READING BETWEEN THE LINES: A SYMMETRY ANALYSIS OF LATE INTERMEDIATE PERIOD CHIRIBAYA MORTUARY CERAMICS FROM THE OSMORE DRAINAGE, SOUTHERN PERU

By

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ABSTRACT

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This dissertation research examines whether the specific arrangement and organization of geometric elements in designs found on ceramic vessels in a burial context reveals key information related to the mortuary practices of the Chiribaya, a prehispanic coastal people. The cemeteries of two sites are the focus of this research, Chiribaya Alta and Chiribaya Baja, which are located in the Ilo valley region of the Osmore drainage in southern Peru. Radiocarbon dates place the occupation of these sites between AD 700/750 – 1359 (Buikstra et al 2005). Scholars cite archaeological and bioarchaeological evidence to propose that Chiribaya people lived in loosely organized sub-groups that were united under one authority (Lozada 1998, 2011; Lozada and Buikstra 2002; Buikstra et al 2005; Reycraft 2000; Jessup 1991). In particular, some scholars (Lozada 1998, 2011; Buikstra et al 2005) cite the differential distribution of ceramic style with other criteria to suggest that individuals who associated with a particular sub-group may have indicated their membership according to cranial deformation style, ceramic style, and where they buried their dead. If, in fact, the Chiribaya people were loosely organized into two sub-groups that were united under an elite class, were there underlying rules that unified the culture? In this dissertation, I evaluate whether unifying factors can be detected by analyzing the geometric designs found on Chiribaya ceramic vessels from a mortuary context.

In this dissertation research I use the method of symmetry analysis, as developed by Washburn and Crowe (1988), to examine if specific design structures were consistently used to

arrange and organize geometric elements and motifs to form the designs on Chiribaya ceramic vessels. Design structure is an organizational feature of design that describes the basic layout and arrangement of elements or motifs and the way the elements and/or motifs are repeated to form a design (Shepard 1948; Washburn and Crowe 1988). Symmetry analysis is the systematic categorization of design structures according to their symmetric motions (Washburn and Crowe 1988). Washburn and Crowe (1988:11) have argued that symmetry analysis discloses cultural preferences for certain design symmetries on patterned material in a given culture. The question is—do these continuities and preferences have cultural meaning?

A detailed analysis of ceramic design structures on 247 ceramic vessels revealed that artists who created the designs found on Chiribaya ceramic vessels preferred a specific and limited set of design structures when organizing the patterns. Moreover, I propose that the symmetric arrangement of the geometric designs metaphorically encoded critical spatial and temporal knowledge referring to the physical environment and solar observations.

For Dahlia and Lupe, you are the reason.

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This dissertation research was based on archaeological collections stored in museums at Centro Mallqui, Museo Algarrobal in Ilo, Peru and Museo Contisuyo in Moquegua, Peru. The museum staff members were highly knowledgeable, warm, and welcoming. Their kindness made me feel at ease during my first solo trip doing field research.

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CHAPTER 1: INTRODUCTION

Chapter Introduction

Social groups without formal writing systems often have other sophisticated methods of passing along their traditions. The goal of this dissertation research is to test whether the specific arrangement and organization of geometric elements in designs found on ceramic vessels in a burial context reveals key information related to the mortuary practices of a prehispanic coastal people. This dissertation research addresses the question: is there detectable patterned human behavior in the mortuary archaeological record at Chiribaya Alta and Chiribaya Baja that results in consistent mortuary ritual practiced by the Chiribaya people of the coastal Osmore drainage?

The coastal Osmore drainage, of the south coast of Peru, has been consistently occupied by human settlements for millennia (see Figure 1.1). Diverse ecological zones in this region enabled the exploitation of various resources to support multiple subsistence strategies. The shoreline of the Pacific Ocean provided abundant marine resources, while thick fog that frequently enveloped the hilly regions above the shoreline created vegetation sufficient for the grazing of llama herds. The lower (Ilo) and middle (Moquegua) river valleys of the Osmore drainage were major ecological zones that supported irrigation agriculture for multiple social groups who settled beyond the coast and in the valley regions.

Figure 1.1. *The location of the Osmore drainage in south coastal Peru*[1].

This coastal drainage is located at the northern edge of the Atacama Desert, one of the driest deserts on earth. The arid climate enabled the amazing preservation conditions of ancient cemeteries in this region; archaeological excavations of prehispanic cemeteries revealed many documented cases in which the colorful textiles and even the skin and hair of the deceased still remain intact. The incredible preservation of human remains resulted in a large database of biological data from which several bioarchaeological analyses have been conducted. This has resulted in many studies that investigate the health, subsistence, body modification, social roles, and residential patterns of prehispanic coastal people (Martinson et al, 2003; Tomczak, 2003; Knudson et al, 2007; Nystrom and Malcom, 2010; Knudson and Price, 2007; Knudson and Buikstra, 2007; Lozada 1998, 2011; Buikstra et al, 2005; Lozada and Rakita, 2013).

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The focus of this dissertation is a prehispanic social group who occupied the coastal Osmore drainage during the late Middle Horizon until the Spanish conquest of the region in the late 16th century, the people associated with Chiribaya material culture. Specifically, this research will examine data pertaining to the Classic Chiribaya Period (AD 750 – 1359), largely within the Late Intermediate Period. Chiribaya people settled near the coast to exploit its marine resources and the spring-fed zones of the ravines. Others built settlements in the river valley, constructing residential areas and agricultural terraces above the Ilo River. People buried their deceased in formally bounded cemeteries adjacent to residential areas. An exception to this rule is at the coastal site of San Gerónimo, where the dead are buried in large shell middens (Jessup, 1991). Vibrant and elaborate ceramics with intricate geometric elements, textiles embroidered with geometric and zoomorphic elements, and a wealth of other grave goods accompany individuals interred at Chiribaya cemetery sites (Jessup, 1991; Umire and Miranda, 2001).

Published archaeological and bioarchaeological studies document the variability in the mortuary practices of the Chiribaya people. Stylistic variability and its differential distribution across Chiribaya cemeteries is documented in ceramic style, artificial cranial deformation, textiles, and wooden spoons (Lozada and Buikstra, 2002; Lozada, 1998, 2011; Nigra, 2009; Minkes, 2008; Boytner, 1998). The dominant model to explain this stylistic variability is that the people within the Chiribaya social group organized themselves into sub-groups, signaling their membership in each sub-group according to burial in a specific cemetery location and associated with different characteristics of ceramic style, grave good type, and cranial deformation style (Lozada, 1998, 2011; Lozada and Buikstra, 2002).

Needed now is a complementary mortuary analysis that investigates this proposition with different lines of evidence that examine the material correlates of mortuary behavior.

Documented stylistic variability according to cemetery location as reported by Lozada (1998, 2011) and Nigra (2009) supports the supposition that space may have been a critical organizing feature in Chiribaya mortuary ritual. Research conducted in this dissertation investigates the use of space in mortuary practices at two levels, at the level of the individual and at the group level, in order to understand how Chiribaya people used space as an organizing feature when burying their dead.

A unique outcome of the arid coastal climate is the recovery of an abundant amount of intact ceramic vessels with detailed geometric designs from mortuary contexts. The frequent inclusion of decorated ceramic vessels in tombs at Chiribaya cemeteries implies that this type of grave good was an integral part of the burial ritual. In this dissertation, I demonstrate how analysis of the colorful geometric designs that garnish Chiribaya ceramic vessels provides clues to consistent practices in Chiribaya funerary ritual.

I use the method of symmetry analysis to detect consistent use of specific design structures that arrange geometric elements and motifs into repeated designs on Chiribaya ceramic vessels. Design structure is a critical attribute of design that characterizes the arrangement and organization of elements into motifs and the manner in which these motifs are repeated to form a pattern (Shepard, 1948; Washburn and Crowe, 1988). Symmetry analysis is the systematic categorization of design structures according to their symmetric motions (Washburn and Crowe, 1988). Washburn and Crowe (1988, p. 11) have argued that symmetry analysis discloses cultural preferences for certain design symmetries on patterned material in a given culture. The question is—do these continuities and preferences, which have been observed through time and space, have cultural meaning? This dissertation research demonstrates that artists who created the designs found on Chiribaya ceramic vessels preferred a specific and limited set of design structures when organizing the patterns. I posit that these choices for specific design symmetries have cultural meaning.

This examination of the underlying structural organization of Chiribaya ceramic designs from a mortuary context will be juxtaposed against a mortuary analysis of the use of space in cemeteries 4 and 7 at Chiribaya Alta in order to detect complementary material correlates in the archaeological record as evidence for consistent patterns in mortuary behavior. I incorporate the spatial dimension of mortuary ritual at the level of the individual and at the level of the group, that is, the cemetery. The research objective is to link the preference for specific design structures with spatial correlates in the mortuary archaeological record in order to explain patterns in mortuary behavior at Chiribaya cemeteries in the coastal Osmore drainage.

Description of Chapters

In Chapter Two, I introduce the cultural and geographic background of the Chiribaya people. I provide a description of the geographic location and physical environment of the Osmore drainage, the general name of the river valley where a majority of the Chiribaya-affiliated archaeological sites have been found. The entirety of Osmore drainage, from the coast to the highlands, contains distinctive ecological zones that have been exploited over several millennia for their diverse resources. I also provide a brief cultural-historic background of this region beginning with a description of Lithic and Preceramic settlements along the coast and leading to the Chiribaya occupation of the coastal Osmore drainage during the Late Intermediate Period.

In Chapter Three I present the theoretical background of this dissertation in three sections. First, the goal of this dissertation is to test the ability of the method of symmetry analysis to reveal the consistent use of a limited set of design structures in the creation of Chiribaya ceramic design. Ethnographic and archaeological analyses document that when cultures organize their designs according to preferred plane pattern symmetries, cultural correlates in patterned human behavior can be detected. In this chapter, I explain how this theoretical link is possible. Second, I explain why an integration of bioarchaeological and mortuary analyses is important for a holistic understanding of a culture's burial traditions. Third, I discuss the use of space as an important organizing feature of burial ritual.

In Chapter Four, I discuss the Research Problem and explain the Research Hypotheses. Published research has focused on the presence of stylistic variation in the Chiribaya mortuary record to explain the existence of opposing sub-groups within the Chiribaya culture. I argue that an analysis that detects underlying patterns of consistent human behavior is necessary to understand the processes that generate and organize Chiribaya funerary practices. Moreover, while bioarchaeological analyses have dominated the research of Chiribaya occupation of the coastal Osmore drainage, I argue that a complementary mortuary analysis is needed to provide critical material correlates to the behavioral patterns detected in the skeletal data. Likewise, when investigating consistencies in the use of preferred design structures that organize patterns on ceramic vessels found in Chiribaya cemeteries, a supplementary analysis of mortuary data is needed that examines consistencies in other aspects of the burial practices. Finally, in order to understand the underlying processes that structured the funerary traditions of the Chiribaya, it is imperative to understand how the manipulation of space at multiple levels dictated these practices.

In Chapter Five, I explain the research design and methodology applied to this dissertation research. I discuss the sites of Chiribaya Alta and Chiribaya Baja, whose cemeteries are the focus of this dissertation research. Next, I describe the two datasets that comprise this analysis. The ceramic vessels included in this study were excavated from the nine cemeteries of Chiribaya Alta and cemetery 1 at Chiribaya Baja, which date to the late Middle Horizon to Late Intermediate Period (AD 750 – 1359). In order to bring a design structure analysis into the context of Chiribaya burial practices, I combine a symmetry analysis with a mortuary analysis of burial data of cemeteries 4 and 7 of Chiribaya Alta. I discuss in detail what symmetry analysis entails and how it was specifically applied to address questions pertaining to this dissertation research. Finally, I explain how I used burial attribute data to conduct a mortuary analysis that incorporates the use of space at the level of the individual and at the level of the group (cemetery).

In Chapter Six, I explain the results of my analysis of ceramic symmetry data and burial attribute data. I used chi-square tests and correspondence analysis to determine the preferred design structures that organized the patterns on Chiribaya ceramic vessels, as well as the distribution of the limited set of design structures across the cemeteries of Chiribaya Alta and Chiribaya Baja. Chi-square analyses were used to test how the use of space, at the level of the individual and at the level of the group, structured the burial process of the Chiribaya.

