

COMMUNITY AND RITUAL ON THE COPACABANA PENINSULA (800 BC – AD 200)

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ABSTRACT

SARA LOUISE JUENGST: Community and Ritual on the Copacabana Peninsula (800 BC – AD 200)

(Under the Direction of Dale Hutchinson)

This dissertation explored the impacts of socio-economic changes in the Titicaca Basin of Bolivia and Peru during the Early Horizon (800 – 50 BC) and Early Intermediate period (50 BC – AD 600). Prior archaeological research has shown that this was a time of dramatic social and economic transformation as shown by the domestication of plants and animals, establishment of sedentary settlements, and the development of long-distance trade networks (Bandy 2004; Bruno and Whitehead 2000; Burger et al. 2000; Capriles et al. 2014; K. Chávez 1989; Chávez and Thompson 2006; Chávez 2012; Erickson 1985, 2000; Hastorf 1999; Moore et al. 1999; Moore et al. 2007; Whitehead 1999). At the same time, the first regional ritual tradition, Yaya-Mama, emerged. What remains unclear is how these economic and social changes impacted the people living in the lake basin and their relationships with each other.

To investigate these socio-economic changes, the author analyzed human skeletal remains excavated from seven sites on the Copacabana Peninsula. Specifically, I observed human skeletal remains of 184 individuals for indicators of diet, disease, ancestry, and tested 40 dental enamel samples for strontium isotopes in order to reconstruct who shared access to resources, who was considered acceptable reproductive partners, and if participants at temple rituals were local or foreign. Particularly, I looked for evidence of social stratification, access to

elite food items, shared ancestry, and migrants to investigate the nature of the social relationships. I also considered differences between osteological age-at-death and sex categories, to understand if particular demographic groups were over- or under- represented at certain sites or if any groups were excluded from burial at temples or community membership altogether.

These measures showed that despite the emergence of complex socio-economic structures, communities on the Copacabana Peninsula were not hierarchically ranked nor exclusive. People shared food, ancestry, and movement across the peninsula, regardless of sex, age, or burial location. Disease was a risk for all groups, not an increased burden for those with the least resources. Instead of depending on social hierarchy, the socio-economic changes of the Early Horizon may have been motivated by common ancestry and communal labor.

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CHAPTER ONE: INTRODUCTION

1.1 Introduction to the Research Problem

A community is a changing collection of people who share a variety of traits and values, some of which are reflected through material goods. In this dissertation, I investigate community in the Titicaca Basin of Bolivia during the Early Horizon and Early Intermediate Period, a time of much social and economic change. I hypothesize that social transformations such as the introduction of agriculture, creation of sedentary settlements, and establishment of long-distance trade could have changed community relationships in several ways: through the development of social hierarchies, the emergence of exclusive ritual communities, and/or an increasing emphasis on ancestry.

During times of social transformation, community structures are often affected, broadening to be more inclusive, narrowing requirements for membership, or creating hierarchies within themselves. My research uses human skeletal remains to investigate who was living in the Titicaca Basin during the Early Horizon and Early Intermediate Period and to understand how they were socially and biologically related to each other, from the perspective of community relationships. Community affiliation can affect one's skeleton in several ways that bioarchaeologists can identify: through the analysis of strontium isotopes in teeth and bone to identify migrants, observation of dental lesions as a way to reconstruct diet and identify dietary differences, observation of skeletal lesions associated with disease and stress, and observation of

phenotypic variation linked to ancestry. I measure these interpersonal relationships through social patterns associated with community structures: hierarchical relationships, participation in ritual, and shared ancestry and kinship.

1.2 The Titicaca Basin during the Early Horizon

Prior archaeological research has shown that the Early Horizon (800 – 50 BC) in the Titicaca Basin (Figure 1.1) was a time of dramatic social and economic transformation. While people continued to exploit wild terrestrial and lacustrine resources, use of domesticated plants increased and small-scale herding of camelids was practiced in the surrounding highlands (Bruno and Whitehead 20003; Capriles et al. 2014; Chávez and Thompson 2006; Hastorf 1999; Moore et al. 1999; Moore et al. 2007; Whitehead 1999). An increase in the creation and distribution of basalt hoes alongside extensive terraces and raised fields documented the increasing reliance on cultivated plants (Chávez 2012; Erickson 1985, 2000). People lived in semi to fully sedentary settlements (Bandy 2004) and invested heavily in the landscape by building the first public architecture (K. Chávez 1989; Chávez 2012). Long-distance trade routes brought exotic goods such as obsidian into the region from as far as 200km away, following complicated networks that moved large quantities of high-quality material (Burger et al. 2000; Stanish et al. 2002). At the same time, the first regional ritual tradition, Yaya-Mama, emerged.



Figure 1.1 The Titicaca Basin (circled), Copacabana Peninsula (white arrow) and surrounding highlands (Google 2015)

The Yaya-Mama Religious Tradition is marked in the material record by temples, stone sculptures, supernatural iconography, and ritual paraphernalia like ceramic trumpets (K. Chávez 1989; Chávez 2004; Janusek 2004:128-129). While temples shared many attributes, other aspects, such as ceramic style and exact temple layout, varied significantly throughout the region. Because of the variation in temples across the lake basin, scholars have characterized this ritual tradition in various ways: the emergence of social stratification (Levine 2012; Plourde and Stanish 2006; Stanish 1999, 2003; Stanish and Levine 2011), a unifying regional identity with local variation (K. Chávez 1989; Chávez 2004; Janusek 2004:128), a mediator of social tensions (Bandy 2004), and a cult of ancestor worship (Hastorf 2003; Roddick and Hastorf 2010).

The social and economic changes of the Early Horizon were regional and large-scale, changing the ways that people obtained food and resources, occupied the landscape, and conceptualized the cosmos. Such rapid transformation of routine practices would have impacted people's social relationships with each other, reflected through community structures and social hierarchy. Their communities could have shifted in scale or inclusivity in order to accommodate

these changes because of new social roles and power relationships. Identifying how communities were structured during the Early Horizon will provide a more complete understanding of the socio-economic changes that occurred and how they impacted the people living in the lake basin.

1.3. Investigating Past Communities

Archaeologists have become increasingly interested in community over the past two decades. However, identifying past communities still poses a number of methodological and theoretical challenges. Communities exhibit elusive social patterns, making them hard to recognize in the archaeological record (Isbell 2000; Yaeger and Canuto 2000). Thus, archaeologists have historically used clustered groups of houses, settlements, or burials to describe community, rather than trying to address symbolic or imagined social relationships (although see Agbe-Davies 2010; Canuto and Yaeger 2000; Davis 2011; Isbell 2000; Goldstein 2001).

Bioarchaeologists are also increasingly interested in social issues. Scholars have discussed ethnicity (Blom 2005; Stojanowski 2010; Sutter 2000), identity (Knudson and Stojanowski 2009; Sofaer 2006; Stodder and Palkovitch 2012; Torres-Rouff 2011), migration and population movements (Knudson 2004; Turner and Armelagos 2012), and biological affinity as proxies for kinship and marriage partnerships (Stojanowski and Buikstra 2004; Sutter and Cortez 2005; Sutter and Verano 2006; Torres-Rouff 2002; Torres-Rouff et al. 2013). In their attempts to address these social issues, they have integrated a variety of methods, data, and approaches. However, scholars have not yet identified bioarchaeological methods and theory appropriate to investigate *community* relationships in the archaeological record.

I investigate communities by analyzing human burials from Early Horizon (800 – 50 BC) and Early Intermediate Period (50 BC – 600 AD) sites on the Copacabana Peninsula (Figure

1.1). Human burials were often associated with Yaya-Mama temples, yet the proximity and association between burials and temples varied. Thus, comparing temple vs non-temple (or more loosely associated) burials can reveal differences in community. I propose to investigate communities through three aspects of daily life: social hierarchy, participation in ritual, and ancestry.

First, I ask if burial at temple sites reflects the emergence of hierarchical communities on the peninsula. The emergence of social classes is often associated with the development of ritual complexes, agricultural systems and trade networks. In fact, on the northern side of Lake Titicaca, an intensely stratified society developed during the Early Horizon alongside the emergence of a ritual cult (Chávez 1992). Did the emergence of the Yaya-Mama Religious Tradition also signal the creation of social hierarchy?

To identify social hierarchy, I measure relative rates of stress and disease. Bodily health has been recognized as one of the best indicators of rank and status, due to the various health stressors associated with low social standing such as malnutrition and increased workloads (Goodman and Leatherman 1998). Differences in rates of disease, stress, and malnutrition are reflected by skeletal and dental indicators. I compare these lesions amongst burial populations. I also compare dental traits that reflect phenotype in an attempt to understand biological relationships between individuals and burial groups. Finally, demographic patterns can reflect hierarchies based on age and sex dictated patterns of burial at various locations.

Second, I consider the role of Yaya-Mama temples and sacred resources. Maize was central to many Andean rituals in the past as it is in the present, mostly in the form of maize beer or *chicha* (although other Andean crops can also be used to make fermented beverages, often also called *chicha*). It remains today a potent symbol of personal and community identity. Other

scholars have suggested that Yaya-Mama temples provided *chicha* to participants, a symbolic action that would have demarcated ritual participants from others in the lake basin (Logan et al. 2012). Perhaps burial location (temple vs non-temple) also reflects this emergent community division.

Biological effects of diet, especially cariogenic foods like maize, can be observed through the appearance of certain skeletal elements and the condition of teeth. I measure rates of dental and skeletal lesions in order to assess whether people had the same access to cariogenic foods. I compare these lesions between individuals, burial populations, and demographic categories in order to see how special food resources were shared.

Finally, I investigate ancestry and migration. Yaya-Mama temples have previously been interpreted as centers for ancestor veneration and important for reinforcing community and family bonds (Hastorf 2003; Roddick and Hastorf 2010). If this emphasis on ancestry occurred at temple ceremonies, identification with sacred places on the landscape (such as temples) and participation in these ritual may have been central to community bonds. Did the Yaya-Mama Religious Tradition impact the ways that people identified with each other and their ancestors?

I investigate communities of descent by observing shared phenotypic traits in tooth formation and nonmetric dental traits (Sutter and Cortez 2005; Sutter and Verano 2006). To identify migrants I measured ratios of strontium in teeth from sampled individuals buried at temple and non-temple sites. Strontium isotopes found in human bone and teeth vary by geology and can suggest who was native to the lake basin and/or identify outsiders or migrants (Knudson 2004; Turner and Armelagos 2012).

Based on interpretations of hierarchy, ritual participation, ancestry, and kinship, I reconstruct community relationships in order to better understand the large-scale socio-economic

changes associated with the Early Horizon. These changes could have impacted local communities as people became divided into social hierarchies or social relationships were reorganized due to shifts in power. However, the creation of social hierarchy and development of complex socio-economic systems were likely not a uniform process across geographic region and time period. By investigating community, in the Titicaca Basin during the Early Horizon, we can see how these larger processes occurred and how they impacted local groups.

1.4. Skeletal Sample from the Copacabana Peninsula

I examine human skeletal remains from the Copacabana Peninsula in order to address these questions of community and social relationships during the Early Horizon and Early Intermediate Period. The burial sample represents a minimum of 184 individuals from seven previously excavated Yaya-Mama temples on the Copacabana Peninsula of Bolivia (Figure 1.2).

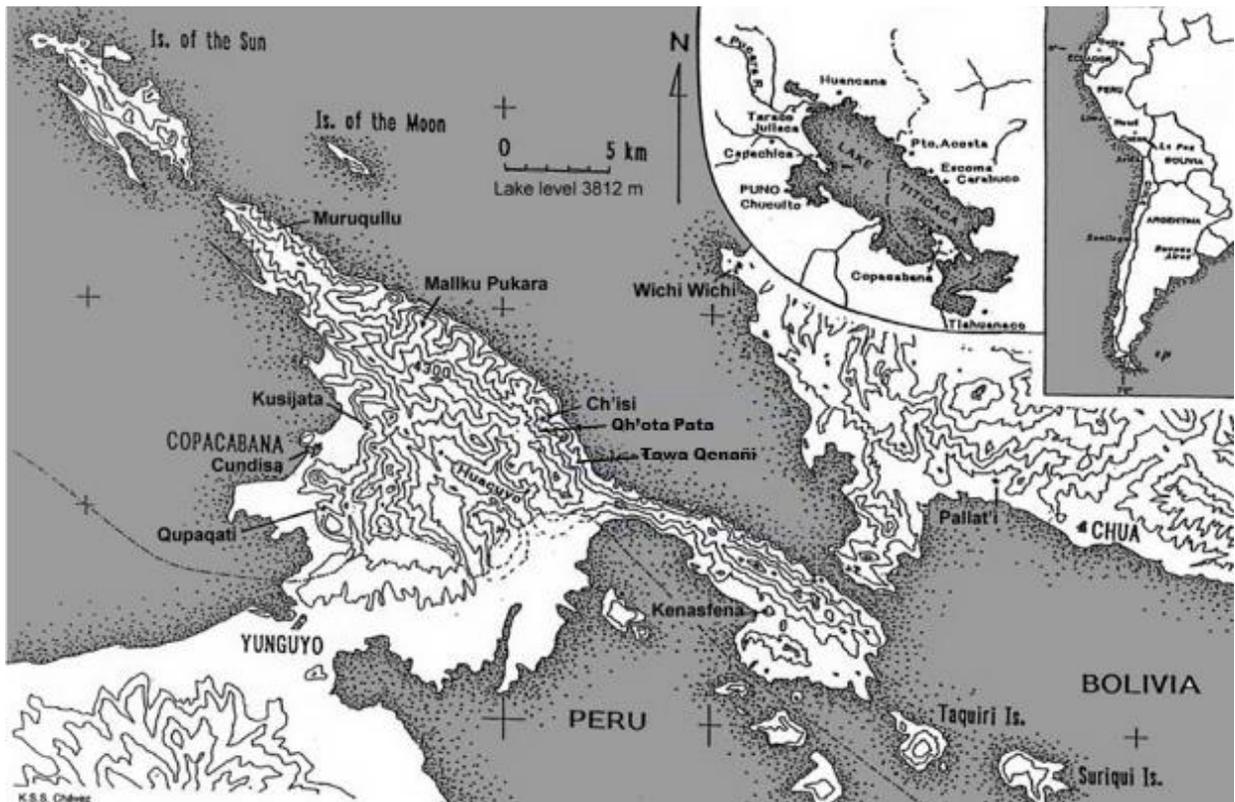


Figure 1.2 Map of the Copacabana Peninsula with temple sites and modern cities (Chávez 2012)

The remains were excavated from these seven sites between 1992 and 2001 under the direction of Karen Mohr Chávez and Sergio Chávez, and from 2003-2008 under the direction of Sergio Chávez and Stanislava Chávez. All excavation was done as a part of the International and Interdisciplinary Yaya-Mama Archaeological Project (also called the Yaya-Mama Project). This archaeological project works closely with Aymara-, Quechua, and Spanish-speaking communities and local populations to direct research questions, to protect and preserve archaeological sites and resources, and to promote education about the ancient history of the lake basin (detailed in Chávez 2008). The skeletal remains used in this dissertation were curated by the Yaya-Mama Project in Copacabana, Bolivia. The remains excavated between 1992 and 2006 were initially analyzed and documented by Dale Hutchinson as a member of the Yaya-Mama Project (Hutchinson 1997; Hutchinson and Norr 2002), studies that I build upon in this dissertation. The skeletal remains are currently being returned to local peninsular communities following the original written agreements with them (Chávez 2008b). Teeth used for isotopic analysis in this project were obtained with official export permits in 2006 from the National Institute of Archaeology in Bolivia (INAR).

In order to test my hypotheses about community structures and socio-economic changes, I analyze these human skeletal remains for markers of genetic relationships and indicators of disease and diet. Additionally, I tested 40 dental enamel samples for strontium isotopes. I compared skeletal and molecular evidence of community affiliation between different site types, as well as among individual temple sites. Particularly, I look for evidence of social stratification, access to elite food items such as maize, shared ancestry, and migrants in order to investigate the nature of the social relationships. I also look at differences between osteological age-at-death and sex categories, to understand if particular demographic groups were over- or under- represented

at certain sites or if any groups were excluded from burial at temples or community membership altogether.

1.5 Organization of the Dissertation

I begin this dissertation by providing information on the ecology and archaeology of the Titicaca Basin, specifically focusing on the developments of the Early Horizon. I also cover the chronology of the site, Chiripa, where the first public, ritual architecture in the region was documented by scholars. The increasing ritualization of this site was likely mirrored at many sites around the lake basin. I discuss the archaeological correlates associated with Yaya-Mama to see the material expression of community as it is currently understood for this region and time period. In Chapter 3, I describe how archaeologists have attempted to define and identify community in the past and how bioarchaeology provides a suitable approach to address these issues when archaeological remains are ambiguous. I propose the facets of community membership that can be identified through bioarchaeological methods. I specifically address how different types of ethnographically and archaeologically documented communities in the Andes could be reflected through skeletal material. In Chapter 4, I describe the methods used in this dissertation to analyze community structures and social roles among these individuals as well as the sites from which the burial sample comes. I also include estimates of osteological age-at-death and sex for each site, to give a demographic profile for each site involved. In Chapter 5, I present my results for each method used. Results for total demographics are presented first, followed by dietary and disease indicators and lesions, biodistance analysis, and strontium isotopes. Chapter 6 includes a discussion of these results and I offer interpretations of notable patterns and trends. Finally, in Chapter 7, I explain the relationship of the community data to the

original questions about the social and economic changes during the Early Horizon and Early Intermediate Period and offer conclusions.

By understanding who was engaged with the Yaya-Mama religious tradition and how they were related to others in the lake basin, I provide insight on the social and political transformations that occurred in the Titicaca Basin during the Early Horizon and Early Intermediate Period. I additionally demonstrate how bioarchaeology can contribute to knowledge about daily life and social roles within ancient communities, especially when archaeological evidence is scarce or ambiguous.

CHAPTER TWO: THE ECOLOGY AND ARCHAEOLOGY OF THE TITICACA BASIN

2.1 Introduction

The Titicaca Basin has long been an area of cultural intrigue, prompting the development of many mythologies and enduring scholarly research interests. This region was home to some of the Inka Empire's fiercest rivals and became central to many Andean myths concerning the origins of peoples and gods. To date, most archaeological research in the region has focused either on Tiwanaku, an archaeological site and culture centered on the southeastern edge of the lake from AD 400 – 1000, or the Inka occupation of the Islands of the Sun and Moon. However, people occupied the lake basin much earlier, and an intricate social, political, and ritual milieu had existed for thousands of years. This section will review the relevant background and archaeological history of the Titicaca Basin prior to Tiwanaku (Figure 1.2). I begin with an overview of lake basin ecology in order to explore the food resources available to ancient groups and the ecological variables with which people contended. I then discuss the archaeological evidence for increasing regional integration and changing subsistence strategies and settlement patterns from 3000 BC – AD 200. Although the burials that contribute to the skeletal sample for this project do not extend through this entire time period, the socio-political changes of the Early Horizon are necessary to contextualize in the larger social landscape. Finally, I will describe the regional ritual tradition, Yaya-Mama, which emerged during this period, tracing the origin of public ritual from the site of Chiripa and across the Copacabana Peninsula.

2.2 Ecology of the Titicaca Basin

The Titicaca Basin provides an interesting setting for cultural developments because of its unique ecology. At 3,810 meters above sea level, Lake Titicaca is the world's highest navigable lake. This lake dominates the regional ecology, raising lakeside temperatures by as much as 8°C and providing habitats for a variety of plant, fish, amphibian, and avian species (Stanish 2003; Miller et al. 2010). The lake has a surface area of about 8400km² but is divided by the Copacabana Peninsula into two parts, united only by the thin Straits of Tiquina (Figure 2.1). The northern portion of the lake, called Chucuito or Lago Grande, is larger and deeper, containing numerous small islands and draining into marshy swamps, especially on the southeastern border. The southern portion of the lake is called Wiñaymarka or Lago Pequeño and is overall smaller, shallower, and with fewer islands. During extremely cold periods of the Pleistocene, lake water became trapped in glaciers. These lakes may have been fully separated and the Straits of Tiquina may have briefly been dry (Orlove 2002). Despite this, both areas of the lake support similar biomass and share many aquatic species. While the shallower waters of Wiñaymarka are slightly more hospitable for many fish and amphibian species, this smaller portion of the lake is also more susceptible to climactic shifts (Miller et al. 2010) which can affect the reliability of resources.



Figure 2.1 Map of Lake Titicaca showing the division between Lake Chucuito and Lake Wiñaymarka. (Google 2014)

The Titicaca Basin is classified as an inter-tropical climactic zone because of its geographical location just south of the equator. Yet, the high altitude and mountainous terrain create distinct ecological obstacles that other inter-tropical zones do not face. Because of typically low ambient temperatures and humidity, it may be more accurate to characterize the region as alpine (Stanish 2003). However, like many other inter-tropical zones, the region has a relatively consistent pattern of rainfall. Most precipitation (rain, sleet, or snow) occurs between December and March followed by a windy, dry season from April to November. June through September, the driest months, are sometimes completely rainless (Stanish 2003), although recent fieldwork indicates that this pattern may be shifting with global climate change, as it rained or snowed almost daily throughout June 2012 and 2013. Despite the cool temperatures, low humidity, and a typical dry season, the region is highly productive for certain types of agriculture and pastoralism. This section will discuss the types of resources available in the region and how early human groups exploited them.

2.2.1 *Animal Life*: The majority of fish in the lake belong to two genera: *Orestias* (common name, killifish) and *Trichomycterus* (common name, burrowing catfish). There are 26 species within these two genera, most of which are relatively small in size, ranging from 5 – 19 cm in length (Miller et al. 2010). The killifish species are fairly diverse and adapted to a range of local niches throughout the lake, while the catfish species tend to be bottom-dwellers feeding on organic remains and macro-invertebrates along the lake floor. Today, other species such as rainbow trout and silverside have been introduced to the lake, out-competing some indigenous fish and decimating their populations. The native species are still commercially fished but are less valuable than the newly introduced species (Orlove 2002). Both killifish and catfish have been documented archaeologically, demonstrating a consistent occupation by these species over time. In fact, during the time period central to this study, these two species of fish are one of the most commonly found food resources at temple and residential sites in the southern lake basin (Capriles et al. 2008; Capriles et al. 2014; Moore et al. 1999; Miller et al. 2010).

Amphibious life in the lake includes many species of toad and frog, including one of the largest frog species in the world, *Telmatobius coleus* or the Titicaca frog. While these frogs are impressive, weighing as much as two pounds and stretching more than 20 inches long, they mostly dwell on the lake floor, absorbing oxygen directly through their thin, wrinkled skin, and are rarely seen today (and not found in archaeological assemblages) (Navas 1997). More common are smaller varieties of toad and frog which also inhabit the lake. While not eaten today, they are occasionally found in archaeological assemblage, suggesting that they were consumed in the past (Moore et al. 1999).

Waterfowl and terrestrial lakeside birds are plentiful in the lake basin with over 60 species residing on or near the lake today. Archaeologically, at least 23 taxa have been identified

at just one site (Moore et al. 1999), indicating that this high level of diversity is traceable into the past. Bird varieties include aquatic birds such as coots, grebes, ducks, flamingos, cormorants, and Andean geese, in addition to more terrestrial birds such as tinamous, doves, flickers, owls, and Andean sparrows (Moore et al. 1999; Janusek 2008). Three of these types (large grebes, cormorants, and the ruddy duck) are present in the archaeological record but have not been observed in the region since 1996 (Moore et al. 1999). Many of these birds build nests in accessible places along the edge of the lake, adding to the resource base exploited by humans in the past and present.

Mammalian life in the lake basin can be divided into two main groups: large mammals which include camelids, deer, and predators, and small mammals which are mostly rodents. Camelids (llamas, alpacas, vicuñas, and guanacos) have been present in the region for at least 10,000 years, with domestication of llamas and alpacas occurring between 3,000 – 1,500 BC (Aldenderfer 1989; Stanish 2003). These species have a fairly important impact on the local ecology as they need significant sources of food and water to maintain their large herds (Dransart 2002; Moore et al. 1999). Regularly found at archaeological sites and herded today, the domesticated camelids are and were used for meat, for transporting goods long distances, and as a source for wool and bone tools (Moore et al. 1999; Stanish 2003). Vicuña and guanacos are extremely rare, if ever present, in the lake basin today but may have been hunted in the past. Highland deer are also rare in the modern day but were hunted by early Titicaca Basin residents (Aldenderfer 1989). Large mammals in this region also include predators such as pumas, Andean wolves, Andean foxes, and small felines called *titis*. These predators are increasingly rare but have been found archaeologically. The felines were often depicted in ancient iconography (Figure 2.2) (K. Chávez 1985; S. Chávez 1992; 2002, 2004; Moore et al. 1999). Small mammals

native to the lake basin include mice, viscacha (the guinea pig's wild cousin), and guinea pig or *cuy*. *Cuy* were domesticated elsewhere in the Andes and were present in the Titicaca Basin by 1000 BC as a food resource. It remains unclear if domestication occurred here independently from other Andean areas or if already domesticated *cuy* were imported (Moore et al. 1999).

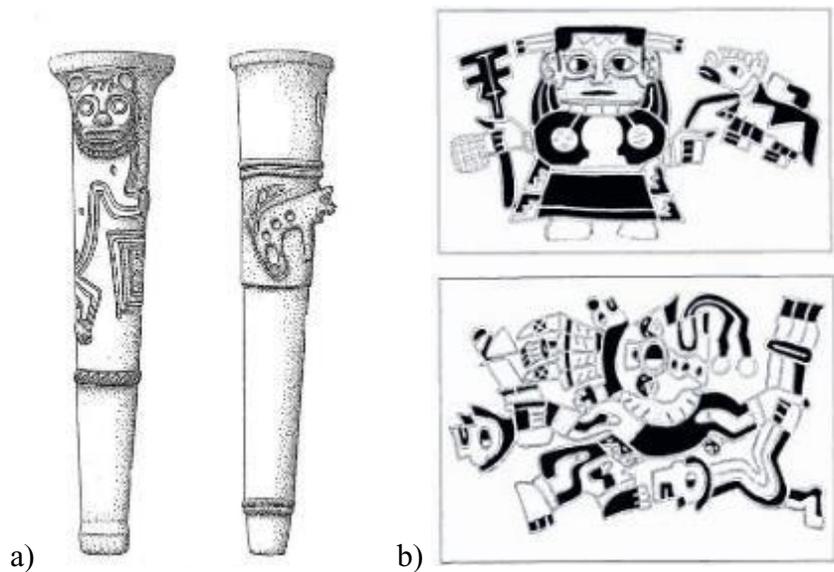


Figure 2.2 a) Feline iconography on ceramic trumpets from the northern and southern lake basin (S. Chávez 1988) b) Yaya-Mama female figure holding a camelid (above), Yaya-Mama figure interpreted as “Feline Man” (below) (Chávez 2005).

2.2.2 Environmental zones: Lake Titicaca is surrounded by the *altiplano*, or high plains, of the Andes. The *altiplano* is cold, relatively arid, and contains two important ecozones: the *suní* and the *puna* (Figure 2.3).

The *suní* lies between 3,500 and 4,000 meters above sea level and generally includes the areas directly surrounding Lake Titicaca. This is the most productive agricultural land and was likely the location for raised field agriculture during the Tiwanaku state (AD 400 – 1000) (Erikson 2000; Kolata 1986; Stanish 1999). People built elaborate terraces in this zone during the Early Horizon (800 – 200 BC), rebuilding, expanding, and lengthening the walls and platforms over time, with some still in use today. These terraces were and are useful for agriculture as they create microclimates protective against the cold, allowing for cultivation of products that might

not be possible otherwise. They were also likely used to pasture camelids between trips to the higher *puna* zone (Chávez 2012).

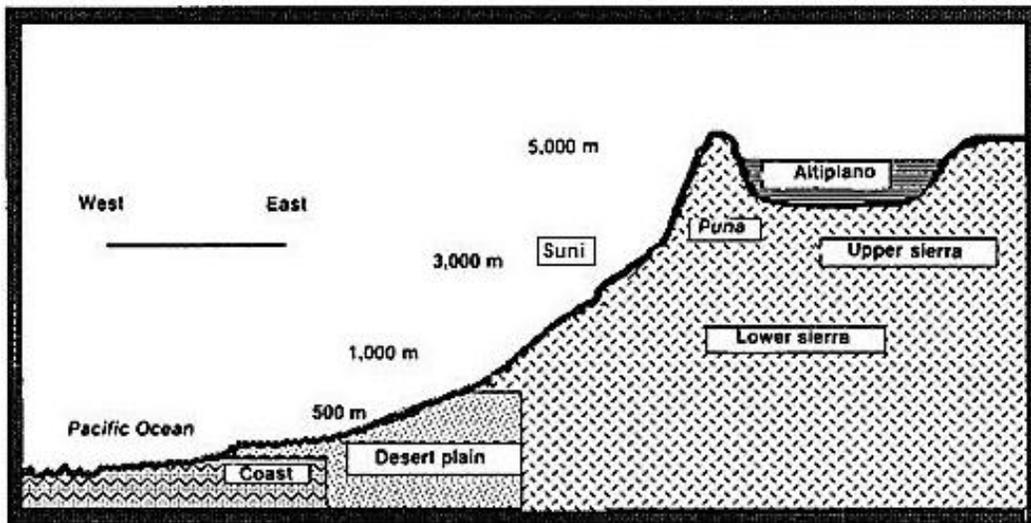


Figure 2.3 Ecological Zones of the Andes (Stanish 2002)

Agricultural products grown in the *suní* include tubers, legumes, chenopods, and maize. Potatoes, oca, quinoa, *mashwa*, and *tarwi* are the most important and most common crops grown in this region today and historically (Hastorf 1985). The maximum altitude at which maize can grow has been long debated. Many scholars (Hastorf 2003; Janusek 2008; Stanish 2003) argue that this region is too high and cold for the productive cultivation of maize, except in areas immediately adjacent to the lake and on the temperature-buffered Islands of the Sun and Moon. Sergio Chávez argues that local farmers today (and in the past) on the Copacabana Peninsula have been able to grow healthy maize around the lake shores and with decreasing production up through zones 4,200 meters above sea level, using hardy local strains of maize and elaborate terracing to create the appropriate microclimates (Chávez 2012). During fieldwork, I observed maize growing in lake-level fields regularly (Figure 2.5), although less frequently at higher altitudes.



Figure 2.5. Maize growing in a lakeside field approximately 3,810m above sea level

The *puna* is the ecological zone between 4,000 and 4,800 meters above sea level and was (and continues to be) primarily used for camelid herding. Few crops grow at this altitude, except for tubers which can grow throughout the *puna* (although see Chávez 2012). Even hearty tubers thrive better in lower zones than the *puna* (Erickson 2000; Stanish 1999). However, many indigenous grasses grow here and camelid herding is productive. Most pastoralists regularly moved their herds through this ecological zone cyclically depending on availability of water and size of the herd (Dransart 2002; Janusek 2008).

2.3 Early Human Settlements in the Titicaca Basin

Chronological sequences and time periods in the Andes are variable by region and researcher. I utilize a relative Andean chronology based on the Master Sequence of the Ica Valley (Menzel et al. 1964) (Figure 2.5) as the Yaya-Mama tradition crosses several local cultural phases and stages (K. Chávez 1988). The time periods pertinent to this study are the Preceramic (3000 – 1800 BC), Initial Period (1800 – 800 BC), Early Horizon (800 – 50 BC), and Early Intermediate Period (50 BC – AD 600). The site of Chiripa has important cultural phases

relevant to the Yaya-Mama Religious Tradition; these phases are also included here. Finally, archaeological material correlates of Yaya-Mama on the Copacabana Peninsula appear during the Early Horizon and are present throughout the first half of the Early Intermediate Period, marked on the figure by the shaded column.

Year	Master Sequence Phase	Chiripa Cultural Phase	Presence of Yaya-Mama Religious Tradition
500	Early Intermediate Period	Early Tiwanaku	
0		Late Chiripa	
500	Early Horizon	Middle Chiripa	
1000		Initial Period	Early Chiripa
1500			
2000	Preceramic		

Figure 2.5 Chronology of the Titicaca Basin based on the Master Sequence established for the Ica Valley of the south coast of Peru (based on K. Chávez 1988)

Preceramic groups in the Andean highlands moved regularly, spending warmer periods in the high *puna* zones and moving to the relative warmth of the lakeside *suní* during colder seasons (Stanish 2003; Janusek 2008). These groups may have been territorial, marking their ranges with cemeteries and possible ritual offerings. Few of these monuments have been found but their presence indicates that groups were interested in marking the landscape in obvious and ritual ways, even before the development of fully sedentary settlements (Aldenderfer 1989, 1990).

Gold artifacts were recently discovered in a Preceramic burial from the Titicaca Basin and date to approximately 2000 BC, reflecting the development of complex technologies and possible social aggrandizing (Aldenderfer et al. 2008). Finally, domestication of llamas and alpacas likely occurred during the Preceramic Period. Determining exact dates for camelid domestication is difficult, given that all four species can and do interbreed (Aldenderfer 1989; López and Restifo 2012).

Sometime during the Preceramic period (3000 – 1800 BC), groups began cultivating wild plants at a fine-scale and increasingly relied on lacustrine resources (Cohen 2010; Erickson 2000; Janusek 2008; Kolata 1986; Murray 2005). By the Initial Period (1800 – 800 BC), household-level cultivation of plants combined with foraging, hunting, herding, and fishing allowed for the establishment of semi-sedentary settlements (Bandy 2004; Bruno and Whitehead 2003; Capriles et al. 2014; Hastorf 2005; Moore et al. 1999). Some of the first plant domesticates included quinoa (Bruno and Whitehead 2003) and tubers such as potatoes and oka (Aldenderfer 1989).

