPENDIX C)

Figure 6: Cribra Orbitalia



5.2.1 Taphonomy and Trauma

Four individuals exhibit unique cranial markings along the frontal bone (1925.1588.169707, 1925.1588.169609, 1925.1588.169758, 1925.1588.169647). Each of the individuals' exhibit different numbers of these markings. These instances appear in the form of grooves oriented vertically on the frontal bone. Some of these markings appear to be robust vascular lines beginning in a foramina and tapering off as they ascend toward the coronal suture. This extreme vascularization is an interesting pathological expression that will require more investigation. Others could be the

Figure 7: Taphonomic Processes

result of taphonomic processes such as rodent activity. Two other individuals exhibit similar processes on the posterior portion of their parietal bones. (1925.1588.169711 &1925.1588.169665)

Two other individuals have evidence of blunt force trauma on the frontal bone. The individual on the right is a female (1925.1588.169713) while the individual on the left is male (1925.1588.169611). A third individual (1925.1588.169783) has foreign material embedded in the left parietal bone.

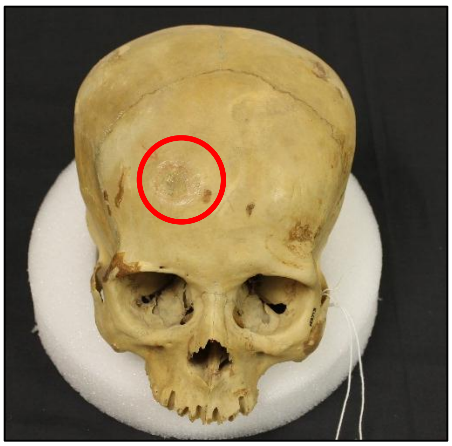


Figure 9: Female Cranial Trauma

Figure 8: Male Cranial Trauma

5.3 Isotopic Results

Results for the isotopic parameters for oxygen and carbon for the Cerro Del Oro samples are presented in Table 6.1 and discussed below. This table also includes the demographic parameters considered such as age-at-death, biological sex, and presence or absence of cribra orbitalia. Given that the isotopic ratios serve as proxies for dietary carbon and water resources, I address each element individually before addressing them synthetically as a collective data set. Statistical analysis combines both the isotopic, demographic, and pathological parameters. The parametric and non-parametric variance analyses and correlation analysis were conducted using SPSS 21.0. The sex estimation categories are divided into male (M), female (F), indeterminate (I), and non-applicable (NA). The indeterminate category is for individuals who lacked sufficient osteological material to make a sex estimation identification. The non-applicable category is for individuals of insufficient age to determine a category. The cribra orbitalia category is in two categories: present (1) and absence (0). The isotopic values are given numerically in concordance with their established ratios.

Table 3: Data Parameters

Accession #	**Age Category**	**Sex**	**δ^{18}O (‰, vSMOW)**	**δ^{13}C (‰, vPDB)**	**Cribra Orbitalia**
169609	Adult	M	21.14	-9.76	0
169610	Adult	M	21.65	-10.34	0
169611	Adult	M	-----	-----	0
169625	Adult	I	21.32	-9.71	----------
169633	Adult	I	21.65	-9.70	----------
169641	Adult	M	21.33	-9.83	0
169647	Adult	F	21.33	-9.80	0
169653	Adult	I	21.56	-9.25	----------
169657	Adult	F	21.52	-10.05	1
169664	Adult	M	21.79	-10.63	0
169665	Adult	M	20.78	-9.24	1
169670	Juvenile	NA	23.10	-10.07	0
169671	Adult	F	21.32	-11.24	0
169674	Adult	M	21.77	-9.29	0
169677	Juvenile	NA	------	------	1
169680	Adult	M	21.65	-10.43	0
169696	Juvenile	NA	22.56	-8.64	0
169707	Adult	M	21.62	-9.12	0
169709	Adult	M	22.00	-11.08	0
169711	Adult	M	20.96	-7.90	0
169713	Adult	F	21.93	-10.84	0
169714	Adult	M	--	---	0
169724	Adult	F	20.53	-10.71	1
169729	Adult	F	20.92	-9.07	0
169758	Adult	F	21.14	-5.87	1
169759	Juvenile	NA	21.08	-7.71	1
169760	Adult	F	21.94	-6.39	1
169762	Adult	F	20.98	-7.91	1
169783	Adult	F	21.11	-10.34	0
169787	Adult	F	19.17	-9.97	1
169827	Juvenile	NA	24.84	-3.41	0
169850	Adult	M	22.20	-10.02	0
170249	Adult	F	22.42	-9.06	1
170287	Adult	F	22.25	-9.59	1
170280.a	Juvenile	NA	20.78	-9.16	0