In the final chapter, Chapter Seven, I merge the results of the symmetry analysis with the mortuary analysis and published bioarchaeological reports to demonstrate consistent trends in the funerary practices of the Chiribaya people of the coastal Osmore drainage, Peru. Results discussed in this dissertation establish that artists did use a specific and limited set of design structures to arrange and organize the designs that decorated Chiribaya ceramic vessels that were included in the tombs of the deceased. Furthermore, I argue that the color symmetry of the patterns on the ceramic vessels provides clues to the basic organizing principles that structured

Chiribaya mortuary practices and cultural knowledge that was key to prehispanic lifeways. Analysis of mortuary data demonstrated consistent human behavior between cemeteries 4 and 7 at Chiribaya Alta at the individual and cemetery level. This dissertation demonstrates that incorporating multiple lines of evidence, which include a symmetry analysis of ceramic design structures with an analysis of burial attributes at two different spatial levels and published bioarchaeological studies, expands the kinds of meaningful inferences of past social practices that can be made based on mortuary data.

CHAPTER 2: CULTURAL AND GEOGRAPHICAL CONTEXT

Chapter Introduction

In this chapter I will introduce the Chiribaya culture, a series of prehispanic communities located within the Osmore drainage of southern Peru from AD 700/750 until the Spanish conquest of the region during the late sixteenth century (Reycraft, 1998, 2005). Analysis in this dissertation will focus on the Classic Chiribaya period, which dates to the late Middle Horizon to the Late Intermediate Period (AD 700/750-1359) (Reycraft, 2005; Lozada and Buikstra, 2002; Lozada et al, 2009; Buikstra et al, 2005; Zaro et al, 2010; Malcom and Nystrom, 2010). I will first provide a general description of the Osmore drainage, the valley where a majority of the Chiribaya-affiliated sites are located. Next, I will briefly discuss the chronological history of the Osmore drainage and surrounding regions beginning with the Lithic and Preceramic periods and ending with the Late Intermediate Period prehispanic cultures. I will review Chiribaya settlement patterns and the general mortuary ritual of individuals interred at Chiribaya-affiliated cemeteries.

Geographical Context

The geographic focus of this research is the Osmore river drainage in far southern Peru. For consistency, I will follow the nomenclature for this river system used in Stanish and Rice (1989). The term “Osmore” is the name for the entire drainage from the coast to the highland; valley names specify the geographical sections within the drainage (Stanish and Rice, 1989, p. 12). Archaeological sites and research pertaining to this dissertation will refer to sites located in the Moquegua river valley (1000-2000 meters above sea level) and in the Ilo river valley (0-1000 meters above sea level). The Moquegua Valley and the Ilo Valley comprise the middle and lower sections of the Osmore river drainage system, respectively (Stanish and Rice, 1989, p.

12) and will be referred to in this dissertation as the “middle valley” or the “Moquegua Valley” and the “lower valley” or the “Ilo Valley”.

Humberto Ghersi identified the first Chiribaya-affiliated sites in 1956 in the Ilo Valley. Based on ceramic remains and mortuary treatments, such as grave offerings, Ghersi (1956) stated that the archaeological evidence represented the development of a distinct local culture. Surveys along the southern Peruvian coast indicates the geographic extent of the Chiribaya stretched south to the Azapa Valley in Chile and north up the coast to the Tambo Valley, near Arequipa, Peru (see Figure 2.1; Jessup, 1990; Buikstra, 1995; Reycraft, 1998; Zaro et al, 2010; Umire and Miranda, 2001). Sites with Chiribaya material culture have been detected as far as 50 km East from the Pacific Ocean up to the Moquegua Valley (Rice, 1993; Zaro et al, 2010; Knudson and Buikstra, 2007).

Figure 2.1. *The geographic extent of the Chiribaya material culture*[2].

The lower and middle elevations of the Osmore drainage, zero to 1900 meters above sea level (masl), comprise a sub-tropical desert zone and are characterized by humid, semi-warm climate and low precipitation, which range from barren and uncultivated coastal plains (or *pampas*) to areas of agricultural potential along the valley floor (Rice, 1989, p. 23-25; Umire and Miranda, 2001, p. 15). The merger of the rivers Tumilaca, Torata, and Huaracane forms the middle or Moquegua Valley, extending from about 1600 masl above the modern city of Moquegua down to about 900 masl (see Figure 2.2). This merger of the three rivers affords the Moquegua Valley great potential for farmland because the surface flow of water is relatively

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predictable (Rice, 1989, p. 29-31). At about 900 masl the environment shifts to a dry, rocky gorge that is about 31 km long and separates the Moquegua valley from the Ilo valley (see Figure 2; Owen, 2005, p. 51). Surface water and sparse areas of farmland reappear in the coastal or Ilo Valley, which is about 25 km long and extends from 325 masl to the Pacific Ocean (Owen, 2005, p. 51; Lozada Cerna and Buikstra, 2002, p. 50). Sheer valley walls characterize the lower Osmore drainage that make the Ilo Valley narrow and V-shaped, causing valley residents to be cut off from diverse coastal resources (Reycraft, 1998, 2000). Reycraft (2000) suggests that this separation of the valley from the coast fostered an agricultural specialization for inhabitants of the Ilo Valley.

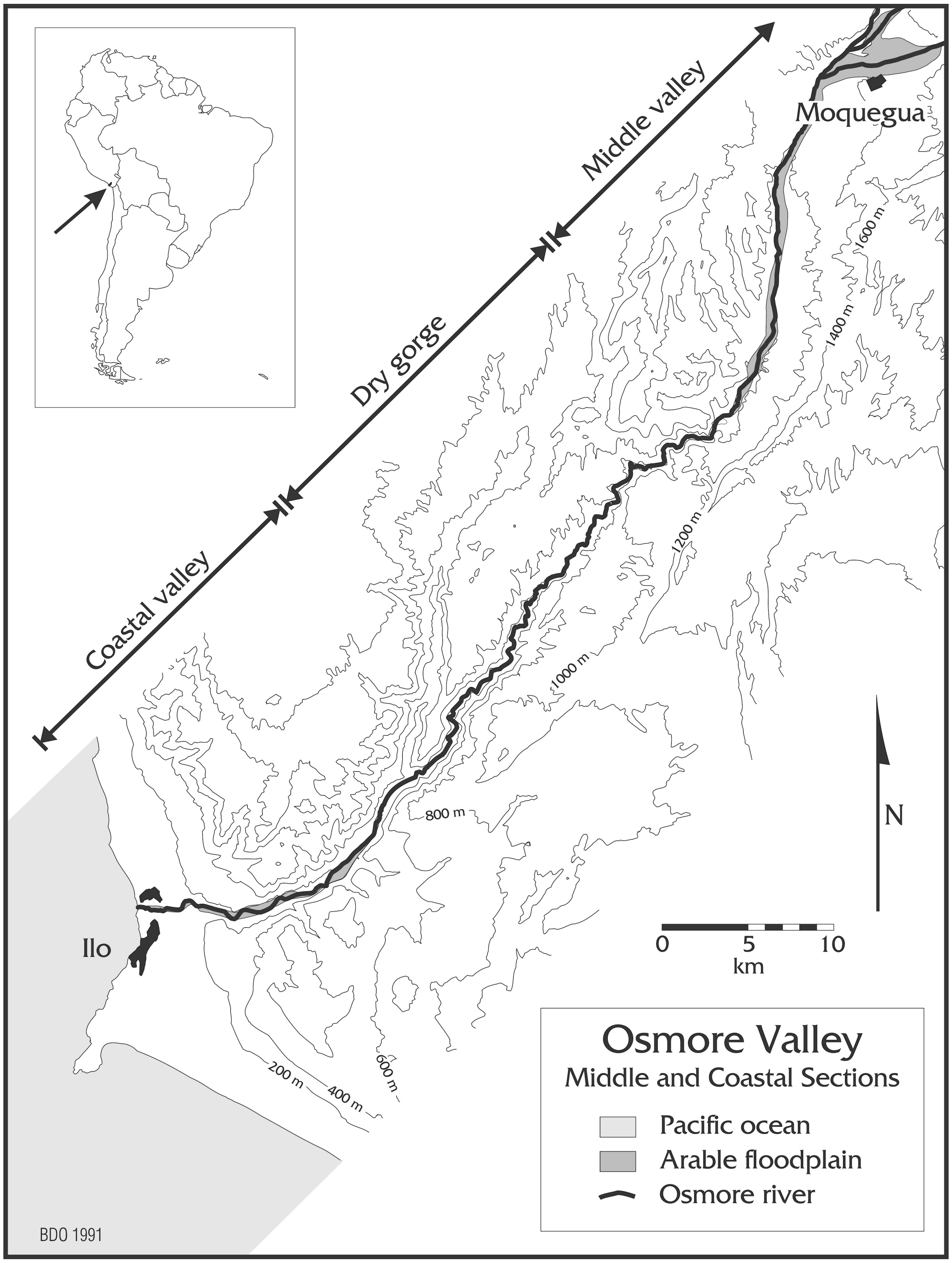

Figure 2.2. *The geographical sections of the Osmore drainage in southern Peru* (Owen, 1993a, p. 5). Reprinted with permission from Bruce Owen.

Outside the Ilo Valley bottom is the coastal spring area, which supported three ecological microzones (Reycraft, 2000). The foothills supported a dense growth of *lomas* fog vegetation, a seasonal source of pasture plants suitable for camelid herds and small game hunting (Reycraft, 2000; Owen, 2005, p. 51; Rice, 1989, p. 23; Umire and Miranda, 2001, p. 15-16). The areas in which the *lomas* fog occurs are characterized by small hills and a slight increase in elevation with the formation of modest sand dunes (Umire and Miranda, 2001, p. 15-16). The spring-fed drainage enabled the use of small tank and canal irrigation systems and the Pacific coast provided abundant marine resources (Reycraft, 1998, 2000).

Time

Evidence from archaeological sites in the Osmore Drainage indicates that Chiribaya populations inhabited this region of southern Peru from the late Middle Horizon (AD 600-1000) until the Spanish conquest of the late 16th century (Reycraft, 1998, 2000). Reycraft (1998) determined that the Chiribaya occupation of south coast Peru should be divided into two time periods: the Classic Chiribaya period (AD 700/750 – 1359) and the Terminal Chiribaya period (AD 1360 – 1600). Cemeteries with Chiribaya material culture dating to the Classic Chiribaya period are the focus of this dissertation. Radiocarbon dates from several Chiribaya archaeological sites throughout the Osmore drainage place the Classic Chiribaya occupation of this region from AD 750 – 1359 (Lozada and Buikstra, 2002; Lozada et al, 2009; Buikstra et al, 2005; Zaro et al, 2010; Malcom and Nystrom, 2010), with the earliest radiocarbon dates coming from cemeteries 3 and 7 at Chiribaya Alta (Lozada and Buikstra, 2002; Malcom and Nystrom, 2010). However, this suggested range of time for Chiribaya occupation of the Osmore drainage does not come without controversy.

It has been documented that Chiribaya people living on the coastal Osmore Drainage ate large quantities of fish and shellfish (Tomczak, 2003; Jessup, 1991); however, ocean waters off the coast of the modern town of Ilo are very depleted in radiocarbon and this can cause radiocarbon dates from human bone samples to look deceptively old (Owen, pers. comm. 2016;

deFrance et al, 2009). To correct for this problem, the estimated age of local seawater and the "corresponding local offset from the global marine calibration curve at the time of interest" must be known (Owen, 2002, p. 701). A suggested solution for this problem is to subtract 40 years from the terrestrial date before calibration is applied, known as the Southern Hemisphere correction (SHC) (Owen, 2002, p. 705). The radiocarbon dates from Chiribaya mortuary contexts were developed from samples of human remains and 41 years subtracted, applying the Southern Hemisphere correction (Buikstra et al, 2005, p. 72). It is beyond the scope of this dissertation to contribute to the discussion of radiocarbon dates from Chiribaya-affiliated sites. Recognizing that many radiocarbon samples were taken from remains of human bone and in the name of consistency, I will continue to reference the Classic Chiribaya period occupation of the Osmore drainage from approximately AD 750 –1359.

Chronological History of the Osmore Drainage

In the following overview of human occupation of the Osmore drainage and nearby valleys, I will follow the chronological sequence as discussed by Moseley (2001). Table 2.1 provides a brief summary of the chronology for the south central Andes.

Time Period	
Late Intermediate Period	A.D. 1476 - A.D. 1000
Middle Horizon	A.D. 1000 - A.D. 600
Early Intermediate Period	A.D. 600 - 200 B.C.
Early Horizon	200 B.C. - 400 B.C.
Initial Period	400 B.C. - 1800 B.C.
Preceramic Period	1800 B.C. - 3000 B.C.
Lithic Period	3000 B.C. ↓

Table 2.1. *Chronology for the Osmore Drainage, as discussed in this research*. *Time ranges are derived from Moseley, 2001.