Animal domesticates included the aforementioned camelids (alpacas and llamas) and potentially *cuy*. Wild animals such as guanacos, fish, and birds were also regularly consumed (Moore et al. 1999; Moore et al. 2010). While llamas and alpacas almost certainly had been domesticated by this time, how they were used is less certain. It remains unclear whether camelids were domesticated as a meat resource or for their other by-products, including wool, bone, and dung (Moore et al. 1999). Camelid remains recovered from the site of Chiripa dating to the Initial Period are mostly from large species of camelid (llama or guanaco). This is a similar pattern to modern herding groups in southern Peru, who primarily use their animals for meat. However, most of the camelid remains from the Initial Period were from adult or older juvenile

animals, which is in stark contrast to the Peruvian samples composed mainly of juveniles (Kent 1982; Moore et al. 1999). Therefore, Moore et al. (1999) suggest that in the Initial Period camelids were killed during prime adult years with an emphasis on non-meat products or people practiced relatively conservative culling practices, perhaps to defend against lean years. Llamas and alpacas at Chiripa may have been valued for their wool rather than as a food resource.

Local trade and lake resources were also highly important for these semi-sedentary horticulturalists. As Moseley (1975; 2001) suggested for complex societies on the coast of Peru, the lacustrine resources of Lake Titicaca were likely plentiful enough to support small sedentary villages. Large quantities of fish scales and bones have been recovered from sites all around the lake basin, and fish remained central to diets for many centuries after plant and animal domestication (Capriles et al. 2008; Capriles et al. 2014; Miller et al. 2010; Moore et al. 1999). In addition to the animal resources that the lake provided, totora reeds may have been gathered for consumption and construction of rafts, houses, and other structures (although exactly when and how this plant was used is based largely ethnographic and ethnohistoric research) (Chávez 1998; Janusek 2008; Marcus 2010; Orlove 2002). S. Chávez (1998:361) noted that modern lake basin inhabitants harvest totora for fuel, construction and food, and a lake algae called *llachu* for feeding livestock. Past lake basin inhabitants may have similarly utilized these resources in this way. These horticulturalists also engaged in reciprocal relationships with neighbors in varying ecozones (Janusek 2008). Thus, it seems likely that seasonally migratory, hunting and foraging groups in this region had access to a variety of foods—highland *puna* and lacustrine resources in addition to goods from lower productive zones. Although these groups were living in semi-permanent villages, fissioning at this time was relatively common, with people easily relocating

settlements from time to time, possibly due to a low investment in land resources or seasonal fluctuations in temperature and resources (Bandy 2004; Capriles et al. 2014).

While lake resources continued to be important in the Early Horizon (800 – 50 BC), plant domesticates, especially quinoa and the newly-introduced maize, became more common in the lake basin, suggesting that horticultural products increased in importance (Bruno and Whitehead 2003; Stanish 2003; Murray 2005). Maize in the region may have either been locally grown or traded into the region from lower altitudes (Bruno and Whitehead 2003; Chávez and Thompson 2006; Berryman 2010; Logan et al. 2012). Herding domesticated llamas and other camelids was an increasingly important economic strategy in Early Horizon, making pasture space a more valued commodity (Moore et al. 2007).

During the Early Horizon, people constructed extensive terraces, remodeling the landscape in a significant way. Terrace walls were as high as three meters and often included additional staircases and access ramps. Undoubtedly, terrace construction was a group project and construction of these walls was very labor intensive. Experimental attempts reported in Chávez (2012) show that the process of shaping a single stone would have taken at least 40 minutes of labor from four adult men. Despite the labor required, these terraces were worth the effort given their agricultural productivity. By constructing large terraces, people prevented soil erosion down the sides of this vertical landscape, increased field space by creating more flat areas, created microclimates suitable to growing crops that require warmer temperatures, and made pasture space for camelids during fallow seasons (Chávez 2012). The construction of terraces and domestication of plants and animals shows a definite increase in landscape investment. This may indicate increased connection or meaning attached to particular place or the creation of local “temple domains” (K. Chávez 1997; Chávez and Thompson 2006). Karen

Mohr and Sergio Chávez suggested temple domains as a way to conceptualize the connection between Yaya-Mama temple sites and the surrounding terraces. Perhaps temples acted as redistribution centers of supplies and labor to create these earthworks (K. Chávez 1997; Chávez and Thompson 2006; Chávez 2012). This idea will be further explored in section 2.5 of this chapter and in Chapter 7 of this dissertation.

People began to trade via long-distance routes during this time as well, moving goods between regions several hundred kilometers away from the Titicaca Basin. Early Horizon goods from sites around the lake basin are associated with exotic resources, such as obsidian, which were collected at considerable distances from the Titicaca Basin. Obsidian studies at Chiripa showed that the sources of this stone were as far away as Chivay and Alca in the Department of Arequipa in Southern Peru and possibly from as far as Chavin in the Central Peruvian highlands. (Burger et al. 2000) (Figure 2.7). Obsidian flakes have been found in addition to completed tools, indicating that production occurred on sites in the lake basin and that the tools did not come into the region accidentally or sporadically (Burger et al. 2000; Stanish et al. 2002). The obsidian for these tools likely came through a “down-the-line” network of communities (Stanish et al. 2002), implying that complicated social networks were involved in moving large quantities of raw material great distances. People may have also been using these trade routes to move less durable goods such as exotic foodstuffs and coca leaves. Certain foods and ceremonial goods such as coca only grow at lower altitudes. Access to these items would have been reliant on trade networks such as those moving obsidian during the Early Horizon.

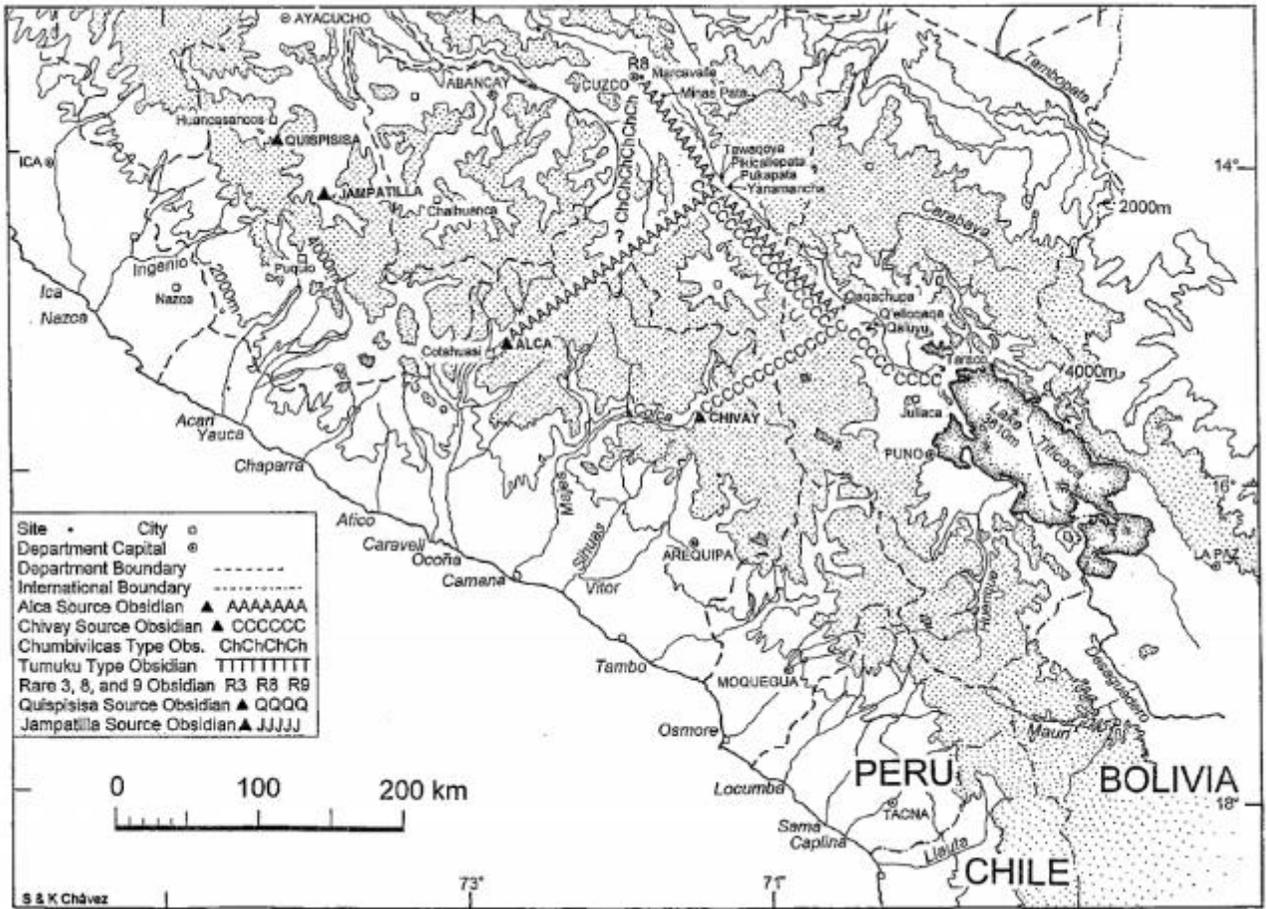


Figure 2.7. Relationship between the Títicaca Basin and near obsidian sources during the Early Horizon (Burger et al. 2000)

As farming intensified and new social institutions emerged throughout the Early Horizon, Bandy (2004) notes that villages became more stable, with fissioning happening less and less frequently over time. Investment in and the cost of leaving a settlement became much higher due to reliance on agricultural products and increasingly complex social relationships. Additionally, small agricultural or pastoral fields might now have expanded into once vacant areas, thereby limiting the “open” areas into which people could move (Bruno and Whitehead 2003; Bandy 2004). This type of social and geographic circumscription has been documented in other areas of the world as playing an important role in the development of agricultural societies and social hierarchies (Carneiro 1970; Chagnon 1968:251). Here, this trend of decreased settlement

fissioning at least demonstrates an increased stress threshold within villages—as conflicts arose, people mediated disagreements rather than splitting from the community and founding a new settlement (Bandy 2004). The ability to manage social tensions has important implications for the development of communities and potentially communal identities in this region as people became more invested in belonging to a certain group or territory. Increasing site stability of this form continued through the Early Horizon (800 – 50 BC) and into the Early Intermediate Period (50 BC – AD 600). Occurring along with this process was the emergence of a previously unknown social institution: a broad scale, regional religious tradition (K. Chávez 1988; Chávez 2004; Chávez and Chávez 1976).

2.4 Emergence of Ritual in the Titicaca Basin during the Early Horizon

The material and architectural correlates of early ritual activity in the southern Titicaca Basin were initially identified at the site of Chiripa, on the Taraco Peninsula. Chiripa has a long history of excavation (see Bennett 1936; Browman 1978, 1981; K. Chávez 1988; Hastorf 2005; Kidder 1956; Layman and Mohr 1985; Mohr 1966). Wendell Bennett (1936) was the first to identify the artifacts from Chiripa as a distinct culture and style, followed by extensive excavations from Alfred Kidder II and a team from the Pennsylvania University Museum (today called the University of Pennsylvania Museum of Archaeology and Anthropology) in the mid-1950s (Kidder 1956). Following Kidder's excavations, David Browman excavated at Chiripa in the 1970s and identified three main stages of occupation corresponding to Kidder's earlier work (Browman 1978, 1981). Archaeologists have since re-named and revised these three main stages of occupation, naming them the Early (1500 – 800 BC), Middle (800 – 200 BC), and Late (200 BC – 200 AD) Chiripa Periods (K. Chávez 1988). These periods are marked by episodes of

mound and sunken plaza construction in addition to an elaboration of ritual feasting and mortuary activities throughout the site.

During the Early Chiripa Period, a relatively large mound was constructed at Chiripa. At least 5m high, the top of this mound featured rectangular structures built in a trapezoidal ring around a central sunken court (Figure 2.8). These rectangular structures were likely storerooms for ritual items and foods or areas for private ritual (K. Chávez 1988). Human burials, botanical remains, and ceramics were excavated from the stone floor of these structures, indicating they were sacred places possibly for feasting, intimate rituals, or storage of special foodstuffs. Fish, tubers, and quinoa were the most common food remains found. Notably, these food remains were also present at other contemporaneous non-ritual sites on the Taraco Peninsula and in the lake basin (Berryman 2010; Capriles et al. 2014; Moore et al. 1999; Roddick and Hastorf 2010). It seems that feasts at Chiripa during the Early Chiripa Period were composed of an abundance of otherwise normal foods, rather than imported or exotic foodstuffs. It is also possible that people prepared these foods in ritually significant ways (Berryman 2010). Because of the limited space and use of domestic foods, scholars have suggest that early rituals at Chiripa were intimate, personal, or familial events, possibly honoring recently deceased relatives, ancestors, and other mythical or supernatural figures (K. Chávez 1988; Hastorf 2003; Janusek 2008; Roddick and Hastorf 2010).

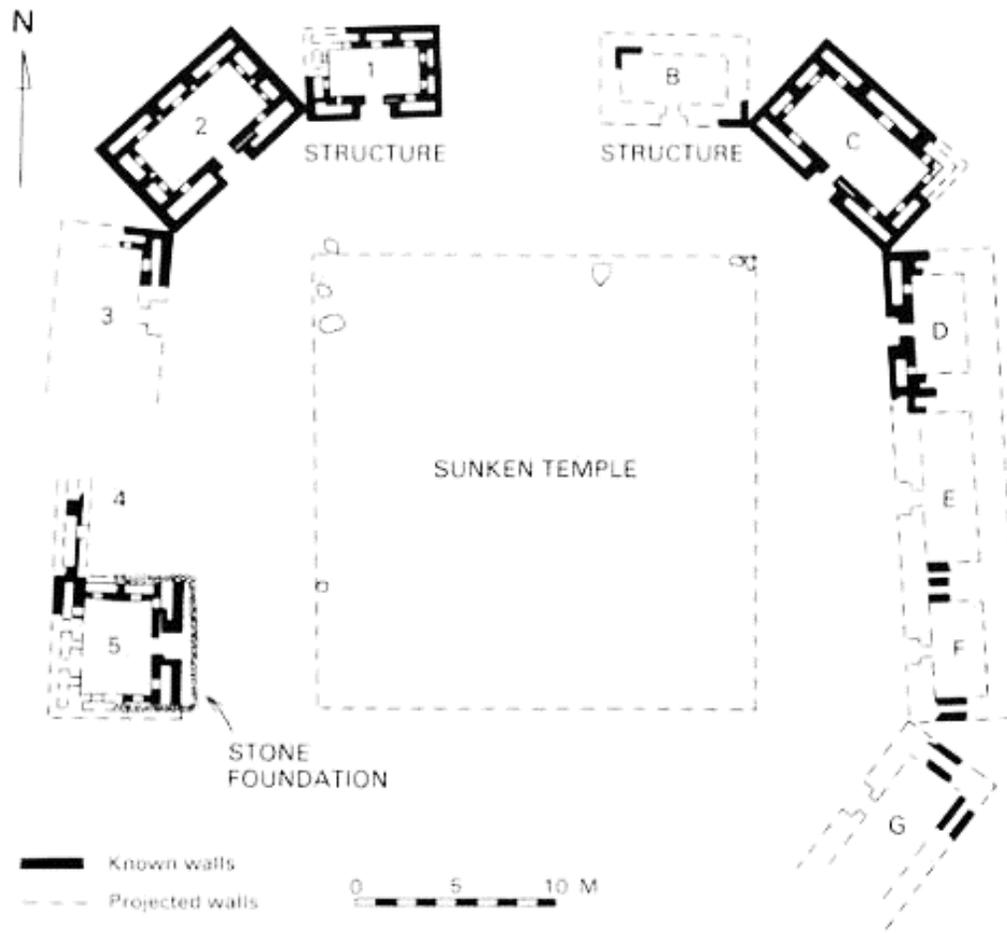


Figure 2.8. Site map of sunken temple and surrounding structures at Chiripa, based on the Sawyer map, Kidder's notes, and Bennett 1936 (K. Chávez 1988)

Construction during the Middle Chiripa Period included at least three building events on the mound at Chiripa, adding height and structures, as well as the creation of two sunken courts (Browman 1981; K. Chávez 1988; Hastorf et al. 2001; Janusek 2008). These courts were large enough that most of the local population could have attended ceremonies, a shift that indicates strengthening community bonds and a focus on group ancestors as opposed to private ceremonies. The cycle of building on the mounds supports this idea, as structures were covered over and re-built every twenty years or so, approximately the span of a human generation (Bandy 2001; Hastorf 2003; Roddick and Hastorf 2010).

Despite increasing monumental architecture at Chiripa, there is little evidence for increasing social stratification or hierarchy. Hastorf (2003) and Logan et al. (2012) note that ritual activity in temple areas seems to have been communal in nature, with ceremonies focused on venerating ancestors through sharing sacred food and drink. This trend is echoed at other temple sites in the southern lake basin, with little archaeological or skeletal evidence for warfare, violence, or aggressive competition (Chávez 1992, 2002, 2012) (although see Levine 2012, Plourde and Stanish 2006, Stanish and Cohen 2011, and Stanish and Levine 2010 for evidence of increasing hierarchy and warfare in the northern lake basin during this time). Heterarchy may be a better explanation for the power dynamics occurring at these sites (Chávez 1992, 2002, 2012).

Food remains from various areas of Chiripa indicate that tubers, quinoa, fish, and wild fowl (again, staples of domestic diets) remained central to the ritual feasting that occurred at the mounds and sunken courts (Hastorf 2003:317; Steadman and Hastorf 2001). However, there were increases in particular kinds of fish. This may indicate that some fish were considered more sacred, were rarer in the lake basin, and were closely linked with supernatural forces or ancestors, or any combination of the above (Capriles et al. 2008; Capriles et al. 2014). Maize, traditionally associated with ritual in the Andes, is occasionally found in botanical assemblages from this period. Trade routes connecting Chiripa to lower altitudes may have brought this crop to the site (Stanish 1999) or maize may have been locally grown (Chávez and Thompson 2006). In whichever manner maize was entering the region (locally grown or imported), it seems that the ritual significance of maize was developing during the Middle Chiripa period. Overall, the site of Chiripa during the Middle Chiripa period was likely a locus for increasing ritual activity at the community level, centered on the mound and plaza centers.

Ritual elaboration and community involvement at Chiripa developed to include ornately painted walls, several mounds, and clay-floored plazas by the Late Chiripa period. However, this increasing investment in ritual was not confined to the site of Chiripa nor the Taraco Peninsula. Throughout the Middle Chiripa period, people across the southern lake basin built similar sunken court and mound structures. This collection of sites and their apparent shared ritual ideologies comprise what is called the Yaya-Mama Religious Tradition (K. Chávez 1988).

2.5 The Yaya-Mama Religious Tradition in the Archaeological Record

Defined by Karen Mohr Chávez in 1989, the Yaya-Mama Religious Tradition is marked by the construction of the aforementioned sunken temples, carved stone sculptures, the use of supernatural images, and the presence of ritual paraphernalia like ceramic trumpets (K. Chávez 1988; S. Chávez 2002; Chávez and Chávez 1970, 1976). Developed at the site of Chiripa during the Early Chiripa Period (corresponding with the Initial Period), the religious tradition and its associated sunken temples were present throughout the southern Titicaca basin by the Middle and Late Chiripa Periods (roughly corresponding with the Early Horizon and Early Intermediate Period) (K. Chávez 1988; S. Chávez 2004; Stanish 2003). The temples were square or rectangular sunken spaces built on high hills, artificial mounds, or at the foot of towering cliffs (S. Chávez 2004). As on the original mound built at Chiripa, the sunken courts were often surrounded by rooms for storing ritual goods and/or very private rituals (K. Chávez 1988; Janusek 2008; Moore 1996; Whitehead 1999). Because of their relatively small size, both the temples and associated storage bins were spatially and socially restricted areas. These spaces may have been used for the private rituals of symbolically significant individuals and for the storage of high status and/or ritual items (K. Chávez 1988). Temples were also closely associated with the previously mentioned terraces. On the Copacabana Peninsula, all identified temple sites

were closely surrounded by terraces, while areas without temples were much less likely to have similar ancient construction (Chávez 2012). Perhaps the labor needed to construct terraces and the temple sites themselves was coordinated and marshalled by temple authorities or through temple-coordinated activities.

Interestingly, despite the broad similarities in temple construction and the association with terraces, details of site layout and location often differed. For example, at the temple sites of Ch'isi and Muruqullu on the Copacabana Peninsula, burials surrounded the temple, whereas at Chiripa and Mallku Pukara, the sunken temples were surrounded by storage chambers (S. Chávez personal communication 2011; S. Chávez 2004; Janusek 2008; Stanish 2003). Additionally, temple site location varied: Mallku Pukara was perched atop a local peak at 4,200 meters above sea level, while Muruqullu sat on the lip of a cliff with a higher peak directly behind it, and Qopakati was on the side of a sloping ridge. While the interiors of the sunken temple courts were similar, neither geographic location nor exact temple layout seem to have been strictly controlled as a part of the Yaya-Mama Religious Tradition.

Sculpted stone *stelae* or monoliths were perhaps the most distinctive and important feature of the tradition, in that they were long-lasting and highly visible. These monoliths have been found throughout the lake basin (Figure 2.9). While most monoliths have been disturbed, moved from their original location, or found today in museum collections around the world, one large monolith at Ch'isi was found *in situ*, incorporated into the temple wall itself. Unfortunately, because there are few examples of *stelae in situ*, and this monolith is the only one found in a wall, whether this was a common practice remains unclear. Carved iconography on these *stelae* typically included representations of male and female human figures and heads with rayed appendages (K. Chávez 1988; Chávez 1992, 2002, 2004; Chávez and Chávez 1976;

Janusek 2008). The Taraco Yaya-Mama stelae, after which the tradition was named, has become the classic archaeological example of Yaya-Mama iconography: one side of the standing stone sculpture depicted a male figure while the other showed a female (Figure 2.10). Each character had an elaborate headdress, a checkered belt, and a navel with rays emerging from it, possibly indicating fertility and reproduction. Snakes or serpent-like figures run along the sides between the two figures, representing the Yaya-Mama emphasis on natural images and connections with the earth. Dual complementarity, between male and female, human and nature, life and death, was a recurring iconographic theme on Early Intermediate Period ceramics; the Taraco Yaya-Mama stelae also shows this complementarity given its inclusion of both male and female figures (S. Chávez 2002, 2004; Janusek 2008). These themes were repeated in the region for many centuries after Yaya-Mama sites were abandoned, reflecting the enduring power and importance of such images (Burger et al. 2000; S. Chávez 2004; Cohen 2010).

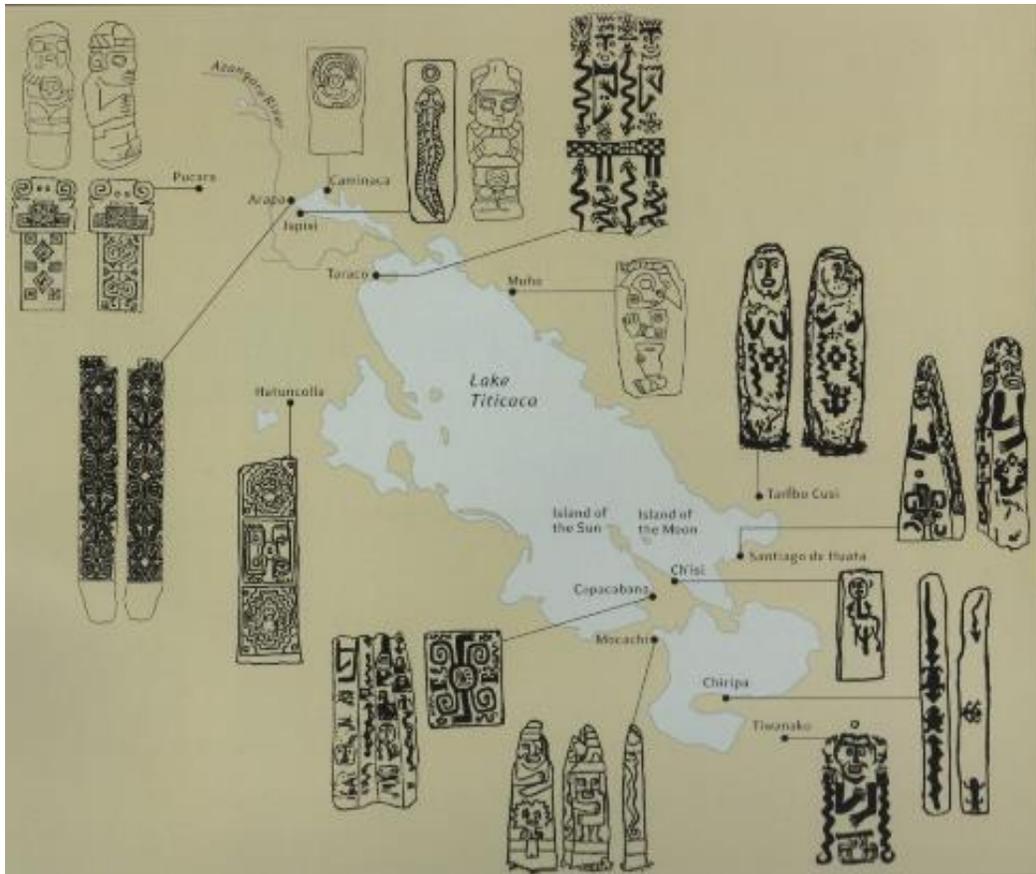


Figure 2.9. Map of the Titicaca Basin marking location of Yaya-Mama stone stelae (Chávez 2004)

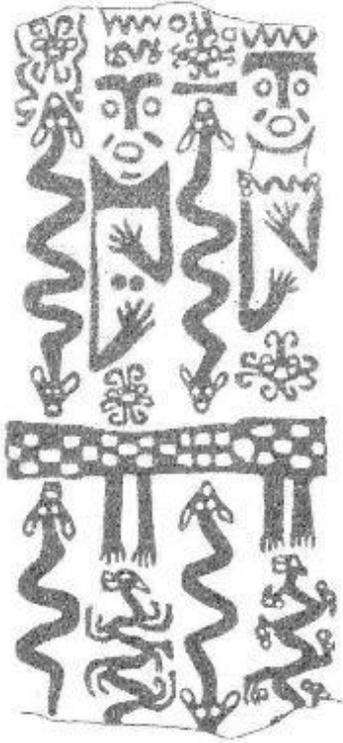


Figure 2.10. Drawing of the Taraco Yaya-Mama Stela (K. Chávez 1988)

Ritual paraphernalia, such as ceramic trumpets, ceremonial burners, and decorated ceramic vessels of varying size, were another important aspect of the Yaya-Mama tradition (K. Chávez 1988; S. Chávez 2004; Janusek 2008:82-83; Stanish 2003). Most ceramics found at Yaya-Mama sites were jars or *ollas* in a range of sizes, bowls, ceremonial burners, and more rarely, ceramic trumpets. *Ollas* and bowls were often large enough to hold enough food for many people, suggesting feasting, although this varied by site size and location (K. Chávez 1988; Steadman 2007:69-73). Burners were identified by the presence of shallow bowls with burnt organic material inside (K. Chávez 1977, 1988). Fragments of ceramic trumpets were less common than other pieces. Few complete trumpets have been excavated from the Early Horizon and Early Intermediate Period (although they are more common on the northern shores of lake at the site Pukara) (K. Chávez 1988). One trumpet from Ch'isi has been fully reconstructed, from approximately 40 ceramic sherds found scattered across the site and offering structures (S.

Chávez personal communication). Other complete trumpets in museum collections have been identified as Yaya-Mama through paste, dimension, and manufacture technique and design. Unfortunately, these pieces lack provenience and context.

While complete trumpets are rarely found archaeologically, they were constructed in similar ways to other ritual ceramic pieces. The majority of ceramics were made from fiber-tempered or baked clay with a variety of pastes and a burnished finish. Decoration included painted and carved Yaya-Mama religious images, such as felines, frogs, snakes, checkered shapes, and other geometric figures that are consistently found on pottery across temple sites. Trumpets were incised and painted with designs running along the length of the instrument, occasionally with other modeled, applied figures on the sides (Figure 2.11) (K. Chávez 1988). Notable decoration on ceramics from Chiripa included a molded zoomorphic head and possible anthropomorphic nose (Steadman 1999:66, 71). Overall, the amount of decoration increased over time (K. Chávez 1988; S. Chávez 2002, 2004; Steadman 1999, 2007).



Figure 2.11. Ceramic trumpet with a feline image (Chávez 2004)

While certain motifs were repeated on these objects across sites, they varied in detail and likely reflect local stylistic differences (K. Chávez 1989, 2002; S. Chávez 2004; Cohen 2010). The type of clay used varied greatly, including at least four different types from local and nonlocal sources (K. Chávez 2002). At many temples, more than one type of paste and clay were present, although rarely were all four. Pastes and tempers varied as well, and included mica, dense translucent quartz, or coarse white quartz (Steadman 1999:66-71, 2007: 69-73). This could

reflect a number of possibilities: personal decision-making about the ideal clay type, trade with others around the lake basin, multi-community use of the temple sites, or emerging elite styles of ceramic production, limited in availability and accessibility.

Despite the array of research cataloguing and describing the hallmarks of the Yaya-Mama Religious Tradition, scholars disagree on how ritual practice affected Early Horizon social roles. While this tradition emerged concurrently with other social changes including increasing sedentism, shifting subsistence practices, and emerging long distance trade routes, the relationship between religion and other social practices is disputed. Some authors suggest that this emerging ritual tradition represented the development of social hierarchy and status, with new achieved or ascribed elites gathering at these temples and participating in socially-valued rituals (Janusek 2008; Stanish 2003). Others suggest that these temples represented an ancestor-focused ritual practice that allowed for local variation between communities but united the lake basin into a common identity (S. Chávez 2002, 2004; Hastorf 2003; Roddick and Hastorf 2010).

2.6 Socio-economic and political developments during the Early Horizon

Archaeologists have documented the suite of political, social, and economic changes that occurred in the Titicaca Basin during the Early Horizon, from the import of foreign goods, the increased reliance on domesticated plants and animals, and the emergence of regional ritual. In other parts of the world, developments such as these are often accompanied by social status aggrandizing and emergent social hierarchies (Earle 1997; Eshed et al 2010; Larsen 1995; others). However, given the ecological backdrop for these developments, the situation in the Titicaca Basin may have proceeded differently. How did people living in the lake basin during the Early Horizon navigate these new social institutions and construct their communities?

Bioarchaeological data can provide a new way to investigate these issues, by delineating the community relationships of those buried at sites around the Copacabana Peninsula. The following chapter will first describe how a community-based analytical scope in archaeology has identified and clarified past community relationships. I will then suggest how bioarchaeology can expand on and contribute to this endeavor. I will also describe ethnohistorically and archaeologically documented community types in the Andes, as examples of the variety of communities and how bioarchaeology is uniquely suited to identify differences between them in the archaeological record.

CHAPTER THREE : THEOREIZING A BIOARCHAEOLOGY OF COMMUNITY

3.1 Introduction

In order to investigate how the Yaya-Mama Religious Tradition affected local lives and community structures, I establish a theoretical framework to investigate community in archaeological contexts and show how bioarchaeological factors can help reveal these relationships. This chapter will first explore what the term “community” means in archaeological contexts and how archaeologists have used the concept of community in reconstructions of the past, and in the Andes in particular. I next discuss limitations of archaeological investigations of community. Finally, I suggest how bioarchaeology offers novel ways of identifying communities in the past.

3.2 Archaeology of Community

The term “community” has been increasingly used in archaeology, particularly since the publication of *The Archaeology of Communities* by Canuto and Yaeger in 2000. This edited volume attempted to define the scope of an archaeology of community. The collection of papers was unified by an intention to go beyond defining community as the aggregation of households or proximal neighborhoods. The archaeology of community, as defined by Canuto and Yaegar, attempted to explore and understand a group of people occupying the same time and place, real or imagined, and the facets of their everyday lives: ecology, subsistence, social interactions and institutions, and identities (Canuto and Yaeger 2000; Davis 2011). The term ‘community’ was

used in several different ways within the publication itself, depending on the region, focus of research, and authorship. Studies of archaeological communities included in the volume investigated evidence of spatial proximity, shared architecture and iconography, trade and exchange, and markers of ethnic or group identity in order to know about life and social interactions in the past.

Archaeologists have defined two important types of communities: natural and imagined communities. *Natural communities* are those formed or identified by proximity and daily interactions and are the most commonly recognized by archaeologists (Canuto and Yaeger 2000; Davis 2011; Marcus 2000). Studies of settlement patterns and subsistence strategies establish the existence of ancient natural communities. Archaeologists postulate that because of close spatial proximity and shared material goods, people acted as neighbors and relied upon each other to live their daily lives. However, “community is not a spatial cluster of material remains” (Yaeger and Canuto 2000) but also includes social relations unfolding in time.

The phrase *imagined communities* refers to groups of people who identify with a deity, ancestor, belief system, or nation and see themselves as linked through this system (Anderson 1983; Isbell 2000). These communities can impact people as much as their physical proximity yet may be harder to trace archaeologically as they are defined by immaterial ties. Although these immaterial ideas are often “materialized” through iconography and artifacts, interpreting the artist’s intent or what these shared artifacts mean is more difficult. Meaning and symbolism do not preserve as well as architecture and ceramics. To address this, Yaegar and Canuto (2000) suggest that we should consider communities as inherently social and continually emerging, but also requiring at least semi-frequent, co-presence of people in order to reinforce social bonds and re-establish community norms and practices. In this way, community is “both an institution that

structures the practices of its members within defined spaces and the continually emergent product of that interaction” (Yaeger and Canuto 2000: 6). With this working definition, we can move beyond the restrictive categories of natural and imagined communities, defining communities as structuring daily practice, forming identities, and continually changing.