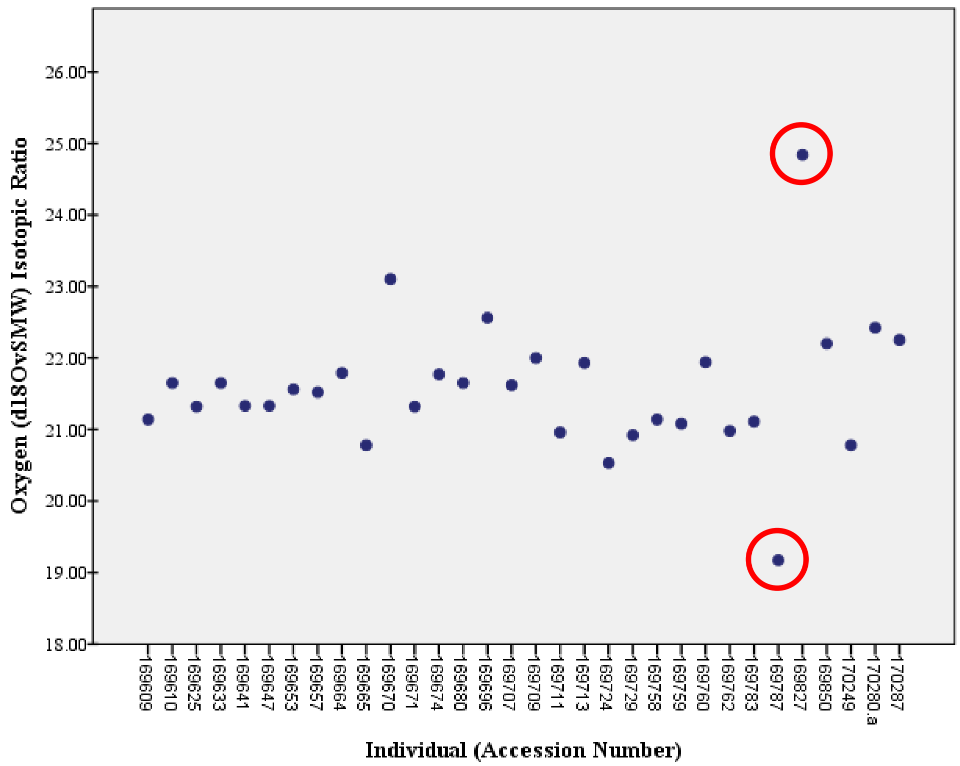
5.3.1 δ^{18}O Results and Discussion

Oxygen isotopes ratios were analyzed using enamel carbonate to estimate each individual's water resource signature. As discussed previously, crown enamel formation differs between teeth, ranging from formation at birth to three and half years (in the case of first molars). It should also be noted, that due to that temporal span there may be some enrichment of oxygen signatures from the weaning stage of life. During breastfeeding children receive their water from their mothers. As the water is filtered through the mother's body there is a subsequent evaporative process that can alter the isotopic signature in the enamel sample.

Variations in oxygen ratios are considered to be indicative of differential consumption of drinking water and are reflective of the drinking water imbibed in early childhood, including that metabolized from maternal body water into breastmilk. Isotopic ratios of consumable water are subject to a number of environmental and climatic factors, i.e. elevation, temperature, and humidity. Oxygen isotopic ratios are expressed in parts per mil (‰) relative to Standard Mean Ocean Water (vSMOW).

Significant variation is present in the δ^{18}O values. 18O/16O values range between 19.2 and 24.8‰, with a mean of 21.6‰ and a standard deviation of .92377‰. Of these values there were several outliers, indicating that at in least two individuals' early childhood they were consuming different water sources than the rest of the population. These two outliers were also consuming different water sources from each other. The rest of the individuals appear to have resided in the same general area and consumed water from similar sources.

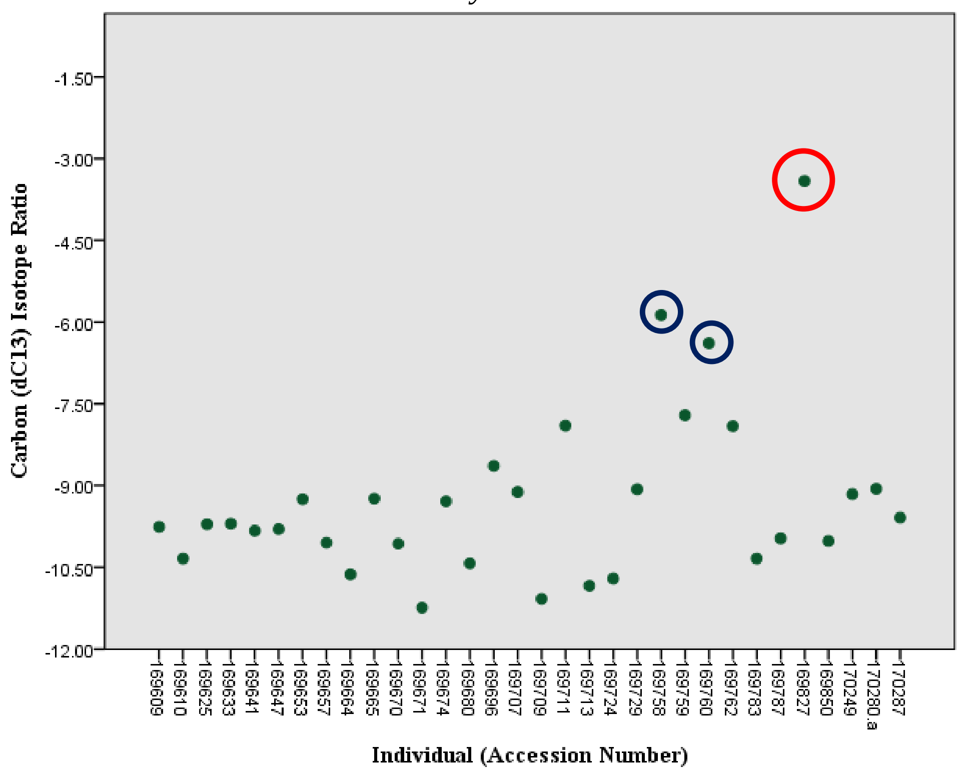
Table 4: Summary of Oxygen Signature by Individual