Lithic and Preceramic settlements

The Lithic Period coincides with dynamic changes associated with the retreat of the Ice Age (Moseley, 2001, p. 107). The Osmore coastal region has a long history of occupation, sustained in large part by local marine resources, stretching back to this period of time. Documented Late Paleo-Indian (11,000-9,000 cal. B.C.) occupation of the Osmore coastal plain is indicated by evidence of coastal forager populations settling in the region and continuing to occupy the area, favoring coastal springs and ravine (*quebrada*) channels, for over 12,000 years (deFrance et al, 2009). DeFrance et al (2009, p. 243) state that there is no evidence for periods of total abandonment of this region; instead, people moved north and south along the coastal plain, with no single site demonstrating a continuous occupation.

Archaeological remains of long-term camps and villages demonstrate the establishment of long-term settlements along the Osmore coastal plain during the Lithic Period. For instance, the Ring Site, located 7.5 km southeast of the modern city of Ilo and 0.75 km inland from the modern-day shoreline, was identified as a residential base camp with long-term occupation (Sandweiss et al, 1989; deFrance et al, 2009). Radiocarbon dates place the initial occupation of the site to about 10,110 CAL. B.C. (Sandweiss et al, 1989; deFrance et al, 2009, p. 236). Faunal evidence from the Ring Site reveal an almost total reliance on marine resources for subsistence (Sandweiss et al, 1989).

The Preceramic period, also termed the Late Archaic period, begins around 3000 BC when sea levels began to stabilize (Moseley, 2001, p. 107). Wise (1997, p. 3) describes trends for the Late Archaic period settlements of the south-central Andean coast as relatively sedentary groups of people living in small villages whose mortuary tradition shifted from extended and artificially treated individuals in multiple burials to flexed individuals placed in single interments. The Late Archaic component (ca. 3650-1670 CAL. B.C) of the coastal site of Carrizal suggests a more intensively occupied and centrally-located settlement pattern near fresh water, marine, and terrestrial resources (Wise, 1989; deFrance et al, 2009, p. 237). Carrizal is located near a coastal spring, 15km north of the Ilo River; the Late Archaic remains consist of a shell midden and a series of domestic terraces located in the hills above the ravine (*quebrada*) (deFrance et al, 2009, p. 237). Similar to the Ring Site, faunal remains indicate marine and coastal organisms as primary sources of the inhabitants' diet (Wise, 1989, 1997; deFrance et al, 2009).

Populations occupying the Osmore coastal plains during the Lithic and Preceramic periods used locally available resources and raw materials for subsistence. Wise (1989) states that while there are similarities in rock art, projectile point styles, and chipped stone raw materials between coastal and highland sites, there is scant evidence of a connection between the two regions. Overall, Wise (1997) describes the residential pattern of Late Archaic period settlements in the coastal Osmore plain as domestic structures located on terraces, which are on hill slopes above midden areas. The cemeteries at the coastal sites of Kilometer 4 and Quiani were segregated from the residential areas.

The Initial Period and Early Horizon

The Initial period marks the adoption of agriculture, albeit at different times, throughout the Andes. Farming appeared in northern and central Peru around 1800 BC; however, agropastoralism was a subsistence strategy in the highland Titicaca region of southern Peru at around 1600 BC, as rainfall increased in this area (Moseley, 2001, p. 107). Cultivation of certain plant species and pottery production were not adopted by culture groups located in the Atacama Desert and the hyper-arid Chilean coast until several centuries later (Moseley, 2001, p. 107). The reason for the delayed adoption of farming in the extreme southern coastal Andes is due to a combination of environmental factors that typify this harsh region. Moseley (2001, p. 110) describes cold up-welling currents that make the Pacific waters off the Peruvian coast the richest fishery in the Western Hemisphere. However, the frigid waters create a "temperature inversion that inhibits rainfall in the world's driest desert." While all the coastal waters could be fished, less than ten percent of the desert could be farmed even with large irrigation networks. Moreover, the self-watering river floodplains were narrow and offer little land available for farming.

During the Initial period, in the southern highlands of the Lake Titicaca region, agropastoral communities grew and prospered after 1600 BC to about 900 BC when drought set in (Moseley, 2001, p. 154). The inception of agropastoralism and subsequent population growth in the southern highlands was met with the construction of large and small civic-ceremonial architectural works, such as those found at the site of Chiripa, located on the southern shore of Lake Titicaca (Moseley, 2001).

In contrast, Initial period populations living along the far south coast, in the Atacama Desert, experienced a harsher environment created by a higher and drier mountain range and maintained different subsistence strategies than their Lake Titicaca counterparts (Moseley, 2001). Moseley (2001, p. 157-158), citing the work of Nuñez and Dillehay, states that around the last century BC farming and herding may have been separate subsistence strategies managed by distinct groups of people living in the highland oasis of San Pedro de Atacama and the Río Loa desert valley in northern Chile. Farmers living in the desert valley and herders, traveling between the highlands and the valley, may have maintained a symbiotic relationship for the transport and exchange of goods and resources.

In the southern Andes, the Early Horizon, beginning around 400 BC, can be characterized by elaborate and ornate material culture. In the southern highlands, northwest of Lake Titicaca, people associated with Pukara material culture and the Yaya Mama Tradition built monumental architecture and created complex, corporate-style ceramics (Moseley, 2001). Along the southern coast, the Paracas cultural tradition spanned six river valleys from Cañete to the Nazca river drainage (Paul, 1991). This tradition is known for the Paracas Necropolis, an extensive burial ground with large underground and semi-subterranean structures containing multiple interments (Moseley, 2001, p. 160-162). In 1927-1928, Julio C. Tello excavated over 400 mummy bundles from this site (Frame, 1991, p. 110). This expansive area contained tombs with elaborate embroidered garments and other grave wealth, but no residential architecture was found, leading investigators to interpret this space as a burial ground for local lords or for elites from surrounding areas (Frame, 1991).

The Early Intermediate Period

The earliest ceramic assemblages in the coastal Osmore drainage date to The Early Intermediate Period (200 BC – AD 600), which marked a time of social change in this region, as agricultural practices appear to be a dominant subsistence economy. Survey work revealed archaeological sites associated with El Algodonal Early Ceramic (AEC) assemblages were organized near the valley floor, ranging from 1km from the coast to 20 km inland (Owen, 1993b). The settlements, which have calibrated radiocarbon dates from 100 BC to AD 380, consisted of large habitation terraces built on steep hillsides and situated to take advantage of the arable land of the valley bottom (Owen, 1993b). In an apparent shift from previous and subsequent time periods, marine resources did not play a dominant role in the subsistence strategy of populations associated with El Algodonal Early Ceramic style. Excavations of middens at AEC sites in the coastal Osmore drainage revealed an emphasis on maize, with marine resources making up only a small density of midden mass (Owen, 1993b).

The use of formally bounded cemeteries or placing the dead in areas separate from the living, as well as elaborate treatment of the dead is documented during the Early Intermediate Period (200 BC – AD 600) in the Osmore drainage. Individuals buried with AEC style pottery tended to be buried in artificial mounds near habitation terraces, without grave goods, and occasionally "with body parts separated and interred in nonanatomical positions" (Owen, 1993b; Owen, 2005, p. 70). At the coastal cemetery of Wawakiki, there is evidence that the skull was removed from the body following a period of decomposition, suggesting a possible display of ancestors by living relatives (Buikstra, 1995, p. 239).

During the Early Intermediate Period, indigenous farmers with a complex and varied mortuary tradition populated the middle Osmore (Moquegua) valley. The Huaracane tradition, the earliest-pottery-using populations in the Moquegua valley (385 BC), is characterized by residential terraces located on low hilltops in close proximity to the floodplain (Goldstein, 2000; Feldman, 1989). Residents at Huaracane-affiliated sites used mixed subsistence strategies of simple canal-based agriculture complemented by herding, hunting, and marine resources (Goldstein, 2000, p. 343). The first cemeteries identified in the mid-valley region of the Osmore Drainage are associated with the Huaracane tradition (Buikstra, 1995; Feldman, 1989). The mortuary practices of the Huaracane range from single or multiple interments in simple pits or cylindrical cysts to burial mounds containing multiple individuals, but limited grave goods (Buikstra, 1995; Goldstein, 2000). The burial mounds were a common method of interment during most of the Huaracane occupation of the Moquegua valley; they were round semisubterranean structures and located adjacent to habitation terraces (Buikstra, 1995; Goldstein, 2000). A shift in the mortuary practices that occurred late in the Huaracane occupation of the middle valley was the use of boot tombs or shaft and chamber tombs that were located away from residential areas. Cemeteries containing boot tombs often contained multiple interments, large quantities of grave goods, and were found on bluffs that overlooked the valley (Goldstein, 2000, p. 350-351). Moreover, the presence of foreign or exotic goods in boot tombs indicates an elite subgroup within the Huaracane population that used cemetery location, tomb form, and certain grave goods to set themselves apart from the rest of the population (Feldman, 1989: Goldstein, 2000, p. 356).

Middle Horizon

During the Middle Horizon (AD 600 – AD 1000), Tiwanaku, a large polity based in the southern region of Lake Titicaca, and Wari, another large polity based in the Ayacucho region, expanded their cultural and political influence to the lower altitudes of the Moquegua valley. Archaeological survey and excavations of Tiwanaku-affiliated sites, in particular, demonstrate an intensive occupation of the region with numerous residential areas, agricultural exploitation, cemeteries, and ceremonial centers that were replicas of the monumental Tiwanaku ceremonial center in the altiplano (Goldstein, 2015; Hoshower et al, 1995).

The late Middle Horizon marks a time in the lower and middle Osmore drainage in which multiple social groups with distinct material cultures were living in close proximity to one another, but without much contact with each other. In the middle valley, populations associated with Wari and Tiwanaku material cultures occupied this region with its indigenous inhabitants, the Huaracane (Costion, 2013). Excavations of Huaracane-affiliated sites did not reveal evidence of a Wari or Tiwanaku presence, even though archaeological sites with Wari and Tiwanaku architecture were located nearby (Costion, 2013). Further towards the coast, Chiribaya populations occupied the lower Osmore drainage, exploiting the resources of the ocean and the Ilo river valley, seemingly without much contact with occupants of the middle valley. Archaeological surveys conducted by Owen (1993a) did not find any evidence of Tiwanaku settlements on the Osmore coast.

Late Intermediate Period

Scholars suggest that contact between inhabitants of the lower and middle Osmore drainage was initiated with the decreased and later demise of the Tiwanaku sociopolitical influence throughout the southern Andean region at the onset of the Late Intermediate Period

(AD 1000 – AD 1476). Around AD 1000, inhabitants of Tiwanaku settlements in the Moquegua valley begin to disperse with some establishing residences in the higher altitudes of the Osmore drainage, while others moved to the lower reaches of the Ilo river valley (Owen, 2005; Buikstra et al, 2005). Citing excavation and survey work, Owen (1993a, 2005) states that middle valley groups migrated to the Ilo river valley and constructed habitation and agricultural terraces near the already-occupied residential zones of the Chiribaya (Owen, 1993a, 2005). Archaeologists conducting survey and excavation work in the Ilo river valley identified the material culture used by this middle valley group as "Ilo-Tumilaca/Cabuza", particularly after similarities in stylistic traits with ceramic assemblages found at the type site of Tumilaca in the Moquegua Valley and after a ceramic assemblage found in the Azapa region of northern Chile (Owen, 1993a). For consistency, I will use the term "Ilo-Tumilaca/Cabuza" when referring to the group of people who are associated with this material culture.

Archaeological evidence suggests that populations using the distinct styles of Chiribaya or Ilo-Tumilaca/Cabuza material culture shared the resources of the Ilo river valley in relative peace for at least two centuries. For instance, there is no documented archaeological evidence of violence and, with the exception of a defensive wall that surrounded Chiribaya Alta, residential and agricultural terraces were built in non-defensible locations along the floodplain or slightly above it (Owen, 2005). There is even evidence that groups of people with Chiribaya or Ilo-Tumilaca/Cabuza material cultural were buried in the same cemeteries with the distinctive mortuary traditions of each group. The sites of El Algodonal and La Cruz in the Ilo Valley contained both Chiribaya and Ilo-Tumilaca/Cabuza burials, which were located in distinct, yet adjacent sections at each site (Owen, 1993a; Minkes, 2005). Minkes (2005, p. 213) suggests that inhabitants of the lower Osmore drainage followed “a burial tradition in spatially defined and culturally segregated zones.”

Around AD 1360, the settlement patterns in the lower Osmore drainage were altered by major climatic events and subsequently shifted to smaller habitation sites on the coastal Osmore plain. Reycraft (1998, 2000) reports that during the Late Intermediate Period, the lower Osmore drainage experienced massive depopulation due to the Miraflores El Niño event that brought torrential rains and mudflows that breached the valley irrigation canals, burying the residential areas and their associated agricultural fields. The effects of the environmental disaster on the Chiribaya people can be detected in the change in residential patterns and in the almost total loss of decorative elements on ceramics and textiles (Reycraft, 1998, 2005). Chiribaya Alta was abandoned and the irrigation canal was never rebuilt (Reycraft, 1998). The Ilo Valley was sparsely populated by scattered residential areas that were built on top of fossilized debris flows and agricultural terraces (Reycraft, 1998). In contrast, the coastal plains were inhabited by small settlements that exploited the diverse mirco-environments of the coastal springs, the *lomas* area, and the marine resources (Reycraft, 1998; Zaro and Alvarez, 2005; Zaro, 2007; Zaro et al, 2010).