3.2.2 Patterns of Community in the Andes: In the Andes, communities have been explored primarily through the lens of *ayllus* or extended household groups. *Ayllus* are defined as community kinship networks that are larger than a household but smaller than a state or ethnic identity, similar to a clan or lineage (Abercrombie 1998; Albarracin-Jordan 1996; Bastien 1978; Goldstein 2000; Janusek 2008; Platt 1982). Participation in a particular *ayllu* is and was most often related to descent from a common ancestor either through genetic relationships or fictive kin, such as godparents (Janusek 2008; Murra 1980). What made an *ayllu* unique from other types of community was physical space. While the main corpus of an *ayllu* was typically clustered around hamlets or villages, they also included groups of people who moved much farther away. These dispersed communities often maintained close ties with those left behind, marrying endogamously and maintaining cultural traditions such as ceramic and architectural styles. Thus, *ayllus* were sometimes geographically extended networks, spanning large areas and creating diaspora communities far from the original homeland of the community (Goldstein 2000; Janusek 2008; Murra 1980, 1985). This type of community structure exists today and is clearly described in colonial Spanish accounts and Inka history.

Archaeologists have extended this pattern of community into the past, looking for evidence for ethnic enclaves far from others showing similar cultural traits. Goldstein (2000) documented diaspora communities associated with *ayllus* during the Tiwanaku state (AD 600 – 1000). In order to do so, Goldstein established four criteria: (1) peripheral residence; (2)

maintenance of cultural traits of the home *ayllu*; (3) maintenance of the social and political hierarchies of the home *ayllu*; and (4) co-existence with other regional ethnic groups.

Archaeological markers of these criteria included spatial reconstruction of homeland communities and buildings, maintenance of mortuary practices, construction and use of homeland ceramics, and other “stylistic practices that leave a mark on material culture” (Goldstein 2000:191). This likely included markers such as dress and personal adornment as well, although these items are less archaeologically visible depending on preservation.

Using these measures, Goldstein identified macro- and micro- *ayllus* associated with diaspora colonies of the Tiwanaku state. Settlements in lowland valleys 300km away from Tiwanaku maintained many Tiwanaku traditions such as ceramic, iconographic, and architectural styles, despite the long distance between the two areas. They also retained an emphasis on maize products in their daily diets and ritual ceremonies. Through these maintained traditions, colonists were actively remembering and recreating their homelands in new places and maintaining the social ties to their macro *ayllu* (Goldstein 2000; Murra 1980). On a finer scale, Goldstein documented differences between sites within these valleys, in the types of ceramics used and the decorations incised on them. Drawing on Murra (1980, 1985), Goldstein interpreted these differences as evidence for subdivisions within the Tiwanaku enclave; there were smaller *ayllu* divisions within the larger macro-*ayllu* identity. In this study, Goldstein was able to use archaeological markers and material remains to create a nuanced understanding of prehispanic Andean communities hundreds of kilometers from their homeland yet still connected through strong community ties (2000).

3.2.3. Issues Identifying Community in the Past: While archaeologists worked hard to create nuanced methodologies and theoretical frameworks to identify community in the past,

there are still problems. Ceramic, iconographic, and architectural styles could be used by groups completely unassociated with the original creators. For example, the Southeastern Ceremonial Complex (SECC) present in the United States from AD 1300 – 1500 was initially described and interpreted as a ritual complex that united disparate groups into a common ritual identity and community. Identification of the SECC as a regionally integrative ritual was based largely on shared supernatural iconography, interpreted as a uniting cosmology or understanding of the universe (Reilly 2004; Waring and Holder 1945). However, more recently, researchers have argued that this iconography was not part of any single “complex” but composed of multiple artistic styles within different cultural domains. The SECC was not actually representative of a common, Southeastern community (Knight 2006; Reilly 2004). Instead, groups were using some similar symbols but selecting from several artistic suites, depending on historical, environmental, and social circumstances (Knight 2006). Even images common across sites may have been used for different reasons and in different ways (Knight et al. 2001; Knight 2006). In this instance, what was originally interpreted as a large community was actually shared iconography across disparate communities. Identifying communities based on the aesthetic properties of material remains is thus problematic.

3.3 Bioarchaeology of Community

Bioarchaeology can contribute to the reconstruction of past communities by going beyond examining the material remains left behind and considering human skeletal remains. Human skeletal remains can be understood as more than physical bodies; skeletal remains can reflect the lived experiences of people through various lesions, markers, and elemental composition of bones. Bioarchaeologists have used skeletons to identify social patterns such as ties of ethnic groups, social classes, residential blocks, religious affiliations, and real or fictive

kinship. Bioarchaeology as a discipline has recently turned toward addressing social issues, moving from classifications and quantifications of pathology and bodies to exploring nuanced topics such as identity (Insoll 2007; Grauer and Stuart-Macadam 1998; Knudson and Stojanowski 2009; others), ethnicity (Jones 1997; Lucy 2005a; Zakrzewski 2011; others), social hierarchies (Barret and Blakey 2011; Martin et al. 2014; others), socially determined age categories such as childhood and adulthood (Halcrow and Tayles 2011; Littleton 2011; Lucy 2005b; Sofaer 2006, 2011), sex and gender (Díaz-Andreu 2005; Meskell 2001; Sofaer 2006), and more.

All of the studies listed above have contributed important methodological approaches, comparative frameworks, and innovative analyses to our understandings of the past. However, few go beyond group affiliation to discuss *community* and social relationships: how the social definitions and identities identified above can come together to structure daily practices.

Community relationships would have been inscribed on people's skeletons in several important and enduring ways: through genetic relationships and shared phenotypes, daily practices and disease exposure, dietary choices, and place of residence.

Important to this study is the connection between ritual affiliation and community. Ritual or religious affiliation would have structured or promoted community inclusiveness as ritual often includes both "perceived ethnic groupings and aspects of activity" (Zakrzewski 2011:186). By affecting the way people think about themselves and each other and directly affecting the activities people undertake, ritual and religion are often central to creating and reinforcing divisions of "us" and "them". This daily reminder of who participates in activities and who is excluded (or deviates from these patterns) creates community *habitus* in repetitive ways that are inscribed on the human skeleton (Canuto and Yaeger 2000; Wernke 2007; Zakrzewski 2011).

Thus, this theoretical framework is a good way to investigate ritual communities: how were the people involved sharing not only their ritual spaces and beliefs but also their daily practices, ancestry, homes, and diet?

Bioarchaeology can use an array of methods to add to knowledge about past communities. Many disease processes, nutritional insults, and genetic traits leave indelible marks on the skeleton, making the analysis of skeletal remains a valuable avenue of inquiry into issues of past health, diet, and kin relationships (Armstrong 2003; Buikstra 1977; Larsen 2002; Sofaer 2006). By examining variation in skeletal elements, we can establish genetic relatedness between populations and potentially identify outlying individuals or unrelated populations (Schwartz 2007; Stojanowski and Buikstra 2004; Sutter and Cortez 2005). Strontium isotopes in bone and teeth can be traced to local geologic areas where people were living, which is important as physical proximity is often a factor determining communities (Davis 2011; Isbell 2000). Finally, by exploring a variety of pathological indicators of stress, disease, and diet, we can reconstruct health and dietary profiles for individuals and populations. Variation in these profiles between people and populations reflects different food values, access to food items, and exposure and susceptibility to pathogens (Klaus and Tam 2009; Roberts and Manchester 2005; Sofaer 2006).

3.3.1. Genetic Relationships: Community structures are often related to ancestry and reproductive relationships. While kinship is not always genetic, the biological needs of human infants necessitate extended and intimate parenting, which often creates strong ties between parents and offspring. Social relationships surrounding parenting and extended families often create the basis for community membership.

In the Andes, kinship included genetic and non-genetic family members through the *ayllu* system in the past and present. *Ayllu* membership in the Andes was most often linked to a

common ancestor. Non-blood kin relationships or fictive kin also existed within the *ayllu* system but were rarer because descent from a common sacred, biological, ancestor was so important to *ayllu* membership (Abercrombie 1998; Goldstein 2000; Janusek 2008; Murra 1980). *Ayllu* boundaries were not determined by spatial divisions but by the historical and genealogical relationship to a real or fictive ancestor. Additionally, marriage and reproduction tended to be endogamous, as the *ayllu* structured social roles and mapped community affiliation (Goldstein 2003: 184). Thus, people from the same *ayllu* would display similar genetic markers, especially when compared to multiethnic, multi-*ayllu* groups. Genetic relationships expressed in phenotype can help archaeologists re-create genetic and community relationships. This offers important data for recreating past community structure, given that community members are often both social and biological kin (Stojanowski and Buikstra 2004). While measuring phenotypic expression of genetic relationships is not a perfect measure of community, it can be the first step to outlining social relationships, especially when combined with markers of social affiliation such as burial location and associated material goods,.

3.3.2. Co-presence and Physical Proximity: While physical proximity is certainly not the only delineation of communities, the idea of “natural communities” relies heavily on proximity. People that live near each other often engage in trade as a way to access necessary food items and other material goods. Along with material goods, these relationships can also contribute to the trade of ideas, practices, and beliefs. Modern potters in the northern Titicaca Basin regularly trade with neighboring towns as they all have become experts in one or two steps of the potting process i.e. clay collection, molding forms, firing large/small pots, and decoration. While each village maintains a local identity, they are closely linked to their neighbors to form a larger potting community (K. Chávez 1992).

Conversely, sometimes communities are not limited to direct neighbors as we have seen with Andean *ayllus*. In the *ayllu* system, families often extended vertically along mountainsides in order to gain access to multiple different ecozones. For instance, having a relative in a lower ecozone may provide access to goods such as chili peppers to those people living in higher regions, who may trade for these items with llama wool and potatoes (Goldstein 2000; Janusek 2008; Murra 1980, 1985). Family communities were thus somewhat spread out across the landscape and likely through different geologic zones. In this geographic pattern, even distant *ayllu* members would return to their natal homeland community fairly regularly, maintaining what Yaeger and Canuto call “frequent co-presence” (2000: 6). In this way, geographic distance does not necessarily correlate directly with community relationships.

Movement of people in the Andes has also been caused by processes unrelated to community or in fact, due to a breakdown or upheaval of community. The Inka Empire regularly re-located large portions of conquered communities, in order to weaken social ties and manipulate labor (Covey 2000, 2008; D’Altroy 2003; Moseley 2001; others). Under the control of some Andean states, Wari, Tiwanku, and Moche, people moved around considerable regions, as they created colonies, expanded into new areas, and developed elaborate trade networks (Goldstein 2003; Knudson 2004; Knudson and Tung 2011). Finally, during times of war, people were occasionally captured and brought to sacred locations to be sacrificed or held captive (Sutter and Cortez 2005; Sutter and Verano 2006). Sometimes people who were buried near each other may have lived or originated from much further away and relocated either through force or choice.

Bioarchaeology can test geographic relationships of past peoples through strontium isotope studies. Strontium naturally varies according to the age of local geology and this mineral

becomes incorporated into the skeleton over one's lifetime. Testing and comparing the strontium signatures in bone and teeth of individuals and populations can show where people lived prior to their deaths (Ericson 1985; Kundson 2004; Price et al 2002; Slovak and Paytan 2011).

3.3.3. Reconstruction of Diet: Foods often hold specific social associations and meanings that are particular to groups. Some foods are commonly associated with ritual settings or specific locales (see Berryman 2010; Mintz and Dubois 2002; Parker Pearson 2003; others). The sacred status of a foodstuff can be reinforced through consumption and consecration at events at ritual sites (Feeley-Harnik 1995; Mintz and Dubois 2002). Through this ritual consumption, certain foods become central to and necessary for ritual practices for the engaged communities. Ritual participants are more likely to consume a sacred food item in significant contexts and potentially in greater volume than other communities' members (especially if it is otherwise limited or exotic). Participants in ritual traditions who consume these foods are thus delineated from non-participants, a division that is reinforced every time that food is consumed. (Berryman 2010; Mintz and Dubois 2002). Because of this division, analyzing differential consumption of food and highly-valued food items in particular can reveal community and ritual affiliations.

The ritual importance of maize in the Andes (Berryman 2010; Chávez and Thompson 2006; Logan et al. 2012; Moseley 2001) is a good marker for communal belief systems. While maize is staple food item for many regions of the Andes, it carries a particular sacred meaning, linked to *Pachamama* (the earth mother) and renewed life (Berryman 2010; Moseley 2001). At modern and past festivals, people served maize in the form of *chicha*, or maize beer, in order to lubricate social interactions, reinforce social bonds, and justify political power (Janusek 2008; Logan et al. 2012; Moseley 2001). Evidence for consumption of maize is thus a "red-flag" marker of social interactions that unite people and form special communal ties.

In Andean archaeological contexts, shared consumption of maize may indicate the creation of a ritual community that understood maize as a special food item. Logan et al. (2012) suggest that sharing *chicha* at temples in the Titicaca Basin was central to ceremonies of ancestor veneration. Those ceremonies likely also worked to reinforce community bonds, through the sharing of that beverage (Janusek 2008; Logan et al. 2012). However, the distribution of *chicha* at these ceremonies and outside of a ceremonial context remains unclear. Differing access to maize, both in liquid and solid forms, may delineate social hierarchies either within a community (at a temple) or between groups (at temples compared to non-temples). Throughout the Early Horizon and Early Intermediate Period in the Titicaca Basin, maize may have acted as a marker for community relationships and participation in ritual events.

Bioarchaeology can establish patterns of maize consumption by using several skeletal indicators as proxies for dietary reconstruction. Increased rates of caries and nutrient deficiencies, and stable isotope signatures associated with consumption of C4 plants evidence are often used as evidence of moderate to high maize consumption (and conversely, a deficit of caries and isotope profiles lacking C4 signatures may indicate little or less dietary maize) (Berryman 2010; Larsen 1995). Because maize consumption can impact the skeleton in lasting ways, bioarchaeologists can use these multiple indicators and measure to evidence this.

3.3.4. Reconstructing Health: Patterns of health and disease often reflect social hierarchy and community boundaries. Social hierarchies often delineate community boundaries in that they limit people's interactions and change how they identify themselves. Thus, social status and its proxy of health can help reveal community as well. Goodman and Leatherman (1998) suggest that poor health is the most reliable indicator of low social status. This is due to a number of reasons including the increased workload of lower social classes, substandard housing, limited

access to clean water or good sanitation practices, psychosocial stress caused by discrimination and worry, and decreased access to nutrition especially during childhood growth (Goodman 1998; Goodman and Martin 2002; Marquez Morfin 1998; Sapolsky 2004). These contributors to health listed above are structured by and changed through larger processes such as public policies, systems of exchange, subsistence strategies, and social roles (see Crooks 1998; Farmer 1999, 2003; Goodman 1998; Swedlund and Ball 1998; others). While the type of structures and policies in place are variable by population and culture, each of these larger processes leave people at increased *risk* of disease and expose them to more physical and social stress overall.

Exposure to pathogens reflects one's daily habits and nutritional status, both of which are often dictated by social roles such as gender or class. Labor patterns and way of making a living vary from person to person, group to group, but will more heavily impact the bodies of those who do the most intensive labor. Social hierarchies tend to place the majority of physical labor on the (sometimes literal) shoulders of the lower classes. Heavy workloads demand more nutrients and other bodily resources, resulting in increased physical stress. Depending on one's nutritional status and access to resources in order to replenish bodily stores of energy, supplementary resources may or may not be available. An individual who has only adequate nutrition may not be able to supplement bodily resources used by intense or prolonged physical activity (Goodman and Leatherman 1998).

Nutrition and immune function are inextricably linked and directly impact each other (McDade et al 2008; Scrimshaw 1959). Certain nutrients (i.e. iron, vitamin C, vitamin A) help build the cells that identify and fight pathogens and are thus integral to maintaining immune function. Caloric intake overall is also necessary for adequate immune function as the immune system is energetically costly. Without key minerals such as iron or important vitamins, or an

overall adequate caloric intake, immune function can be negatively impacted, elevating the risk of contracting a disease (Scrimshaw 1959).

Conversely, having a disease can limit one's ability to uptake important vitamins and minerals or to acquire adequate nutrition. Fighting infection limits the amount of nutrients that the body can absorb, as energy is diverted to other systems. Additionally, symptoms of disease often contribute to loss of nutrients, through vomiting, blood loss, or diarrhea. Cultural practices surrounding illness often proscribe strict dietary regimens for those that are ill. Diets associated with illness may or may not include foods high in the nutrients necessary to adequately rebound from disease. This can create a cycle of illness and malnutrition ultimately leading to severe and rapid declines in health that have long and difficult recoveries, especially in childhood (McDade et al 2008; Scrimshaw et al 1959).

Because of the link between activity, social status, nutrition, and immune function, socially structured patterns such as workload and dietary intake directly impact health and risk of disease. Thus, patterns of health and disease can reflect social structures and hierarchies present in a population. While social hierarchies may be present within a single community, they may also delineate community boundaries, as elite individuals eat different diets, perform different activities, live in different locations, and interact less regularly with non-elites. Risk of and exposure to disease can therefore indicate community affiliations, according to elite or non-elite status.

Skeletally, bioarchaeologists can observe these health patterns amongst past populations in ways that are invisible to other methods of inquiry. Long-term stressors, such as chronic malnutrition, disease, and intense labor, are visible on human skeletal and dental remains through a variety of skeletal and dental lesions. We can use these lesions as proxies for overall individual

and population health. Observing differences in prevalence of lesions and indicators associated with stress between burial populations can allow us to see differences in health and subsequently, differences in social status.

3.3.5. Reconstructing Titicaca Basin Communities. Physical proximity, genetic relatedness, diet and special food items, and disease are identifiable via the human skeleton through a variety of methods (detailed in the subsequent chapter). Bioarchaeology is thus well-suited to identify past communities, particularly in instances where the archaeological remains are ambiguous. Following this assumption, I use bioarchaeological methods to reconstruct ancient communities on the Copacabana Peninsula in the southern Titicaca Basin in an attempt to capture the impacts of larger social and economic changes on daily life. The subsequent chapter will provide details about the sample, the sites from which the burials came, and the methods used.

CHAPTER FOUR: SAMPLE AND METHODOLOGY

4.1 Introduction

In this chapter, I first introduce the reader to the seven archaeological sites around the Copacabana Peninsula from which the burial sample for this research came: Ch'isi, Muruqullu, Cundisa, Q'hota Pata, Qopakati, Kenasfena, and Tawa Qeñani. For each site, I describe the geographic location, the surrounding environs, unique architectural and mortuary features, and the contribution to the overall sample size (i.e. how many Early Horizon people were buried there). I then describe the variety of methods used in order to untangle and understand the community and individual relationships of those buried at temples and non-temples. These methods included 1) establishing a basic demographic profile for each individual and burial population, 2) creating a dietary and health profile for each individual and burial population by recording skeletal and dental lesions, 3) establishing biological distance or genetic relatedness between individuals and burial populations, and 4) determining geographic origins of individuals buried at all sites through strontium isotope analysis.

4.2 Skeletal Sample

This section discusses each of the archaeological sites and their mortuary samples. I describe each site's physical location, relationship to local landmarks such as modern towns, large mountain peaks, and the lake, and discuss the duration of site occupation. The burial size from each site is also discussed and I present demographic information in order to contextualize

each sites' burial population. Burial numbers and age/sex estimates for each burial can be found in Appendix A.

4.2.1. Ch'isi. Ch'isi was a Yaya-Mama temple site on the eastern side of the Copacabana Peninsula. Overlooking the modern town of Chissi, this temple was perched on a ridge that separates a low valley and the shores of the eastern portion of Chucuito. The view from this site included the eastern shore of Lake Chucuito and a stunning panorama of a snow-capped peak in the Eastern Cordillera, Mt. Illampu (Figure 4.1). No contemporaneous habitation site associated with this temple has been located; it is possible that the modern town obscures an earlier occupation (Figure 4.2) (S. Chávez personal communication 2010). Notably, Q'hota Pata, a non-temple site but with similar material remains, was located within 500m of the temple. The relationship between these two sites remains unclear but is explored further throughout this dissertation.



Figure 4.1. View of Illampu and Eastern Cordillera from Ch'isi



4.2. Aerial view of Ch'isi temple (marked with arrow) in relationship to the modern town, Chissi. (Google 2014)

The temple, temple perimeter, and all surrounding human burials were excavated in 1993 – 1995 by Karen Mohr and Sergio Chávez. Temple reconstruction was facilitated by the use of the original stones on the lower levels as well as the inclusion of gathered local stone, marked with an X to denote their modern origin. This temple is the only reconstructed Yaya-Mama temple to date. Reconstruction was directed by Karen Mohr and Sergio Chávez and Eduardo Pareja, the Bolivian co-investigator of the project (Sergio Chávez personal communication 2015).

The temple at Ch'isi was a sunken court approximately 25m x 25m and 1.5m deep (Figure 4.3). There was a stairway leading down into the court on the west wall, offset from

center in accordance with typical Yaya-Mama construction. A large carved stone stela over one meter tall flanked the southern side of this entrance. This is the only stone stela found in situ in the southern Titicaca Basin from the Early Horizon. The image on this stela was a face with rayed appendages (Figure 4.4). Although the top is currently broken, this sculpture may have stood as tall as 2m (Sergio Chávez personal communication 2012).



Figure 4.3. View of the reconstructed sunken court at Ch'isi.



Figure 4.4. Carved stela at Ch'isi adjacent to the stairwell

Surrounding the sunken court were rings of burials in tombs lined with stone (Figure 4.5). These burials were oriented similarly to the ritual storage units/small buildings at Chiripa, surrounding the sunken court with diagonal burials at each corner of the sunken court. The other burials were placed roughly parallel with the sunken court walls (Chávez and Chávez 1997; S. Chávez 2004). Most tombs included one individual, although a few contained co-mingled remains of several individuals. Based on the inclusion of more than one individual and co-mingling of some remains, it seems likely that most tombs had been reopened occasionally, either to add more individuals or potentially leave offerings of food and drink. Few tombs had associated grave goods (Sergio Chávez personal communication 2012). There were a total of 52 individuals interred at this site. All were associated with the Yaya-Mama occupation of the temple.

Adults were exactly 50% of this burial population with 26 of 52 estimated as adult (Table 4.1). There were 13 juveniles (25%) and ten infants (5.2%). There were also two young adults (3.8%) and one adolescent (1.9%). Sex was estimated for all 28 adults and young adults (Table 4.2). All subadults were listed as indeterminate sex. I estimated that two individuals were females (7.1%) and four were probably females (14.2%). Four individuals were classified as males (14.2%) and another nine were listed as probable males (32.1%). Nine adults (32.1%) could not be classified into a category and remained indeterminate.



Figure 4.5. Site plan with scale showing the excavated semi-subterranean temple and surrounding burials and offering deposits. X's mark human burials. Drawn by K. and S. Chávez.

4.1.2. Muruqullu. Muruqullu was located on the northeastern portion of the Copacabana Peninsula, near the modern town of Sampaya (Figure 4.6). This temple was located at the point

of a ridge overlooking Lake Chucuito and was surrounded by terraces, most of which were contemporaneous with temple occupation (Chávez 2012). The view from this site included the Islands of the Sun and Moon (Figure 4.7), as well as the snow-capped peaks of the Eastern Cordillera. No habitation site is associated with this temple (Sergio Chávez personal communication 2011).



Figure 4.6. Location of Muruqullu (marked with white arrow) in relation to the modern town of Sampaya. Note the surrounding terraces. (Google 2014)



Figure 4.7. Muruqullu (marked with white arrow) in relationship to the Islands of the Sun and Moon (Google 2014)

Excavated by Sergio and Stanislava Chávez in 2006 and 2007, Muruqullu had two stages of Yaya-Mama occupation. During both stages, people used the site for burial. The early temple at Muruqullu was a sunken court, about 5m x 7m in size and 1.5m deep. The later temple widened the sunken court to approximately 12m x 15m. From the Early Horizon and Early Intermediate Period contexts, ceramics mostly included Chiripa and Qalassassaya styles. Some Tiwanaku ceramics were found in the southern portion of the site (Stanislava Chávez personal communication 2015).

Burials at this site did not entirely surround either temple complex as they did at Ch'isi but were placed mostly to the southeast of the site, in a flat area abutting the temple (Figure 4.8). Notably, there were at least three burials around the temple, diagonally placed at three corners, as seen at Ch'isi. However, the majority of the burials were in the cemetery-like area next to the temple. This cemetery mostly included Early Horizon and Early Intermediate Period burials but also contained remains of several Preceramic burials and a few individuals associated with

Tiwanaku ceramics. There was one large tomb that contained the remains of at least 12 individuals that was not associated with any grave goods or cultural identifiers. Early Horizon and Early Intermediate Period burials were identified by the inclusion of Yaya-Mama ceramics, stone tools, or having a stone-lined tomb (Sergio and Stanislava Chávez, personal communication 2012). In total, there were at least 97 individuals; 83 individuals were associated with the temple occupation of the site.

Adults made up the majority of the burial sample at Muruqullu, with 47 of 83 individuals (56.7%) (Table 4.1). Juveniles comprised the second most common age range with 16 individuals (19.3%). There were nine young adults (10.8%), eight adolescents (9.6%), four infants (4.8%) and one fetus. Sex was estimated for all adult and young adult individuals (56 of 83) (Table 4.2). Of the adults and young adults, I estimated that three individuals were females (5.4%) and ten were probable females (17.6%). I estimated that three individuals were males (5.4%) and 17 were probable males (30.4%). Twenty-three adults and young adults (41.1%) were labelled as indeterminate sex.

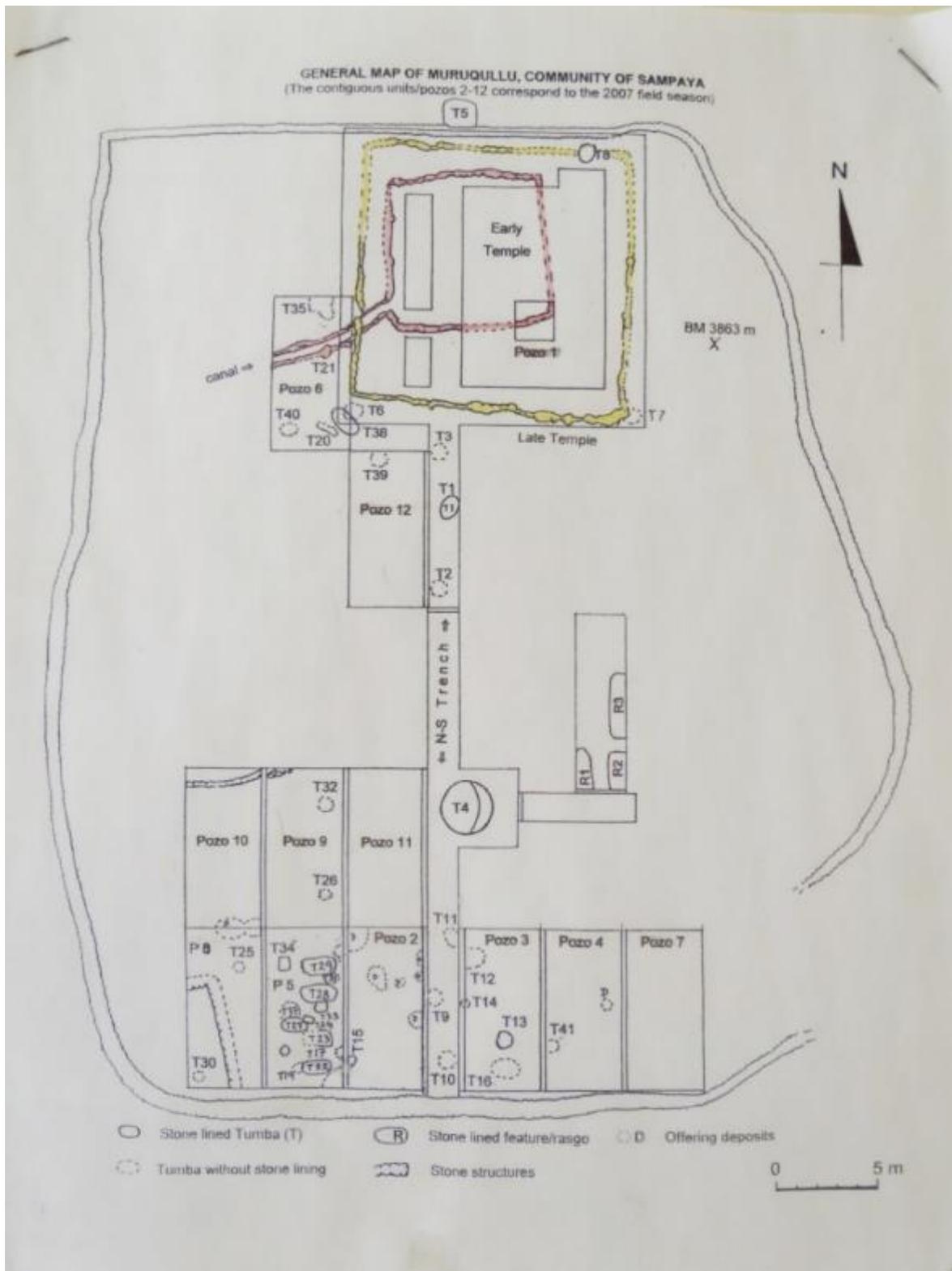


Figure 4.8. Site plan with scale showing the excavated semi-subterranean early and late temples, and additional southern excavated extensions. Drawn by Sergio and Stanislava Chavez.

4.2.3. *Other temple sites: Qopakati, Tawa Qeñani, Kenasfena.* Qopakati was a Yaya-Mama temple located on the northwestern portion of the Copacabana peninsula, close to the modern border between Peru and Bolivia (Fig 2.1). Views from this site included the marshy shores of northern Lake Chucuito, a clear view of the snow-capped volcano Ccapia, and the far northern shoreline of the lake. This site was also associated with early rock art, carvings and painting of camelids and an Andean cross. The antiquity of this art is somewhat unclear; it may predate or be contemporaneous with the temple. Qopakati excavations only included preliminary test pits and a trench, so less is known about temple structure and orientation. However, the trench uncovered several burials associated with the temple structure which appeared to have stone-lined graves. Most of these burials contained the remains of one or two individuals, totaling seven individuals. Two of these individuals were adults (33.3%), three were young adults (50%), and two were juveniles (33.3%) (Table 4.1). Of the adults and young adults, I estimated two were female (40%), two were probable females (40%), and one was a probable male (20%) (Table 4.2).

Tawa Qeñani was a small, rectangular site on the eastern portion of the Copacabana Peninsula, just south of Ch'isi and Qh'ota Pata (Fig 2.1). It may have been linked with local control of terraces and fishing (Sergio Chávez personal communication 2015). There were three individuals buried at Tawa Qeñani. All three individuals were juveniles, ranging from four to ten years old (Table 4.1). Because of their juvenile status, sex could not be estimated for this burial population (Table 4.2).

Kenasfena was a temple site on the southeastern portion of the Copacabana Peninsula, near the modern town of Huayllani close to the straits of Tiquina (Fig. 2.1). This site had at least three temple construction events during the Early Horizon. Test excavations revealed two

burials, both adult individuals (Table 4.1). One of these individuals was estimated to be female, while the other was indeterminate (Table 4.2).

4.2.4. *Cundisa*. Cundisa was a site located in the heart of modern Copacabana with evidence of continuous occupation and use from the Early Horizon through the modern day (Chávez 2008). This site is currently beneath the modern governmental office of Copacabana and threatened by construction of an asphalt-capped market place. Cundisa is located in the highest part of the town, a bluff that runs between the two larger peaks on the outer boundaries of the town. The view from this site prior to modern construction would have included an impressive sloped incline down to the shores of the northwestern portion of Lake Chucuito and the far eastern shore, the two surrounding hills, and a glimpse to the west of the snow-capped volcano, Ccapia.

First excavated by Karen Mohr and Sergio Chávez in 1992 and further excavated by Sergio and Stanislava Chávez in 2008 and 2009, Cundisa was a large site with many stages of occupation. Burials from this site included Early Intermediate Period, Tiwanaku, and Inca individuals. In strata associated with the Early Horizon and Early Intermediate Period, Sergio and Stanislava Chávez identified a Yaya-Mama temple structure, as well as burials associated with this time period (Figure 4.9). These burials had notably worse preservation than burials at other sites, possibly because they were not buried in the same stone-lined tombs noted at Ch'isi and Muruqullu (S. Chávez 2008). Despite the presence of a Yaya-Mama temple at this site, the Early Horizon and Early Intermediate Period burials do not appear to have been closely related to the temple. Because of this, these burials were classified as “non-temple”. These burials included at least 33 individuals.

At Cundisa, the overwhelming majority of individuals were adults (26/33 or 78.8%) (Table 4.1). There were also four adolescents (12%), two juveniles (6.1%), and one young adult (3%). Sex was estimated for all adult individuals at this site (Table 4.2). I estimated one individual was female (3.8%) and five were probable females (19.2%). Ten individuals were probable males (38.5%) and two were male (7.6%). I listed eight adults as indeterminate sex.