5.3.2 $^{13}C/^{12}C$ Results and Discussion

Carbon isotopic signatures in enamel carbonate are used to estimate the available dietary carbon. These ratios are the result of the pool of resources from lipids, carbohydrates, and protein. As stated above, dental enamel is deposited in early childhood and does not turnover and is therefore representative of the diet consumed in the early years of life. It should be noted, that due to the temporal span of dental development there may be some enrichment from the weaning stage of life. During breastfeeding children receive their sustenance from their mothers and are therefore a trophic level higher than their mothers. Due to the difference between tooth developments, each tooth type has a different level of enrichment from this time period. There is slight variation in the d^{13}C ratios. $^{13}C/^{12}C$ values range between -11.24‰ and -3.41‰, with a mean of -9.2541‰ and a standard deviation of 1.62302‰. Of these values there was a significant outlier indicating that this individual's early childhood diet was very different that the rest, likely consuming either diet including significant marine resources and/or terrestrial C_4 plants and their animal consumers (highlighted by the red circle in Table 5). The two individuals marked by blue circles (Table 5) express more variation in their carbon resources than the rest of the population. Though the rest of the individuals appear to have consumed similar terrestrial and C_3 resources there is still a 6‰ range in the distribution of the sample when the outlier is excluded. This indicates that there is moderately significant variation in the terrestrial resources being consumed.

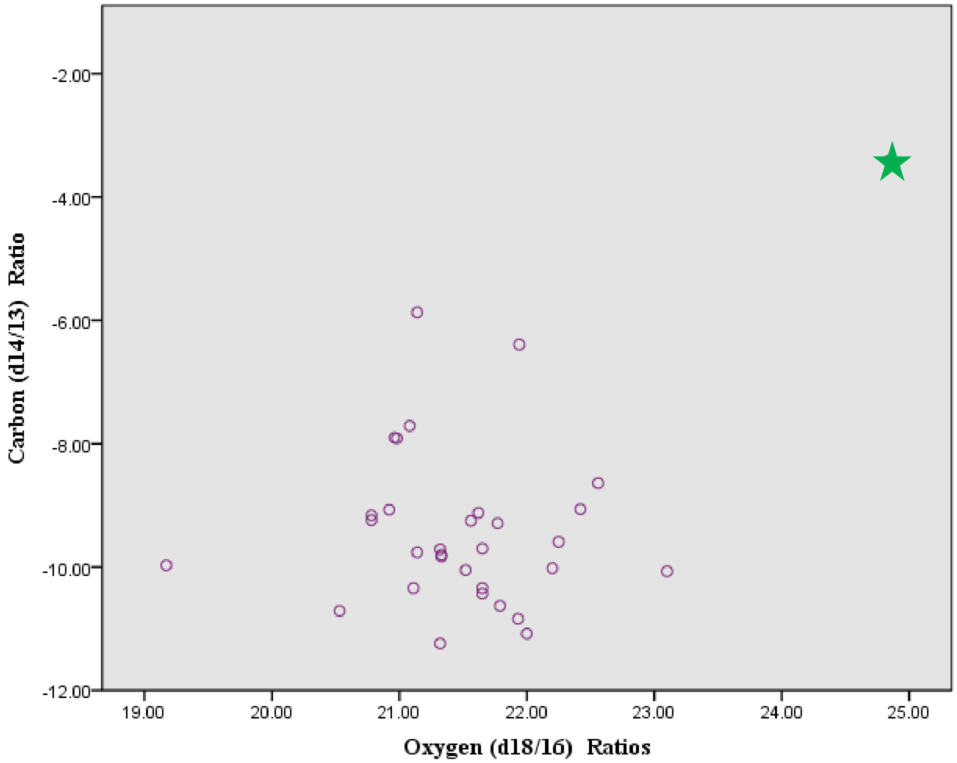
Table 5: Carbon Value Distribution by Individual



5.3.3 Synthesis of $^{13}C/^{12}C$ and $^{18}O/^{16}O$ results

There are a four outliers in this sample population. It is likely that the individual marked by the green star in Figure 5 is an individual who lived their early years in another area consuming different food resources than the rest of the sampled population. The rest of the individuals likely had access to similar water sources and consumed a similarly terrestrial diet.