The Chiribaya

The Chiribaya occupation of the Osmore drainage spans the late Middle Horizon until the conquest of the region by the Spanish and can be divided into two phases – the Classic Chiribaya phase and the Terminal Chiribaya phase (Reycraft, 1998, 2005). Reycraft (1998) defines the time period between AD 1000- 1360 as the late Classic Chiribaya phase because it represents a time of “cultural florescence, population growth, and enhanced agricultural development.” Jessup (1991) describes the Classic Chiribaya phase as a long period of development characterized by the establishment of control over diverse resources, a certain degree of economic specialization, and the development of strong inter-site social hierarchy. Excavations of trash middens and burials from coastal and lower valley Classic Chiribaya sites suggest the presence of two sub-groups that subdivided the culture group according to the subsistence strategies of fishing and farming (Ghersi, 1956; Jessup, 1990, 1991; Lozada and Buikstra, 2002). Furthermore, Jessup (1991, p. 11) suggests that excavations of cemeteries at Chiribaya Alta and San Gerónimo provide evidence for "the presence of an elite status group that cross-cut individual Chiribaya site boundaries." Research and analysis conducted in this dissertation will focus on ceramic vessels and mortuary remains that date to AD 700/750 – 1359.

The Terminal Chiribaya phase (AD 1360 – 1600) was marked by shifts in the settlement patterns and subsistence strategies that coincided with the Miraflores El Niño event (Reycraft, 1998). This final phase is characterized by widespread de-population of lower valley settlements and smaller habitation sites located along coastal plains with an almost total loss of decorative elements on ceramics and textiles (Reycraft, 1998, 2005).

Settlement patterns

Classic Chiribaya settlements were strategically placed in locations that maximized the potential of available resources: the abundant marine resources of the Pacific coast and the agriculture potential of the Ilo and Moquegua river valleys (see Figure 2.3). In the Ilo Valley, residential areas and agricultural terraces were constructed near the river floodplain. In recent years, the river in the Ilo Valley flows on the surface for only a few days or weeks each year. However, archaeological evidence based on abandoned prehispanic irrigation systems suggests that the flow of water in the Ilo river valley was more abundant and possibly flowed year-round in ancient times (Owen, 2005, p. 51; Owen, 1993a, p. 6).

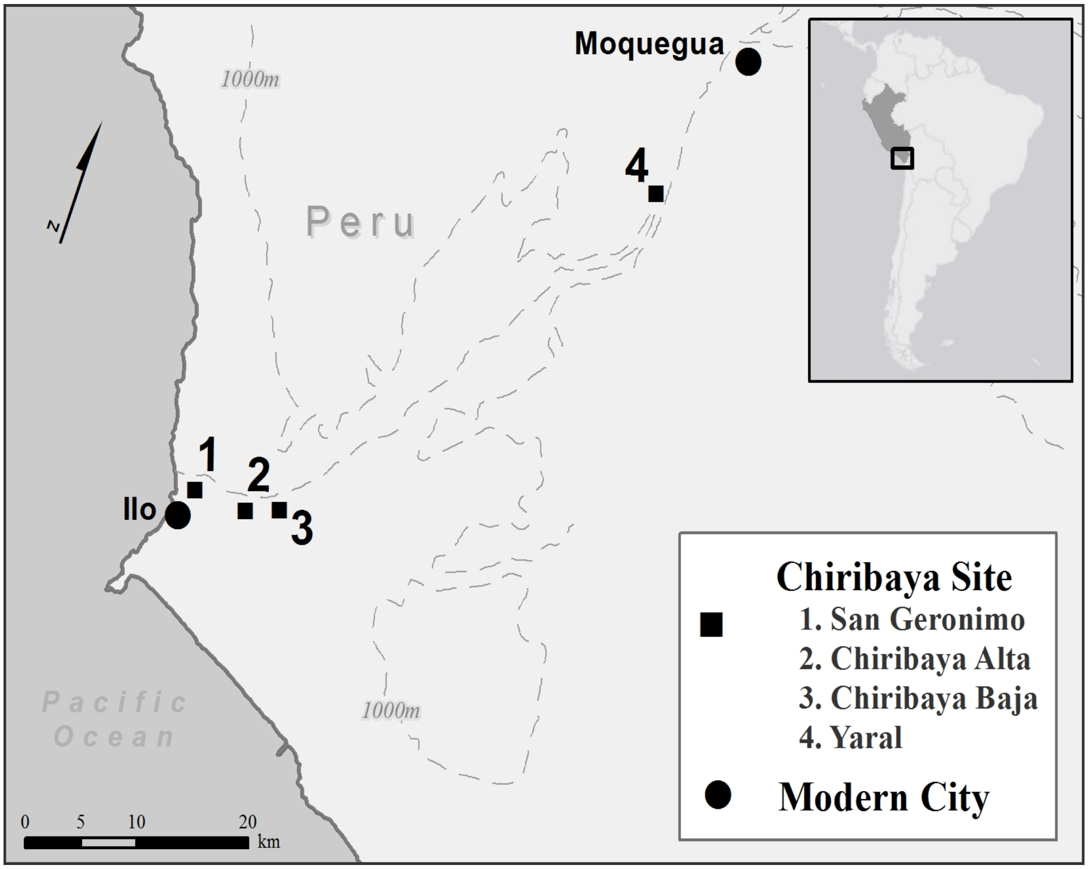

Figure 2.3. *Chiribaya archaeological sites discussed in this research* (modified after Buikstra, 1995, p. 234)[3].

The Ilo Valley has sheer walls that cut off valley inhabitants from coastal resources; this led to a specialization in agriculture as a primary resource for those settled in this area (Reycraft, 1998, p. 29). Chiribaya occupants of the Ilo Valley constructed a 7km canal irrigation system into the rock face of the valley wall that linked sites throughout the north side of the lower valley (Jessup, 1990; Reycraft, 1998). By A.D. 1000, Chiribaya farming villages were organized into densely populated settlements located near the valley floor and were heavily dependent on irrigation agriculture (Zaro et al, 2010). For instance, Chiribaya Baja, located in the Ilo Valley, contained residential zones and 13 agricultural terraces close to the floodplain indicating a specialization in agriculture (Umire and Miranda, 2001; Rice, 1993). Survey and excavation

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work in the Moquegua Valley revealed that people using Chiribaya material culture occupied an extensive site, El Yaral, which contained residences, agricultural terraces, and two cemeteries (Rice, 1993).

An example of a Chiribaya dwelling comes from Chiribaya Baja. At Chiribaya Baja, residential areas were large, mud-walled structures with rectangular rooms (Jessup, 1990). Excavation results suggest that these rooms were sectioned or partitioned spaces for specific activities: there were smaller rooms for sleeping; slightly larger rooms for cooking; elongated, rectangular spaces that acted as corridors; and finally large spaces thought to be open-air patios (Umire and Miranda, 2001, p. 69; Jessup, 1990, p. 6). The layout of these dwellings and the internal divisions in certain rooms lead Jessup (1990) to suggest that Chiribaya Baja residences were occupied by nuclear families that were part of a larger extended family.

Along the Osmore coast, there are distinct sets of natural resources: beaches, lomas, and spring-fed ravines (*quebradas)* (Wise, 1989). Chiribaya sites located near the coast were concentrated near springs and exploited three micro-environments: *lomas* vegetation for camelid herding and small game hunting; spring-fed canal irrigation for plant cultivation; and the plentiful marine resources of the Pacific Ocean (Reycraft, 1998, p. 29-32). Certain Chiribaya settlements along the Osmore coast, such as at San Gerónimo, seemed to have specialized in the procurement of marine resources. Jessup's (1990, 1991) excavation of the coastal site of San Gerónimo revealed a dependence on marine resources based on shell midden deposits and a predominance of fishing tools found in burials.

The *lomas* vegetation offered another opportunity for other supplemental subsistence strategies, hunting and pastoralism. The Chiribaya culture flourished during a time when the flow of water in the Ilo Valley was more consistent and the *lomas* region, which looks like a desert today, was most likely more lush and productive (Jessup, 1990). Camelid herding may have been maintained on the pampas above the valley floor as another resource for valley occupants (Reycraft, 1998, p. 29-32). The Ilo Valley is narrow, making intensive agricultural practices difficult; therefore, researchers hypothesized that Chiribaya populations used pastoralism of camelid herds to supplement small-scale agriculture (Lozada et al, 2009). Archaeological evidence of corrals and corral-like structures were found along the coastal Osmore drainage, especially north of the modern city of Ilo (Umire and Miranda, 2001). While archaeological artifacts and structural remains do not indicate that llama herds remained on the coast year-round, stable isotope analysis of camelid remains from coastal Chiribaya tombs found that camelids were being raised in the lower Ilo Valley and not imported from the highlands (Umire and Miranda, 2001; Lozada et al, 2009). Regardless of llama transhumance patterns, the importance of this animal to the Chiribaya population is evident. Llama herds were used for transportation, a source of protein, and clothing was exclusively made with llama wool (Jessup, 1990). The significance of this animal is further underscored by the inclusion of llama parts in human burials (Jessup, 1990).

Archaeological survey work and excavations located beyond the coastal Osmore drainage revealed that inhabitants of Chiribaya settlements, particularly in the areas between ravines (*quebradas*), had more diverse subsistence strategies as opposed to the economic specializations that typify the coast and Ilo Valley (Jessup, 1990; Zaro and Alvarez, 2005; Zaro, 2007; Zaro et al, 2010). For instance, at the site of Wawakiki, an intervalley site located north of the Ilo valley, archaeological excavations revealed a subsistence strategy that involved the exploitation of multiple resources available in the region, such as agriculture supported by coastal springs, marine resources, and wild terrestrial resources found among the *lomas* vegetation (Zaro and

Alvarez, 2005; Zaro, 2007). Furthermore, Zaro and colleagues (2010) argue that survey work revealed settlements, agricultural terraces, and formally bounded cemeteries in the region between the Ilo and Tambo river valleys, indicating that diverse resource strategies may have sustained Chiribaya populations well after the El Niño event that decimated Ilo Valley populations in the mid 14th century.

<u>Subsistence patterns</u>

Stable carbon and nitrogen isotope ratios have been examined to reconstruct the diet and subsistence resources of the Chiribaya culture in the coastal and middle Osmore drainage (Tomczak, 2003; Buikstra et al, 2005). Results found that individuals living in this region during the late Middle Horizon to Late Intermediate Period (AD 700 – 1359) were subsisting on the resources available in their local economy (Tomczak, 2003). Individuals buried at the coastal site of San Gerónimo were found to have a predominately marine-based diet, while the population at the cemeteries of Chiribaya Baja consumed most of their food from terrestrial resources (Tomczak, 2003, p. 273-275). Interestingly, Chiribaya Alta, located on a bluff that overlooks the Ilo Valley to the East and the Pacific Ocean to the West, had a mixed subsistence pattern among its nine cemeteries. Cemeteries 3, 4, 5, 7, and 8 of Chiribaya Alta show strong marine signals, meaning the individuals buried at these cemeteries had a predominately marine-based diet during their lifetimes (Tomczak, 2003, p. 272; Buikstra et al, 2005, p. 75). In contrast, results from the remaining cemeteries at Chiribaya Alta suggest that individuals had a greater reliance on terrestrial-based resources (Tomczak, 2003, p. 275).

Furthermore, carbon and nitrogen isotope analyses of archaeological human hair samples demonstrated that individuals at Chiribaya Alta had a more varied, seasonal diet of marine plants and animals and terrestrial resources, such as maize (Knudson et al, 2007). In contrast, individuals buried at the Chiribaya-affiliated site of El Yaral, located approximately 50 km from the coast, had a more homogenous diet and mostly consumed terrestrial resources (Knudson et al, 2007).

Chiribaya Mortuary Ritual

Cemetery organization

Chiribaya cemeteries in the lower and middle Osmore drainage are arranged in formally bounded areas that are separated from, yet located close to, residential zones (Buikstra, 1995; Minkes, 2005). An exception to this pattern is the coastal site of San Gerónimo, where burials are predominately recovered from midden contexts (Buikstra, 1995; Jessup, 1990). Generally, tombs in the lower Osmore drainage (the Ilo Valley) are rectangular in shape with straight walls made of stone and mortar and sealed with large stone slabs and mud (Buikstra, 1995; Jessup, 1990). According to Jessup (1990, p. 4), excavations at Chiribaya Alta, Chiribaya Baja, and San Gerónimo revealed two variations of rectangular tombs: 1) tombs constructed with four stone walls; and 2) tombs constructed with only two parallel stone walls with the other two walls left unfinished. The tombs with two stone walls had a greater depth, a larger quantity of grave goods, and were often associated with San Geronimo phase ceramics.