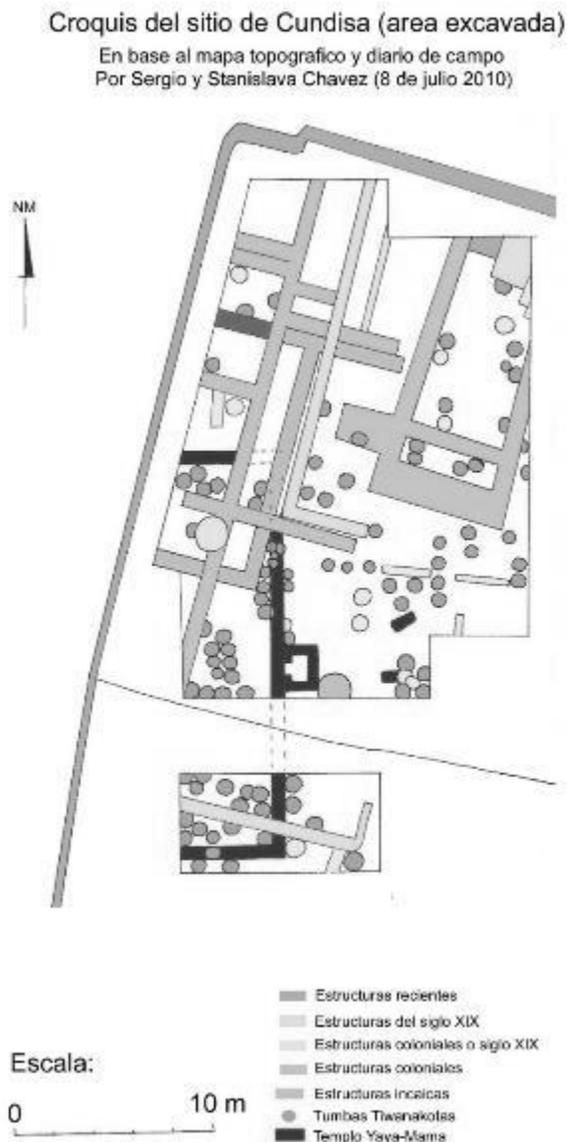


Figure 4.9. Site plan showing three sides of Yaya-Mama Temple and burials at Cundisa. Drawn by Sergio and Stanislava Chávez.

4.2.5 *Q'hota Pata*. Q'hota pata was a non-temple site located in the valley adjacent to the temple at Ch'isi. Due to its location in the adjacent valley, the snow-capped peaks and lake seen from Ch'isi are not visible from this site. Identified by a collection of Early Horizon ceramics, stone tools, and two human burials, the use of this site remains unclear. Both individuals from Q'hota Pata were estimated to be adults (Table 4.1). One was 25 – 35 years of age, while the other was likely over 40 years of age. I estimated that one individual from Q'hota Pata was a probable female, while the other was indeterminate (Table 4.2).

4.2.6. *The Skeletal Sample*. This skeletal sample represents the overall population of the Copacabana Peninsula during the Early Horizon and Early Intermediate Period in a few different ways. First, these sites were located on all sides of the peninsula and in a variety of environments: high on peaks, on flat plains, and in valley bottoms. The only geographical similarity between sites was a dramatic view of Lake Chucuito or the visibility of distant snow-capped peaks, both important features of the landscape. Variation in site location may represent different social groups or local preferences. This variation may have also impacted health and diet, as local microclimates impacted exposure to pathogens and what crops could be grown. By including this variety of sites, I can capture variation in health and diet at a finer scale. Additionally, the sites include both temples and non-temple populations. While the temple sample is more robust (144 individuals), the other sites' burial populations (35 individuals) provide a clear comparison and statistical significance. Second, this sample includes all age groups, from pre-natal individuals through very old adults (Table 4.1). Having a range of age categories allows me to identify any patterns based on age. Finally, these populations include males, females, and probable individuals of both sexes (Table 4.2). This allows for pattern observation along sex divisions. The following chapter will present the results of data collection

for all sites in terms of biodistance correlation analysis, strontium isotope analysis, and presence and rates skeletal indicators of diet and disease.

Age Category	Temple Sites					Non-Temple Sites	
	Ch'isi	Muruqullu	Tawa Qenani	Kenasfena	Qopakati	Cundisa	Q'hota Pata
Adult	26	47	0	2	2	26	2
Young Adult	2	9	0	0	3	1	0
Adolescent	1	8	0	0	0	4	0
Juvenile	13	16	3	0	2	2	0
Infant	10	4	0	0	0	0	0
Fetus	0	1	0	0	0	0	0
Totals	52	83	3	2	7	33	2

Table 4.1 Frequency of individuals per age category at each site.

Sex Category	Temple Sites					Non-Temple Sites	
	Ch'isi	Muruqullu	Tawa Qenani	Kenasfena	Qopakati	Cundisa	Q'hota Pata
Female	2	3	NA	1	2	1	0
Probable Female	4	10	NA	0	2	5	1
Male	4	3	NA	0	0	2	0
Probable Male	9	17	NA	0	3	10	0
Indeterminate	9	23	NA	1	0	8	1

4.3 Methods: Demographic Profile

Estimating age and sex is a necessary part of an osteological study, as these demographic data may affect how other skeletal indicators of health and diet present on the skeleton.

Additionally, understanding the demographic composition of burial populations is an important step to be aware of any existing prejudices or missing subsets of a population in the dataset.

When possible, all the following measures of age and sex were used in conjunction to most accurately estimate these factors. Differences in age and sex profiles for each site were tested for statistical significance using Monte Carlo chi-squared significance tests at the Odum Institute at UNC Chapel Hill.

4.3.1. Age Estimation. Age was determined for each individual based on a number of dental and skeletal traits, when possible. Dental eruption and wear are considered reliable

markers of age (Buikstra and Ubelaker 1994; Murphy 1959; Ubelaker 1989). Tooth eruption and tooth root formation were scored using the standard eruption chart (Ubelaker 1989). I paid special attention to the eruption of the adult first, second, and third molars, erupting at approximately 6, 12, and 18 – 22 years, respectively. Additionally, I scored dental wear and occlusal attrition based on scoring systems developed by Murphy (1959) and Smith (1984). This diagram is widely used for age estimation (Buikstra and Ubelaker 1994). When possible, I used both dental eruption and dental wear to estimate age.

When dentition was not available, I estimated age based on cranial suture closure, the appearance of the pubic symphysis and fusion of the epiphyses of long bones. The sutures of the cranium slowly fuse over one's lifetime; they are open at birth, remain relatively open throughout childhood, and undergo fusion through middle and old adulthood. They are typically fully obliterated by 55 years of age. When articulated crania were present, I compared suture patterns to a standard set of images of progressive suture closure (Meindl and Lovejoy 1985; photos by P. Walker in Buikstra and Ubelaker 1994).

The pubic symphysis of both males and females undergoes a series of standard changes throughout the life course. I compared intact pubic symphysis to the Todd (Todd 1921a, 1921b) and Suchey-Brooks (Brooks and Suchey 1990; Suchey and Katz 1986) pubic symphysis mold series and subsequently gave them the corresponding score and age category. The epiphyses of long bones fuse throughout childhood and adolescence. This pattern of fusion is notably regular across populations, within a certain range, and can be used to accurately estimate approximate age for young individuals. Notable epiphyses were the proximal and distal tibia (fusing around 12 – 16 years), the distal femur (14 – 16 years), the iliac crest (17 – 20 years), and the medial clavicle (20 – 25 years), as these unions mark the upper limits of childhood and adolescence,

often an important social moment in one's life (Buikstra and Ubelaker 1994; Sofaer 2006; Ubelaker 1989).

The age categories used in this dissertation include adult (over 25 years of age), young adult (18 – 25 years), adolescent (12 – 18 years), juvenile (3 – 12 years), infant (0 – 3 years), and fetus (prenatal). When an age range could not be estimated or groups were lumped for analysis, I used adult (over 18 years) and subadult (under 18 years). These age categories were selected because they represent moments of significant biological change over the life course which often have social consequences, such as weaning and puberty. Biological processes like weaning and puberty are often cross-culturally important to social status as they reflect new periods of independence and a significant shift in relationships between people (Halcrow and Tayles 2011:336; Sofaer 2006, 2011).

4.3.2 Sex Estimation. Sex was estimated for each adult individual when cranial and pelvic elements were present. It is very difficult to estimate sex for individuals under the age of 12, as most skeletal indicators of sex develop during puberty. For this reason, I did not estimate sex for individuals categorized as juvenile or infant. I estimated sex for adult and adolescent individuals using the following pelvic and cranial traits.

Pelvic traits are the most reliable skeletal sex indicators, as these bones are most impacted by reproductive needs and consequences. Female pelves tend to be wider overall and marked by the presence and appearance of the following features: the subpubic concavity, the ischiopubic ramus, the ventral arch, the greater sciatic notch, the pelvic outlet, and the preauricular sulcus. I scored these features according the standards in Buikstra and Ubelaker (1994) following methods developed by Bass (1987), Buikstra and Meilke (1985), and Phenice (1969). Taking an average of these scores, I estimated probable pelvic sex whenever possible.

Certain cranial traits are also strongly correlated to sex because of varying levels of hormones and muscle development. I scored each individual with an observable cranium on the appearance of the following traits: supraorbital margin, superciliary arches, nuchal crest, and mastoid process, according to standards in Buikstra and Ubelaker (1994) following methods developed by Acsádi and Nemeskéri (1970). While these features are less reliable than pelvic sex, the two methods combined give a generally accurate picture of individual sex.

For statistical analyses, I combined probable and definite sex categories (i.e. combining probable females and females). Because the overall samples of individuals for whom sex could be estimated were small, this allowed for statistically significant comparisons. In my qualitative observations, I maintained these as separate categories.

4.4. Methods: Dietary and Health Profile

The skeletal and dental lesions and indicators recorded for this project include periosteal reactions, osteomyelitis, porotic hyperostosis (PH), cribra orbitalia (CO), dental caries (DC) and abscesses (DA), antemortem tooth loss (AMTL), and linear enamel hypoplasia (LEH). These indicators combined show childhood health and nutritional status (porotic hyperostosis, cribra orbitalia, and linear enamel hypoplasias), overall systemic stress and disease in childhood and adulthood (periosteal reactions and osteomyelitis), and dietary composition and oral health (dental caries, dental abscesses, and antemortem tooth loss). Each of these lesions or indicators is described in the following sections. Instances of other abnormalities or lesions, such as scurvy or mastoiditis, were recorded but were notably rare and not a part of the ultimate analysis. Trauma and fracture were recorded when present but were also rare in these populations.

4.4.1 Dental Cavities, Abscesses and Antemortem Tooth Loss: These three indicators are generally linked to diet. By assessing dental wear and carious lesions (cavities), it is possible to

determine the amount of “stickiness” and grit present in the food consumed, such as the presence of grit from grinding stones used in processing maize. These factors can help determine what was being processed and eaten. “Sticky” foods, such as maize and quinoa, often adhere to the enamel of teeth and can lead to massive carious lesions (Figure 4.10) (Cucina et al 2011; Hillson 2008; Larsen 1995). Chewing nonfood items, such as coca leaves in the Andes, can also predispose dentition to cavities, although these lesions tend to cluster along the cement-enamel junction rather than occlusal surface as with food-related cavities (Indriati and Buikstra 2001). If dental caries exposes the pulp cavity of a tooth, bacteria can infiltrate and infect the surrounding bone, causing an abscess (Figure 4.11) (Hillson 2008; Roberts and Manchester 2007). Dental caries and abscesses can lead to antemortem tooth loss, as surrounding alveolar bone is eroded away (Figure 4.12).

Importantly, both dental caries and dental abscess formation are impacted by a number of other factors outside of diet, including oral micro-flora and fauna, acidity, rate of saliva flow, and hormone levels (see Hillson 2008; Lukacs 2011; Lukacs and Largaespada 2006; Temple 2011). Studying caries and abscess formation is thus not a definitive way of determining diet as these other factors predispose some individuals and protect others. However, tracking rates of these processes can corroborate other lines of evidence that demonstrate shifts in a population’s diet (Berryman 2010; Hillson 2008; Hutchinson 2004; Larsen 1995, 2000).



Figure 4.10. Dental caries



Dental caries was recorded when the dentin was visible. Darkened spots of enamel were not considered cavities until the dentin was exposed (Berryman 2010; Cucina et al 2011). Dental caries was scored by location on tooth or tooth root, size of lesion, and depth of lesion. Dental

abscesses were recorded separately from cavities, unless the edges of the cavity were still visible and obvious. I noted teeth lost antemortem in association with abscesses and cavities but made no correction factors or assumptions about why teeth had been lost (i.e. attributed tooth loss to caries) (Cucina et al 2011). Alveolar resorption and healing of abscesses and tooth loss were also recorded.



Figure 4.12. Antemortem tooth loss

4.4.2 Cribra Orbitalia and Porotic Hyperostosis: Periods of nutrient stress and deficiency in childhood can have effects on the skeleton that persist into adulthood. Cribra orbitalia and porotic hyperostosis are lesions in the eye orbits and on the cranium, respectively, which can occur independently of one another (Figures 4.13 and 4.14). Both are generally considered to be indicative of anemia or certain other nutrient deficiencies in childhood (Kent 1986; Larsen 2002; Stuart-Macadam 1985, 1992; Walker 1986; Walker et al 2009). Many types of anemia cause these lesions including genetic variants like sickle-cell. However, given the geographic distribution of most anemia-related genetic problems, it is unlikely that prehispanic highland Andean populations dealt with them. It can be reasonably assumed that porotic hyperostosis and cribra orbitalia in this context is indicative of nutritional or parasitic problems, specifically related to iron-deficiency. Iron-deficiency anemia can result from low availability of dietary iron or from excessive bleeding caused by parasitic infections (Blom et al. 2005; Kent

1986; Walker 1986). When compared with other evidence for malnutrition and dietary reconstructions, potential causes for iron-deficiency and its associated lesions can be determined (Blom et al. 2005; Kent 1986). Evidence for healing of these lesions indicates if the dietary stresses were relieved.



Figure 4.13. Porotic Hyperostosis (from Aufderheide and Rodriguez-Martin 1998)

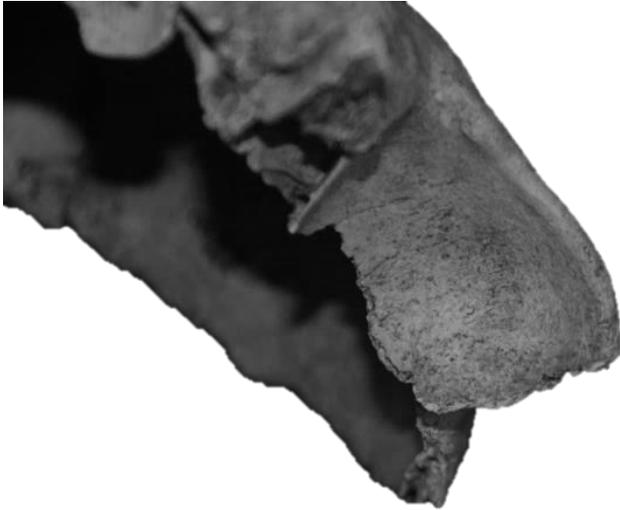


Figure 4.14. Cribra orbitalia in the left orbit (healed)

Porotic hyperostosis and cribra orbitalia were recorded by location and size of the defect according to standard methods in Buikstra and Ubelaker (1994). Additionally, these lesions were observed for signs of healing, recorded as fully healed (smoothed bony surface without remaining pits and remodeled diploic expansion), some healing (some pits visible, diploic expanded), or active (no evidence for remodeling).

4.4.3 Linear Enamel Hypoplasia: Episodes of severe disease or nutritional stress in childhood can cause disruption and defects in the development of dental enamel (Figure 4.15). These are characterized by grooves or pits on tooth crowns. Linear enamel hypoplasia can also be caused by traumatic injury to individual teeth. The etiology of enamel hypoplasia can be differentiated by observing the lesions on more than one tooth from the same mouth; hypoplasia caused by trauma are more likely to be isolated cases. Thus, dentitions that show multiple linear enamel hypoplasia were likely impacted by systemic nutritional stress or infectious disease, rather than trauma (Hillson 2008; Temple 2010). Because tooth crowns typically develop at a standard rate, LEH can indicate at what age an individual suffered from a severe stressor during childhood depending on where the defect is located on the crown (Fitzgerald and Rose 2008;

Hillson 2008). LEH were recorded by tooth and location on the tooth. Quantity of linear enamel hypoplasia was recorded per tooth and per mouth.



Figure 4.15. LEH on canines and premolars (adapted from Museum of London webpage, Watts 2012).

4.4.4. Periosteal Reaction and Osteomyelitis: These nonspecific disease indicators allow insight into childhood and adult health. Periosteal reaction (inflammation of the outer layer [periosteum] of long bones) and osteomyelitis (infection and inflammation of the medullary cavity) signal the presence of an infection or traumatic event (Figures 4.16 and 4.17) (Roberts and Manchester 2007; White et al. 2011). Periosteal reactions are characterized by deposition of woven bone atop of the outer layer of cortical bone, typically along the shafts of long bones. This bony reaction is caused by chronic inflammation of the periosteum due to the presence of

bacteria or some other pathogen. Healed periosteal reactions are observable even after these lamellar depositions have become smoothed over time. Osteomyelitis occurs when a bacterial infection penetrates the medullary cavity of long bones, causing inflammation and new bony growth along the interior of long bones. These infections typically form a draining sinus and are often accompanied by exterior periosteal reactions as well (Roberts and Manchester 2005). Relative healing, or lack thereof, can indicate the ability of the person to recover from these stress events, providing a commentary on overall individual health.

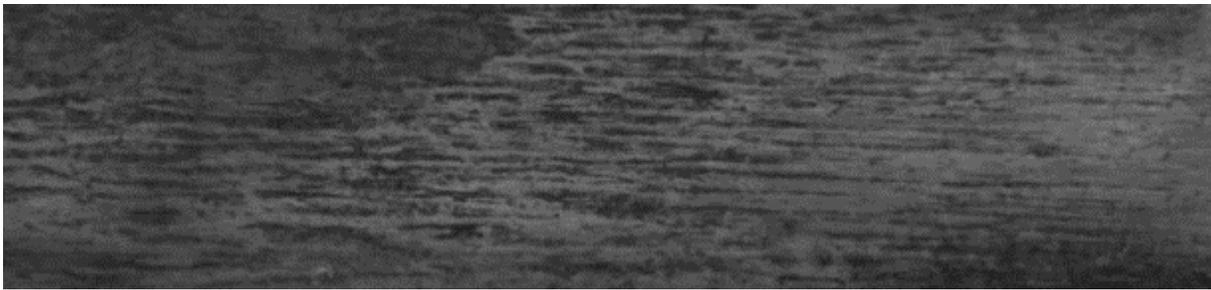


Figure 4.16. Periosteal reaction on a long bone shaft

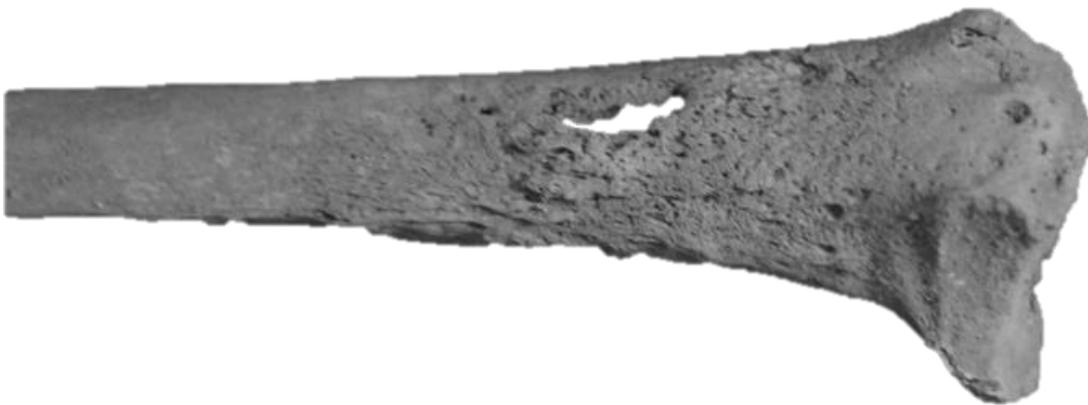


Figure 4.17. Osteomyelitis on a distal radius (note the sinus)

Periosteal reactions and osteomyelitis were recorded by skeletal element, location on element, and extent of the lesion. Healing was recorded as fully healed (woven bone was

remodeled although defect was still notable), some healing (woven bone was partially smoothed but active areas were still observable), and active (no evidence for healing). I additionally recorded osteomyelitis by obstruction of the marrow cavity (if observable) and noted the presence of draining sinuses. Bilateral appearance of these lesions or presence on multiple skeletal elements was recorded as probable infectious response, while lesions noted on a single skeletal element or associated with trauma were excluded to avoid over-representation in the sample.

4.4.5 Statistical Analyses for Dental and Skeletal Indicators. Using the skeletal and dental data collected above, statistical analyses were used to look for patterns. I used Monte Carlo chi-squared significance tests to look for significant patterns of lesion and indicator distribution between temple and non-temple burial populations. I also looked for variation within temple and non-temple populations, by age, sex, and associated grave goods, was tested. Monte Carlo tests were used because they are able to statistically compare multiple variables from small datasets and still provide significant results. Significance was attributed to comparisons when $p > 0.05$. In this way, we can see the patterning of burials, grave goods, or burial demographics related to diet, health, or familial relationships. All statistical procedures were performed using the SAS 9.2 at the Odum Institute for Research in Social Science at UNC Chapel Hill under the direction of Chris Weisen.

4.5 Methods: Biodistance Analysis

This measure estimates how closely related different populations were, based on prevalence of certain morphological traits. The basic premise is the morphology of certain biological traits is determined hereditarily, thus populations that are closely related should have phenotypes that look similar when compared to those of groups less closely related (Schwartz

2007). These calculations include within and between group variation (Stojanowski and Buikstra 2004). Skeletal and dental traits that are inherited can be used to determine these relationships. Observation of these traits produces a record of shared population traits, which can be statistically analyzed to show outliers within a population (Schwartz 2007; Scott and Turner 1988; Stojanowski and Buikstra 2004; Sutter and Cortez 2005; Sutter and Verano 2006) as well as different morphological compositions between groups (Konigsberg 1990).

I used nonmetric dental traits since skeletal preservation was less reliable across sites and burials. I recorded nonmetric dental variation, following the rankings established by the ASU Dental Morphology System (Turner et al. 1991). I included all individuals with observable permanent dentition, complete and incomplete in order to have the largest comparable population possible. I excluded deciduous teeth and extremely worn teeth as they often do not present the same types of variation or are unobservable.

Certain nonmetric traits were selected for statistical analysis in order to avoid biases described by Sutter and Cortez (2005). Some traits are highly correlated with each other or other individual traits such as sex and are therefore not good markers of biological distance. I also chose to include the same traits as Sutter and Cortez (2005) to preserve comparability between studies. Therefore, I included the following nonmetric dental traits in this study: maxillary incisor shoveling and double shoveling, presence of peg or congenitally absent lateral incisors, metacone and hypocone cusp presence and formation of maxillary molars, root number variation for maxillary molars, mandibular molar cusp number and formation, congenital absence of third molars, and supernumerary teeth. Each of these traits was scored according to the ASU Dental Morphology System and entered into an excel database.

4.5.1 Statistical Analysis. Statistical analyses for calculating biodistance involve establishing the correlation or agreement between pairs of individuals, first for a single burial population and subsequently between populations. Individuals were included if they had scores for at least five of the dental traits listed above and pairs were included when both individuals had scores for matching dental traits. Identical individuals had a score of “1” (total agreement) while individuals not sharing any traits scored “0” (no agreement). Pairs thus “agreed” on a scale of 0 to 1, with anything above 0.5 suggesting a close genetic relationship (Chris Weisen personal communication 2013). Subsequently, the scores for each pair were averaged across the population to see group cohesion for a single burial population. Outliers with little agreement with any other individual in the population were also noted.

Each population was subsequently compared with every other burial group in turn. Each individual from site A was matched with every individual at site B. These relationships were then averaged to give an overall agreement rating between different populations. Again, “1” denoted perfectly identical populations while “0” would indicate no agreement between populations. Numbers above 0.5 are expected values for closely related groups accounting for normal phenotypic variation. These statistical procedures were performed using the SAS 9.2 at the Odum Institute for Research in Social Science at UNC Chapel Hill under the direction of Chris Weisen.

4.6 Methods: Migration and Strontium Isotope Analysis

Variation in isotopic strontium in rock reflects the age of a geologic formation. Geologists have used strontium for nearly 70 years in order to answer a diverse number of questions, including the age of geologic features, the process of crust formation, and the reconstruction of past environments (see Aberg 1995; Bachman et al. 1985; McMillan et al.

1993; and others). More recently, other researchers including paleontologists, biologists, and archaeologists have used strontium isotope variation to track migration of humans and non-human animals in the past and present (see Ingram and Weber 1999; Kennedy et al. 1997; Knudson 2008; Price et al. 1994; Turner and Armelagos 2012; and others). These studies are successful because strontium is incorporated into human (and animal) skeletons and dentition over the course of one's life.

4.5.1. Strontium Geochemistry. Strontium present in local geology is reflected in groundwater, and thereby is incorporated into local fauna and flora. Isotopes present naturally in the environment include ^{84}Sr , ^{86}Sr , ^{87}Sr , and ^{88}Sr ; three of these isotopes are non-radiogenic (^{84}Sr , ^{86}Sr , ^{88}Sr). ^{87}Sr is radiogenic, formed from the decay of rubidium 87 (Faure and Powell 1972; Knudson 2004; Slovak and Paytan 2011). Ratios of ^{87}Sr to other isotopes can therefore demonstrate the age of a particular geologic formation, with increasing ^{87}Sr over time. Rocks older than a million years have the highest ratios of ^{87}Sr and ^{86}Sr (.717 and higher) while younger rocks have lower ratios (as low as .704). Additionally, seawater and marine geology have a unique isotopic strontium composition with an $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of .7092 (Veizer 1989).

4.5.2. Strontium Biochemistry. Through the consumption of food and water, ^{87}Sr and ^{86}Sr are incorporated into the human skeleton and teeth through because of their similar molecular structures to calcium. During dental enamel and bone formation, strontium can be substituted for calcium into the hydroxyapatite of teeth and bones (Ezzo 1994; Slovak and Paytan 2011). Thus, the strontium in one's body directly reflects the strontium present in bedrock for either the region where one resided during the period of dental or bony formation or the region of one's main sources of food and water (Ericson 1985; Knudson 2004; Slovak and Paytan 2011).

In teeth, strontium reflects the region where one lived during childhood and adolescence since adult dental enamel is fully formed by 10 – 15 years of age (Table 4.1) (Hillson 2008; Slovak and Paytan 2011). Strontium incorporated into bones will reflect where one lived in the years prior to death, as bony tissue regenerates continually (Knudson 2004; Parfitt 1983). If a person consumes predominantly local water and food over the course of their childhood and lifetime, their dental and skeletal strontium ratios, respectively, should reflect the local geological strontium. Assuming local resource consumption, strontium ratios more than 2 standard deviations from the local mean indicates an individual who relocated to the place of burial, either prior to or after death (Ericson 1985; Knudson 2004; Price et al 2002; Slovak and Paytan 2011).

Permanent tooth type	Approximate timing of dental crown formation
First incisor	3 months to 5 years old
Second incisor	3 months to 5 years old
Canine	6 months to 4 years old
First premolar	2–5 years old
Second premolar	3–6 years old
First molar	0–2½ years old
Second molar	3½–6½ years old
Third molar	9½–12 years old

Table 4.1 Approximate timing for dental enamel formation for human adult dentition. Data from Hillson 2008 and Slovak and Paytan 2011.

4.6.3 Strontium Laboratory Methods. I tested teeth from 40 individuals excavated from sites around the Copacabana Peninsula in order to see the geographic origins of these individuals. Dental enamel is ideal for this test as it is resistant to diagenetic contamination, especially compared to bone (Knudson 2004; Waldron et al 1979). Additionally, because strontium ratios in dental enamel reflect where one lived in their early years, any ratios outside of the Titicaca range will indicate immigrants to the area. A comparison with bone samples would

allow for an approximate estimation of when a person relocated during their life course; however, removing bone samples from Bolivia was not possible during the time of this study. Most of the burials included here were primary interments with skeletal elements correctly articulated, indicating that individuals were buried shortly after death while flesh and muscle tissue still held the skeleton together. Likely, this means that burial population was living near to their burial site prior to death. Because of this, it is likely that strontium outliers relocated to the Titicaca Basin during their lifetimes, rather than after death.

All tooth samples were prepared and cleaned by the author or Audrey Horne (a trained student and employee) at the Isotopic Geochemistry Laboratories at the University of North Carolina at Chapel Hill under the direction of Dr. Drew Coleman. Mechanical cleaning of each tooth was performed with a Dremel 200 drill to remove contaminants adhered to the tooth surface, as well as any penetrating contamination to the outer layer of enamel. After each tooth sample was cleaned, approximately 5 – 10mg of dental enamel was removed.

Two to three mg of crushed enamel was dissolved in ~550 μ L of a 3.5N HNO₃ solution in a class 100 air environmental hood and centrifuged to prepare for chemical analysis. The author or Audrey then loaded the sample onto EiChrom SrSpec resin in the tip of a 10mL BioRad polypropylene column. This resin is particularly good at removing calcium and rubidium from strontium (Slovak and Paytan 2011). The SrSpec resin was cleaned and preconditioned with ~500 μ L 3.5 N HNO₃ prior to loading the sample. Resin was used for one sample and then discarded to prevent contamination between samples. Once the sample was loaded, I rinsed it first with three drops of 3.5 N HNO₃ (approximately 30 μ L each), followed by five bulk rinses of 3.5 N HNO₃ (approximately 500 μ L each). Following these rinses, the Sr sample was eluted twice

with ~500 μ L of distilled H₂O. Finally, I added one drop of H₃P₀₄ and then evaporated the samples on a hot plate.

After re-dissolving in 2 μ L of 0.1 H₃P₀₄ and 2 μ L of TaCl₅, the samples were loaded onto degassed Re filaments and measured by a VG Sector 54 thermal ionization mass spectrometer with dynamic multi-collection. This type of collector provides the most accurate results, as the strontium isotopes are compared at multiple cross-reference points (D. Coleman personal communication 2014). The standard error for this machine is generally between 0.00006% and 0.00010%, after collecting data for 100 dynamic cycles. The author and Audrey Horne performed all of the lab work and data collection for strontium isotope analysis at the Isotope Geochemistry Laboratories at The University of North Carolina at Chapel Hill.

4.7 Community Analysis

I analyzed each individual from the seven sites, combining these multiple lines of evidence to assess community and daily life on the Copacabana Peninsula during the Early Horizon and Early Intermediate Period. The next chapter will present the results of this analysis.

CHAPTER FIVE: RESULTS

5.1 Introduction

This chapter covers the results for the skeletal indicators linked to diet and disease, biodistance analysis and strontium isotope tests (details on individual burials in Appendix A). I first present patterns in the demographic information for each site. Next, I report the frequencies of the skeletal indicators of diet, followed by skeletal indicators of disease. Statistically significant differences between and within sites, sexes, and age groups will be given for each set of data. Next, I present the biodistance results, based on observations of nonmetric dental traits. Observed traits were compared within and between sites. Additionally, the results of the 40 enamel samples tested for variation in strontium isotope ratios are presented. Finally, I present the rare cases of trauma in the population. Important patterns or notable exceptions are emphasized throughout the chapter, to be discussed in the subsequent chapter.

5.2 Demographic Patterns

Age estimates for all sites revealed some interesting initial patterns (Figure 5.1). Overall, adults comprised approximately half of the entire skeletal sample (104/184 or 57% of individuals), with juveniles the second most numerous group (36/184 or 20%). Young adult, adolescent, and infant categories each had 15-20 individuals and only one site had evidence for fetal remains. The dearth of fetal remains and the low number of infant remains are likely tied to issues of preservation because of the fragile nature of these remains rather than a true reflection of the risk of mortality. Despite this issue, some fetal and infant remains did preserve and many

juvenile remains are included in the sample. In fact, at some sites, juveniles comprised the entire burial population, a trend discussed below.

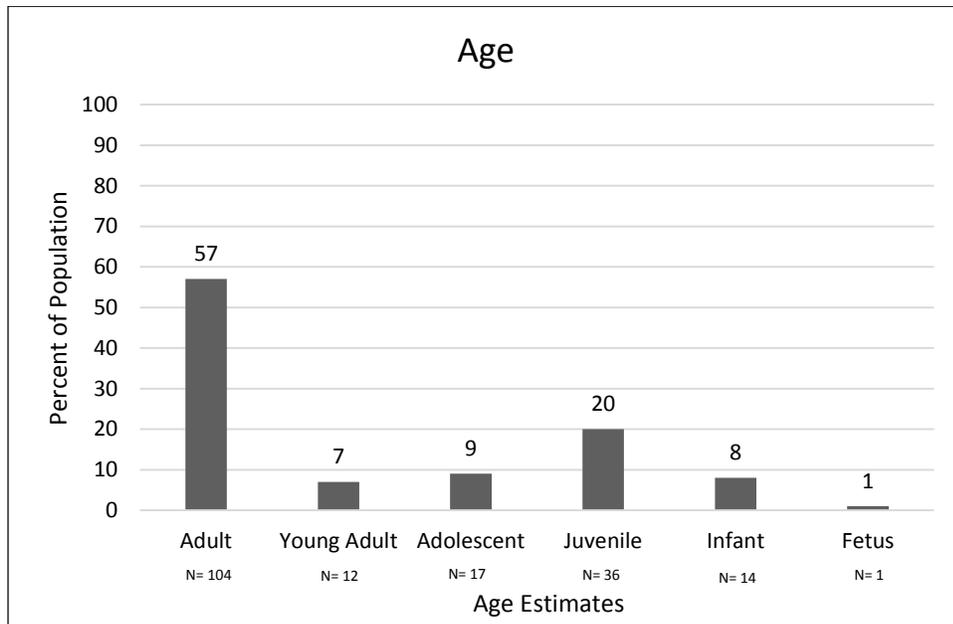


Figure 5.1. Percent of individuals per age category for the total Copacabana burial sample.