Table 6: Carbon and Oxygen Distributions



6 DISCUSSION AND CONCLUSIONS

6.1 Summary of Findings

Situated approximately 5 km from the modern city of Cañete, Cerro del Oro is ideally located to explore the interactions between the political influences of Nasca and Wari in the periphery. The site is located on the northwest side of Cerro Del Oro, a Middle Cañete cemetery (approximately AD 500-700), that spreads across the hillside. Archaeological evidence from the current research of Dr. Francesca Fernandini confirms that this valley interacted with both the Nasca and the Wari. Kroeber originally interpreted this collection as having been influenced by Nasca with few elements of Wari, or in his words "Tiahuanaco" materials. Recent research counters this interpretation suggesting that this site was occupied during both cultural periods. Linked through material culture, it was the goal of this research to investigate the possibility of non-local individuals interred in the local cemetery. The skeletal material (N=56) excavated in 1925 by Alfred Kroeber lacks much of the contextual data that would have been collected during a modern excavation, i.e. burial sketches and body orientation. Nonetheless, this collection can provide valuable contributions to scholarly understandings of Cerro del Oro and the larger Cañete Valley.

Isotopic data collected from this population indicates variability in both diet and consumable water resources. This may indicate a non-local individual interred in the Middle Cañete cemetery. Variations in carbon isotopic values indicate different carbon resources. Due to the nature of enamel carbonate, these isotopic values paint the picture of this population's diet with a broad brush. To refine these findings, it would be necessary to take bone samples to isolate carbonate and collagen samples to further examine diet later in life and understand what portions of the diet were related to protein intake versus carbohydrate type. This will prompt discussions on individual and group variability and potentially subgroup interactions and access to resources. As the evidence of cribra orbitalia is present within the population but in all but one case a healed pathology, this was the result of a survived pathological insult.

The analyses described in this thesis shed light on the research questions presented at the beginning of this thesis.

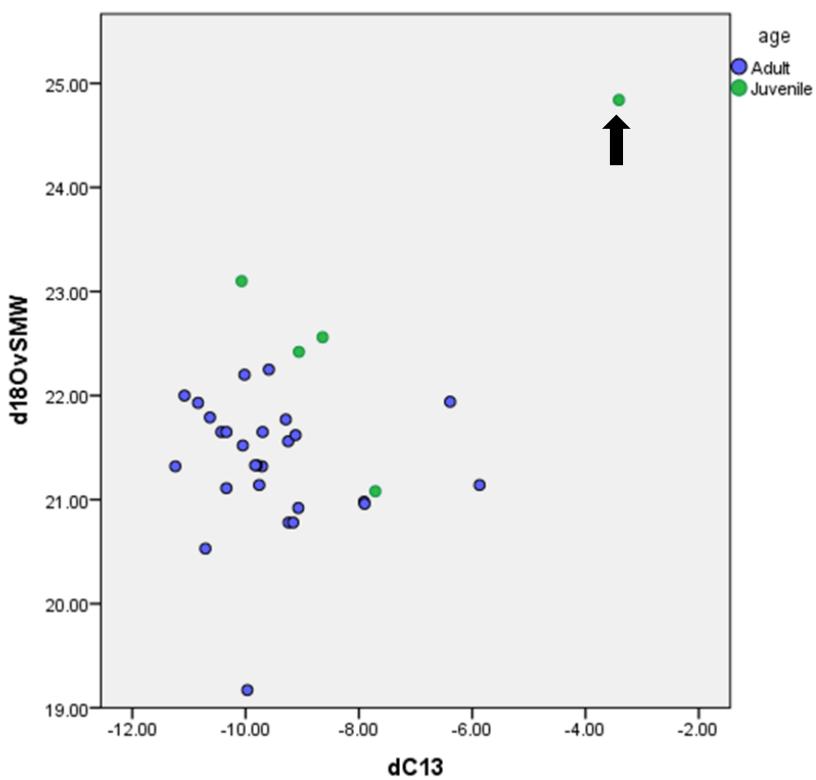
- *What are the demographics of the thirty-five individuals sampled from the Cerro del Oro cemetery?* This collection consisted of six juveniles and twenty-nine adults. Due to their age, the juveniles could not be assigned sex estimations. The adult sub-set of the population consisted of twelve females and thirteen males. Three adult individuals were not assigned sex estimations because they lacked sufficient elements for consideration.
- *Is there variation in diet between the individuals represented by the thirty-five individuals from the Cerro del Oro population?* Variation occurred in the carbon isotopic signatures indicating that one of the individuals was consuming different carbon resources than the other individuals.
- *Do these values suggest that the remains are "local" or "non-local" individuals?* The oxygen isotopic signatures indicate that there were individuals who accessed different water sources than the rest of the population. Future analysis of strontium would further inform on the residential patterns of these individuals.
- *Are biogeochemical analyses useful in elucidating residential origins and modeling paleomigration in the Cañete valley?* Yes, these analyses can help to discover where these individuals lived in their early life. It would be beneficial to

add geological samples to further enhance the likelihood of identifying the location from which the individuals came.

6.2 Discussion

When the outlier is excluded, the 6 ‰ difference in the carbon isotopic signatures in the population represents moderate variability in dietary resources carbon consumption. This variation has interesting implications for understanding the food choices of this population. Distributions of diet represented in Table 7 shows that the outliers in this population are juvenile individuals.

Table 7: Age Distributions



The outlier marked by the black arrow is a juvenile and appears to have consumed a markedly different diet during early life. There are a number of potential food resources that could result in a $\delta^{13}C$ signature of -3.41‰. One possibility is the consumption of maize. This could either be through the consumption of corn gruel, on the cob, or through *chicha* (corn beer). In the case of *chicha,* consumption this could also affect the individual's oxygen isotopic signature. Through the brewing process of *chicha*, the corn is boiled in water then left in open air cisterns to ferment (Jennings, 2004; Valdez, 2006). The process of boiling and evaporation could result in enrichment of the oxygen isotopic signatures that are reflective of consumption rather than of a different geological water source.