In contrast, the common tomb shape at the Moquegua valley site of El Yaral is circular to oval cists (Buikstra, 1995; Jessup, 1990). While circular tombs are common at Chiribaya cemeteries in the Moquegua Valley, this tomb shape also appears at Chiribaya-affiliated cemeteries in the lower Osmore (Ilo) valley, for instance at the sites of Algodonal and Loreto Viejo (Jessup, 1990).

Treatment of the individual

While there is variation in Chiribaya funerary ritual, standard practices have been observed among the recorded burials throughout the lower Osmore drainage. Typically, Chiribaya burials are single interments, however, there are occurrences of multiple individuals in one tomb (Lozada, 1998; Buikstra et al, 2005). Chiribaya deceased were individually wrapped into what is commonly called a mummy bundle, or *fardo*, using textiles made from llama wool and woven with colorful designs. The individual was then placed in the tomb, usually in a seated and flexed position, with back against the wall and facing either South or East (Ghersi, 1956; Buikstra, 1995; Minkes, 2005; Jessup, 1990). The process for bundling the dead followed a similar procedure for all age groups, with the exception being for infants who were placed in a burial urn or an *olla* after being bundled (Minkes, 2005; Lozada and Rakita, 2013). First, the individual was placed in a seated and flexed position and then wrapped with at least one, but often multiple, *camisas* (shirts) and tied with a wool rope, the Chiribaya usually used rope made from llama wool (Jessup, 1990, p. 4; Minkes, 2005, p. 214). At the site of La Cruz in the Ilo valley, Minkes (2005, p. 214) reported that the deceased appeared to be buried in their personal, worn clothes. There is no evidence that Chiribaya people practiced artificial mummification of the dead (Minkes, 2005). The hyper-arid environment of the south coast of Peru causes little or no decomposition of the dead and results in natural mummification (Marquet et al, 2012).

Small offerings were often fitted inside the textiles of the mummy bundle and placed on top of the body. Tied bags filled with coca leaves were frequently placed on the shoulders of individuals (Jessup, 1990). Guinea pigs were tied to the individual's exterior and a small, hollow gourd was often placed between the legs. Small ornaments, such as stone and shell beads and small quantities of metal were tucked inside the textiles of the *fardo* (Jessup, 1990).

<u>Grave good distribution</u>

There is considerable variation in the quantity and type of grave goods found in Chiribaya burials in the lower and middle Osmore drainage; one factor in this variation seems to be cemetery location. The circular, cist tombs at the Moquegua valley site of El Yaral contained relatively few grave goods, with common offerings being a ceramic vessel, a gourd, and a wooden spoon (Buisktra, 1995, p. 259). In contrast, the Ilo valley Chiribaya tombs had varying amounts of grave goods, ranging from burials with limited quantities, such as those at Chiribaya Baja, to the typically high number of offerings found at San Gerónimo, which have an average of 10-15 ceramic vessels per burial (Knudson and Buikstra, 2007; Jessup, 1991, p. 6). The most ostentatious burial yet recorded among the Chiribaya population is burial 419 from cemetery 4 at Chiribaya Alta. It contained three mummy bundles, one male and two females; all three individuals were facing north. Grave goods surrounded each corpse; the male was associated with as many offerings as the two females combined. A total of 137 grave goods were recovered from burial 419 (Buikstra et al, 2005).

While there are differences in the type of grave goods that were included in Chiribaya burials, there appears to have been a standard set of offerings for each tomb in the Ilo valley. Jessup (1990, p. 5) notes that the grave offerings from Chiribaya rectangular tombs are abundant and, at minimum, contain a bowl, a narrow-necked vessel (*vasija cerrada*), and a jar; these ceramics are usually decorated. Non-ceramic grave goods typically found in tombs are: little boats (*balsas*), gourds, spoons, baskets, wooden vessels (such as keros, cups, or jars), musical instruments, and tools for activities such as fishing, hunting, and weaving (Jessup, 1990, p. 5).

The feeding of the dead appears to have been an important component of Chiribaya mortuary ritual (Ghersi, 1956; Minkes, 2005). Common food remains found in Chiribaya burials are ears of corn and beans, along with sweet potato, potatoes, and yucca. Fruits include pacae, lucuma, and guava. Molle fruit, an important ingredient in the preparation of *chicha* beer, was found inside *cántaros* and two-handled *ollas* (*chombas)* (Jessup, 1990, p. 5). Camelids also represented an essential aspect of the livelihood for the Chiribaya people of the Osmore drainage as evidenced by the regular inclusion of camelid remains, such as feet, ears, and heads, in interments (Jessup, 1990).

Differences in Burial Treatment: Age and Sex

Age

Grave good distribution at Chiribaya cemeteries on the Osmore coast and in the Ilo valley did not vary according to biological age. Children, even aged six and younger, were subject to similar mortuary treatment as adults, such as burial with gender-specific grave goods (Jessup, 1991, p. 12; Lozada and Rakita, 2013, p. 121).

In contrast, there is evidence that there were age distinctions in Chiribaya cemeteries in the Ilo valley based on location and clothing style. Archaeologists excavating at the cemeteries of La Cruz and Chiribaya Baja observed that distinct age groups were buried in separate, but adjacent parts of the cemetery; however, this observation has yet to be tested (Minkes, 2005, p. 215). Minkes (2005) found an association between *camisa* (shirt) type and age group among individuals buried in cemeteries in the lower Osmore drainage. Adults were almost exclusively buried with *camisas* (shirts) that were elaborate and time-consuming to produce, while deceased adolescents and children wore plain shirts (Minkes, 2005, p. 215-216).

Sex

Evidence for differential distribution of grave goods according to biological sex has been recorded at Chiribaya cemeteries in the lower Osmore valley and in the middle Osmore valley. Wooden keros are common in male burials at cemetery sites in the lower and middle Osmore drainage (Jessup, 1991; Buikstra, 1995). At the coastal site of San Gerónimo male burials were also likely to contain harpoons, fishhooks, weights, string, and occasionally non-utilitarian axes (Buikstra, 1995, p. 259). Females buried at San Gerónimo tended to be buried with looms and large numbers of ceramic vessels (Buikstra, 1995, p. 259). Decorated *chicha* vessels and miniature wooden boats (*balsas*) were common to both males and females buried in Chiribaya cemeteries in the Ilo valley (Jessup, 1991, p. 12; Buikstra, 1995, p. 259). Lozada and Rakita (2013) used ethnohistorical data and biological data from the cemeteries at Chiribaya Alta and determined that funerary goods could be a marker for gender roles and life stages in Chiribaya society. For instance, females were frequently buried with lucuma fruit, which is linked with fertility, and items of textile production; while males were associated with keros (as consumers of *chicha* beer) and musical instruments (Lozada and Rakita, 2013, p. 119).

Sex distinctions based on mortuary treatment have been cited. For instance, women wore their hair long, hanging loose or in braids and were buried with one or more tunics with a wide belt wrapped around their waist (Minkes, 2008). Males were buried dressed in one or more trapezoidal tunics, the majority decorated with asymmetrical or figurative stripes, and wearing their hair in complicated braided patterns (Minkes, 2008). Minkes (2008) notes an observed correlation between more complex hairstyles and elaborately decorated textiles. At the coastal site of San Gerónimo, women always had their faces covered with cloth, while men had their faces uncovered with their hairstyles and hats visible (Jessup, 1990; Buikstra, 1995; Minkes, 2008).

Evidence of Social Differentiation in Chiribaya Mortuary Ritual

There is evidence that the Chiribaya chose certain burial attributes when burying the dead to distinguish themselves from neighboring social groups. Documented mortuary evidence at prehispanic cemeteries in the Osmore drainage demonstrates that individuals who used distinctive Chiribaya and Ilo-Tumilaca/Cabuza material culture were living and burying their dead in close and peaceful proximity to one another (Owen, 1993a, 2005; Minkes, 2005). Chiribaya-affiliated burials are reported to have contained a higher frequency of grave goods than their Ilo-Tumilaca/Cabuza counterparts, as well as different tomb shapes and structures (Owen 2005). Another manner in which the distinct social groups appeared to have differentiated themselves from one another was with clothing style. At the Ilo Valley site of La Cruz, a cemetery excavation revealed half of the cemetery contained Ilo-Tumilaca/Cabuza-affiliated burials and the other half, Chiribaya burials; the two sections did not mix burial styles (Minkes, 2005). Minkes (2005, p. 218) found that Chiribaya individuals were buried wearing trapezoidal-shaped shirts (*camisas*) and Ilo-Tumilaca/Cabuza male and females preferred long shirts (*camisas*).

The Chiribaya people used stylistic preferences and cemetery location to organize themselves into sub-groups within the Chiribaya culture. Reycraft (2005) suggests that shirt quality and form can be assigned to both sex and status-rank distinctions. Furthermore, Reycraft (2005, p. 63), citing Boytner (1998), describes textiles from Chiribaya Alta as generally finer, denser, and having more elaborate dye coloring and finish techniques than those studied from other Classic Chiribaya sites. Individuals buried among the nine cemeteries of Chiribaya Alta appear to have been segregated according to the criteria of spoon style, cranial deformation style, and ceramic style. Nigra (2009) found significant correlations among spoon style, ceramic style, and cemetery location. Artificial cranial modification is defined as the "sustained molding of the [human] cranium for longs periods of time during infancy" (Lozada, 2011, p. 228). Lozada (1998, 2011) argues that a social division according to cranial deformation style is most apparent among the nine cemeteries at Chiribaya Alta.

Chapter Summary

In sum, the Osmore drainage, in south coastal Peru, has been occupied for the past 12,000 years. People who lived in the Osmore drainage and were associated with the Classic Chiribaya material culture lived in communities dating between AD 750-1359. Their livelihood depended on the exploitation of the abundant local resources available in the ocean, the *lomas* area, and the agricultural potential of the Ilo Valley. They wrapped their dead in intricately woven textiles, called mummy bundles or *fardos*. The extremely arid climate of south coastal Peru enabled the remarkable preservation of the mummy bundles and their associated grave goods. Published research documents marked variation in the distribution of grave goods, particularly wooden spoon styles and ceramic styles (Nigra, 2009; Lozada, 1998, 2011). Moreover, differential distributions have been detected in artificial cranial deformation styles within the Chiribaya social group and among *camisa* styles between Chiribaya and Ilo-Tumilaca/Cabuza people, neighbors whose settlements were adjacent to Chiribaya settlements in the Ilo Valley (Minkes, 2005; Lozada, 1998, 2011; Buikstra et al, 2005; Lozada and Buikstra, 2002). In other words, stylistic variation between Chiribaya sub-groups and between the Chiribaya people and neighboring communities has been documented. Yet missing is an analysis that investigates the underlying rules that Chiribaya people followed to create designs found on their material remains. This dissertation presents a case study that examines the underlying rules or structure that generated Chiribaya ceramic design. Results of this inquiry coupled with an analysis of the distribution of ceramic design structures across Chiribaya cemeteries will lead to additional information about the mortuary practices of the Chiribaya. This will be further discussed in Chapter 3.

CHAPTER 3: THEORETICAL CONTEXT

Chapter Introduction

In this chapter I will discuss the importance of design structure as a critical variable when investigating the patterned behavior of prehistoric communities. This dissertation will test the ability of the method of symmetry analysis of ceramic design structures to reveal fundamental patterns in Chiribaya mortuary practices. However, in order to understand the method of symmetry analysis, one must first understand what design structure is and how it can relate to patterned human behavior. Design structure describes the way elements are arranged into motifs and the motifs are repeated to form a pattern (Washburn and Crowe, 1988). I will cite published ethnographic and archaeological research that demonstrates how classifying the organization and arrangement of design structures according to preferred plane pattern symmetries can provide important clues about patterned human behavior and the organizational principles of a culture.

To provide critical context for an analysis of Chiribaya ceramic design structure, I will also conduct a mortuary analysis of Chiribaya burial practices. In this chapter, I discuss the importance of integrating bioarchaeological analyses with a mortuary analysis and highlight several studies that present this approach. Finally, I will examine the use of space as an informative component in mortuary ritual and how recognizing the use of space at multiple levels contributes to a holistic approach to mortuary analysis.