There were significant differences in age profiles between sites ($p=.033$) (Figure 5.2). Both temple sites Ch'isi and Muruqullu included a large proportion of juvenile individuals (25% and 19% respectively) while the burial sample from the non-temple site Cundisa included just two juvenile individuals (7%). Additionally, temples were the only sites to include remains of infants (5% of the total population at Ch'isi and Muruqullu) and the sample from the temple Tawa Qeñani included only the remains of juvenile individuals. Notably, juvenile remains are much more common at temples compared to non-temple sites. This may relate to issues of differential preservation, discrepancies in extent of excavation of temple vs non-temple sites, or taphonomic changes to bone. However, it is also possible that this reflects significant differences in the mortuary practices and mortal risks of people interred at different peninsular locations.

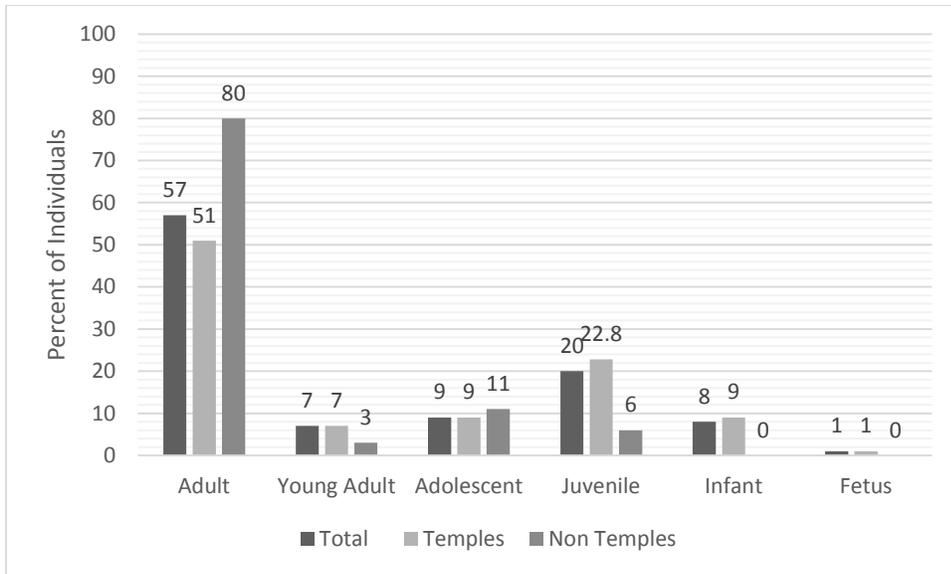


Figure 5.2. Percent of Individuals per age category by site type.

Sex estimates for burials at all sites revealed interesting patterns as well (Figure 5.3). When sex or probable sex could be estimated, probable males were most commonly represented (39/87 individuals or 45%). When probable males and males are included together, they represent over half of the individuals for whom sex could be estimated (54/87 or 62%). Probable females and females included 33 individuals in total (38%). Sex could not be estimated for 44 adult individuals.

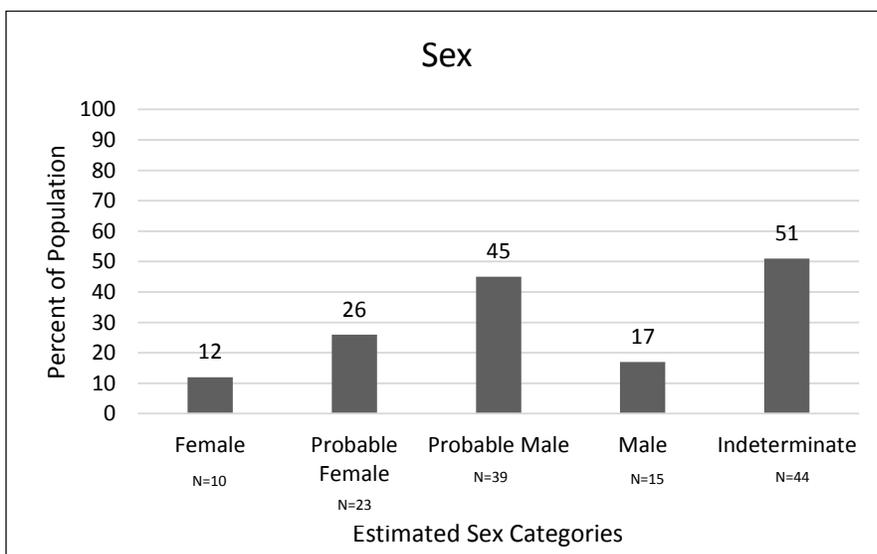


Figure 5.3. Percent of individuals per sex category for all adult individuals.

Beyond the disproportionate sex ratio, there were significant differences in the sex ratios between sites ($p=.035$) (Figure 5.4). The only sites to have more females or probable females than males were the non-temple Q’hota Pata (one probable female and one indeterminate) and temple Qopacati (two females, two probable females, and one probable male) and both of these samples are notably small. This disproportionate sex ratio between sites was not affected by the varying number of indeterminate individuals at each site (although this was generally the largest population for all sites). When sex could be estimate, the largest burial populations are dominated by male and probable male individuals.

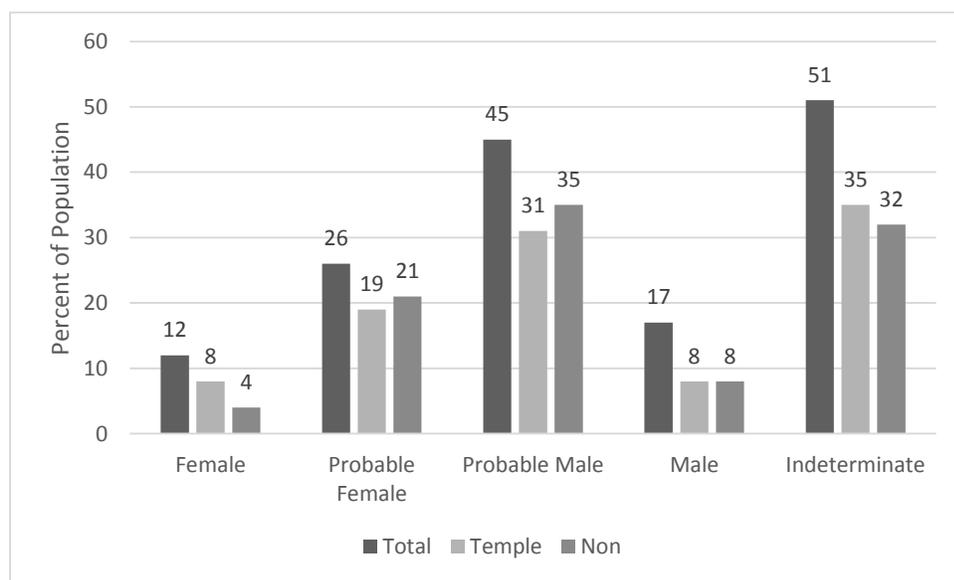


Figure 5.4. Percent of individuals per sex category by site type.

5.3 Skeletal Indicators of Diet

I recorded dental cavities and abscesses, cribra orbitalia, and porotic hyperostosis as skeletal indicators of nutritional deficiencies and dietary composition (see chapter four, section 4.3). Of the recorded lesions, caries was the most common, followed by cribra orbitalia, abscesses, and finally porotic hyperostosis (Figure 5.5). In the subsequent section, I report lesion

frequencies by type, as sample totals and by site. Finally, I will compare indicators statistically by site, by age groups across all sites, and by sex estimates across all sites.

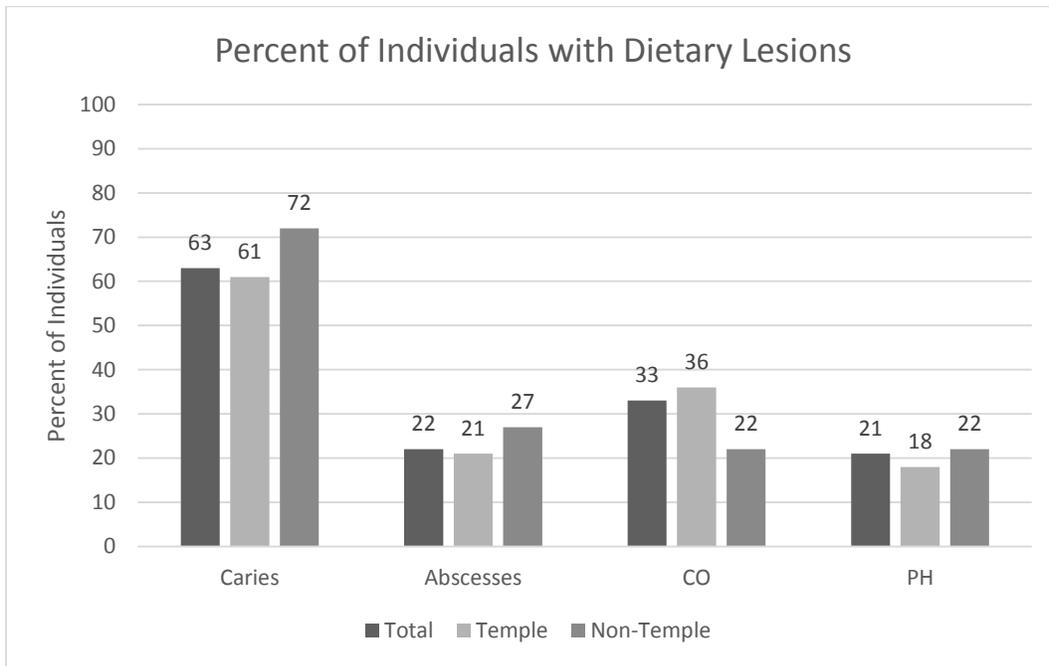


Figure 5.5. Percent of individuals with skeletal and dental lesions related to diet on the Copacabana Peninsula.

5.3.1 Dental cavities and abscesses

I observed 129 individuals (74%) and 1394 (95%) teeth for evidence of caries and dental abscesses (Table 5.1). There were 271 affected teeth (19.4%); 81 (62.8%) of 129 individuals had caries, represented by at least one carious lesion on one tooth (Table 5.2). Twenty (24.7%) of these individuals were females or probable females, twenty-nine (35.8%) were males or probable males, and thirteen (16.4%) were subadults. Sex could not be estimated for 25 adult individuals with caries. Twenty-eight individuals (21.7%) had at least one dental abscess, with a total of 56 affected teeth/tooth sockets (Table 5.3). Ten females or probable females, 13 males or probable males, and no subadults were affected. I could not estimate sex for five individuals with dental abscesses.

Site	Total Observed	Frequency of Individuals Affected	Percent of Individuals Affected	F	M	SA
Temples						
Ch'isi	39	19	49%	21% (4)	58% (11)	5% (1)
Muruqullu	58	41	71%	29% (12)	27% (11)	12% (5)
Kenafena	1	1	100%	100% (1)	0	0
Qopacati	6	3	50%	66% (2)	33% (1)	66% (2)
Tawa Qeñani	3	1	33%	0	0	100% (1)
Non-Temples						
Cundisa	20	15	75%	7% (1)	40% (6)	27% (4)
Q'hota Pata	2	1	50%	0	0	0
Totals	129	81	63%	20	29	13

Table 5.1. Individuals with carious lesions in the Copacabana burial sample

Site	Total Teeth Affected	Average number of affected teeth per mouth	Average number of lesions per tooth
Temples			
Ch'isi	83	4.4	1.3
Muruqullu	123	3	1.24
Kenafena	3	3	1.5
Tawa Qeñani	5	5	2.5
Qopacati	9	3.33	2
Non-Temples			
Cundisa	45	3.07	1.48
Q'hota Pata	3	3	1
Total	271		

Table 5.2. Number of teeth affected by caries and number of lesions per tooth

Site	Total Observed	Frequency of Individuals Affected	Percent of Individuals Affected	F	M	SA
Temples						
Ch'isi	39	9	23%	22% (2)	56% (5)	0
Kenafena	1	1	100%	100% (1)	0	0
Muruqullu	58	10	17%	40% (4)	40% (4)	0
Qopacati	6	2	33%	50% (1)	50% (1)	0
Tawa Qeñani	3	0	0	0	0	0
Non-Temples						
Cundisa	20	4	20%	25% (1)	75% (3)	0
Q'hota Pata	2	2	100%	50% (1)	0	0
Totals	129	28	22%	10	13	0

Table 5.3. Individuals with dental abscesses in the Copacabana burial sample

5.3.1.1. Dental lesions at Temples:

Ch'isi: 39 of the 52 individuals (75%) had observable dentition for recording dental lesions and indicators. Of these 39 individuals, I observed dental caries on 19 dentitions (48.7%) with a total of 84 carious lesions (Figure 5.1). Sixty-five (16.4%) of 396 teeth were affected with an average of 4.4 cavities per mouth and 1.3 cavities per tooth. Notably, of the 19 afflicted individuals, 11 (57.9%) were estimated male or probable male while only four (21.1%) were estimated female or probable female. One individual (5.3%) with caries was a subadult. Sex could not be estimated for three affected individuals (15.8%).

Nine or 23.9% of the 39 individuals with observable dentition also had dental abscesses, all in association with dental caries (Figure 5.6, Figure 5.7). There were a total of 18 dental abscesses, averaging two per mouth. Five individuals (55.5%) with dental abscesses were male or probable male, two (22.2%) were estimated female or probable female, and there were no subadults with dental abscesses. Sex could not be estimated for two affected adult individuals (22.2%).

Muruqullu: Fifty-eight (68.2%) of 85 individuals at Muruqullu had observable dentition used to record dental lesions and indicators. Of these 58, 41 individuals (70.7%) had dental caries with a total of 123 carious lesions (Figure 5.8). Ninety-nine (15.6%) of 636 teeth were affected with an average of 3 carious lesions per mouth and 1.24 lesions per tooth. I estimated that 12 affected individuals (29.3%) were female or probable female, 11 (26.8%) were male or probable male, and five (12.2%) were subadults. I could not estimate sex for 13 individuals with caries.

Ten of 58 (17.2%) individuals had dental abscesses with a total of 17 abscesses recorded or 1.7 per mouth (Figure 5.9). Of these ten individuals, I estimated four (40%) were female or

probable female and four (40%) were male or probable male. Sex could not be estimated for two adults with dental abscesses. No subadults had dental abscesses.

Kenasfena: One of two individuals at Kenasfena was observable for dental lesions. This adult probable female individual had eight maxillary teeth, two (25%) of which had caries. This same individual had seven maxillary dental abscesses, both healed and unhealed. All mandibular teeth had been lost antemortem and the alveolar surface was completely remodeled, making lesion or abscess observation impossible.

Tawa Qeñani: All three individual at Tawa Qeñani were observable for dental lesions. Two (6.1%) of the 33 teeth were affected; one subadult individual had caries, with a total of five small pit lesions on two mandibular deciduous molars. This individual was estimated to be 4-6 years old. No individuals had evidence for dental abscesses.

Qopakati: Six of seven individuals at Qopakati were observable for dental lesions. Five (7.7%) of 65 teeth had a carious lesions; three (50%) of six individuals had a total of ten carious lesions and an average of two per tooth. Two affected individuals were adolescent females while the third individual was an adult probable male. Dental abscesses affected two (33.3%) of six observable individuals with a total of five abscesses. The adult probable male with caries also had one dental abscess. The other individual was an older probable female who had abscesses on four maxillary and mandibular teeth. This individual also suffered a lot of antemortem tooth loss, possibly associated with previous abscess formation.

5.3.1.2. Dental lesions at Non-Temples

Cundisa: At Cundisa, 20 of 24 (83.3%) individuals had dentition observable for caries or a total of 229 teeth (Figure 5.10). Of these 20 individuals, 15 (75%) had caries; 31 (13.5%) of 229 teeth were affected. There were 46 carious lesions in total with an average of 3.07 lesions

per mouth. I calculated that each tooth had 1.46 cavities on average. Eleven adult individuals (73% of total affected) had carious lesions, with one affected female (9%) and six affected males or probable males (54.5%). I could not estimate sex for four adults with caries. Finally, another four individuals (26.7%) with caries were subadults.

Four of 20 (20%) observable individuals had dental abscesses. One individual had two abscesses, while the other three had only abscess apiece. All individuals with abscesses were adults and all had carious lesions present on their dentition as well. One adult was estimated female while the other three individuals were males or probable males. There were no subadults with abscesses.

Q'hota Pata: Both individuals at Q'hota Pata were observable for dental lesions with a total of 30 teeth. One adult individual had caries, with three carious lesions on three different teeth. This individual was of indeterminate sex. Both adults from Q'hota Pata had dental abscesses; the probable female adult had one healed maxillary molar abscess while the indeterminate adult had three dental abscesses associated with two left mandibular molars and one right maxillary molar.



Figure 5.6. Mandibular carious lesion and surrounding abscess from Ch'isi.



Figure 5.7. Mandibular abscesses from Ch'isi.



Figure 5.8. Caries at Muruqullu



Figure 5.9. Dental abscesses at Muruqullu



Figure 5.10. Interproximal caries from Cundisa.

5.3.2 Cribra Orbitalia

I observed 99 individuals for cribra orbitalia, finding 33 individuals (33.3%) with these lesions (Table 5.4). I documented seven females or probable females, eight males or probable males, and 17 subadults with cribra orbitalia. Sex could not be estimated for one adult individual.

Site	Total Individuals Observed	Frequency of Individuals Affected	Percent of Individual Affected	F	M	SA
Temples						
Ch'isi	25	14	56%	0	5	9
Kenasfena	1	0	0	0	0	0
Muruqullu	50	12	24%	33% (4)	17% (2)	42% (5)
Qopacati	4	2	50%	50% (1)	0	50% (1)
Tawa Qeñani	1	1	100%	0	0	100% (1)
Non-Temples						
Cundisa	17	3	18%	33% (1)	33% (1)	33% (1)
Q'hota Pata	1	1	100%	100% (1)	0	0
Totals	99	33		7	8	17

Table 5.4. Individuals with cribra orbitalia in the Copacabana burial sample

5.3.2.1. Cribra Orbitalia at Temples

Ch'isi: Twenty-five of 52 (48.1%) individuals had eye orbits that were complete enough to observe for CO. Of these 25, 14 individuals (56%) presented cribra orbitalia lesions, in either one or both eye orbits (Figure 5.11). Five adult males or probable males (35.7%) showed evidence for healed lesions while no female or probable female individuals had cribra orbitalia lesions.

Muruqullu: There were 50 crania with complete eye orbits observable for cribra orbitalia. Of these 50, 12 (24%) had cribra orbitalia lesions in one or both eye orbits. I estimated the four (33.3%) were female or probable female and two (16.7%) were male or probable male. The remaining affected individuals (50%) were all subadults with active lesions.

Kenasfena: One of two individuals at Kenasfena was observable for cribra orbitalia but did not show any evidence for lesions. The other individual was missing all cranial remains, making observation impossible.

Tawa Qeñani: One of three individuals was observed for cribra orbitalia. A 9-11 year old subadult individual had a complete cranium with active cribra orbitalia lesions (Figure 5.12). I noted that the cribra orbitalia lesions for this individual were especially extreme.

Qopakati: Four individuals from Qopakati were observable for cribra orbitalia and I documented two affected individuals. The other individual was an adolescent female with well-healed orbital lesions.

5.3.2.2. *Cribra Orbitalia at Non-temples*

Cundisa: Seventeen of 24 (70.8%) individuals had crania or orbital fragments observable for cribra orbitalia. Of these 17, three individuals (17.6%) presented lesions indicative of cribra orbitalia. Of those affected, I estimated that there was one adult female, one adult male, and one subadult.

Q'hota Pata: One of two individuals was observable for cribra orbitalia at Q'hota Pata. The cranium of the probable female from Q'hota presented well-healed cribra orbitalia lesions.



Figure 5.11. Active cribra orbitalia lesions at Ch'isi



Figure 5.12. Cribra Orbitalia in the right eye orbit from Tawa Qeñani.

5.3.3 Porotic Hyperostosis

One hundred and eight crania were complete enough for me to observe for porotic hyperostosis (Table 5.5). Of these 108, 20 (18.5%) had porotic hyperostosis lesions. Three females or probable females, six males or probable males, and nine subadults had porotic hyperostosis. I could not estimate sex for two adult individuals with porotic hyperostosis.

Site	Total Number of Individuals Observed	Frequency of Individuals Affected	Percent of Individuals Affected	F	M	SA
Temples						
Ch'isi	30	4	13%	0	50% (2)	50% (2)
Kenasfena	1	0	0	0	0	0
Muruqullu	54	11	20%	18% (2)	27% (3)	45% (5)
Qopacati	3	1	33%	0	0	100% (1)
Tawa Qeñani	1	1	100%	0	0	100% (1)
Non-Temples						
Cundisa	17	3	18%	33% (1)	33% (1)	0
Q'hota Pata	2	0	0	0	0	0
Totals	108	20		3	6	9

Table 5.5. Individuals with porotic hyperostosis in the Copacabana burial sample

5.3.3.1 Porotic Hyperostosis at Temples

Chisi: Thirty individuals (57.7%) had crania or cranial fragments observable for porotic hyperostosis. I recorded these lesions on four individuals (13.3%) (Figure 5.13). Two adult male or probable male individuals and two subadults were affected. No female or probable female adults had evidence for porotic hyperostosis lesions.

Muruqullu: Fifty-four crania were observable for porotic hyperostosis lesions. Eleven (20.4%) of 54 crania were affected by these lesions (Figure 5.14). Two affected individuals (18%) were estimated female or probable female, three (27.3%) were estimated male or probable male, and five (45.5%) were subadults. Sex could not be estimated for one affected adult individual.

Kenasfena: One of two individuals at Kenasfena was observable for porotic hyperostosis but did not show any evidence for lesions. The other individual was missing all cranial remains, making observation impossible.

Tawa Qeñani: One 9-11 year old subadult individual had a complete cranium on which I observed porotic hyperostosis. The other two individuals lacked cranial remains.

Qopakati: I was able to observe three individuals for porotic hyperostosis and documented one case. This was on the same juvenile individual who had cribra orbitalia lesions in both orbits.

5.3.3.2 Porotic Hyperostosis at Non-Temples

Cundisa: Seventeen of 24 (70.8%) individuals had crania or parietal fragments observable for PH. Similar to cribra orbitalia, three of these individuals (17.6%) presented porotic hyperostosis lesions, although they were notably not the same individuals that had cribra orbitalia lesions (Note: none of the affected individuals had both orbits and parietal fragments for

observation of both traits). I estimated that one individual was an adult female, one was an adult probable male, and one was of indeterminate sex.

Q'hota Pata: Neither cranium from this site had porotic hyperostosis.



Figure 5.13. Porotic Hyperostosis at Ch'isi



Figure 5.14. Porotic Hyperostosis at Muruqullu

5.3.4 *Comparison of dietary indicators by burial population*

According to Monte Carlo Chi squared tests where $p < 0.05$ indicates statistical significance, only one dietary indicator varied significantly by population: cribra orbitalia ($p = 0.0043$). Temple burial populations (especially Ch'isi and Muruqullu) had significantly more individuals affected by cribra orbitalia than non-temple populations.

5.3.5 *Comparison of dietary indicators by sex and age*

Certain dietary indicators varied significantly by sex estimates, according to Monte Carlo Chi Sq tests where $p < 0.05$ indicates statistical significance. For these calculations, sex categories were lumped as female/probable female and male/probable male. Indeterminate individuals with dietary lesions or indicators were not included in these statistical analyses. Lesions that did not vary significantly by sex were cribra orbitalia ($p = 0.1876$), porotic hyperostosis ($p = 0.7685$) and dental abscesses ($p = 0.43$). However, dental caries did vary significantly by sex ($p = 0.0418$), with males/probable males more likely to have caries than females/probable females at the population level.

Dietary indicators varied by age; however, they did so in predictably significant ways. Adults, both male and female, were more likely than subadults to experience dental caries and abscesses. Given that carious lesions and dental abscesses are the results of continued tooth use and exposure to bacteria as well as diet; this is not a surprising result (Hillson 2002). Cribra orbitalia and porotic hyperostosis were found in both adults and subadults, although more active lesions were observed in subadult individuals. Again, this is not surprising considering that the biological processes that create these lesions are only possible during childhood (Roberts and Manchester 2007). Thus, lesions on adult individuals indicate survivors of childhood malnutrition. Subadults with active lesions may not have survived the stress incident long enough for these lesions to heal.

5.4 Skeletal Indicators of Disease

The skeletal indicators of disease used in this dissertation are periosteal reactions, osteomyelitis, and linear enamel hypoplasia. I will present the observed presence of these lesions for the total sample and at each site, noting healed and unhealed lesions when appropriate and organized by temple and non-temple affiliation. I will also present any trends in affected skeletal element for periosteal reactions and osteomyelitis and affected tooth for linear enamel hypoplasia. Then, I will compare rates of these lesions and hypoplasia across all sites and by sex and age.

5.4.1 Totals for Copacabana Peninsula

Before presenting data by site and subcategory, I will first give an overview of total disease lesions found for the 175 individuals from the Copacabana Peninsula included in this study (Figure 5.15).

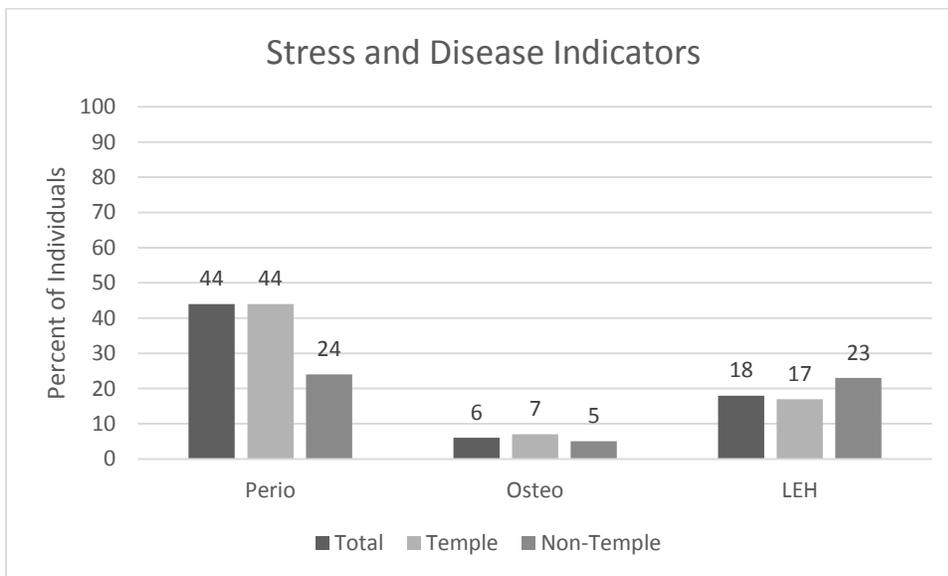


Figure 5.15. Percent of individuals with skeletal and dental lesions of disease across burial samples

5.4.2 Periosteal Reactions

I observed 112 /175 (64%) individuals for evidence of periosteal reactions (Table 5.6). Of these 112, 49 (43.8%) had periosteal reactions on at least one skeletal element. Thirty (61.2%) of

49 cases were active. I estimated that 14 affected individuals were females or probable females, 20 were males or probable males, and eight were subadults. I could not estimate sex for seven individuals with periosteal reactions.

Site	Total Individuals Observed	Frequency of Individuals Affected	Percent Individuals Affected	Percent with Active Lesions	Percent Healed Lesions	F	M	SA
Temples								
Ch'isi	21	11	52%	81% (9)	19% (2)	36% (4)	54% (6)	0
Kenasfena	2	1	50%	0	100% (1)	0	100% (1)	100% (1)
Muruqullu	60	23	38%	78% (18)	22% (5)	22% (5)	39% (9)	17% (4)
Qopacati	6	4	75%	0	100% (4)	50% (2)	25% (1)	50% (2)
Tawa Qeñani	2	1	50%	100% (1)	0	0	0	100% (1)
Non-Temples								
Cundisa	19	7	37%	29% (2)	71% (5)	29% (2)	43% (3)	0
Q'hota Pata	2	2	100%	0	100% (2)	50% (1)	0	0
Totals	112	49	44%	61% (30)	39% (19)	14	20	8

Table 5.6. Individuals with periosteal reactions from the Copacabana burial sample.

5.4.2.1. Periosteal Reactions at Temples

Ch'isi: Twenty-one of 52 (40.3%) individuals at Ch'isi were observable for periosteal reactions and osteomyelitis. Of these 21 individuals, 11 (52.4%) had bilateral lesions consistent with periosteal reactions (Figure 5.16). Nine (81.1%) of these cases were active. All affected individuals were adult; there were four (36%) female or probable females and six (54%) males or probable males with periosteal reactions. I could not estimate sex for one affected individual. All cases were observed on long bones with tibiae and femora most commonly affected.

Muruqullu: Sixty of 85 (70.6%) individuals at Muruqullu were observable for periosteal reactions. Of these 60, 23 (38.3%) had bilateral periosteal reactions and 18 (78.3%) of these were active (Figure 5.17). The majority of affected individuals were adults; I estimated that five (21.7%) were adult females or probable females, nine (39.1%) were adult males or probable

males, and five (21.7%) were adults of indeterminate sex. There were additionally four (17.4%) subadults with periosteal reactions. The most commonly affected skeletal elements were tibiae and femora, although humeri were also affected.

Kenafena: Both individuals at Kenafena were observable for periosteal reactions and osteomyelitis. The probable male individual had bilateral healed periosteal reactions on his tibiae.

Tawa Qeñani: Two (66.6%) of three individuals at Tawa Qeñani were observable for periosteal reactions. One individual, a 9-11 year old subadult, had mild but active periosteal reactions on bilaterally on tibiae and femora.

Qopakati: Six (85.7%) of seven individuals at Qopakati were observable for periosteal reactions. Of these six individuals, four (66.6%) had periosteal reactions. All of these reactions were healed. One adult probable female, one adult probable male, one juvenile, and one adolescent female had healed reactions, primarily on their tibiae and femora, although one individual had humeral involvement as well.

5.4.2.2 Periosteal Reactions at Non-temples

Cundisa: Nineteen (79.2%) of 24 individuals at Cundisa were observable for periosteal reactions. Of these 19, I recorded 7 individuals (36.8%) with bilateral or multiple-element periosteal reactions (Figure 5.18). The majority of these lesions were healed; only two reactions (28.6%) were active at the time of death. All affected individuals were adults. I estimated that two (28.6%) were females or probable females, three (42.9%) were males or probable males, and two (28.6%) were of indeterminate sex. The affected skeletal elements included tibiae, femora, and one fibula.

Q'hota Pata: Both individuals at Q'hota Pata were observable for and affected by periosteal reactions. These reactions were on the left femora and one tibia of both individuals and all reactions were healed.



Figure 5.16. Periosteal Reaction on a proximal right femur from Ch'isi



Figure 5.17. Periosteal Reaction on a tibia from Muruqullu.



Figure 5.18. Healed periosteal reaction from Cundisa.

5.4.2 Osteomyelitis

I observed 112 /175 (64%) individuals for evidence of osteomyelitis. Osteomyelitis was present on seven (6.3%) of 112 observable individuals (Table 5.7). These cases were identified by either medullary involvement (observed through broken long bone shafts) or by the presence of draining sinuses. All cases of osteomyelitis were active. I estimated the two affected individuals were females or probable females and four individuals were males or probable males. I could not estimate sex for one affected individual and no subadults were documented with evidence of osteomyelitis.

Site	Total Individuals Observed	Frequency of Individuals Affected	Percent of Individuals Affected	Percent with Active Lesions	Percent with Healed Lesions	F	M	SA
Temples								
Ch'isi	21	3	14%	100%	0	33% (1)	66% (2)	0
Kenasfena	2	0	0	0	0	0	0	0
Muruqullu	60	3	5%	100%	0	33% (1)	33% (1)	0
Qopacati	6	0	0	0	0	0	0	0
Tawa Qeñani	2	0	0	0	0	0	0	0
Non-Temples								
Cundisa	19	1	5%	100%	0	0	100% (1)	0
Q'hota Pata	2	0	0	0	0	0	0	0
Totals	112	7	6%	100%	0	2	5	0

Table 5.7. Individuals with osteomyelitis from the Copacabana burial sample.

5.4.2.1 Osteomyelitis at Temples

Ch'isi: Twenty-one of 52 (40.3%) individuals at Ch'isi were observable for osteomyelitis. Three (14.3%) of the observable 21 individuals had evidence of osteomyelitis (Figure 5.19). In all three cases, these infections were active. I estimated that one (33.3%) affected individual was an adult probable female while the other two (66.6%) were adult probable males. There were no subadults with osteomyelitis. The probable female had bilateral infection on her tibiae, while one probable male was affected on his left femur and the other on his left ulna. All affected individuals also had periosteal reactions, although not necessarily directly associated with the osteomyelitis indicating systemic infection.