Though there was some consumption of maize in the Nasca valley during the EIP, it was not the primary component of the diet (Buzon et al., 2012, 2011). During the Middle Horizon, the residents of the Wari heartland consumed significant quantities of *chicha* as both a ritual and feasting food (Jennings, 2004). This beverage was integral to religious and social practices in Wari life and is seen as an indicator of Wari influence on a site (Jennings, 2004). The potential presence of maize consumption in this context may be indicative of Wari contact in the Cañete Valley. This potential scenario would place Wari people in this valley in concordance with the recorded Wari ceramics. Collagen from dentin samples would further elucidate the protein component of dietary composition.

Another possible scenario is the consumption of other C_4 plants such as kiwicha, or amaranth. This terrestrial plant can grow in this environment and has a similar signature as maize. This possibility is less likely due to the lack of botanical evidence for amaranth recovered from Cerro del Oro.

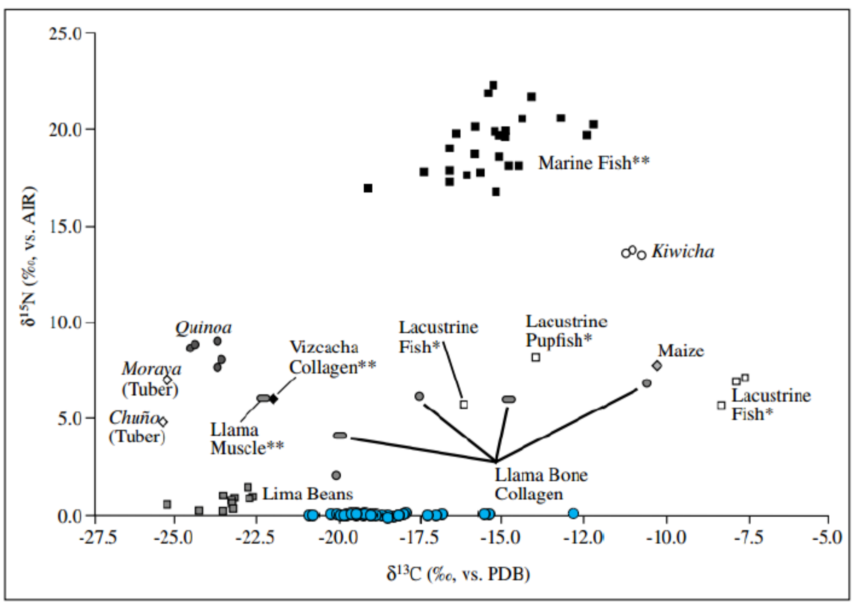


Figure 10: Andean Food Web

Figure 10 is a chart adapted from Turner (2010) and shows the dietary distribution of the population of Cerro del Oro (blue dots) along the x axis ($\delta^{13}C$). The chart shows the potential "menu" items that are available across the Andes. Dr. Christina Kellner's (2008) work in the Nasca region during the transition between the EIP and the Middle Horizon suggest that the dietary patterns shifted to incorporate a wider variety of resources during this time period. Buzon and colleagues (2012) also suggest an increase in dietary variation during the Middle Horizon. This may suggest that during Wari influence that there was an increased need to find additional food resources.

If there is evidence of Wari influence, how was it expressed? Was it the result of changing cultural practices or the movement of people from the heartland into Cañete Valley? Suggested by the isotopic signatures and burial practices, but needing substantiation from further research, it appears that a combination of both might have been the case. The finding of Wari style burials by Dr. Fernandini (2015) suggest Wari elite individuals were interred there. This interpretation will need to be substantiated through isotopic investigations of these newly recovered remains. The presence of a single individual in this research's population with an interpretively different signature suggests a change in cultural practice that includes the consumption of maize.

For the rest of the population at Cerro del Oro they may have been enacting similar forms of cultural resistance through the maintenance of local dietary practices over the incorporation of "non-local" practices. Practices are similar to those present at the site of La Tiza in the Nasca Valley where the local diet was maintained even during the period of influence by the Wari (Buzon et al, 2012). Fernandini (2015) found botanical remains of maize at several locations on Cerro del Oro. She interpreted these resources as a highly "commemorative" food and served during feasting events (Fernandini, 2015). When this intriguing information is analyzed alongside the isotopic data it creates more questions than answers. If maize was indeed a prestige crop in this context, then it would mark the majority of the sample population as non-elites who could not/did not access this particular resource. The presence of maize across the site was also suggested to be part of a ritual abandonment practices where by maize was ritually "consumed" and was incorporated into the fill placed inside buildings as they were closed off (Fernandini, 2015).