Ceramic Design Structure

Ceramic vessels with painted or incised designs are a valuable kind of material culture, especially when the focus of study is a culture without a writing system. Design structure is a significant, yet seldom-recognized attribute of design that informs about other structured relationships in culture. It is an organizational feature that describes the basic layout and arrangement of elements or motifs, and the way the elements and/or motifs are repeated to form a pattern (Shepard, 1948; Washburn and Crowe, 1988). At its most basic level, design structure describes the division of a design field, either as subdivided or not subdivided by framing lines or decorative lines prior to further symmetrical arrangement of the elements or motifs within these areas (See Figure 3.1; Shepard, 1948). This fundamental understanding of design structure is critical because, as Shepard (1948, p. 229-230) demonstrated, different types of design structures permit different types of element arrangement and repetition. For instance, an artist who chooses a band design with a design structure that is framed by vertical lines or is not subdivided at all, will have no limitations (or at least very few limitations) as to the kinds of motions possible for the arrangement of design elements and motifs that are repeated to form a pattern (Shepard, 1948, p. 227).   In contrast, the zig-zag design structure that forms the basis of the Chiribaya step-fret motif does have limitations on the types of possible motions that organize the motif. This difference in artist's choice of basic design structures does reflect consistent human behavior and does have cultural implications. These ideas will be further explored throughout this dissertation.

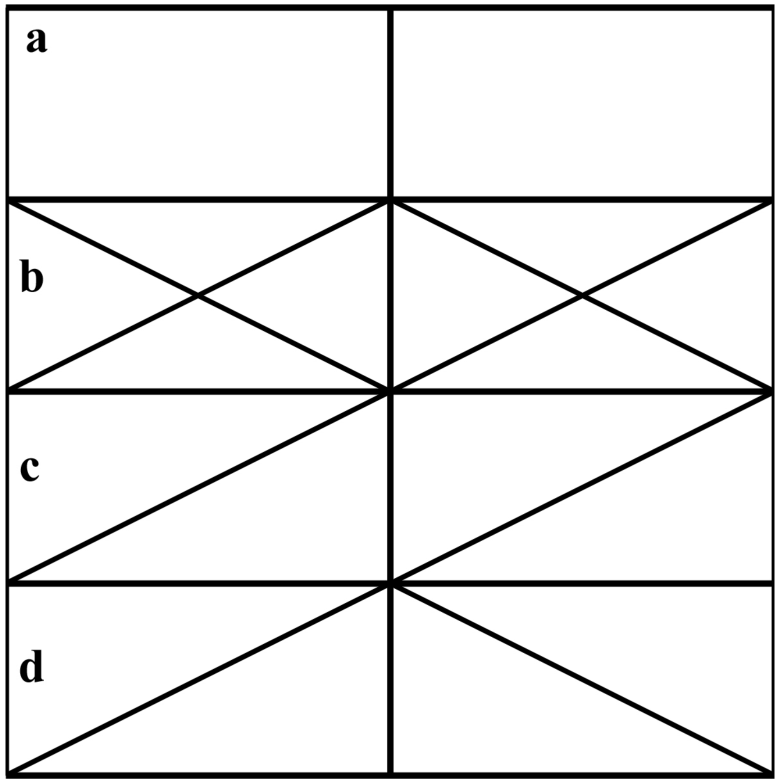

Figure 3.1. *An example of framing lines that subdivide a design field.* * a = no framing lines; b = criss-cross framing lines; c = diagonal framing lines in the same direction; d = opposing diagonal framing lines (modified after Shepard, 1948, p. 229).

George Brainerd (1942) conducted the first archaeological study that analyzed the symmetrical arrangement of complex designs found on American prehistoric pottery. Brainerd categorized two complex design systems from two different ceramic assemblages (Pueblo III B/W and X Fine Orange from Chichen Itza) to demonstrate that such assemblages can be classified and objectively compared. In a more comprehensive discussion of design structure, Anna Shepard (1948) demonstrated the applicability of the classification of the symmetric motions of elements and motifs to recognize preferred symmetrical arrangements of a particular culture, as well as deviations from such preferences, by analyzing multiple ceramic assemblages from the prehistoric American Southwest.

Ethnographic accounts demonstrate that within a culture artists produce patterns that are non-randomly structured. That is, within a given culture, patterns are consistently created using a limited number of the symmetry motions to generate specific design structures. Further, researchers have shown that these preferred structural arrangements have cultural correlates. What are these correlates? It appears that in many cases continuity in the structure of ceramic design in a culture embodies fundamental principles of how a group organizes itself. Similarly, a change in a culture's preferred design structure system signifies major shifts in fundamental organizational principles and relationships within a culture.

Friedrich (1970) found that how designs are structured in a painting style is an indicator of the intensity of communication between painters working in a small Tarascan town. Arnold (1983) demonstrated how the fundamental structuring principles that organize the environmental and social space in a modern Andean village of Quinoa are metaphorically expressed in the manner in which artists organize and arrange the designs on their ceramic vessels. Washburn (1999) analyzed archaeological data from the Pueblo I-III sequence to show the dominant use of bifold rotation, arguing that this preferred structure metaphorically represents the reciprocities that exist between kin and religious societies in Pueblo farming communities.

In contrast, changes in design structure preference can signify changes in intra-cultural organizing principles. For instance, Washburn and colleagues (2010) demonstrated that changes in the design structure system of ceramic vessels from prehistoric pueblo communities of the American Southwest correlated with shifts in residential patterns, population aggregation, and environmental stress. In another study Washburn (2014) argued that a shift in design structure was a metaphorical representation of a major shift in social relationships in pueblo life that corresponded to a drought in the 12th to 13th century. One-dimensional, bifold patterns were the preferred design structure of small farming pueblo units characterized by inclusive reciprocal kin-based relationships. As people responded to the drought by moving to large multi-storied pueblo structures containing multiple kin-groups, social relationships changed to a focus on an exclusive social unit, the household, metaphorically represented by a preference for finite symmetries (Washburn, 2014).

Design Style

Stylistic analyses have a lengthy history. Among the tenets relevant to the issues examined in this dissertation, researchers have claimed that design style transmits important cultural messages (Wobst, 1977; Wiessner, 1983). Wobst (1977, p. 321) defines style as, "that part of the informal variability in material culture that can be related to the participation of artifacts in processes of information exchange." Information exchange is viewed as communication in which a message is transmitted or received (Wobst, 1977, p. 321). Design style is subject to local or even individual variation, which has been used to produce artifact-specific analytical units reflecting varying degrees of style.

Many archaeologists have relied on stylistic categories to build local and regional phases of technological development. Focusing on stylistic analyses of Peruvian ceramics, Max Uhle, in his influential work (1902), created the first chronological sequence for prehispanic Peru based on a seriation of ceramic style found within a stratigraphic sequence of burials. Relevant to this study, David Jessup (1990, 1991) developed the Chiribaya ceramic phases based on stratigraphic distribution of the stylistic attributes of vessel form and size, design color, and element arrangement and patterns.

Design style has also been used in ethnographic and archaeological analyses to identify modes of interaction between social groups. In an ethnographic analysis of Kalahari San projectile points, Wiessner (1983) found the stylistic information contained in the lithics was a good indicator of linguistic group boundaries. Bawden (2005) identified changes in burial practice, ceramic iconography, and architecture style as evidence for ethnogenesis, or the formation of ethnic groups, at the site of Galindo in the Moche valley. Chávez (2002) analyzed stylistic attributes of Andean highland Pukara ceramic vessels demonstrating two main themes in Pukara iconography: the Camelid Woman and Feline Man. The Camelid Woman represented the economic aspect of the community, in terms of her association with wool-producing alpaca and plants; in contrast, the Feline Man reflected the political aspect involving power, control, competition, and violent conflict (Chávez, 2002). Reycraft (2005) interprets stylistic influence of middle valley Estuquiña decorative elements and vessel forms on coastal Chiribaya textile and ceramic assemblages, which occurred after severe climatic events, as a shift in the way the Chiribaya population expressed their ethnic identity.

A limitation of a stylistic analysis is that it focuses on the combined set of variations of multiple attributes of a cultural feature, such as artifact type, size, shape, as well as design elements and motif. Because it is unclear why some objects carry differences in attributes such as shape, form, and color, the term 'style' is difficult to define let alone to use as an analytical tool (Wobst, 1977, p. 317). Wiessner (1983, p. 270) notes that when conducting a stylistic analysis, certain attributes must have functional possibilities ruled out before determining that an object carries social information. This very issue was a problem for Wiessner (1983, p. 273) during her analysis of the stylistic attributes of the Kalahari San projectile points; often the author could not determine which attribute was the result of function or historical events and which stylistic characteristics were carrying social messages.

Design style analysis is artifact-specific, making it difficult to define comparable units of analysis and it is also culture-specific, making it difficult to make systematic comparisons of specific attributes between social groups (Washburn and Crowe, 1988). That is, given this limitation a stylistic analysis is difficult to duplicate if one wishes to expand the study to explore style change across different time periods, regions, or culture groups.

The Cultural Significance of Design Structure

I have argued above that design structure is an important attribute capable of providing key information about cultural activities (e.g. Washburn et al, 2010). However, it is clear that these results must be compared to ethnographic and other analyses in order to explain a culture's preferences for these geometric symmetries and how these preferences correspond to specific human behavior(s).

Ethnographic research of Andean highland communities documents the concept of *dualism* as a fundamental organizing mechanism of social groups. *Dualism* or *complementary dualism* is principally described as the existence of opposites, such as male/female, dark/light, or village/rural, in which each half is an interdependent and critical part of the whole (Arnold, 1983; Ossio, 1996; Webb, 2012). One way in which this basic organizing principle of *dualism* manifests itself in Andean social groups is through the organization of the social environment in which people live. For instance, ethnographic research describes two separate highland communities, Quinoa and Andamarca, as each being divided into village vs. rural sections and complementary kinship groups (Arnold, 1983; Ossio, 1996). Franquemont and Franquemont (2004) observe that symmetrical organization is present in the social relations of the Chinchero, such as the reciprocal labor sharing relations in which labor obligations pass back and forth between community members. The division of characteristics in the physical environment is another way in which *dualism* is perceptible in Andean social groups. Arnold (1983) describes the people of Quinoa organizing their physical environment according to complementary ecological zones that are separated by an irrigation canal. Silverman-Proust (1998) demonstrates how people in the highland town of Q'ero organize their activities according to daylight and darkness.

The *complementary dualism* documented in two modern Andean highland communities has been interpreted as representing a symmetrical social system that is metaphorically represented in the bilateral pattern structures on their textiles. Franquemont and Franquemont (2004) documented weavers in the modern town of Chinchero, near Cuzco, Peru who predominantly use glide reflection—a combination of the symmetric motions of translation and reflections--to form the repetitive patterns on their cloth. The symmetric motions of translation and reflection are so embedded as organizing principles, that they even have their own names in the Quechua language: *tanka* (translation) and *chongo* (reflection) (Franquemont and Franquemont, 2004, p. 181). Silverman-Proust (1998) observed that weavers in the highland community of Q'ero organize repetitive geometric designs on their textiles according to systematic color variation and bilateral reflections. These patterns are infused with important messages regarding underlying structuring principles that organize the community on social and spatial terms (Silverman-Proust, 1998).

Such deliberate consistency in the symmetrical arrangement of geometric designs is not limited to modern Andean highland communities, but it has also been documented in the archaeological contexts of coastal social groups. Frame (2004) demonstrates how the symmetrical repetitions of asymmetrical zoomorphic creatures in Nasca textiles, such as condors, are a metaphorical representation for how the animals moved in nature. Paul (2004) discovered that weavers who created textiles excavated from the mortuary context of the Paracas Necropolis preferred to structurally organize one-dimensional patterns with glide reflection or bifold rotation symmetrical motions. In an analysis of textile headbands from the Paracas Necropolis, Frame (1991) noted that the repetitive symmetrical motions used to create the geometric patterns were limited to rotation, glide reflection, and mirror reflection. The author argued that the systematic organization of the motif arrangement and the number and color variation used in the creation of the headbands was also replicated on an extended scale for the larger embroidered textiles (Frame, 1991). Washburn (2004) analyzed the ceramic design structure system from the site of Ica Viejo in the Ica valley of southern Peru to examine the nature of the relationship between the conquering Inca and local Ica population. By uncovering the preferred symmetrical motions in the arrangements of Ica elements and motifs, the author demonstrated how new Inca elements were incorporated into Ica-Inca copies of the Cuzco style within the rules of the local Ica valley design structure system.

In essence, the systematic categorization of design structure according to its symmetries can reveal that artists within a particular social group arranged design elements in consistent nonrandom structures, which can be correlated with patterned human behavior. This dissertation will show how the particular structures of geometric designs repeatedly found on Classic Chiribaya ceramics in a mortuary context serve as a metaphor of core Chiribaya cultural norms. I will demonstrate this by using symmetry analysis to evaluate how the Chiribaya culture group of the coastal Osmore drainage expressed cultural meaning in burial ritual through the patterned arrangement of geometric elements and motifs found on ceramic vessels that were buried with the dead.