Muruqullu: Sixty of 85 (70.6%) individuals at Muruqullu were observable for osteomyelitis. Three (5%) of the 60 observable individuals had osteomyelitis (5.20). All three reactions were active and affected adult individuals. I estimated that one individual was female, one was a probable male, and one was of indeterminate sex. There were no subadults with osteomyelitis. The skeletal elements affected in these three cases were three tibiae, one ulna, and two radii. The female individual was the most strongly affected, with evidence for active osteomyelitic infection on her left ulnae, bilateral on her radii, and on her left tibiae. The probable male individual was affected on his lower left tibia (right not observable). Notably, this active infection was associated with several deep, unhealed cutmarks, possibly an attempted amputation of this limb because of the severity of the infection. All osteomyelitis was associated with periosteal reactions.

Kenafena: Both individuals from Kenafena were observable for osteomyelitis. Neither showed these lesions.

Tawa Qenani: Two of three individuals from Tawa Qenani were observed for osteomyelitis. Neither had evidence for these lesions.

Qopakati: Six (85.7%) of seven individuals at Qopakati were observable for periosteal reactions and osteomyelitis. None showed evidence for these lesions.

5.4.2.2. *Osteomyelitis at Non-temples*

Cundisa: Nineteen (79.2%) of 24 individuals at Cundisa were observable for osteomyelitis. One (5.3%) of 19 observable individuals at Cundisa had evidence for osteomyelitis. This individual was an 18-22 year old probable male with active osteomyelitis on his right tibia and fibula. His left lower leg bones were not recovered during excavation and were therefore not observable. Both the tibial and fibular osteomyelitis was associated with active periosteal reactions.

Q'hota Pata: Both individuals were observable for osteomyelitis but neither showed evidence of these lesions.



Figure 5.19. Osteomyelitis from Ch'isi



Figure 5.20. Osteomyelitis from Muruqullu.

5.4.3 Linear Enamel Hypoplasias

I observed 129 (73.7%) of 175 individuals for linear enamel hypoplasia. Twenty-three (17.8%) had these enamel lesions with an average of one per tooth and 2.6 per mouth (Table 5.8). I estimated that one affected individual was female, four were males or probable males, and 16 were subadults. I could not estimate sex for one adult individual with linear enamel hypoplasia.

Site	Total Individuals Observed	Frequency of Individuals Affected	Percent Individuals Affected	F	M	SA
Temples						
Ch'isi	39	4	10%	25% (1)	0	75% (3)
Kenafena	1	0	0	0	0	0
Muruqullu	58	11	19%	0	27% (3)	73% (8)
Tawa Qeñani	3	3	100%	0	0	100% (3)
Qopacati	6	1	17%	0	0	100% (1)
Non-Temples						
Cundisa	20	4	20%	0	25% (1)	25% (1)
Q'hota Pata	2	0	0	0	0	0
Totals	129	23	18%	1	4	16

Table 5.8. Individuals with linear enamel hypoplasia from the Copacabana burial sample.

5.4.3.1 Linear Enamel Hypoplasia at Temples

Ch'isi: Thirty-nine (75%) of 52 individuals had dentition observable for linear enamel hypoplasia. Of these 39, four (10.3%) individuals had linear enamel hypoplasia with a total of

nine hypoplasia between them, averaging 2.25 per mouth. I estimated that one affected individual was an adult female while the remaining three individuals were subadults. Enamel hypoplasia were most common on adult canines and incisors.

Muruqullu: Eleven (18.9%) of 58 observable individuals had linear enamel hypoplasia, totaling 25 lesions with an average of 2.27 per mouth (Figure 5.21). There was an average of 1.17 lesions per tooth; most teeth only had one observable enamel disruption. The majority of affected individuals (8/11 or 72.7%) were subadults. I estimated that all three affected adult individuals were males or probable males. The most commonly affected teeth were canines, followed by lateral and central incisors.

Kenasfena: Neither individual had evidence for linear enamel hypoplasia.

Tawa Qenani: All three individuals were observable for and affected by linear enamel hypoplasia. There were a total of six linear enamel hypoplasia with an average of one per tooth. The 9-11 year old individual had three linear enamel hypoplasia with one on a central incisor, a premolar, and maxillary second molar crown. The 7-9 year old individual had one hypoplasia on a maxillary incisor (the other was not observable), and the 4-6 year old individual had one hypoplasia on each maxillary central incisor.

Qopakati: Six (85.7%) of seven individuals were also observable for linear enamel hypoplasia. I recorded one juvenile individual with five hypoplasia on five teeth. This individual was 6-8 years old. A single hypoplasia was observed on each of the following teeth: both maxillary central incisors, the left maxillary canine, and both mandibular canines.

5.4.3.2 Linear Enamel Hypoplasia at Non-Temples

Cundisa: Twenty of 24 (83.3%) individuals at Cundisa had dentition observable for linear enamel hypoplasia. Of these 20, four individuals (20%) had a total of six enamel

disruptions with an average of one disruption per tooth (Figure 5.22). One affected individual was a subadult while the remaining three were adults. I estimated that one affected adult was a probable male, while the other three were of indeterminate sex. The affected teeth included canines (three affected), central incisors (two affected), and one lateral incisor.

Q'hota Pata: Neither individual had linear enamel hypoplasia.

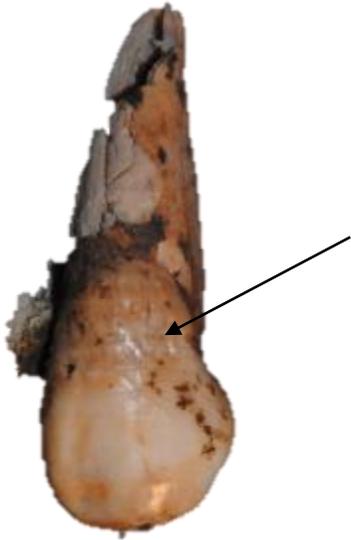


Figure 5.21. LEH on a canine from Muruqullu



Figure 5.22. LEH on canines from Cundisa.

5.4.4. Comparison of Disease Lesions by Site

One disease indicator was significant between burial populations: linear enamel hypoplasia ($p=.0098$). Individuals were much more commonly affected by linear enamel

hypoplasia at Cundisa (25%) and Tawa Qeñani (100%) than other sites. Given Tawa Qeñani's small and age-biased sample (three individuals, all of whom were subadults), this may not reflect a true pattern for that site. However, the large percentage of individuals affected at Cundisa is notable when compared to the other large burial populations.

5.4.5 Comparison of Disease Lesions by Sex and Age

No disease lesions were significant by age or sex across all populations.

5.5 Trauma

Trauma was very infrequent for all populations. Overall, the trauma for the entire skeletal population represents low levels of interpersonal violence and accidental injury. I will briefly present this information in order to account for its potential as a vector for disease and impact on demographic patterns.

Fourteen (7.6%) of 184 individuals had evidence for trauma. Fractures were found on six crania, two vertebrae, three ribs, one ulna, and one radius. Cutmarks were found on two tibiae, five ribs, and one femur. Three cranial fractures and all cutmarks were peri-mortem wounds; all of traumas were healed. One parietal fracture from the temple Ch'isi was associated with a successful and well-healed trepanation (Figure 5.23) while another parietal fracture from the non-temple Cundisa had an unsuccessful trepanation attempt (Figure 5.24) (Juengst and Chávez 2015). The ulnar and radial fractures (Figure 5.25) occurred on different individuals and did not appear to be defensive wounds but were more likely associated with falling onto an outstretched hand (Walker 1997). One cutmark was closely associated with active osteomyelitis: perhaps evidence of an attempt to remove the infected limb (Figure 5.26). Twelve injured individuals were adults and two were subadults.



Figure 5.23. Trepanation scar on the left parietal of an individual from Ch'isi.



Figure 5.24. Depressed fracture and trepanation attempt on an individual from Cundisa.



Figure 5.25. Healed distal ulnar fracture on an individual from Ch'isi.



Figure 5.26. Cutmarks and osteomyelitis on an individual from Cundisa.

5.6 Biodistance Analysis

Nonmetric dental traits were observed for 175 individuals from five burial groups: four temples (Ch'isi, Qopakati, Muruqullu, and Tawa Qeñani) and one non-temple (Cundisa). Results at two levels – individual and population – were statistically compared to show correlation and agreement of the dental traits. Each individual's teeth remained linked to each other while being compared to others from their same and other burial groups.

At the population level, these results show that overall most groups in the study were closely related biologically. Agreement equal to or above 0.5 indicates close correlation and little disagreement between individuals overall. I found that all populations agreed with themselves

(little intragroup diversity or variability of dental traits) and with other temple and non-temple burial populations (little intergroup diversity or variability of dental traits) (Table 5.9). The only exception to this was the comparison between two temples sites (Muruqullu to Ch'isi) and the comparison of Muruqullu to itself, when the correlation analysis results were slightly below 0.5 (0.4852 and 0.466 respectively). However, these results are so close to the agreement cutoff, it is unlikely that they reflect significant results and may be caused by variability in sample size for each burial group (Chris Weisen personal communication 2014).

Sites	Ch'isi	Qopakati	Cundisa	Muruqullu	Tawa Qeñani
Ch'isi	0.5011	0.5811	0.5798	0.4852	0.5519
Qopakati		0.5610	0.6119	0.5298	0.6205
Cundisa			0.6403	0.5344	0.6856
Muruqullu				0.4660	0.6170
Tawa Qeñani					0.8339

Table 5.9. Agreement of Biodistance Traits between sites.

5.7 Strontium Isotope Results

Strontium isotope tests were run for 40 dental enamel samples from five of the burial populations including: three temples (Ch'isi, Qopakati, and Tawa Qeñani) and two non-temples (Cundisa and Q'hota Pata). Samples from the temples Muruqullu and Kenasfena were not accessible at the time of isotope testing due to issues obtaining permits to remove human material from the country. Samples were selected from a collection brought to UNC Chapel Hill in 2006 (D. Hutchinson personal communication) from burials at the sites listed above, which had been excavated prior to that date. This collection included tooth samples from 52 temple individuals (45 individuals from Ch'isi, four individuals from Qopakati, and three individuals from Tawa Qeñani) and ten non-temple individuals (nine individuals from Cundisa, and one

individual from Q'hota Pata, as well as individuals from two sites not included in this dissertation.

I selected 40 tooth samples from all relevant populations to include all represented age and sex categories and from multiple burials from the same site when possible. I tested 29 temple individuals (23 individuals from Ch'isi, four from Qopakati, two from Tawa Qeñani) and nine non-temple individuals (eight from Cundisa and one from Q'hota Pata). Two samples from a site called Kusijata were also tested. The tested samples included all sex estimate categories: three female individuals, five probable females, three males, four probable males, and seven indeterminate adults. The sample also included all age groups: 16 adults, five young adults, one adolescent, 11 juveniles, and five infants. Details on samples and results can be found in Appendix B.

Of the 40 samples tested, the majority of individuals (29/40) fell within the Titicaca Basin range (0.7083- 0.7110). However, eight individuals fell clearly outside of this range and three individuals were just below the lower end of this range (Figure 5.27, 5.28). I will present the strontium results by site, focusing on the outlying and borderline individuals.

5.7.1 Strontium signatures from Temple Populations

Ch'isi: Twenty-two of 23 samples from Ch'isi fell within the Titicaca Basin range. One female individual (CHR87B1) was slightly below the Titicaca Basin minimum with a strontium signature of 0.708199. Notably, the standard of error for this sample was 0.0008 which would place CHR87B1 squarely within the local range, making it difficult to say that this individual's signature is definitely foreign. In order to account for this possibility for error but still capture the most variability in the overall sample, this individual was classified as "semi-local".

The local individuals sampled from Ch'isi overall included six adult individuals, five young adults, six juveniles, and five infants. Of the post-pubescent individuals, there was one female, two probable females, three males, and four probable males. While females and probable females are slightly underrepresented in the tested enamel samples compared to males and probable males, the infant and juvenile teeth sampled reflect maternal strontium signatures, accounting for this portion of the population.

Qopakati: I tested four individuals from Qopakati and all four had nonlocal strontium signatures. This included one adult probable female (QO N23.6 W26 T1), one adolescent female (QO N26.5 W25.6 T1), and two juvenile individuals (QO N23.6 W26 T2 and QO N23.6 W26 T1 IN2). The signatures ranged from 0.70732 – 0.70764, averaging right around .7075. The teeth tested included a third molar, second molar, and two deciduous teeth, reflecting the location where these individuals lived during late and middle childhood and during gestation. Despite the limited excavation of Qopakati, it is notable that all the excavated burials had nonlocal strontium signatures. However, because of the limited excavation, we cannot say whether or not these individuals are representative for the entire site or if these clustered burials represent a distinct group within the larger burial population.

Tawa Qeñani: I tested two individuals from Tawa Qeñani and both returned local strontium signatures. Both of these were juvenile individuals; one was a 9-11 year old (TQ5T1) and one was a 4-6 year old (TQ1EsqExt). The teeth tested included the developing crown on a third molar from TQ5T1 and first adult molar from TQ1EsqExt. Because of when these teeth develop, it is likely that TQ5T1's signature is reflective of where this individual lived, while the signature of TQ1EsqExt reflects maternal locality.

5.7.2 Strontium Signatures from Non-Temple Populations

Cundisa: I tested the enamel from eight individuals buried at Cundisa. Four individuals had strontium signatures local to the Titicaca Basin, three had nonlocal signatures, and one was semi-local. The three individuals with nonlocal signatures included one adult of indeterminate sex (CU100IN1) and two juveniles (CU100IN2 and CU72). CU100IN1 and CU100IN2 had almost identical strontium signatures (0.70774 and 0.70777 respectively). Given their burial proximity, age estimates (35-40 years and 3-5 years respectively), and matching strontium signatures, it is tempting to suggest that these individuals were mother and child, a trend which will be explored further in Chapter 6. CU72 was a 7-9 year old whose strontium signature was 0.70711.

One individual from Cundisa (CUT30) had strontium signature just below the Titicaca Basin mean (0.70824) and was classified as semi-local. This individual was an adult of indeterminate sex. I tested the second maxillary adult molar of this individual, indicating that this semi-local status is reflective of early to middle childhood location.

Four individuals from Cundisa were local. All of these individuals were adults. Three were of indeterminate sex and I estimated one was a probable female. Teeth tested included one mandibular and one maxillary third molars, one maxillary second molar, and one maxillary canine, representing strontium signatures from early life through late childhood/early adolescence.

Q'hota Pata: I tested one individual from Q'hota Pata (QP 1A/4) and found that this individual was nonlocal. QP1A/4 was an adult probable female, likely over 40 years old. I tested her third molar, indicating that her nonlocal signature reflects her late childhood/early adolescent residence.

Site	Number of samples	Total local	Total Semi-local	Total Non-local
Temples				
Ch'isi	23	22	1	0
Tawa Qeñani	2	2	0	0
Qopakati	4	0	0	4
Non-temples				
Cundisa	8	4	1	3
Q'hota Pata	1	0	0	1
Total	38	28	2	8

Table 5.10. Number of strontium samples and local/non-local individuals by site.

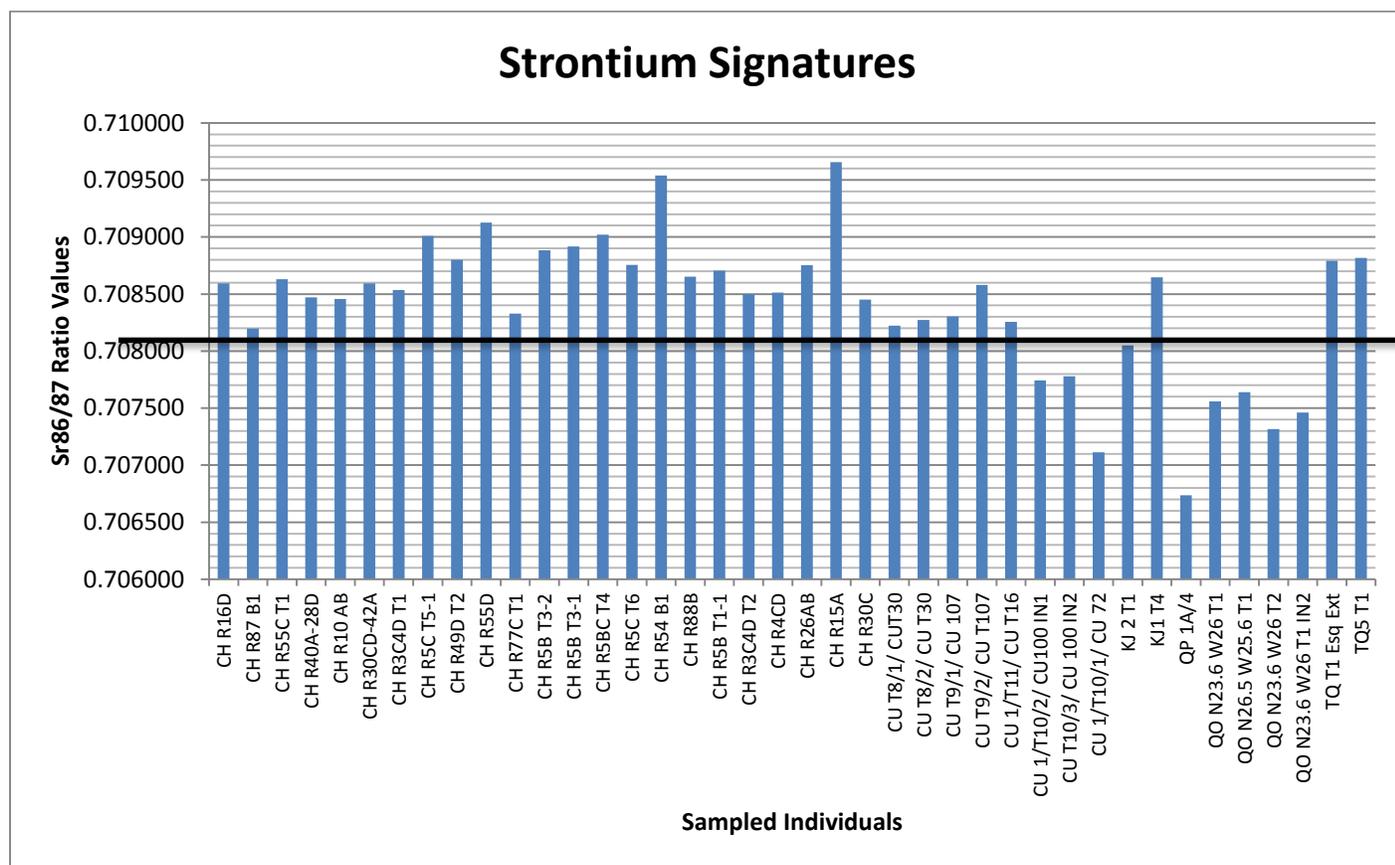


Figure 5.27. Strontium signatures from 40 dental enamel samples. Titicaca Basin local range minimum marked with black line.

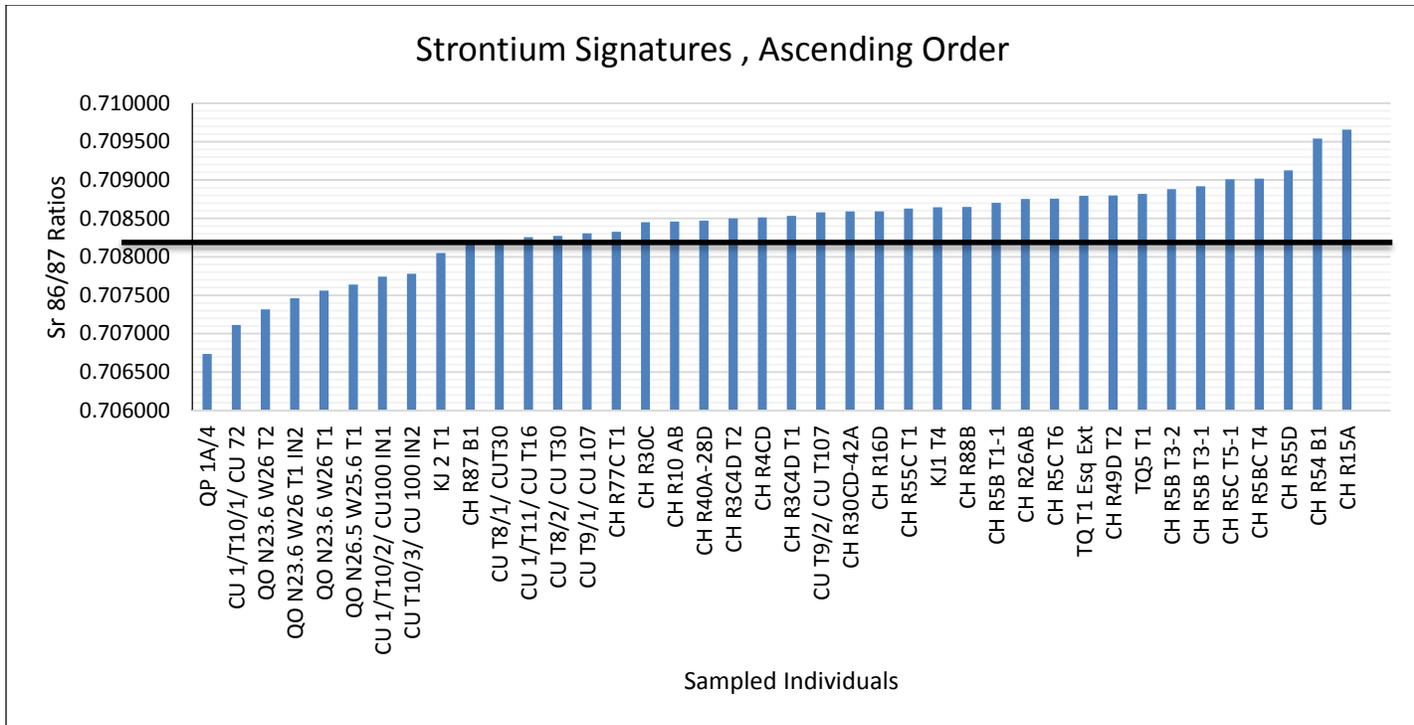


Figure 5.28. Strontium signatures in ascending order. Titicaca Basin local range minimum marked with black line.

5.8 Summary

This chapter presented the results for skeletal indicators of diet and disease, biodistance analyses, and strontium isotope analyses. In the following chapter, I will integrate these data to identify and discuss notable trends and community relationships. I will also compare these data to other studies from the Andes to identify significant differences or similarities in disease, diet, and community relationships.

CHAPTER SIX: DISCUSSION

6.1 Introduction

In this chapter, I discuss major trends noted in the data from the results section. I start by addressing each category of data – demographics, diet, disease, biodistance, and migration – and propose possible explanations for each trend. Discussion of and comparison with existing literature is used to highlight, support, and contrast with my findings. I conclude this chapter by proposing one way that these lines of evidence can be combined to address issues of community in the Titicaca Basin.

6.2 Demographic Trends

6.2.1 Age: Subadults (fetuses, infants, juveniles, and adolescents) comprised a little over 25% of the total population, somewhat lower than average for most pre-hispanic Andean and pre-modern global mortuary samples (Verano and Ubelaker 1992). This could reflect a few important trends: poor preservation of delicate skeletal material, moderately low mortality for subadults, and/or low fertility. Poor preservation likely contributed to low numbers of infant remains. In fact, many infants were identified by dentition alone. However, there may have been other causes contributing to the relatively low percentage of subadult remains. Female fertility and fecundity often drives the number of subadults in a burial population. As each female has more children, there is a greater chance for each child to become part of the burial population (Armelagos 1991; Tung and Del Castillo 2005; Wood et al. 1992). In many cases, the inclusion of a high number of subadult burials reflects increased fertility, rather than increased mortality

for the age cohort. In this study, however, subadults may have been more vulnerable to mortal risk than other portions of the population, given the associated stress markers found on many subadult remains.

Subadult mortality can be caused by many factors, including malnutrition, disease, and trauma, from either endogenous or exogenous sources. Neonatal deaths (occurring between birth and 30 days) are often the result of endogenous causes, such as low birth weight, underdevelopment, or trauma suffered during the birth process. Post neonatal mortality results from exogenous causes: exposure to pathogens, nutritional inadequacy, neglect, interpersonal trauma, or accidents (Halcrow and Tayles 2011: 340). Additionally, certain moments during growth and development are especially stressful and risky for subadults because of competing metabolic demands such as daily bodily maintenance, brain development, and overall bodily growth. If a child is additionally stressed by disease or malnutrition while also spending energy on these other bodily demands, his/her risk of mortality is elevated (Halcrow and Tayles 2011; McDade et al. 2008; Sofaer 2006).

In my sample, subadults were at greatest risk of mortality between three and twelve years of age. This large range includes the years of greatest bodily demand for resources in terms of growth and development of the body and brain, and the years that children were most at risk for disease and malnutrition, as they were weaned and exposed to new pathogens. Additionally, adolescents were at elevated risk for mortality, when compared to other bioarchaeological studies. While infancy and developmental years are commonly risky for children, most individuals have developed antibodies to most diseases and have lowered metabolic demands by the time they reach adolescence (Chisholm 1993; Kaplan et al. 2000). It is possible that individuals who died as adolescents were stressed as infants and children and were thus less

resilient to disease later in life. In addition to early life stress leaving individuals at higher risk, the inclusion of a high proportion of adolescents (25% of all subadults) in the burial sample may indicate that this age group was placed at high risk of mortality through daily activities or social roles, rather than bodily stress from maturation and development.

A similar pattern of mortality risk in late childhood was found for Neolithic agriculturalists in the Levant (Eshed et al. 2004). In this study, Eshed and colleagues found that while mortality overall did not increase for new agriculturalists, the 10-15 year old age cohort had higher mortality during the Neolithic than earlier times. Adolescents accounted for 5% of total Neolithic deaths while only 2-3% of earlier Natufian burial groups. While the authors do not discuss reasons for this trend specifically, they account for other demographic changes through changing social and gender roles associated with subsistence strategy (Eshed et al. 2004). The inclusion of more adolescents in the burial sample may have also related to changing social roles, a similar pattern to the Copacabana Peninsula during the Early Horizon and Early Intermediate Period.

Age distribution varied by site type. There was a large proportion of juvenile and infant individuals buried at temples compared to non-temple sites. While juveniles were included in the burial population at the non-temple site, Cundisa, they composed a significantly smaller portion of the population (7.3%) than they did at the temples Ch'isi (25%) and Muruqullu (19.3%). Furthermore, the temple site Tawa Qeñani's burial sample was entirely comprised of juvenile individuals. While this may partially reflect issues of differential preservation, discrepancies in extent of excavation, or taphonomy, it is possible that this signals significant differences in the mortuary practices and mortal risks of people interred at temples and non-temples.

Burials of important or elite children in the Andes were regularly associated with sacred places or *huacas*. This is perhaps best exemplified through the well-known Inka *capac hucha* ceremony, when select children were sacrificed on sacred mountain peaks at important moments during the ritual cycle (Andrushko et al. 2011; Moseley 2001). While this is an extreme example, important or elite children throughout Andean history and prehistory have had notable mortuary roles, often buried at sacred locations or places closely associated with the ancestors.

The connection to lineage was important since the children themselves likely did not reproduce before death. Without biological offspring to continue their lineage, deceased children and infants became ancestors to the whole community and were thus buried at places significant to community identity (Moseley 2001). Sharratt (2014) notes that Tiwanaku infant burials in the Moquegua Valley mimicked adult burial in the *altiplano*, evoking imagery of highland ancestry and connecting these infants to Tiwanaku ancestors. Likewise, during Spanish colonization of the Andes, Catholic priests attempted to take advantage of this tradition and replace local ancestor cults with Christianity by including children in church burials. Burying children in and around churches associated Christianity and Christian spiritual figures with important ancestors, embodied through these children (Wernke 2007). By mimicking adult burial and burying juveniles at significant locations, Andean peoples created and reinforced ancestral lineages.

Perhaps the high proportion of infant and juvenile burials at Yaya-Mama temple sites presages such practices. Burying young individuals at ritually significant centers linked them to their ancestral lineage. This action simultaneously created these young dead as symbolic ancestors for individual lineages while also reinforcing ties to community lineages more broadly. Children and infants buried at Yaya-Mama temples, and the dearth of subadult remains buried elsewhere, may reflect this enduring Andean tradition.

6.2.2. *Sex.* Sex estimates for all sites revealed interesting patterns. When sex could be estimated, probable males were most commonly represented overall (39/87 individuals). When probable males and males are included together, they represent over half of the individuals for whom sex could be estimated (54/87 or 62%). Probable females and females included 33 individuals in total (38%). Sex could not be estimated for 44 adult individuals yet this difference between males and females reflects a significant difference in the sex ratios between sites ($p=.035$).

The over-representation of males and probable males does not change significantly when considering temple or non-temple burials. At temples, females and probable females compose 41% of the adult population for whom sex could be estimated while at non-temples, they are 37% of this population. It is thus clear that females and probable females are under-represented at both temple and non-temple sites. This under-representation of females and overrepresentation of males may reflect a few different trends.

It is possible that gender roles during the Early Horizon mandated different mortuary treatment of males and females. Many female and probable female burials in this sample were associated with either subadults or other adults. While males and probable males were not always single interments, they were less likely to have a companion in their tomb with them. Given this, perhaps males were selectively buried at important locations, both temple and non-temple, while females were buried at important locations only when their mortality co-occurred with someone else. Additionally, it is possible that females were regularly buried elsewhere that is yet to be discovered.

Iconographic analysis of Yaya-Mama ceramics indicates an emphasis on gender equity or a balancing of gender roles (S. Chávez 1992; Hastorf 2003). Stylistic themes called the Camelid

Woman and the Feline Man were distinctly male and female identified, based on the depiction of biological sex characteristics such as breasts and facial hair in addition to culturally gendered items (S. Chávez 1992). These personages and other gendered characters were most often presented in association with each other on either side of a stela, juxtaposed on a vessel, or present on ceramic sherds from the same site. In fact, the tradition was named Yaya-Mama (meaning Father-Mother in Quechua) because of this regular presentation of gender duality.

Hastorf (2003) suggested that the Yaya-Mama ritual complex stemmed from a cult of ancestor/goddess worship. The repetition of female symbols and burial of several females at the Chiripa temple complex indicated that the rituals occurring at these sites focused on fertility and reproduction (of both the earth and humans). The Andean earth goddess, Pachamama, was invoked at these ceremonies, as the provider of the necessary elements for life: food and water. As a “life-giver”, Pachamama was inextricably linked to birth and femininity. In an extension of this, females were associated with the rainy season, agriculture, and fertility while males were associated with the dry season, conflict, and life-taking (S. Chávez 1992). Because burials at the Chiripa temple complex were based around life-giving rather than life-taking, Hastorf suggested that Yaya-Mama ceremonies focused on celebrating the *female* aspects of the universe (Hastorf 2003).

If male individuals were given preferential burial treatment or considered more appropriate for temple burial, this assumed gender equity (S. Chávez 1992) or female celebration (Hastorf 2003) needs to be revisited. Male power and masculinity may have been increasingly valued or emphasized, rather than female reproduction and Pachamama. Men may have had more access to the ritual sphere of life in the Early Horizon and Early Intermediate Period, as shown through their more regular burial at temples. However, it is notable that females and

subadults were not excluded at temples either. Thus, if males were gaining ritual power or status during this time, it was not necessarily exclusive to males or prohibitive to others also having important ritual significance.

6.3 Diet

Diet was assessed in this study along two main lines of evidence: dental lesions and nutritionally-related skeletal pathology, PH and CO. This section will discuss the trends for these indicators, focusing specifically on caries and CO, as these lesions varied significantly in different ways.

6.3.1. Caries and diet: The rate of caries varied significantly between burial populations. The average caries rate ranged from 6.1% of teeth at Tawa Qeñani to 25% at Kenasfena. However, both these temples, Tawa Qeñani and Kenasfena, had limited burial populations, perhaps skewing these extreme numbers. The three sites with the largest burial populations (Ch'isi, Muruqullu, and Cundisa) had a narrower range of caries rates: from 13.5% at the non-temple Cundisa to 16.4% at the temple Ch'isi. This range suggests that some populations may have relied more heavily on carbohydrate-rich diets but that most were consuming relatively moderate to high levels of agricultural products (Turner 1979).

The rate of caries differed slightly between temple and non-temple burial populations; people buried at non-temple sites generally had fewer carious lesions than those at temple sites, although this was not statistically significant. This may indicate that non-temple populations ate cariogenic foods less often than those buried at temples. Interestingly, this finding echoes stable isotope data from a study by Hutchinson et al (n.d.). Hutchinson and his colleagues found significant clustering of nitrogen and carbon signatures when temple and non-temple individuals were sorted. The four non-temple individuals included in their study (all from Cundisa) reflected

a much less diverse diet than those interred at temple sites. Perhaps participation in temple rituals (as reflected by subsequent burial there) included activities that changed diet and exposure to cariogenic foods.

In the dietary stable isotope study performed by Hutchinson et al. (n.d.), 23 individuals from temple and non-temple sites on the Copacabana Peninsula were sampled and tested for carbon and nitrogen isotopes. Results from this study indicated that overall, everyone ate a diet mostly composed of C₃ plants with occasional inclusions of C₄ resources, although there was some clustering by site type as previously mentioned. Modern survey of local C₄ plants includes maize, amaranths, cacti, and several ¹³C enriched lacustrine resources like coot and catfish. During the Early Horizon, only maize and the lacustrine resources would have been available to Copacabana Peninsula populations in large amounts (there is little to no evidence for amaranth or cacti consumption during these time periods). These isotopic results correlate with archaeological food remains as well, as most sites, temple and non-temple, are associated with more C₃ plant remains (such as tubers and quinoa) than C₄ remains. However, maize phytoliths have been found on pot sherds (Chávez and Thompson 2006; Logan et al. 2012), emphasizing the inclusion of this resource in the diet. Maize is especially cariogenic, and is perhaps the catalyst for the caries rates noted at temple (and to a lesser extent, non-temple) sites. However, it remains unclear in what form maize was consumed or who had access to this valued resource.