The botanical presence of maize but lack of isotopic evidence suggesting maize consumption has a number of possible explanations. 1) Maize was a prestige food only consumed by a small number of elite individuals, 2) maize served a ritual function and was not seen as a consumable resource or 3) maize was primarily used as a feasting food and therefore not consumed as a part of the regular diet. The presence of a single individual with a potential maize signature and the presence of burnt remains in feasting contexts suggests the possibility that maize was consumed in some cases. Burnt botanical remains at feasting sites suggest that maize was in fact consumed during these events. It should be noted that these were not *chicha*, but were corn cob remains that are found at the feasting site. As yet, the production of corn beer has not been discovered at Cerro del Oro (Fernandini, 2015). It is therefore most likely that some combination of hypotheses one and three will explain the physical evidence of maize in relation to the isotopic lack of evidence.

Sex distributions of dietary patterns of this population represent a less than clear distinction between the diets of males and females. The individuals in Figure 11 marked by black arrows fall within the cluster of the rest of the population in their oxygen signatures but exhibit slight enrichment in their carbon signatures. Relating back to Figure 5, these two individuals also expressed the presence of healed cribra orbitalia lesions. Variation in the dietary resources of these individuals may have been a contributing factor in the expression of this pathology. Mollusk remains recovered from the site by Fernandini (2015) may account for this carbon enrichment. Depending on the nature of the oceanic food web that the mollusks lived it is possible that they would be expressed with only slightly enriched carbon signatures (Ambrose, 1993).

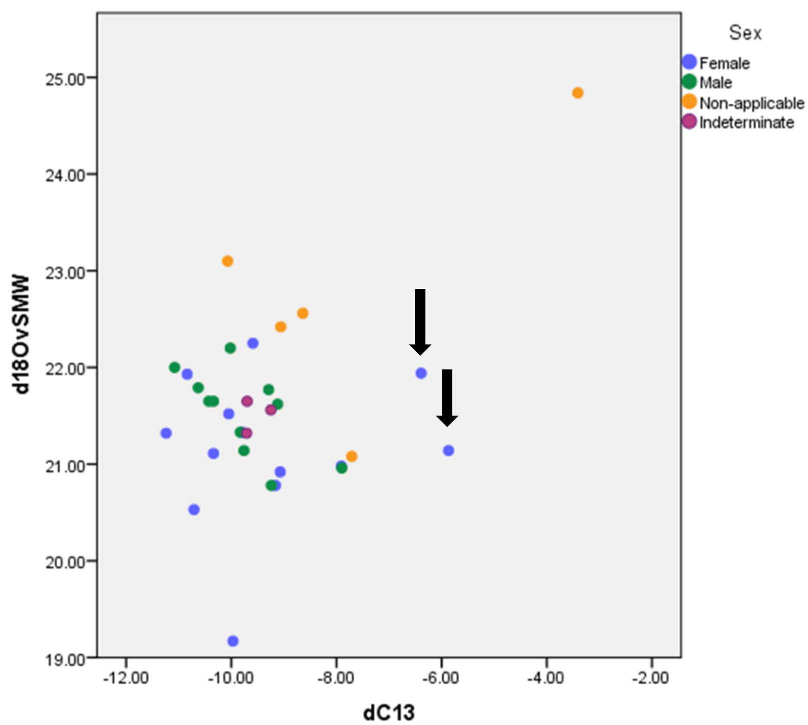


Figure 11: Sex Distribution of Diet

Mean C^{13} isotopic signatures for males (-9.79) and females (-9.30) suggest that overall females and males were consuming similar dietary resources. In light of potential Wari influence, this is interesting because males in the Wari heartland were given preferential access to certain food resources such as *chicha*. This may represent a more egalitarian dietary pattern at the site of Cerro del Oro. Mean O^{18} isotopic signatures for males (21.54) and females (21.27) show that on average, males and females were consuming the same or similar water resources. As at the site of Ancon during the Middle Horizon the majority of the population at site of Cerro del Oro utilized local resources (Cuellar, 2013). Examination of the later occupation of the site could show changes in these mean values and indicate changes to male and female dietary and water consumption patterns that may suggest changes to social, gender, and status composition.

6.3 Future Research

The bioarchaeology of Cerro del Oro is a fascinating and neglected area of study. The results of the original archaeological work are deficient in contextual information that could have been utilized both archaeologically and bioarchaeologically. Recent research by Dr. Francesca Fernandini has begun to alleviate this neglect and shed light on the archaeological past in the Cañete Valley. While we will never know what materials were lost from the mortuary contexts during excavations, there is still much that can be gained from the analysis of this material and even though there are no consistent detailed accounts on the orientation and internment of the skeletal material the skeletal and archaeological material offer the means to reconstruct models of diet, health, demography, identity, and social construction (Parker-Pearson, 2000). It is through the bioarchaeological efforts of this research that an element of the society that utilized this cemetery can be reconstructed. Future analyses on the materials from the mortuary contexts, i.e. the ceramics, will further clarify both the relative time period of this internment phase as well as the nature of the influence of both Nasca and Wari materials.

The addition of strontium isotopic analysis of the sampled individual will provide more nuanced data on the mobility of the individuals interred at Cerro del Oro. Twelve samples will be analyzed for strontium in the coming months to investigate further these questions of mobility.

Possible collaboration with Dr. Francesca Fernandini will examine newly excavated burials, associated with Wari materials, to see if their carbon isotopic signatures will suggest maize consumption. These new burials can shed light on several avenues for data including associated burial goods, questions of consumption versus production, dietary patterns, and pathology.