Mortuary Analysis and Bioarchaeology

Bioarchaeology incorporates analysis of human biological data with contextual archaeological remains to make inferences on past lifeways. The primary goal of bioarchaeology is to reconstruct "the behaviors and lifestyles of prehistoric peoples from their skeletal remains and archaeological contexts" (Pearson and Buikstra, 2006, p. 207). Bioarchaeological studies are interdisciplinary in nature, adding new methodologies adopted from the biological, geological, and chemical sciences to its long historical research record demonstrating what scientists can learn about human behavioral and activity patterns (Pearson and Buikstra, 2006; Larsen, 2006; Knudson and Stojanowski, 2008). Scholars have examined the seasonal availability of resources, dietary preferences, and residence patterns of the Chiribaya people using analyses of stable isotopes and skeletal phenotypic traits (Knudson et al, 2007; Tomczak, 2003; Knudson and Price, 2007; Nystrom and Malcom, 2010). In an extensive literature review, Knudson and Stojanowski (2008) discuss the methods with which bioarchaeologists address questions of social identities of prehistoric peoples, such as identities based on health, age, sex, gender, and ethnic affiliation. Blom (2005) focuses on a specific form of body modification, artificial cranial deformation, and its role as a marker of social identity in and around the Tiwanaku capital in the Bolivian altiplano.

An interdisciplinary approach is crucial to broaden the types of questions that can be addressed with human biological data; however, the key to making meaningful inferences about past human ways of life is to incorporate the archaeological context into the analysis of skeletal data. As Goldstein (2006, p. 377) writes, "context is everything, and while physical anthropology can do a lot with the bones once they are out of the ground, there is much that cannot be done without context and other non-osteological data." Buikstra (1981) asserts that osteological data must be analyzed in conjunction with cultural factors related to the mortuary site so as not to over-generalize or misinterpret the behavior of prehistoric populations. Using human skeletal data to test models or theoretical frameworks conceptualized with archaeological material culture demonstrates this contextual approach. Buikstra (1981) analyzed skeletal data dating to the Archaic period of the American Midwest coupled with contextual burial information to test an archaeologically-derived hypothesis that adaptive efficiency increased over time for hunter-gatherer populations. Blom et al (1998) used human skeletal samples to test a hypothesis based on archaeological material remains, which proposed that groups of people migrated from the site of Tiwanaku, located in the Bolivian altiplano, and settled in the lowland Moquegua valley of southern Peru. On the other hand, some researchers analyze skeletal data in conjunction with archaeological remains to address questions of mortuary behavior. Martin et al (2013, p. 145) present a case study of human remains integrated into a mortuary analysis from the La Plata site in New Mexico, revealing a subset of the population who may have represented a group of enslaved servants. Pertaining to the Chiribaya, Lozada and Rakita (2013) analyze biological data, ethnohistorical research, and grave good distributions to suggest that gendered social roles in Chiribaya culture were assigned as early as childhood.

Extensive published bioarchaeological research has reported on residential patterns, health, access to resources, patterns of body modification, social interaction, and gender roles of the Chiribaya people (Knudson et al, 2007; Tomczak, 2003; Knudson and Price, 2007; Nystrom and Malcom, 2010; Lozada, 1998, 2011; Lozada and Rakita, 2013; Martinson et al, 2003; Buikstra et al, 2005). Needed now is a complementary analysis that incorporates mortuary archaeological data with published bioarchaeological reports. This dissertation examines mortuary behavioral patterns of the Chiribaya people using two forms of archaeological material remains, ceramic vessels and grave goods. A mortuary analysis of Chiribaya material culture will provide more lines of evidence to testable hypotheses and contribute to the contextual, holistic approach of published bioarchaeological studies.

A mortuary analysis that considers the spatial dimension of the burial program has provided archaeologists with a deeper knowledge of human behavior. Silverman (2002, p. 6) states that it is important to not only identify material correlates of social status or social interaction, but to examine the meaning and significance of mortuary behavior through the space and place of death. The spatial dimension of burial ritual is an important component because there are multiple spatial levels of the burial program, such as treatment of the individual, treatment of burial groups, and the location and structure of disposal areas of the dead; these multiple levels are interrelated and co-vary (Goldstein, 1981; Ashmore and Geller, 2005). Building on the work of Saxe (1970), in her innovative work, Goldstein (1981, p. 58) compared different dimensions of space represented in the mortuary patterns of two Mississippian cemeteries. These dimensions corresponded to grave goods around the body, the burial in relation to other burials, groups of burials, and the placement and structure of the entire disposal area. Based on the relationships of these various spatial dimensions, Goldstein (1981) concluded that Mississippian society was organized on the basis of corporate or lineal descent groups that controlled access to critical resources, possibly agricultural land.

The value of a mortuary analysis that incorporates spatial dimensions from a landscape or regional scale has been established (O'Gorman, 2010; Goldstein, 1995; Charles and Buikstra, 2002; Silverman, 2002). Smaller spatial levels of analysis, such as individual burials and burial groups, can also provide crucial information about prehistoric burial practices. Ashmore and Gellar (2005) describe social meaning in the formal arrangement of material assemblages in certain ancient Mayan graves. Furthermore, the authors state that while there is great variety in individual and tomb orientation among the ancient Maya, consistent north-south alignment of certain interments suggests a connection with symbolic or cosmological messages (Ashmore and Gellar, 2005, p. 87-90). O'Gorman (2010) observed that women in longhouses at the Tremaine site, located in southwestern Wisconsin, were buried in more varied body positions than men and suggested that this may relate to greater variety in women's roles and relationships in the longhouse community.

In this dissertation, I incorporate the use of space into the analysis of Chiribaya mortuary ritual at two levels – the level of the individual and the group level. First, I explore the use of space at the level of the individual by examining the placement of grave goods within the tomb and the individual's orientation inside the tomb at cemeteries 4 and 7 of Chiribaya Alta. Second, I analyze space at the group level by exploring the collective orientation of tombs at Chiribaya Alta cemeteries 4 and 7 and by examining the distribution of symmetry class type found on ceramic vessels from burial contexts at Chiribaya Alta and Chiribaya Baja. A mortuary analysis that includes these multiple lines of evidence incorporated with published bioarchaeological reports will add to existing research and highlight new information pertaining to Chiribaya mortuary practices.

An analysis of ceramic geometric design structures will provide a completely different line of evidence for mortuary, spatial, and bioarchaeological analyses. A design structure analysis focuses on one attribute of design: the rules (or structure) that generate the design. Consistency in a design's structure, or the basic arrangement and repetition of geometric elements and motifs, has cultural correlates related to the organization of a group at a basic, fundamental level (Shepard, 1948; Friedrich, 1970; Washburn and Crowe, 1988; Arnold, 1983;

Franquemont and Franquemont, 2004; Washburn, 2004). Therefore, an analysis of Chiribaya ceramic design structures can provide different information beyond processes and meaning of mortuary practices to information related to the processes and meaning of how the Chiribaya people organized their social group.

The importance of multiple lines of evidence when testing hypotheses in order to make meaningful inferences about processes that structured past lifeways has been established (Goldstein, 1981; Buikstra, 1981; Buikstra et al, 2005; Knudson and Stojanowski, 2008). Furthermore, scholars have demonstrated that a contextual approach that incorporates combinations of human biological, spatial, and archaeological material data is necessary so as not to misrepresent past human behavioral patterns (Buikstra, 1981; Goldstein, 1981; Goldstein, 2006; Buikstra and Beck, 2006; Blom et al, 1998; O'Gorman, 2010; Ashmore and Gellar, 2005). In this dissertation, I follow this multi-level, contextual approach of mortuary and bioarchaeological analyses and add another level – a symmetry analysis of Chiribaya ceramic design structures. An examination of geometric design structures from Chiribaya burial contexts will provide different information about mortuary practices than what a mortuary or bioarchaeological analysis can offer. For instance, Chiribaya ceramic vessels with geometric designs were placed in domestic and burial contexts (Reycraft, 2005), which increased the cultural value of the information being relayed by the potters. In other words, an analysis of Chiribaya ceramic design structures will provide critical information beyond patterns in mortuary behavior to the social structure and social messaging of the Chiribaya culture. The merger of an analysis of ceramic design structures with mortuary, spatial, and bioarchaeological data has not been accomplished to date. This dissertation research will broaden questions related social messages and processes of social change that can be addressed using data from a mortuary context by expanding the traditional lines of evidence (bioarchaeological, spatial, and archaeological material data) and synthesizing them with a fourth, independent line of evidence, ceramic design structures.

Chapter Summary

Ceramic design structure is a critical feature for understanding the underlying processes that generate design style. While design style is useful for creating phases of technological development or the transmission of social messages, because style is dependent on multiple attributes, it is difficult to determine if variation in style is due to function, time, or a specific social message. In contrast, design structure is a single attribute that describes the way elements and motifs are arranged and organized to form a design or pattern. Ethnographic and archaeological studies have demonstrated that cultures do prefer a limited and specific set of design structures in order to create their patterns. This dissertation will examine the geometric designs that decorate Chiribaya ceramic vessels in order to detect preferences for specific design structures. However, in order to investigate cultural meaning that may be attributed to such preferences for design structure, an understanding of the mortuary context from which the vessels came is imperative. A mortuary analysis of archaeological material remains that considers the spatial dimension of mortuary ritual and incorporates published bioarchaeological studies will shed new light on our understanding of the mortuary practices of prehispanic coastal groups. To achieve this research objective, I evaluate whether fundamental rules that organized and unified the Chiribaya culture can be detected by analyzing the underlying grammar that created the geometric designs found on Chiribaya ceramic vessels. The results from the analysis of ceramic design structures will then be compared with mortuary and published bioarchaeological data. This research problem is discussed in Chapter 4.

CHAPTER 4: RESEARCH PROBLEM

Chapter Introduction

In this chapter I will briefly review previously reported research pertinent to the research problem, which is: whether unifying factors in Chiribaya mortuary ritual can be detected by analyzing the geometric designs found on Chiribaya ceramic vessels from a mortuary context. I ask the question: is there detectable patterned human behavior in the mortuary archaeological record at Chiribaya Alta and Chiribaya Baja that results in consistent mortuary ritual practiced by the Chiribaya people of the coastal Osmore drainage? In order to address this question, I will present two sets of hypotheses and explain how each hypothesis set will contribute to a greater understanding of the research problem.

Research Problem

This dissertation research examines whether the specific arrangement and organization of geometric elements in designs found on ceramic vessels in a burial context reveals key information related to the mortuary practices of the Chiribaya people. The cemeteries of two sites are the focus of this research, Chiribaya Alta and Chiribaya Baja, which are located in the Ilo valley region of the Osmore drainage in southern Peru. Radiocarbon dates place the occupation of these sites between AD 700/750 – 1359 (Buikstra et al 2005).

Extensive published bioarchaeological work provides a glimpse of the lifeways of people living at Chiribaya-affliliated sites: their menu and diet (Tomczak, 2003; Knudson et al, 2007), health (Martinson et al, 2003), migration and residence patterns (Nystrom and Malcom, 2010; Knudson and Price, 2007; Knudson and Buikstra, 2007), and gender roles and life stages (Lozada and Rakita, 2013). Scholars have cited a degree of variability in the mortuary archaeological record according to stylistic preferences and cemetery location at Chiribaya sites within the Osmore drainage. Chiribaya people used clothing style, particularly shirt (*camisa*) type, to separate themselves in death from their Ilo-Tumilaca/Cabuza neighbors (Minkes, 2005). Boytner (1998) reported textile bags made of a finer quality in burials at the site of Chiribaya Alta as compared to other Chiribaya and Ilo-Tumilaca/Cabuza burials. Nigra (2009) reported an association among wooden spoon style, ceramic phase style, and cemetery location at Chiribaya Alta.

The Chiribaya culture of the Osmore drainage has been described as a complex society with standardized ceramics and burial goods that suggest the presence of a differentiated sociopolitical system composed of a social elite and economic specialists, particularly fisherfolk and farmers (Ghersi, 1956; Jessup, 1990; Reycraft, 1998). Many scholars cite archaeological and bioarchaeological evidence to propose that Chiribaya people lived in loosely organized sub-groups that were united under one authority (Lozada 1998, 2011; Lozada and Buikstra 2002; Buikstra et al 2005; Reycraft 2000; Jessup 1991). Relevant to this dissertation, some scholars (Lozada 1998, 2011; Buikstra et al 2005) cite the differential distribution of ceramic style with other criteria to suggest that individuals who associated with a particular sub-group may have indicated their membership according to cranial deformation style, ceramic style, and where they buried their dead. Lozada (1998, 2011) found a strong association among cranial modification type, ceramic phase style, and cemetery location. If, in fact, the Chiribaya people were loosely organized into two sub-groups that were united under an elite class, were there underlying rules that unified the culture? In this dissertation, I evaluate whether unifying factors can be detected by analyzing the geometric designs found on Chiribaya ceramic vessels from a mortuary context and by analyzing certain burial attributes from the cemeteries of Chiribaya Alta.