6.3.1.1. Chicha and Carious Lesions. The term *chicha* in the Andes describes a variety of socially important, fermented and unfermented beverages, made from quinoa, berries, and maize. The Spanish used this term (likely from the Caribbean word *chibcha* which generally meant fermented beverage [Cutler and Cardenas 1947]) to describe any special or ritual beverage they encountered, blurring the variety of brewing processes, plants used, and flavors produced

(Goldstein et al. 2009). This trend has carried into the modern day, both amongst *chicha* brewers themselves and the archaeologists and anthropologists who write about the production of ancient and modern *chicha*. Unfortunately, this general usage of the term masks the heterogeneity of important social drinks in the Andes, which often act as markers of ethnic identity and elite status (Goldstein et al. 2009). In this dissertation, I explicitly use *chicha* to mean maize beer. Unfermented maize beverages will be discussed as well but will be called maize drinks and highlighted as non-alcoholic.

All types of *chicha* in the Andes are potent social symbols. Various groups have used to *chicha* to highlight elite status (Berryman 2010; Hastorf and Johannessen 1993; Staller 2006), incorporate new territories and legitimize power (Bray 2009; Garcilaso de la Vega 1829; Goodman-Elgar 2009; Hastorf and Johannessen 1993), demarcate ethnic identity (Goldstein et al. 2009), and denote ritual space and activity (Allen 2002; Berryman 2010; Hastorf and Johannessen 1993; Logan et al. 2012). In terms of community, *chicha* was (and is) central to building connections between people; in fact, *chicha* has been described as “integral and integrating” (Tung 2007: 260) to some Andean communities. While the antiquity of *chicha* production in the highland Andes remains unclear, the presence of *chicha* or another unfermented maize beverage at Yaya-Mama temples would not be unexpected, given its communal and ritual nature.

Logan et al. (2012) interpreted maize phytoliths and starch grains from four sites on the Taraco Peninsula as representing just this: the use of *chicha* as a part of Yaya-Mama ceremonies to bond the participants, creating and reinforcing social relationships and hierarchies. The dearth of maize leaves, cobs, or evidence for cooking maize at these sites was juxtaposed to stable isotope and phytolith evidence of consumption and deposition of maize. Based on modern,

ethnohistoric, and archaeologically documented *chicha* brewing procedures, the authors interpreted this suite of remains as evidence for early *chicha* consumption in ritual contexts at these sites. More specifically, *chicha* seems to have been produced on a small-scale but with communal labor for very specific and ritual events (Logan et al. 2012: 251). The production and consumption of *chicha* on the Taraco Peninsula thus both created reciprocal relationships and reinforced distinctions between people.

Were *chicha* and/or other maize beverages also produced and consumed in specific and meaningful ways on the Copacabana Peninsula? Hutchinson et al. (n.d.) argue that the isotope signatures signaling occasional consumption of C₄ plant material could reflect maize in the diet. Given the dearth of maize remains in the archaeobotanical record on the Copacabana Peninsula (excepting phytoliths reported in Chávez and Thompson 2006), it is possible that this occasional consumption of maize occurred in the form of *chicha*, much like Logan et al. (2012) found for the Taraco populations. How do these lines of evidence fit with the skeletal indicators of diet reported here? Is *chicha* production and consumption a logical explanation for the diet clustering at temple vs non-temple sites found by Hutchinson and colleagues?

Comparative bioarchaeological studies in the Titicaca Basin (Berryman 2010) and elsewhere in the Andes (Gagnon 2006; Lambert et al. 2012) have interpreted chronological changes in carious lesions, isotopic values for C₄ plants, and sex differences in caries rates as evidence for *chicha* consumption. Because *chicha* making involves chewing the maize to induce fermentation, Berryman, Gagnon, and Lambert and colleagues are able to discuss potential changes in *chicha* production as well. In these scenarios, the authors found moderate rates of caries (ranging from 10 – 16%) and increasingly positive isotopic values that seemed to be

linked to an increase in *chicha* consumption and production. However, there are significant differences between these studies and the data presented here.

Berryman (2010) included eight Early Intermediate Period (200 BC – AD 200) individuals from the Taraco Peninsula of the Titicaca Basin in her study of changing caries rates over time. Berryman reported that for these eight individuals, 10.8% of teeth had carious lesions, a slightly higher rate than subsequent Tiwanaku populations (although this was at least partially attributed to small sample size). She additionally found sex differences in rates of caries, dental abscesses, and antemortem tooth loss. Sex differences in caries rates were not statistically significant, but males did have more carious lesions than females. While Berryman's sample was too small to securely draw conclusions about this, she notes that this may reflect "greater consumption of plant carbohydrates among males and perhaps a more coarse diet leading to abscesses" (Berryman 2010: 192). For the Tiwanaku populations, Berryman noted that the caries rate was lower overall but that females had more carious lesions than males. She interprets this as a sexual division of labor, specifically around the mastication of maize involved in the production of *chicha* (Berryman 2010: 194).

Isotopic analyses from Late Formative individuals in Berryman (2010) also showed regular consumption of maize and C₄ enriched aquatic foods, although this was highly variable by site. Berryman suggested that most individuals had 10 – 35% of their diet composed of maize and fish, although the diet of one individual from Late Formative Tiwanaku was as much as 55% maize. This individual, and others from Tiwanaku, demonstrate "the presence of significant quantities of maize in the altiplano prior to the Middle Horizon" (Berryman 2010: 210). This study also found increased consumption of maize associated with the Desaguadero Valley, as compared to sites close to the edge of Lake Titicaca and further south on the *altiplano*. Berryman

interpreted this finding as associated with ritual; the Desaguadero sites were more closely linked to Yaya-Mama ritual than the others. In short, Berryman stated that the abundance of maize at Desaguadero Valley sites was “significant in light of Khonkho’s prominence as a major Late Formative ceremonial center and the suspected role of maize in feasting and commensal politics that likely took place at these centers” (Berryman 2010: 216).

In contrast, Gagnon (2006) suggested that *chicha* consumption is best reflected in the archaeological record by increasingly less negative $\delta^{13}\text{C}$ signature in the bones and teeth of individuals who have a stable (or slightly increasing) rate of caries. She argued that because liquids are less likely to stick to teeth than porridges, *chicha* would be less cariogenic than eating maize in another form yet the isotopic signature would remain the same. Using data from coastal Peru, Gagnon documented sex-differentiated access to protein and possibly *chicha*, as isotope values increased for all groups over time, yet caries increased only for females, and to a lesser extent, children (Gagnon 2006: 254).

In a similar study to Gagnon (2006), Lambert and colleagues investigated chronological changes in maize production and consumption on the Peruvian North coast based on changes in C_4 plant consumption and frequency of carious lesions (Lambert et al. 2012). These authors found that C_4 plant consumption, likely maize, increased significantly for adult populations on the coast. Children consumed maize as well, but at lower rates (although they increased over time). All groups had increases in caries over time, again underlining this increase in consumption of maize products. While these authors cannot address the form that these maize products took, they postulate that *chicha* may have played a role (Lambert et al. 2012:161).

The data presented in this dissertation align more closely with Berryman’s interpretation of increasing ceremonialism and *chicha* consumption, although the sex differences in caries

provide an interesting inverse pattern when compared to Gagnon's results. On the Copacabana Peninsula during the Early Horizon, I found that males had significantly more carious lesions than females. Isotopic signatures from Hutchinson et al. (n.d.) reflected more C₄ plant consumption over time, especially for males. It seems that males had increased access to cariogenic, agricultural resources when compared to females or subadults. While some of these lesions may be related to consumption of quinoa and other starchy resources, C₄ values suggest that maize was playing a role in carious lesion formation for everyone, especially for males buried at temples. Perhaps males, more commonly buried at temple sites than females, possibly indicating a more involved role, had more access to ritually significant substances such as *chicha*, explaining both their increased rate of caries and less negative $\delta^{13}\text{C}$ values.

6.3.2. *Cribra Orbitalia and Porotic Hyperostosis*

The other indicators of diet included in this research were cribra orbitalia and porotic hyperostosis. For all individuals included here, subadults were most often affected by these lesions, at a statistically significant level ($p = .0043$). This result was not unexpected for two reasons: first, subadulthood is the only time during which lesions can form and second, subadults are most at risk for nutritional deficiencies in general, as their bodies handle multiple metabolic demands. While healed cribra orbitalia and porotic hyperostosis lesions can be identified on adult individuals, unhealed and healed lesions on subadults are more readily observable and less likely to be obscured by continued osteological processes over the life course.

Cribra orbitalia and porotic hyperostosis occurred at relatively low rates throughout the population. Notably, neither cribra orbitalia nor porotic hyperostosis varied significantly by site type. Temple populations had slightly more affected individuals overall but this was likely related to the inclusion of more subadults in the population, the group most at risk for these

lesions. It seems most likely that nutritional stress was not mitigated by participation in temple rituals nor by the more diverse diets at non-temple sites.

These lesions affected approximately one-quarter of subadults and one-fifth of adults. Comparatively, Tung and Del Castillo (2005) found much higher rates of cribra orbitalia for Wari populations in southern Peru with 43% of the subadult population and 23% of the adult population affected. They interpreted this as evidence of substantial reliance on maize agriculture and associated nutritional deficiencies. Blom et al. (2005) reported even higher rates of cribra orbitalia from the coast of Peru, ranging from 33.3 – 89.6% for occupants of a series of coastal valleys. These authors suggested that parasitic infections may have exacerbated these lesions, compounding already iron-deficient diets. Both the Wari and coastal Peruvian groups experienced cribra orbitalia and porotic hyperostosis at higher rates than the Copacabana populations. This indicates that people living in the Titicaca Basin were likely eating more nutritious and varied diets and may have been buffered from parasitic infection.

However, while overall rates of cribra orbitalia and porotic hyperostosis were low, most lesions were unhealed (57.6% and 65% of lesions, respectively). Nutritional stress may have been endured for a while, allowing lesions to form, but ultimately most individuals did not fully recover from these stressors. The lower rate of healed lesions indicates that nutritional deficiencies were a chronic concern for impacted individuals with a low chance of full recovery. This pattern was reflected by linear enamel hypoplasias as well and is further discussed in the subsequent section.

When combined with caries data, cribra orbitalia and porotic hyperostosis lesions supported the inclusion of a small, intermittent amount of maize products included in the diet of people buried at both temples and non-temples. Diets were overall fairly nutritious and included

diverse resources but some important patterns stood out. First, male individuals buried at temple sites had the highest rate of caries, perhaps linked to increased access to *chicha* or other maize products. Secondly, non-temple sites seem to have had more diverse diets as reflected by the rate of carious lesions, stable isotopes from Hutchinson et al. (n.d.), and the slightly lower rate of cribra orbitalia and porotic hyperostosis. Finally, nutritional deficiencies were relatively rare in this population but when they occurred, they impacted subadults most strongly.

6.4 Disease

Disease for Copacabana populations during the Early Horizon and Early Intermediate Period did not vary significantly by burial location, sex, or age. However, disease was common for all populations, with many individuals presenting nonspecific lesions of chronic infection and systemic stress. Many lesions were healed, suggesting interesting patterns of survival and stress.

Periosteal reactions were common for all burial populations. While these reactions can result from traumatic injury, surgery, and other mechanisms that irritate the periosteum, most of the reactions observed here were bilateral and/or present on more than one skeletal element. This suggests that systemic infections caused the periosteum to become irritated and inflamed. However, this also indicates that individuals survived their infections for a significant amount of time to allow a bony reaction to occur (Wood et al. 1992). Acute infections often kill or pass too quickly for skeletal lesions to form, leaving them invisible in the archaeological record. Thus, individuals with periosteal reactions must have survived their illnesses for long enough to develop skeletal lesions, whether or not they ultimately survived the disease episode.

Osteomyelitis was not common, which is expected given the extreme nature of this infection. However, it was a much more serious problem once contracted. No individuals in the entire population had fully healed osteomyelitic lesions; all individuals with osteomyelitis

succumbed to death with active lesions. Penetrating trauma can sometimes result in this type of infection but most individuals documented here had osteomyelitis on more than one skeletal element, and no infections were obviously associated with skeletal trauma. Interestingly, one individual from Muruqullu had evidence for possible medical intervention associated with these lesions. A probable male individual had a serious osteomyelitic infection on his left tibia. On the distal end of the tibial shaft, there were three deep cuts made through the infected outer layer of bone. It is possible this represents an attempted amputation of the seriously infected limb. Unfortunately for this individual, there was no evidence of healing indicating that he did not survive the infection or amputation attempt.

Linear enamel hypoplasias were not especially common overall, affecting 17.1% of the population. The rate of these lesions was highly variable between populations, ranging from no affected individuals at Q'hota Pata and Kenasfena to 100% of individuals at Tawa Qenani. However, given that these three sites had the smallest sample sizes, these numbers may not reflect real patterns population-wide. Considering the three largest populations, Ch'isi, Muruqullu, and Cundisa, we can still see a range of experiences. At the temple Ch'isi, 10.3% of people were affected by linear enamel hypoplasia, while at the temple Muruqullu, 18.3% were affected, and at the non-temple Cundisa, 25% were affected. Additional differences were noted in *who* was affected by linear enamel hypoplasia; at Ch'isi and Muruqullu, the majority of individuals were subadults while at Cundisa, only one subadult was affected. What could have caused higher rates of linear enamel hypoplasia at non-temple Cundisa adults, compared to temple site subadults?

The exact etiology of linear enamel hypoplasia is complex; these enamel disruptions form for a variety of reasons, linked to health and otherwise. Often, they form in response to a

systemic bodily stressor, such as an extreme illness or starvation event. These stressors must occur during childhood, while the dental enamel is still growing. Linear enamel hypoplasia on adults, like we see at Cundisa, reflected childhood stress from which individuals were able to recover. Conversely, perhaps at temple sites, where individuals with linear enamel hypoplasia were less likely to survive into adulthood, children who were once systemically stressed were more vulnerable to future stressful incidents, ultimately resulting in their mortality. The subadults with hypoplasia at temples would have survived the initial stressor, resulting in the production of the lesion, but were unable to withstand future stressors as they suffered growth faltering.

Differences in temple and non-temple diet could have changed the probability of recovery from stress events, since immune function and nutrition are so closely linked. If individuals more closely associated with temple rituals had less diverse diets (and higher consumption of maize products), their lowered nutritional health would have made them more vulnerable and less resilient to immune stress. However, in this case, I would expect that there would also be elevated rates of other infectious disease for temple burials, as systemic health would be impacted by poor immune function due to malnutrition.

Instead, the higher rate of subadults with linear enamel hypoplasia at temples may be reflective of mortuary practices, rather than lived experiences. Subadult burials were overall more common at temple sites, either reflecting increased subadult mortality for temple populations and/or increased likelihood to bury subadults at especially sacred places on the landscape (see section 6.2.1). Subadults with hypoplasia may be missing from the non-temple contexts because the majority of young individuals who perished on the Copacabana Peninsula were buried at temples, whether or not they had linear enamel hypoplasia.

Periosteal reactions and osteomyelitis show that there was a relatively high to moderate level of non-fatal or chronic infection for all Copacabana populations included in this study. Rates of linear enamel hypoplasia indicate that childhood was a risky time for systemic stress (as is the case for most populations historically and globally) but most individuals never developed these lesions. By maintaining a diverse diet, it seems Copacabana populations protected themselves from nutritional stress. Immune stress may have resulted from increased exposure to pathogens as people changed their patterns of residence and interaction.

Social status and health are often linked, in modern and past eras. Many scholars (Goodman and Leatherman 1998; Goodman and Martin 2002) suggest that marked differences in health between sites may indicate status differences, especially when correlated with grave goods or other assumed indicators of status. However, many studies find no health differences between groups that otherwise appear to occupy different social classes. It is important to note that equal risk of disease may not necessarily correlate to lack of hierarchy or that status differences would be obviously reflected through skeletal markers of disease. Thus, there may be causes for the pattern of disease noted here beyond social equality or lack of hierarchy.

Patterns of residence and interaction changed during the Early Horizon, likely in connection to the establishment of Yaya-Mama temples. Andean ritual centers throughout history tended to attract and develop residential populations once established (Benfer 1992; Dillehay et al. 2014; Moseley 2001). In the Titicaca Basin, the establishment of semi to fully sedentary communities appears to have occurred alongside and in conjunction with the construction of temple complexes at specific places around the lake (Bandy 2004). Whether or not these sites were sacred places prior to temple construction, the materialization of ritual ideas into built structures demonstrates a change in ways of sharing and demarcating sacred space.

People were drawn to these places, likely because of the sacred associations, and established communities in close proximity, investing in the landscape in ways previously unknown.

Yet, by gathering at these sites and re-making the sacred landscape, more than just ideology and conceptions changed. As on the coast of Peru, early sedentary communities linked to ritual sites dealt with accelerated disease transmission due to increased population density and limited mobility (Benfer 1992; Dillehay et al. 2014). As populations increasingly invested in certain places on the landscape, they became less mobile and thereby encountered issues with sanitation and disease circulation more regularly (Armelagos et al. 1991; Benfer 1992). Ubelaker and Newson (2002) found a range of experiences with disease in prehistoric coastal and highland Ecuador, from 3.4% to 34.8% of these populations. They explain this variation in a few ways. First, poor sanitary conditions due to sedentary settlements and increased population size seem to have contributed to some increase in disease. They also discuss the possibility that local climate and environmental factors such as humidity may have affected the circulation of disease. These factors varied for the five prehistory sites in this study, impacting the local populations' rate of periosteal reactions and linear enamel hypoplasia (Ubelaker and Newson 2002).

It is possible that similar processes occurred on the Copacabana Peninsula as people became increasingly sedentary. Local ecological variables around the Copacabana Peninsula, such as natural springs and swampy areas, could have amplified health hazards encountered by these populations. Access to clean water and site sanitation would have been vital for maintaining community and individual health. Differences in these factors between sites could account for the small variations in disease presence between burial populations.

Through increasing investment in particular places on the landscape, Copacabana Peninsula populations may have thus elevated their risk for infectious disease, as reflected by the

skeletal indicators. Temple and non-temple populations had similar risk of developing periosteal reactions and osteomyelitis, indicating similar rates of stress and disease despite local variability in diet and access to maize resources. Disease risk is likely more related to life on the Copacabana Peninsula generally, rather than social status, activity, or nutritional stress.

6.5 Relatedness

Biodistance results showed that all burial populations, temple and non-temple, were overall very closely related. Given the proximity of the sites included here (approximately two hours walking from temple to temple or 12 hours walking between the farthest temples) (S. Chávez personal communication 2012, 2015) and the small size of the population, this is not entirely surprising. It remains unclear whether this relatedness represents common ancestry or reproductive relationships between sites, although both phenomena likely contributed to these close biological distances.

Whether or not the related continuity of the lake basin was caused by common ancestry, the relatively small populations and close proximity of these burials probably necessitated regular interaction and marriage-exchange between these groups. Most notably, burial at temple or non-temple does not seem to have been connected to different lineages or prevented individuals from engaging in reproductive relationships with people ultimately buried at other sites. This may indicate that temple and non-temple burial populations saw each other as viable reproductive partners during life, as opposed to hierarchical opponents or “off-limits”.

If temple and non-temple populations did represent emerging social hierarchies, these boundaries were either not strict in terms of reproductive options or social mobility (i.e. joining the elite temple class) was an option for certain individuals. Social mobility is a plausible explanation for how closely related individuals could be buried at different site types. If temples

represented the emergence of an elite class based on achievement, people with family members of a lower class could earn their way into burial at elite sites. However, in this scenario, the large number of infants and juveniles buried at temple sites would seem out of place. Infants and juveniles likely did not live long enough to achieve anything to raise their social status. While still a possibility, social mobility was clearly not the only way to achieve burial at temples.

Ascribed status is another possible explanation for infant and juvenile burial at temples; subadults with elite parents could have had elevated status despite their young age. However, infants and juveniles were not always buried with adult individuals but were interspersed, sometimes accompanying adults or other juveniles. This may indicate that their burial at temples was unrelated to other individuals' statuses. It seems likely that the inclusion of many subadult burials at temple sites and the close relationships between all sites indicates the social hierarchies were in fact not emerging, at least not in ways that circumscribed reproduction. Overall, the relatedness of all burial populations indicates that social classes and hierarchy were in fact not emerging.

6.6 Co-presence and Physical Proximity

The presence of eight people who spent (at least) their childhood outside the Titicaca Basin suggests a few possible scenarios. Notably, these individuals were buried at both temple and non-temple sites, indicating the Yaya-Mama Religious Tradition was not necessarily responsible for their presence and that foreign status did not exclude people from temple burial. Additionally, these individuals did not appear to be buried differently from the local individuals surrounding them (with the exception of Qopakati where all individuals were foreign). Foreign individuals appear to have been integrated into Copacabana communities in a few possible ways, to be discussed below.

To identify the possible regions from where these individuals came, I used Kelly Knudson's strontium map of the Andes (Figure 6.1) (Knudson 2004). Using archaeological and modern faunal remains, she identified several major strontium zones in the Andes. First, the coastal areas are strongly affected by the strontium values of salt water, averaging 0.7092, and the active geologic zone just below the region, regularly creating new rock and lowering overall strontium values (Knudson 2004). Therefore, the strontium signature of the coastal Andes averages to 0.7074. Intercoastal valleys vary, depending on the age of the geologic formation. Important areas for this study (discussed below) include the Moquegua Valley and San Pedro de Atacama, which have average strontium values of 0.7062 and 0.7076 respectively. The Titicaca Basin and the *altiplano* are older geologic areas and have an average strontium signature of 0.7097. Finally, the eastern cordillera is estimated to have slightly lower values, as this area is still geologically active. The northern and eastern lake shore are therefore estimated to have an average strontium value of 0.7075.

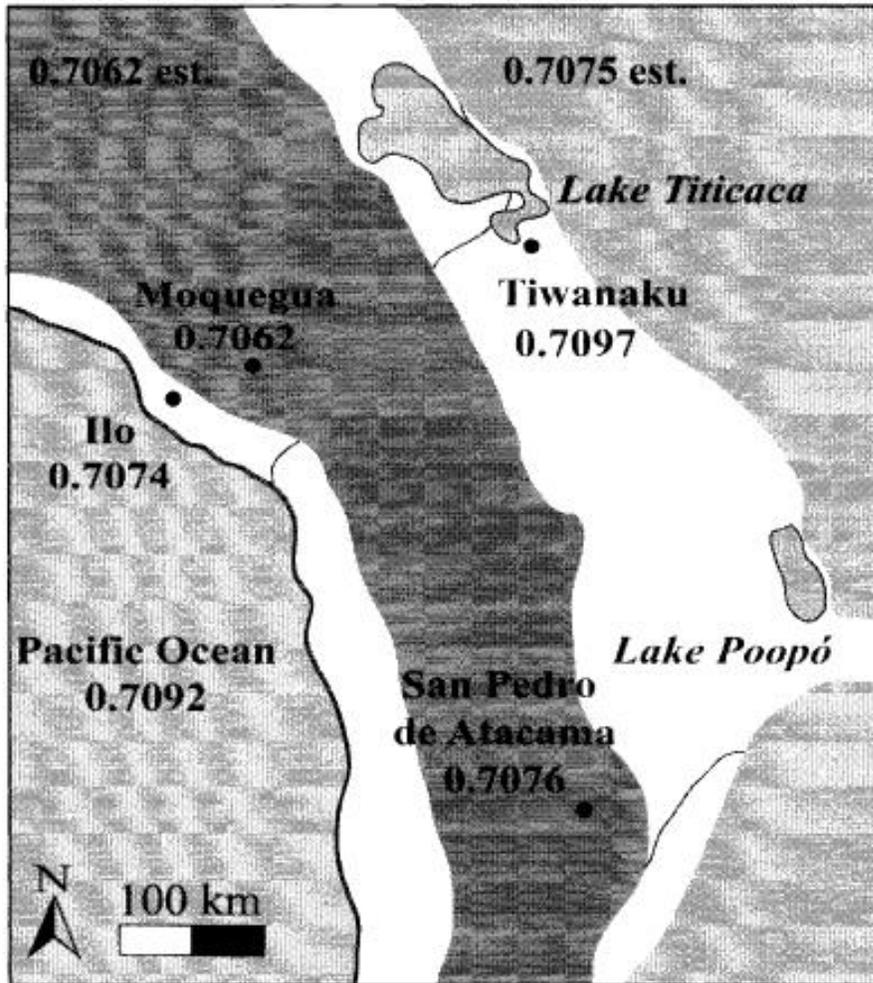


Figure 6.1. Andean Strontium Values (from Knudson 2004)

I suggest three possible interpretive scenarios for the eight strontium outliers on the Copacabana Peninsula. Individuals with 0.707 signatures could be from the northern shores of Lake Titicaca, a region where the Pukara culture developed at the end of the Formative, just after Yaya-Mama dwindled in prominence. Alternatively, strontium outliers with 0.707 and 0.706 signatures could be from the Atacama Desert and the Moquegua Valley, areas much farther away but with important trade connections to the highlands hundreds of years later. These individuals could represent early traders between the two regions. Finally, strontium outliers could represent early formation of *ayllus*—extended kin networks through multiple eco-zones who maintain community enclaves even when far from home. This section will explore these three ideas,

considering the other lines of bioarchaeological evidence, the archaeological evidence from the discussed sites, and other current research on these regions and topics.

6.6.1 Travelers from the Northern Lake Basin

The cultural developments in the northern Titicaca Basin (Figure 6.2) during the Early Intermediate Period were similar to those of the Copacabana Peninsula during the Early Horizon. Sunken courts, decorated pottery, and elaborate temple rituals associated with the Pukara cultural complex were well developed by the end of the Early Horizon and show refinement of ceramic styles seen at Yaya-Mama. However, unlike the Copacabana Peninsula, there is evidence for raiding and localized violence (shown by menacing iconography and skeletal analyses of trauma), increasing social stratification, and a controlling elite class associated with this cultural complex (S. Chávez 1992; Cohen 2010; Plourde 2006; Plourde and Stanish 2006; Stanish and Levine 2011). Despite these new types of power at play, S. Chávez and other scholars agree that it is likely that Pukara drew on similar cosmologies and ceremonies as Yaya-Mama.

People from the northern shore of the lake could have travelled to Yaya-Mama temples during the Early Horizon, witnessing and participating in the rites that occurred at these sites. They also could have engaged in trade and kinship networks, as travel between these two areas could have happened on a semi-regular basis. Burial of northern lake shore residents at both temple and non-temple sites could have easily resulted from these interactions. Others could have moved the ritual traditions there back home with them and incorporated their own ideas, escalating the scale of ritual, elaborating the ceramics, and cultivating an elite class. In this scenario, individuals with 0.707 strontium signatures buried on the Copacabana Peninsula could represent these pilgrims to Yaya-Mama rites or traders between the regions.



Figure 6.2. Potential origin of pilgrims or migrants to the Copacabana Peninsula (circled) (from Stanish and Levine 2011).

6.6.2 Long-Distance Trade with the Moquegua Valley and Atacama Desert

By AD 400, Tiwanaku was established as a regional power and cosmopolitan city center just south of Lake Titicaca. Among other activities, this state established several colonies at lower altitudes. Maize was a key export from these colonies; this crop was brought back to the *altiplano* where it was central to elite diet and used extensively in ritual in the form of *chicha* (Berryman 2010; Goldstein et al. 2009; Janusek 2008). One important region colonized by Tiwanaku was the Moquegua Valley (Figure 6.3), located approximately 137 miles or 220km from the Titicaca Basin. The Moquegua Valley is a rich agricultural region amidst the desert,

irrigated by the Moquegua River. In this region, maize grew very well and Tiwanaku colonists supplied the capitol city with vast amounts (Becker 2013; Janusek 2008).



Figure 6.3 Approximate distance between Copacabana Bolivia and Moquegua, Peru. Google 2014.

Another region under Tiwanaku influence was San Pedro de Atacama, an outpost along important trade routes between the coast, the highlands, and other desert oases located about 440 miles or 708km away (Figure 6.4). While not directly controlled by Tiwanaku, San Pedro de Atacama residents often buried their dead with Tiwanaku vessels, adopted Tiwanaku cranial modification styles, and increased their consumption of maize through association with the state (Knudson 2008; Torres-Rouff 2002). This area likely traded with Tiwanaku regularly, providing salt from the large salt flats in southwestern Bolivia and potentially coastal resources as well.



Figure 6.4 Potential origin for migrants to the Copacabana Peninsula (circled) (from Torres- Rouff and Junquiera 2006).

Importantly, the Moquegua Valley and the Atacama Desert have different underlying geology, and thus the strontium signatures from people who lived in these places are different, averaging around 0.706 and 0.707, respectively. Strontium outliers from Copacabana sites could represent individuals from these areas who moved through the Andes following fledgling long-distance trade routes. Trade with the Cusco region to the north and with the Arequipa region to the west occurred during the Early Horizon and increased through the Early Intermediate Period, as marked by the movement of obsidian (although this trade may have been indirect and unidirectional towards the lake basin) (Burger et al. 2000; Stanish et al. 2003). Trade to these other regions may have developed during Early Horizon as well, allowing Tiwanaku elite to exploit these routes once they gained power. While the durability of obsidian makes this trade item easy to track, people likely used these trade routes to exchange more than just lithic resources. In this scenario, strontium outliers could reflect the intrepid individuals moving great

distances around the Andes and linking important resource regions hundreds of years earlier than previously thought.

6.6.3 *Extended Kin Networks*

An extended kin network could explain both the shared genetic signatures and varied strontium signatures. As discussed in Chapter 3, *ayllus* are a type of endogamous kin network that have been ethnohistorically and archaeologically documented in several areas of the Andes. *Ayllu* membership depended on biological and fictive kinship, creating close and meaningful ties between far-flung living individuals and their ancestors (Albarracín-Jordán 1996; Janusek 2008; Kolata 2013; Murra 1980; Rowe 1946). While the antiquity of this type of kinship is unknown, it is possible to use *ayllus* as an analogy for kinship patterns in the Early Horizon. Strontium outliers from Copacabana could have been community members or kin (biological and fictive) who lived elsewhere in the Andes but had significant connections to the Titicaca Basin because of these kin networks. Individuals born and raised in other parts of the Andes may have been brought back to the Titicaca Basin and buried at important sites in order to reconnect with important ancestral figures and remain a part of the kinship network.

Notably, three strontium outliers were estimated female or probable female and another three were juvenile individuals. The movement of females and children (and their associated reproductive symbolism) supports the idea that people were moving around the Andes because of familial ties or extended kin networks. These females could have relocated to the Titicaca Basin in adulthood, after their dental enamel strontium had been set. However, this would not explain how the subadults got a foreign isotope signature as their enamel strontium is determined by maternal location during pregnancy and breastfeeding (Hillson 2008; Knudson 2004; Slovak and Payton 2011). Subadults with foreign strontium signatures must have had mothers who also

lived in other parts of the Andes, at least during gestation and the early infancy of their offspring. If Yaya-Mama was, at least partially, devoted to goddess and female ancestors, as Hastorf (2003) suggested, perhaps the inclusion of females with foreign strontium signatures underlies this point. Female family members were especially important to bury at significant locations in the “heartland” of the kin group because of their status under Yaya-Mama.

An *ayllu*-type kinship network would also explain the range of strontium signatures seen in the sample. Community enclaves outside of the Titicaca Basin would have been located in several different areas to gain access to a variety of resources. Whether these individuals were coming from the northern lake shore, the Moquegua Valley, or the coast (or other unknown regions), their connections to the Titicaca Basin brought them back to the region for burial.

6.7 Copacabana Burials as Gathering Places for Kin

Albaraccín-Jordán (1996) suggested that early temple sites in the Titicaca Basin represented just this: gathering places for kin groups spread across the region. Berryman (2010) also noted that maize consumption during the Early Intermediate Period was associated with ritual sites, likely connected to ancestry and family lineages. This study shows that people not buried at temple sites were also linked into such a kin network. Burial at non-temple sites was not indicative of significant differences in levels of maize consumption, risk of disease, or access to reproductive partners or different ancestry. These people were equally likely to be from the Titicaca Basin as those at temple sites but were also occasionally from other, more distant regions. The next chapter will expand on this, drawing together these multiple lines of evidence to build a picture of community structure on the Copacabana Peninsula during the Early Horizon.

CHAPTER SEVEN: COMMUNITY ON THE COPACABANA PENINSULA

7.1 Introduction

The results from this study present patterns and suggest answers to questions about daily life, community, and social relationships on the Copacabana Peninsula during the Early Horizon and Early Intermediate Period. First, the data do not suggest that temples represented exclusive communities or the emergence of an elite social class, given the high level of relatedness between all sites and the health parity between and at sites. It seems that males were given preference for temple burial, yet females and juveniles were not excluded from temples either. Second, while maize seems to have been available to individuals at temple and non-temple sites, consumption of maize was more frequent for those closely linked to Yaya-Mama. Perhaps the ritual use of *chicha* at temples led to the increased rate of carious lesions and cribra orbitalia for temple individuals. Finally, individuals with foreign strontium signatures were included in temple and non-temple burial populations (four foreigners at a temple, four at non-temples), emphasizing similarity between sites. It may be that people with foreign isotope signatures were part of communities from the Copacabana Peninsula, but were born outside of it because of extended kin networks.