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APPENDICES

Appendix A: Statistical Output for Isotopic Analysis

Appendix A.1: Descriptive Statistic for Carbon and Oxygen Analysis

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
dC13	32	-11.24	-3.41	-9.2541	1.62302
d18OvSMW	32	19.17	24.84	21.5731	.92377
Valid N (listwise)	32				

Appendix A.2: Descriptive Analysis for Sex Distribution

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
dO18	1.00	13	-8.9477	.74768	.20737	-9.3995	-8.4959	-10.86	-7.88
	2.00	11	-8.5709	.42712	.12878	-8.8579	-8.2840	-9.31	-7.92
	Total	24	-8.7750	.63856	.13035	-9.0446	-8.5054	-10.86	-7.88
dC13	1.00	13	-9.3031	1.65297	.45845	-10.3020	-8.3042	-11.24	-5.87
	2.00	11	-9.7855	.87809	.26475	-10.3754	-9.1955	-11.08	-7.90
	Total	24	-9.5242	1.34947	.27546	-10.0940	-8.9543	-11.24	-5.87

Appendix A.3: ANOVA for Sex Distribution

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
dO18	Between Groups	.846	1	.846	2.181	.154
	Within Groups	8.533	22	.388		
	Total	9.378	23			
dC13	Between Groups	1.386	1	1.386	.753	.395
	Within Groups	40.498	22	1.841		
	Total	41.885	23			

Appendix A.4: Descriptive Analysis for Age Distribution

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
dO18	1.00	27	-8.7552	.60503	.11644	-8.9945	-8.5158	-10.86	-7.88
	2.00	5	-7.3460	1.32115	.59084	-8.9864	-5.7056	-9.02	-5.37
	Total	32	-8.5350	.89581	.15836	-8.8580	-8.2120	-10.86	-5.37
dC13	1.00	27	-9.5274	1.27136	.24467	-10.0303	-9.0245	-11.24	-5.87
	2.00	5	-7.7780	2.58476	1.15594	-10.9874	-4.5686	-10.07	-3.41
	Total	32	-9.2541	1.62302	.28691	-9.8392	-8.6689	-11.24	-3.41

Appendix A.5: ANOVA for Age Distribution

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
dO18	Between Groups	8.378	1	8.378	15.233	.000
	Within Groups	16.499	30	.550		
	Total	24.877	31			
dC13	Between Groups	12.911	1	12.911	5.634	.024
	Within Groups	68.749	30	2.292		
	Total	81.660	31			

Appendix B: Statistical Output For Disease

Appendix B.1 ANOVA Carbon & Cribra Orbitalia

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	22	-9.5241	1.58599	.33814	-10.2273	-8.8209	-11.24	-3.41
2	9	-8.7433	1.69849	.56616	-10.0489	-7.4378	-10.71	-5.87
3	1	-7.9100	.	.	.	.	-7.91	-7.91
Total	32	-9.2541	1.62302	.28691	-9.8392	-8.6689	-11.24	-3.41

ANOVA

dC13

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.758	2	2.879	1.100	.346
Within Groups	75.902	29	2.617		
Total	81.660	31			

Appendix B.2 ANOVA Oxygen & Cribra Orbitalia

Descriptives

dO18

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	22	-8.2891	.83439	.17789	-8.6590	-7.9191	-9.16	-5.37
2	9	-9.0722	.86589	.28863	-9.7378	-8.4066	-10.86	-7.88
3	1	-9.1100	.	.	.	.	-9.11	-9.11
Total	32	-8.5350	.89581	.15836	-8.8580	-8.2120	-10.86	-5.37

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.258	2	2.129	2.995	.066
Within Groups	20.619	29	.711		
Total	24.877	31			

Appendix B.3 Pathology Chart

Disease Value for Cribra Orbitalia: 0 = Absent 1 = Present/Healed; 2= Present/Active

Cranial Deformation: 0= Absent; 1= Present

Trauma= 0= Absent; 1= Present

Identification #	Disease Value	CD	Trauma
170249	1	1	0
169743	0	0	0
170280	0	0	0
169758	1	0	1
169762	2	0	0
169729	0	1	0
169724	1	1	0
169612	0	1	0
169760	1	0	0
169657	1	1	0
169759	1	0	0
169665	1	1	1
169783	0	1	1
169647	0	1	1
170246	0	1	0
169664	0	1	0
169707	0	1	1
169677	1	1	0
169671	0	1	0
169696	0	0	0
169827	0	0	0
169714	0	1	0
169713	0	1	1

Appendix C: Photographs of Cranial Elements

1925.1588.169625

1925.1588.169633

1925.1588.169647

1925.1588.169653

1925.1588.169657

1925.1588.169664


1925 . 1588 . 169664
skull and long bones

1925.1588.169665

1925.1588.169713

1925.1588.169714


1925 . 1588 . 169714
10
cm


1925 . 1588 . 169714
skull
10
cm

1925.1588.169724

1925.1588.169729

1925.1588.169758

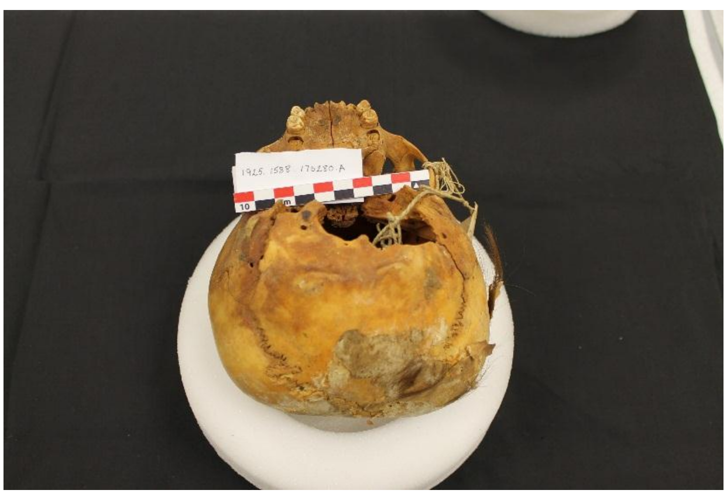
1925.1588.169759

1925.1588.169760

1925.1588.169762

1925.1588.170249

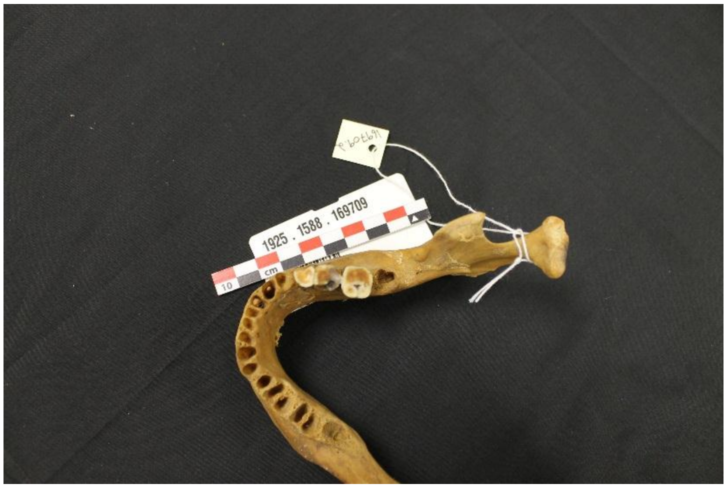
1925.1588.170280



1925.1588.170287

1925.1588.169783

1925.1588.169709



1925.1588.169609

1925.1588.169680

1925.1588.169711


cm


cm


Drawer
42E
cm

1925.1588.169641

1925.1588.169850

1925.1588.169674

1925.1588.169707


1925 . 1588 . 169707


1925 . 1588 . 169707
10
cm

1925.1588.169696

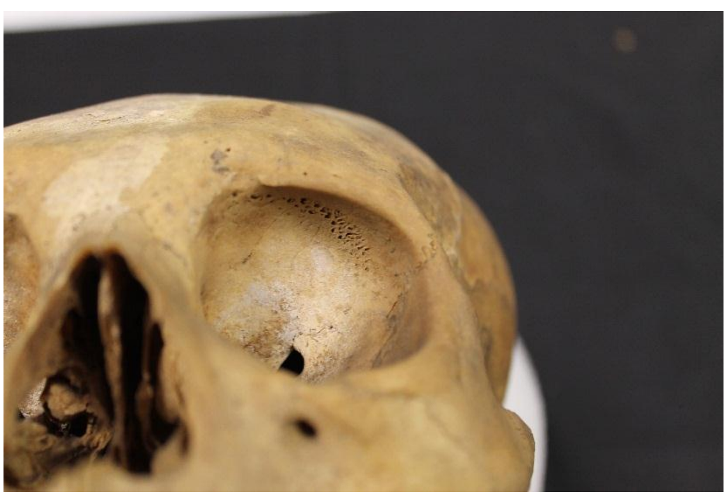
1925.1588.169610

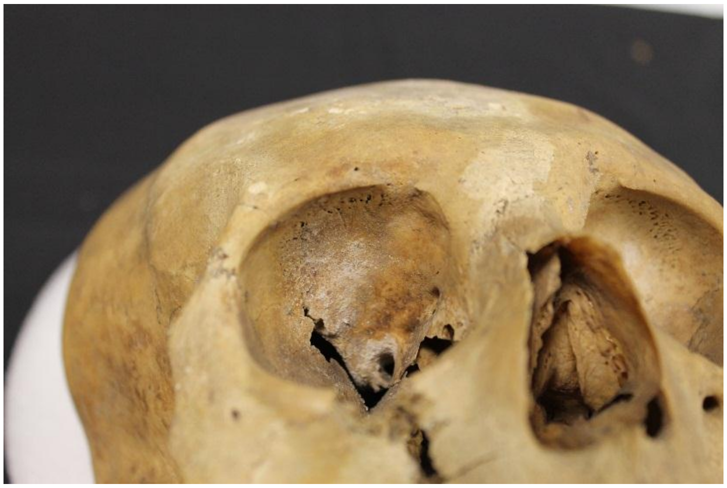
1925.1588.169677


169677


cm

1925.1588.169787





1925.1588.169670

1925.1588.169611

1925.1588.169827

1925.1588.169671


10
cm
1925 . 1588 . 169671
: nosub[B]
skull


1925 . 1588 . 169671