This chapter will elaborate on these points in order to provide an emerging picture of how the larger socio-economic changes of the Early Horizon impacted daily life and community on the Copacabana Peninsula. I will also suggest that the methods used in this dissertation could be

expanded to other regions or scenarios in order to investigate community in the past in more nuanced and subtle ways.

7.2 Social Stratification

The emergence of ritual and the development of social stratification have been closely linked in many regions globally, as ideology lent power to some people and restricted others from access to the supernatural. On the northeastern shores of Lake Titicaca, scholars (Cohen 2010; Plourde 2006; Stanish and Cohen 2005; Stanish and Levine 2011) have shown just this: the construction of elaborate ritual structures was paralleled by an increase in social stratification and violent domination by an elite class. It has thus been suggested that the emergence of Yaya-Mama in the southern lake basin represented a similar process (Janusek 2008; Stanish 2003).

The data included in this dissertation showed very little evidence for increasing social stratification during this period, despite different mortuary locations and diverse ceramic styles. Most markers of status, such as mortuary artifacts, reproductive relationships, and disease lesions, pointed to little social differentiation within and between sites. One of the hallmark signs of aggrandizing behavior is often the inclusion of elaborate or plentiful grave goods as disposable wealth and provision of the afterlife. However, archaeological analyses showed that very few mortuary objects were included in tombs at both temple and non-temple sites. It is possible that perishable grave goods accompanied Yaya-Mama burials; there is some archaeological evidence for re-opening of tombs, likely for a number of reasons such as ritual “feeding” of the dead and adding multiple individuals. However, ceramic and lithic mortuary objects were extremely limited and seemingly random across burials at all sites, with no apparent patterning or clear associations to age or sex.

Reproductive relationships and ancestry were shared across all populations, with few individuals showing great phenotypic divergence or unique ancestry. Not only were those buried at temples closely related, but the individuals interred at non-temple sites also shared ancestry with others in the lake basin. This is significant, as emerging hierarchies often created strict boundaries between social classes, dictating who was considered an appropriate reproductive partner. This is also significant because ancestral lineages were (and are) very important to social status in the Andes. If the people living on the Copacabana Peninsula shared important ancestors, this would have limited social differences and created an inclusive ancestral kin network.

Finally, disease risk and health status did not vary significantly within or between burial populations. Health status is one of the most reliable indicators of social hierarchy, as elite classes were able to access more resources and generally avoid strenuous labor (Goodman and Leatherman 1998). If temples represented the emergence of an elite class, it would be reasonable to expect that the people buried at non-temple sites would have lowered health statuses and, as a result, increased rates of skeletal and dental lesions associated with stress and disease. However, the data here showed very little difference in disease risk between burial populations or between individuals.

The only pattern that may suggest emerging status was the inclusion of significantly more male individuals in temple burial populations. While Yaya-Mama imagery often included juxtaposed male and female figures, this balance in the sexes was not reflected in the burial populations. It seems that burial at temple sites was more available to males, suggesting that these individuals held some kind of power in the ritual sphere or were more closely linked to the ritual tradition. Elevated male status was underscored by their increased consumption of cariogenic and C4 resources: likely maize, possibly in the form of maize beer or some other

maize beverage. *Chicha* was a prized resource throughout the Andes over time and increased access to this beverage often reflected higher status or privilege associated with ritual (Berryman 2010; Goldstein et al. 2009; Hastorf and Johannessen 1993). While Yaya-Mama may have focused on venerating female ancestors and/or Pachamama, males may have been more engaged with these rituals on a daily basis.

Taken together, the mortuary and health indicators suggest that social class or hierarchy did not dictate community boundaries. People buried at sacred locations (temples) did not have significantly more grave goods, were closely related to each other and those buried elsewhere, and were not protected from disease. This confirms the results of other investigations of hierarchy on the peninsula; no archaeological material remains indicate emergent social hierarchy or class structures (Chávez 2012:446-449). The only indicator of emerging social status was tied to sex; adult males were more likely to be buried at sacred places than other adults or juveniles and had more access to sacred *chicha*. Overall, the picture of social status and community was fairly egalitarian during this period, a trend in stark contrast to the developments on the northern side of the lake basin.

If communities were not stratified, what does this mean for the socio-economic changes of the Early Horizon and Early Intermediate Period? Often, socio-economic changes such as the ones occurring in the Titicaca Basin were linked to central authorities or governing bodies that facilitated labor and trade. However, on the Copacabana Peninsula, we do not see evidence for this kind of centralization of power. As has been suggested by Sergio Chávez, power may have been heterarchical or shared across settlements, with groups equally responsible for their own share of the labor required to cultivate fields, build terraces, and maintain trade networks (Chávez 2012: 449).

7.3 Ritual Consumption

Diet during the Early Horizon was mostly composed of local wild and domesticated resources, with increasing emphasis on agricultural products over time. The archaeological and isotopic evidence for diet from archaeological sites and burial populations around the southern lake basin reflects this trend and was supported by the rate of caries in this dissertation. It seems that people were eating agricultural products with regularity but were also still exploiting wild game and lacustrine resources. This diverse diet kept nutritional health relatively high across the lake basin because people had access to a variety of resources and nutrients that supported immune systems and allowed them to resist or rebound quickly from pathogens.

Diet did not vary drastically between temple and non-temple burial populations, although there were a few notable differences. People buried at non-temple sites seem to have eaten fewer cariogenic foods or had a more diverse diet overall, resulting in a lower rate of caries. Isotopic studies of these populations show that perhaps non-temple populations had lower C4 signatures because of the inclusion of more diverse foods in their diet, rather than less C4 in total amounts. By having a broader selection of foods, they may have limited the impact of the cariogenic component of their diet.

Conversely, this trend may be reflecting an emphasis on cariogenic, C4 products in the diet of those buried at temples, making these populations more vulnerable to carious lesions and restricting their range of isotopic signatures. Likely, this relates to an increase in consumption of maize, probably in the form of *chicha*. Goldstein (2003) described the power of Tiwanaku ritual as “largely fueled by the accelerated cycle of political feasting that came about with the introduction of maize beer” (166). While Yaya-Mama temples did not have evidence for hierarchical political maneuvering or status climbing, *chicha* may have already had significant

social and ritual importance, drawing communities and families together to temple sites and solidifying those bonds. Additionally, while people buried at temples seem to have had more regular access to this resource, they were not the only ones. Those buried at non-temple sites also consumed C4 and cariogenic resources occasionally, perhaps at special occasions when the entire peninsular population (or the macro-community) gathered for feasts and festivals, potentially hosted at temple sites or elsewhere on the peninsula.

7.4 Ancestor Veneration and Kinship

Yaya-Mama temples have previously been interpreted as sites for ancestor veneration and loci for lineages to gather and reaffirm familial ties (Hastorf 2003; Roddick and Hastorf 2010). I have provided additional data to support this idea, as shown by the inclusion of numerous subadult burials at temples and the burial of non-local individuals at both temple and non-temple sites. The association between children and *huacas* in the Andes is clear; important children were regularly buried in significant ways and/or at sites closely linked to the ancestors. Yaya-Mama temples were apparently no exception. The significantly higher proportion of subadults buried at temples mimics the trend seen at many other Andean sites. Important children were buried at sacred places to create and reinforce connections with real and fictive ancestors.

Also important was the inclusion of non-local individuals buried on the Copacabana Peninsula. These people were likely part of extended kin networks and were brought back to the Titicaca Basin before or after death, possibly in order to reconnect with their ancestral homeland. If this was an *ayllu* type or long-distance kinship network, the non-local individuals would have been buried in the lake basin as the place where their ancestors reside. The movement of females and subadults especially underscores this significance. Whether these individuals moved to the

lake basin before death, or were relocated after, their presence in the burial population indicates the importance of and connection to the landscape that these kin groups felt.

7.5 Community and Socio-economic Change during the Early Horizon

Community on the Copacabana Peninsula during the Early Horizon had several important characteristics. First, community relationships were relatively non-hierarchical, with shared ancestry and kinship between burial populations, little difference in risk of disease, and no evidence of individual wealth accumulation. Second, food values also seem to have been shared across groups as most people ate very similar diets, although the allocation and consumption of certain substances like *chicha* may have occurred more commonly at temple events. Finally, kinship and social interactions were structured around ancestry, with closely related people moving long distances to reinforce bonds with ancestors.

Overall, community during the Early Horizon was *inclusive* to most groups living on the Copacabana Peninsula. There may have been socially-excluded portions of the population not buried at the sites included here; however, there is not yet any evidence for this. People had relatively equal access to food, mates, and movement across the peninsula, regardless of sex, age, or burial location. Disease was a risk for all groups, not an increased burden for those with the least resources. I suggest that this may indicate inclusivity; boundaries between groups on the peninsula did not exist, were not strictly enforced, or did not impact people's lives in a way that preserved in the bioarchaeological or archaeological record. Temple affiliation, the most visible archaeological marker of community or group division, apparently did not mean that temple groups discriminated or persecuted groups who did not participate in the ritual tradition. Temple and non-temple burial groups seem to have shared a lot of resources and may have actually composed one single community.

The social and economic changes of the Early Horizon were significant for many reasons: introducing new resources to the lake basin and changing the ways that people interacted with the landscape and each other. Prior to the Early Horizon, people were more mobile, marking the landscape in less permanent ways. Perhaps during this time, people became more settled through increasing investment in landscape shown by the construction of terraces, temples, and agricultural fields. These endeavors would have necessitated communal labor, motivated by an emphasis on shared ancestry and reciprocal kin obligations. By emphasizing their shared heritage, people may have been able to motivate labor and facilitate trade without creating social hierarchies or using coercive force.

7.6 Bioarchaeology of Community

The lines of evidence used in this dissertation – paleopathology, dietary reconstruction, biodistance, and migration – showed how people interacted across a region, the various social roles they played, and their group affiliations. This evidence also indicated some previously unidentified trends, including patterns of population movement and group affiliation. Assuming that burials on the peninsula were necessarily local because of the early time period would have missed an important part of kinship and movement of people in the Early Horizon. Additionally, assuming that the emergence of ritual indicated changes to social hierarchies or the development of an elite class would have misrepresented the communities that existed. By combining these lines of evidence, this dissertation has presented a more nuanced picture of community and social interactions for these peoples.

As social issues are brought to the forefront of bioarchaeological research, our methods for answering these new questions must also be developed. Many archaeologists struggle to identify social roles or community groups beyond physical proximity and shared iconography.

Yet, communities were created and re-created through interactions that may not have preserved in material remains. The human skeleton can offer ways to “see” community in ways previously unrecognized, as this dissertation showed. Uniting the multiple avenues of inquiry used here would be useful in other situations as well, to support or contrast with archaeological interpretation of the past.

7.7 Future Directions

Future research can expand and clarify some of the social trends noted here. First, the identification and excavation of more non-temple burial populations will provide a more complete comparison between site types and allow for more secure conclusions about the differences between these social groups. Dietary isotope testing from more individuals will help support or explain the carious lesions patterning, both between site types and sex categories. This may also clarify how much maize was present in the lake basin and provide more secure conclusions about whether maize was locally grown or imported. Finally, additional strontium tests from the populations not sampled here and local faunal comparisons will allow for a more complete picture of the movement of peoples around the highlands and lake basin.

APPENDIX A. Burial provenience, analyses performed, age, sex, skeletal and dental pathology, and trauma.

Site	Individual #	Bio-distance?	Strontium?	Age Category	Age	Sex	Dental pathology	Cranial Pathology	Post-Cranial Pathology
Ch'isi	Pozo 26A-B N6 T1	Y	Y- local	Adult	20-25	M	Y	Y	Y
Ch'isi	Pozo 87B R1 N1	N	Y-semi local	Adult	30-35	F	Y		
Ch'isi	Pozo10A T1		N	Adult	20-35	I			
Ch'isi	Pozo10A-B R1	Y	Y- local	Adult	20-25	PM	Y	Y	Y
Ch'isi	Pozo12B N4	N	N	Adult	20-35	I			
Ch'isi	Pozo15A R1 N1	Y	Y- local	Young Adult	17-23	PM	Y	Y	
Ch'isi	Pozo16D N4-7 R1	Y	Y- local	Adult	25-30	F	Y		Y
Ch'isi	Pozo30B R1	Y	N	Adult	25-30	PF	Y		Y
Ch'isi	Pozo30C Rasgo1	Y	Y- local	Adult	20-25	PM	Y		
Ch'isi	Pozo30C-D y42A	Y	Y- local	Adult	20-30	PM			Y
Ch'isi	Pozo40A	Y	N	Adult	20-35	I			
Ch'isi	Pozo49D T1 Ind1	N	N	Infant	birth-6mos	I			
Ch'isi	Pozo49D T1 Ind2	N	N	Juvenile	2-5years	I			
Ch'isi	Pozo49D T2	N	Y- local	Infant	6mos-1yr	I			
Ch'isi	Pozo49D T3	Y	N	Juvenile	8-10yrs	I		Y	
Ch'isi	Pozo4C-D R/N5	Y	Y- local	Adult	20-25	M	Y	Y	Y
Ch'isi	Pozo54C T1	Y	N	Adult	30-40	I	Y		
Ch'isi	Pozo54C T2	Y	N	Juvenile	5-10yrs	I		Y	
Ch'isi	Pozo55C-D R.N1 T1	Y	N	Juvenile	16-18	PF			Y
Ch'isi	Pozo55D Ind1	N	Y- local	Infant	birth-6mos	I			
Ch'isi	Pozo5B T1/2 Ind1	N	N	Juvenile	3-4yrs	I	Y	Y	
Ch'isi	Pozo5B T3 Ind1	N	N	Juvenile	3-4yrs	I			
Ch'isi	Pozo5B T3 Ind2	N	N	Infant	birth-6mos	I			
Ch'isi	Pozo5B/5C T4	N	Y- local	Juvenile	3-4yrs	I			
Ch'isi	Pozo5C T5 Ind1	N	Y- local	Infant	9-18mos	I		Y	

Site	Individual #	Bio-distance?	Strontium?	Age Category	Age	Sex	Dental pathology	Cranial Pathology	Post-Cranial Pathology
Ch'isi	Pozo5C T6 Ind1	N	Y- local	Juvenile	4-6yrs	I		Y	
Ch'isi	Pozo5C T6 Ind2	N	N	Infant	1-2yrs0	I			
Ch'isi	Pozo77B R1	N	N	Juvenile	2-4yrs	I			
Ch'isi	Pozo77C R1 Ind1	Y	Y- local	Infant	6mos-1yr	I		Y	
Ch'isi	Pozo77C R1 Ind2	Y	N	Adult	35-45	I	Y		
Ch'isi	Pozo77C R1 Ind3	Y	N	Juvenile	2-4yrs	I			
Ch'isi	Pozo87B N4D R1	N	N	Adult	20-35	I			
Ch'isi	Pozo87C-88B N3A R1 Ind1	Y	N	Adult	20-30	M	Y	Y	
Ch'isi	Pozo87C-88B N3A R1 Ind2	Y	N	Adult	25-30	PM	Y		
Ch'isi	Pozo88B N4 R1	N	Y- local	Juvenile	9-11yrs	I		Y	
Ch'isi	Rasgo 35CD-36AB Ind2	Y	N	Juvenile	6-10yrs	I			
Ch'isi	Rasgo32B	Y	N	Adult	25-30	PM	Y		Y
Ch'isi	Rasgo35B-34C Ind1	Y	N	Young Adult	17-23	PM	Y	Y	Y
Ch'isi	Rasgo35B-34C Ind2	Y	N	Adult	20-35	I			
Ch'isi	Rasgo35B-34C Ind3	Y	N	Adult	20-35	I			
Ch'isi	Rasgo35CD-36AB Ind1	Y	N	Young Adult	20-25	I	Y	Y	Y
Ch'isi	Rasgo35CD-36AB Ind3	Y	N	Adult	20-30	PM			
Ch'isi	Rasgo40A-28A N2	Y	Y- local	Adult	30-35	PF	Y		Y
Ch'isi	Rasgo4D-3C/1 T1	Y	Y- local	Adult	25-30	PF	Y		
Ch'isi	Rasgo4D-3C/2 T2	Y	Y- local	Adult	20-25	M	Y	Y	
Ch'isi	Rasgo54B1+55D	N	Y- local	Juvenile	7-9yrs	I		Y	
Ch'isi	Rasgo55C Burial1	Y	Y- local	Adult	25-30	I	Y		
Ch'isi	Rasgo55C T2 N1 Ind1	Y	N	Adult	30-40	PM	Y		
Ch'isi	Rasgo55C T2 N1 Ind2	N	N	Infant	6-9mos	I			

Site	Individual #	Bio-distance?	Strontium?	Age Category	Age	Sex	Dental pathology	Cranial Pathology	Post-Cranial Pathology
Ch'isi	Rasgo5B Ind1 T1	N	Y- local	Juvenile	4-6yrs	I			
Ch'isi	Rasgo5B Ind2 T1	N	Y- local	Infant	birth-9mos	I			
Ch'isi	Rasgo5B Ind3 T1	N	Y- local	Infant	birth-6mos	I			
Cundisa	CU 1/T10/1/ CU 72	Y	Y- Non local	Juvenile	7-9yrs	I	Y	Y	
Cundisa	CU 1/T10/2/ CU100 IN1	N	Y- Non local	Adult	35-45yrs	I			
Cundisa	CU 1/T11/ CU T16	Y	Y- semi local	Adult	40-50	PF	Y	Y	
Cundisa	CU T10/3/ CU 100 IN2	Y	Y- Non local	Juvenile	3-5yrs	I	Y		
Cundisa	CU T8/1/ CUT30	Y	Y- semi local	Adult	40+	I	Y		Y
Cundisa	CU T8/2/ CU T30	N	Y- semi local	Adult	25-50	I	Y		
Cundisa	CU T9/1/ CU 107	Y	Y- Local	Adult	35-45	I	Y		
Cundisa	CU T9/2/ CU T107	Y	Y- Local	Adult	20-25	I	Y		
Cundisa	Trinch. 3S, Nivel 4	Y	N	Adult	25-35	I	Y	Y	
Cundisa	Tumba 107	Y	N	Adult	25-35	I	Y		
Cundisa	Tumba 114 IN1	Y	N	Adolescent	14-16	PM		Y	
Cundisa	Tumba 114 IN2	N	N	Adult	35-50	PF			
Cundisa	Tumba 114 IN3	N	N	Adult	45+	M			
Cundisa	Tumba 114 IN4	N	N	Adult	45+	F		Y	Y
Cundisa	Tumba 21	Y	N	Adult	25-30	PM	Y	Y	Y
Cundisa	Tumba 29 IN1	Y	N	Adult	35-45	PF			
Cundisa	Tumba 29 IN2	Y	N	Adult	25-35	PM	Y		Y
Cundisa	Tumba 29 IN3	Y	N	Adolescent	12-15yrs	PM		Y	
Cundisa	Tumba 4 IN1	Y	N	Adolescent	14-18yrs	I	Y		
Cundisa	Tumba 4 IN2	N	N	Adult	35-45yrs	PM			
Cundisa	Tumba 4 IN3	N	N	Adult	25-50yrs	I			
Cundisa	Tumba 43	N	N	Adult	20-50yrs				
Cundisa	Tumba 51	N	N	Adult	40+	I			Y
Cundisa	Tumba 52 N3	N	N	Adult	25-35	I	Y		
Cundisa	Tumba 53	N	N	Adult	30-40	PF			Y
Cundisa	Tumba 72	Y	N	Adult	30-40	PM			

Site	Individual #	Bio-distance?	Strontium?	Age Category	Age	Sex	Dental pathology	Cranial Pathology	Post-Cranial Pathology
Cundisa	Tumba 73	N	N	Adult	25-50	I			
Cundisa	Tumba 74	Y	N	Adolescent	16-18yrs	PF			
Cundisa	Tumba 88 IN1	N	N	Young Adult	18-22	PM			Y
Cundisa	Tumba 88 IN2	N	N	Adult	35-50	PM			
Cundisa	Tumba 92	Y	N	Adult	45+	PM	Y		
Cundisa	Tumba 96	Y	N	Adult	25-35yrs	PM	Y		
Cundisa	Tumba 97	N	N	Adult	25-50	I			
Kenafena	T. en R1 IN1	Y	N	Adolescent	15-17	PM			Y
Kenafena	T. en R1 IN2	Y	N	Adult	45+	PF	Y		
Muruqullu	JSP T1 IN1	Y	N	Adult	30-35	I	Y		
Muruqullu	JSP T2 IN1	Y	N	Adult	35-45	PF	Y	Y	
Muruqullu	JSP T3 IN1	Y	N	Adult	25-30	PF	Y		
Muruqullu	T12 P3 IN1	Y	N	Adult	35-45	PF	Y		Y
Muruqullu	T14	N	N	Juvenile	3-5yrs	I		Y	
Muruqullu	T15 N2	N	N	Juvenile	2-5yrs	I		Y	
Muruqullu	T16	N	N	Adult	25-35	M			Y
Muruqullu	T17 P5-disturbado	Y	N	Young Adult	17-23	I	Y		
Muruqullu	T18 P5-disturbado	Y	N	Adult	25-35	PF	Y	Y	
Muruqullu	T19 P5 - disturbado	N	N	Young Adult	17-23	I	Y		
Muruqullu	T20 P6 N2	N	N	Young Adult	17-23	I	Y		
Muruqullu	T22 P5 IN2	Y	N	Adult	20-25	I	Y	Y	Y
Muruqullu	T22 P5 IN3	Y	N	Juvenile	14-16	I	Y		
Muruqullu	T22P5 IN1	Y	N	Adult	25-30	PF	Y	Y	
Muruqullu	T23 P5	N	N	Adult	20-30	I			
Muruqullu	T24 IN1	N	N	Infant	birth-6mos	I			
Muruqullu	T25 P8 N2 IN1	Y	N	Adult	30-40	PM			Y
Muruqullu	T25 P8 N2 IN2	N	N	Adult	20-30	I			
Muruqullu	T27 P5	N	N	Infant	6-9mos	I			
Muruqullu	T28 P5 IN1	Y	N	Juvenile	15-18yrs	I	Y		
Muruqullu	T28 P5 IN2	Y	N	Young Adult	17-23	PF	Y		
Muruqullu	T29 IN2	Y	N	Juvenile	14-16	PM	Y	Y	Y
Muruqullu	T29 P5 IN1	N	N	Adult	25-30	PM			Y
Muruqullu	T29 P5 IN1A	Y	N	Juvenile	6-8yrs	I	Y		
Muruqullu	T29 P5 IN3	Y	N	Juvenile	12-15yrs	PM	Y	Y	
Muruqullu	T29 P5 IN5	Y	N	Young Adult	20-25	PM			Y

Site	Individual #	Bio-distance?	Strontium?	Age Category	Age	Sex	Dental pathology	Cranial Pathology	Post-Cranial Pathology
Muruqullu	T29 P5 IN6	Y	N	Juvenile	7-9yrs	I	Y	Y	
Muruqullu	T29 P5 IN7	N	N	Juvenile	3-5yrs	I		Y	
Muruqullu	T31 IN1 Pozo 5	N	N	Adult	35-45	PM	Y		Y
Muruqullu	T31 IN2 P5	Y	N	Adult	20-30	PF	Y		Y
Muruqullu	T31 IN3 P5	Y	N	Adult	20-25	PF	Y		
Muruqullu	T31 IN4 P5	Y	N	Adult	35-45	PM	Y		
Muruqullu	T31 IN5 P5	N	N	Fetus	6mos in utero	I			
Muruqullu	T31 P9	N	N	Adult	35-45	PM	Y		Y
Muruqullu	T32 P9	N	N	Infant	birth-2yrs	I			
Muruqullu	T34	N	N	Infant	birth-6mos	I			
Muruqullu	T35 IN1 P6	Y	N	Adult	30-40	I	Y		
Muruqullu	T35 IN2 P6	Y	N	Adult	25-30	I	Y		
Muruqullu	T35 P6 Ind 3	Y	N	Juvenile	6-8yrs	I			
Muruqullu	T36 R5	Y	N	Adult	25-30	M	Y		
Muruqullu	T37 IN1	Y	N	Juvenile	6-8yrs	I			Y
Muruqullu	T37 IN2	Y	N	Adult	25-30	PM	Y	Y	
Muruqullu	T38 IN1 P6	Y	N	Juvenile	7-9yrs	I	Y		
Muruqullu	T38 IN2 P6	Y	N	Adult	25-30	PF	Y		
Muruqullu	T38 IN3 P6	Y	N	Adult	35-40	F	Y	Y	Y
Muruqullu	T38 IN4 P6	Y	N	Adult	20-25	PM	Y		
Muruqullu	T39 IN1 P12	N	N	Juvenile	2-3yrs	I		Y	
Muruqullu	T39 IN2 P12	N	N	Juvenile	1-2yrs	I			
Muruqullu	T4 Gr. S Mez In2	N	N	Adult	30-40	PM	Y		
Muruqullu	T4 Gr. N Mez A1	N	N	Adult	35-45	I	Y		
Muruqullu	T4 Gr. N Mez A2	N	N	Young Adult	20-25	I	Y		
Muruqullu	T4 Gr. N Mez J1	Y	N	Juvenile	4-6yrs	I	Y		
Muruqullu	T4 Gr. N Mez J2	Y	N	Juvenile	4-6yrs	I	Y		
Muruqullu	T4 Gr. S Mez In1	N	N	Adult	20-25	I	Y		
Muruqullu	T4 IN1	Y	N	Adult	20-25	F	Y		
Muruqullu	T4 IN1A	Y	N	Juvenile	5-7YRS	I			
Muruqullu	T4 IN2	Y	N	Juvenile	8-10yrs	I			
Muruqullu	T4 Gr. S IN3	Y	N	Adult	20-25	PF	Y	Y	
Muruqullu	T4 Gr. S IN4	N	N	Adult	20-30	I			
Muruqullu	T4 Gr. S IN5	Y	N	Young	15-18	I	Y		

Site	Individual #	Bio-distance?	Strontium?	Age Category	Age	Sex	Dental pathology	Cranial Pathology	Post-Cranial Pathology
				Adult					
Muruqullu	T4 Gr. N IN6A	Y	N	Young Adult	15-20	PF	Y		Y
Muruqullu	T4 Gr. N IN6B	N	N	Adult	30-40	I	Y		
Muruqullu	T4 Gr. S IN7	N	N	Adult	20-30	I			Y
Muruqullu	T4 Gr. S IN8	Y	N	Adult	30-35	PM			
Muruqullu	T4 Gr. S IN9	Y	N	Juvenile	6-8yrs	I			
Muruqullu	T40 P6	N	N	Juvenile	3-5yrs	I		Y	
Muruqullu	T41 P4	Y	N	Adult	20-25	M	Y		Y
Muruqullu	T6 IN1- disturbado	Y	N	Adult	25-30	PM	Y		Y
Muruqullu	T6 IN2 - disturbado	N	N	Adult	20-25	I	Y	Y	
Muruqullu	T7 IN1	Y	N	Adult	25-30	PM	Y	Y	
Muruqullu	T8 IN1	Y	N	Young Adult	17-23	PF	Y		Y
Muruqullu	T8 IN2	Y	N	Juvenile	14-16	I	Y	Y	Y
Muruqullu	T8 IN3	N	N	Adult	35-45	M	Y		
Muruqullu	T8 IN4	Y	N	Adult	20-25	I	Y		Y
Muruqullu	T9 IN1A	N	N	Young Adult	18-22	F			Y
Muruqullu	T9 IN2	N	N	Juvenile	3-5yrs	I	Y		
Muruqullu	T9 IN3	N	N	Adult	25-30	I	Y		Y
Muruqullu	T9 IN4	Y	N	Adult	25-40	M	Y	Y	
Muruqullu	T9 IN5	Y	N	Young Adult	18-22	M	Y		Y
Muruqullu	T9 IN5A	Y	N	Young Adult	15-18	I			
Muruqullu	Tr. Norte T1 IN1	Y	N	Adult	20-25	F	Y	Y	
Muruqullu	Tr. Norte T1 IN2	Y	N	Young Adult	17-23	PM	Y	Y	Y
Muruqullu	Tr. Norte T1 IN3	Y	N	Juvenile	6-8yrs	I			
Muruqullu	Tr. Norte T1 IN4	Y	N	Adult	20-25	PM	Y		
Muruqullu	Tumba en Rasgo1	Y	N	Adult	25-30	I	Y		Y
Q'hota Pata	P1A T. en N.4 In1	Y	Y- Non local	Adult	40+	PF	Y	Y	Y
Q'hota Pata	Rescate Tumba In1	N	N	Adult	25-35	I	Y		Y
Qopacati	T.1 P.1 IN2A	Y	Y- Non local	Juvenile	8-10yrs	I	Y		
Qopacati	T.1 P.1 IN2B	Y	N	Adult	25-30	PM	Y		Y
Qopacati	T.1 P.1 IN2C	Y	Y- Non local	Adolescent	16-18	F	Y	Y	Y
Qopacati	T.1 P.2 IN1	Y	Y- Non local	Adult	35-45	PF	Y		

Site	Individual #	Bio-distance?	Strontium?	Age Category	Age	Sex	Dental pathology	Cranial Pathology	Post-Cranial Pathology
Qopacati	T.2 P.1 IN1	Y	N	Adolescent	16-18	F	Y		Y
Qopacati	T.2 P.1 IN2	Y	Y- Non local	Juvenile	6-8yrs	I		Y	Y
Qopacati	T.2 P.1 IN3	N	N	Juvenile	6-8yrs	I			
Tawa Qenani	T.1 P5 N2 IN1	Y	Y- local	Juvenile	9-11yrs	I	Y	Y	Y
Tawa Qenani	T.1 P5 N2 IN2	N	N	Juvenile	7-9yrs	I	Y		
Tawa Qenani	T.2 Esq NE Par. Ext In1	N	Y- local	Juvenile	4-6yrs	I	Y		

APPENDIX B. STRONTIUM ISOTOPE ANALYSIS

Site	#	Burial Provenience	Age Category	Sex	Tooth	87/86 Exp Corr (-Rb)	%Sd Err
TEMPLE							
Ch'isi	1	CH R3C4D T1	A	PF	M3	0.708534	0.0007
Ch'isi	2	CH R3C4D T2	YA	M	LRM3	0.708499	0.0007
Ch'isi	3	CH R4CD	YA	M	LRM2	0.708512	0.0008
Ch'isi	4	CH R5B T1-1	J	I	URM1	0.708705	0.0007
Ch'isi	6	CH R5B T3-1	J	I	dLRm1	0.708918	0.0006
Ch'isi	7	CH R5B T3-2	I	I	dURi1	0.708883	0.0008
Ch'isi	8	CH R5BC T4	J	I	dm1	0.709020	0.0007
Ch'isi	10	CH R5C T5-1	I	I	dURm1	0.709010	0.0007
Ch'isi	11	CH R5C T6	J	I	dm1	0.708756	0.0007
Ch'isi	12	CH R10 AB	A	PM	URM2	0.708458	0.0008
Ch'isi	13	CH R15A	YA	PM	URM2	0.709657	0.0007
Ch'isi	14	CH R16D	A	F	LLC	0.708593	0.0007
Ch'isi	15	CH R26AB	YA	M	NM3	0.708753	0.0007
Ch'isi	17	CH R30C	YA	PM	URM3	0.708452	0.0007
Ch'isi	18	CH R30CD-42A	A	PM	URM2	0.708592	0.0007
Ch'isi	22	CH R40A-28D	A	PF	LRPM1	0.708470	0.0007
Ch'isi	23	CH R49D T2	I	I	nm1	0.708800	0.0007
Ch'isi	25	CH R54 B1	J	I	ULM1	0.709540	0.0008
Ch'isi	28	CH R55C T1	A	I	LRM2	0.708629	0.0007
Ch'isi	30	CH R55D	I	I	dm1	0.709127	0.0007
Ch'isi	32	CH R77C T1	I	I	dm1	0.708328	0.0008
Ch'isi	34	CH R87 B1	A	F	LLPM1	0.708199	0.0008
Ch'isi	37	CH R88B	J	I	ULM2	0.708652	0.0006
Tawa Qenani	63	TQ T1 Esq Ext	J	I	NM2	0.708793	0.0007
Tawa Qenani	65	TQ5 T1	J	I	LLM3	0.708818	0.0007
Qopakati	55	QO N26.5 W25.6 T1	Ad	F	NM2	0.707639	0.0008
Qopakati	56	QO N23.6 W26 T1	A	PF	NM3	0.707559	0.0007
Qopakati	57	QO N23.6 W26 T1 IN2	J	I	nm2	0.707461	0.0007
Qopakati	58	QO N23.6 W26 T2	J	I	xm2	0.707316	0.0007
NONTEMPLE							
Cundisa	47	CU T8/1/ CUT30	A	I	ULM2	0.708224	0.0007
Cundisa	48	CU T8/2/ CU T30	A	I	ULM2	0.708272	0.0007

Site	#	Burial Provenience	Age Category	Sex	Tooth	87/86 Exp Corr (-Rb)	%Sd Err
Cundisa	49	CU T9/1/ CU 107	A	I	URC	0.708305	0.0007
Cundisa	50	CU T9/2/ CU T107	A	I	NM3	0.708581	0.0008
Cundisa	51	CU 1/T10/1/ CU 72	J	I	NM3	0.707114	0.0007
Cundisa	52	CU 1/T10/2/ CU100 IN1	A	I	LLM1	0.707744	0.0007
Cundisa	53	CU T10/3/ CU 100 IN2	J	I	dURm1	0.707779	0.0006
Cundisa	54	CU 1/T11/ CU T16	A	PF	LRM3	0.708255	0.0008
Qhota Pata	68	QP 1A/4	A	PF	NM3	0.706737	0.0007

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