An analysis of ceramic design style can demonstrate that differences in stylistic attributes exist within a ceramic assemblage, but it is difficult to determine which design feature produced the variation. A stylistic analysis incorporates many attributes of style and, therefore, when variation exists, it is difficult to determine which attribute caused the variation (Wobst, 1977; Weissner, 1983). In regards to Chiribaya mortuary practices, the true nature of the variation in ceramic style according to cemetery location is unknown because it has not been determined which attributes are results of function or time and which attributes carry social messages. Without understanding this basic issue of which design attributes actually carry the social messages, thereby ruling out function and time, one cannot move on to build explanatory models that incorporate ceramic design data.

The underlying structure of Chiribaya ceramic designs as a feature of style needs to be explored. For style to be meaningful, one must understand the processes and features that form style (Washburn, 2001, p. 68). Design structure, that is, the systematic arrangement and organization of elements and motifs according to the rules of plane pattern geometry that generate repeated patterns, is a critical organizational feature of geometric patterns (Shepard, 1948; Washburn and Crowe, 1988). Research has demonstrated that cultures whose ceramic assemblages are decorated with geometric designs tend to consistently organize these designs by a limited set of symmetric motions or plane pattern geometries (Friedrich, 1970; Arnold, 1983; Washburn and Crowe, 1988). Thus, the limited set of symmetries used to create the patterns is an objective way to characterize the structure of any given design style. The key notion is that the cultural information, metaphorically encoded, lies not in the individual design elements, but in the way the design elements are structured and repeated in the pattern as a whole. The shapes are not the symbol; the pattern structure is the symbol (Washburn, 1999, p. 553).

In this dissertation, I explore whether preferences for specific design structures can be detected among the ceramic assemblages excavated from the cemeteries of Chiribaya Alta and Chiribaya Baja. The detection of consistent design structures in the Classic Chiribaya ceramic assemblage can inform archaeologists about past human mortuary behavior with finer detail. For instance, individuals buried at Chiribaya Alta cemetery 4 preferred the annular cranial modification type and were frequently buried with San Gerónimo style ceramic vessels (Lozada, 2011, p. 233). In contrast, individuals buried at Chiribaya Alta cemetery 7 favored the fronto-occipital cranial deformation shape; moreover, this head shape was highly correlated with the Algarrobal style ceramics (Lozada, 2011, p. 234). However, if an analysis of Chiribaya ceramic design structures reveals that similar underlying rules of design generated both the San Gerónimo and Algarrobal ceramic styles, this could bring to light new questions regarding why people who displayed cultural differences in their physical appearance in life, chose to bury their dead with similar metaphorical codes in death.

The use of space is a critical organizing feature in Chiribaya mortuary ritual. Published reports based on mortuary data from the Osmore drainage document a preference for specific cemetery location when the living buried their dead. Archaeological evidence indicates that while Ilo-Tumilaca/Cabuza and Classic Chiribaya populations resided and buried their dead within close proximity of one another in the Ilo valley, each social group buried their deceased in distinct cemetery locations (Minkes, 2005; Owen, 1993a). Bioarchaeological evidence suggests that sub-groups that divided the Chiribaya culture group may have chosen specific cemeteries at Chiribaya Alta in which to inter their dead (Lozada and Buikstra, 2002; Buikstra et al, 2005). Mortuary systems are multidimensional, meaning there are several essential components that act together to create mortuary ritual (Goldstein, 1981). One way to recognize multidimensional relationships is to investigate the spatial components of mortuary ritual because multiple levels of space can be examined simultaneously (Goldstein, 1981, p. 57). To capture the multidimensional nature of the mortuary practices, I will examine Chiribaya burial attributes at two different spatial levels: the level of the individual and the level of the group.

Specifically, this dissertation will test for preference in the distribution of grave goods around the bodies and whether this preference was consistent across cemeteries 4 and 7 of Chiribaya Alta. That is, were the grave goods deliberately placed either on the body or in piles along the edges of the tomb? Jessup (1990) describes the tendency for small offerings to be placed on the *fardo* or within the textiles folds of the mummy bundle. This particular aspect of Chiribaya mortuary ritual rests with Jessup's (1990) description and has not been tested as a statistically significant pattern. Ghersi (1956) noted the presence of food remains in Chiribaya tombs and Minkes (2005) cited additional archaeological evidence for the feeding of the deceased individual. If there is a preference for the placement of grave goods either on the body or in a pile, along the edges of the tomb, this may illuminate the role of certain grave good types in Chiribaya mortuary ritual.

This dissertation will also look at the use of space beyond the individual level and expand to the level of the group. I analyze the following burial attributes at the group (or cemetery) level: the individual's orientation inside the tomb, the collective orientation of the tombs in the cemetery, and the distribution of symmetry class type across the cemeteries. When a tomb is constructed, the direction that the tomb is oriented may be deliberate and thus repeatedly used to inter many members, or a subset of members, of a culture group (see Ashmore and Geller, 2005). Similarly, the position in which an individual is placed inside the tomb can be meaningful if the placement of the body is deliberate (Rowe, 1995, p. 27; see O'Gorman, 2010). As discussed earlier in this chapter, published research has documented that Chiribaya people buried their dead in specific cemetery locations accompanied by material culture of a particular style (Minkes, 2005; Nigra, 2009; Lozada, 1998, 2011; Buikstra et al, 2005; Owen, 1993a). If a preference for specific ceramic design structures can be detected, the next crucial step is to examine if the distribution of design structures across Chiribaya cemeteries mirrors that of the distribution of ceramic style categories. This will provide an alternate and unique view into the Chiribaya burial program.

Research Question

A body of evidence demonstrates marked variability in the distribution of cranial deformation style, ceramic style, and cemetery location at the Classic Chiribaya cemeteries of the coastal Osmore drainage (Lozada, 1998, 2011; Lozada and Buikstra, 2002; Buikstra et al, 2005). Moreover, textile evidence indicates that Classic Chiribaya people used garment shape and quality to distinguish themselves not only from non-Chiribaya individuals, but also as sex and status distinctions within the Chiribaya group (Minkes, 2005, 2008; Reycraft, 2005; Boytner 1998). However, are there *consistent* patterns within the mortuary ritual of the Chiribaya that act to unite the polity? At the Chiribaya cemetery of La Cruz in the Ilo valley, the living buried their dead in worn garments of a specific style to separate themselves from their Ilo-Tumilaca/Cabuza neighbors (Minkes, 2005). Were there other practices in mortuary ritual that the Chiribaya people used to unify themselves as a group, thereby distinguishing themselves, even in death, from other social groups? This dissertation asks the question: was there detectable patterned human behavior in the mortuary archaeological record at Chiribaya Alta and Chiribaya Baja that resulted in consistent mortuary ritual practiced by the Chiribaya people of the coastal Osmore drainage? In order to address this question, I will look at two archaeological data sets from a mortuary context: ceramic design structure from Chiribaya Alta and Chiribaya Baja and burial attributes of grave good distribution and burial orientation from cemeteries 4 and 7 at Chiribaya Alta.

Research Hypotheses

To address the research question "is there detectable patterned human behavior in the mortuary archaeological record at Chiribaya Alta and Chiribaya Baja that resulted in consistent mortuary ritual practiced by the Chiribaya people of the coastal Osmore drainage?" I will test the following two hypotheses:

Hypothesis 1

The distribution of the following burial attributes will be consistent across cemeteries 4 and 7 at Chiribaya Alta: the patterned placement of grave goods within the tomb, the orientation of the tombs, and the individual's orientation inside the tomb.

a) Patterned placement of grave goods within the tomb (either on the body or along the edges of the tomb) will be consistent across cemeteries 4 and 7 at the site of Chiribaya Alta.

b) The orientation of the tombs and the individual's orientation inside the tomb will be consistent across the cemeteries 4 and 7 at the site of Chiribaya Alta.

Hypothesis 2

The distribution of Classic Chiribaya ceramic design structures will be consistent across cemeteries 1-9 at Chiribaya Alta and cemetery 1 at Chiribaya Baja.

a) There is a preference for specific symmetry classes used to create the Chiribaya ceramic design structure system.

b) The distribution of symmetry classes will be consistent across cemeteries 1-9 at the site of Chiribaya Alta and cemetery 1 at Chiribaya Baja.

c) The distribution of symmetry classes will be consistent according to age and sex of individuals buried at cemeteries 1-9 of Chiribaya Alta. To gain a sense of the distribution of preferred ceramic design structures among the population buried at cemeteries 1-9 of Chiribaya Alta, this dissertation research tests the hypothesis that age and sex groups at these cemeteries were associated with the same specific design structures.

Chapter Summary

Correlations between cemetery location and Chiribaya style – in reference to material and human remains – have been reported (Lozada, 1998, 2011; Lozada and Buikstra, 2002; Nigra, 2009; Minkes, 2005). Based on these results, many scholars posit that the Chiribaya people lived in loosely organized sub-groups that were united under one authority (Lozada 1998, 2011; Lozada and Buikstra 2002; Buikstra et al 2005; Reycraft 2000; Jessup 1991). Pertaining to this research, an association was observed among cranial modification type, ceramic phase style, and cemetery location (Lozada, 1998, 2011). I evaluate if underlying rules that unified the Chiribaya culture can be detected in the mortuary archaeological remains.

I will address this research problem by analyzing the ceramic design structures found on Chiribaya ceramic vessels from a mortuary context and by analyzing certain burial attributes from the cemeteries of Chiribaya Alta. In this dissertation, I investigate how individuals who buried their dead at Chiribaya cemeteries used the mortuary space on two levels: at the level of the individual in the grave and at the level of the cemetery. I hypothesize that consistent funerary practices can be detected in the following four ways: 1.) by examining the distribution of the placement of grave goods either on the body or along the edges of the tomb; 2.) the individual's orientation in the tomb; 3.) the collective orientation of the tombs in the cemetery; and 4.) the distribution of symmetry class types across Chiribaya cemeteries. This analysis will complement published bioarchaeological reports by comparing published results involving human biological data with analysis of archaeological material remains conducted in this dissertation. From this systematic methodology one can then ask how these trends relate to other aspects of the mortuary system of the Chiribaya. The methods for testing the aforementioned hypotheses will be explained in Chapter 5 and the results will be discussed in Chapter 6 of this dissertation.

CHAPTER 5: RESEARCH DESIGN AND METHODOLOGY

Chapter Introduction

This chapter will explain how I addressed the research problems discussed in Chapter 4. First, I will provide descriptions of the archaeological sites that are the focus of this research, Chiribaya Alta and Chiribaya Baja. Next, I will describe the data sets used in this research, as well as address inherent issues that arose during data collection. I will describe the Chiribaya ceramic typology and introduce the three stylistic phases. Third, I will discuss symmetry analysis, the research methodology used to analyze the Chiribaya ceramic design structure system. I will briefly describe the statistical methods used to test the research hypotheses. Finally, I briefly re-state the hypotheses and describe associated procedures for addressing each hypothesis.

Site Descriptions

Chiribaya Alta

The site of Chiribaya Alta is located approximately 6-7 km from the Pacific Ocean on the Pampa del Descanso, a bluff overlooking the Ilo Valley (see Chapter 2, Figure 2.3; Lozada & Buikstra, 2002; Knudson & Buikstra, 2007; Rice, 1993). It is a 36 ha multicomponent site that includes nine cemeteries and is composed of numerous domestic units, plazas, and terraces (Lozada & Buikstra, 2002; Knudson & Buikstra, 2007; Buikstra et al, 2005; Rice, 1993). Chiribaya Alta is the only Chiribaya-affiliated site with evidence of a wall that consists of a semicircular ditch and wall on one side of the site that prevents "approach by level terrain, and a dramatic natural drop to the river on the other [side]" (Rice, 1993: 69). Non-mortuary features on Chiribaya Alta include foundations of cane and wood structures (Rice, 1993). Residential terraces are located on steep slopes that lead down to the valley (Rice, 1993). The domestic patterns on Chiribaya Alta are largely unknown because the residential terraces have yet to be thoroughly surveyed or excavated (Umire & Miranda, 2001).

The nine cemeteries at Chiribaya Alta were identified and excavated in 1989 and 1990 under the direction of Dr. Jane Buikstra as part of the Chiribaya Project (see Figure 5.1; Lozada & Buikstra, 2002, p. 56).

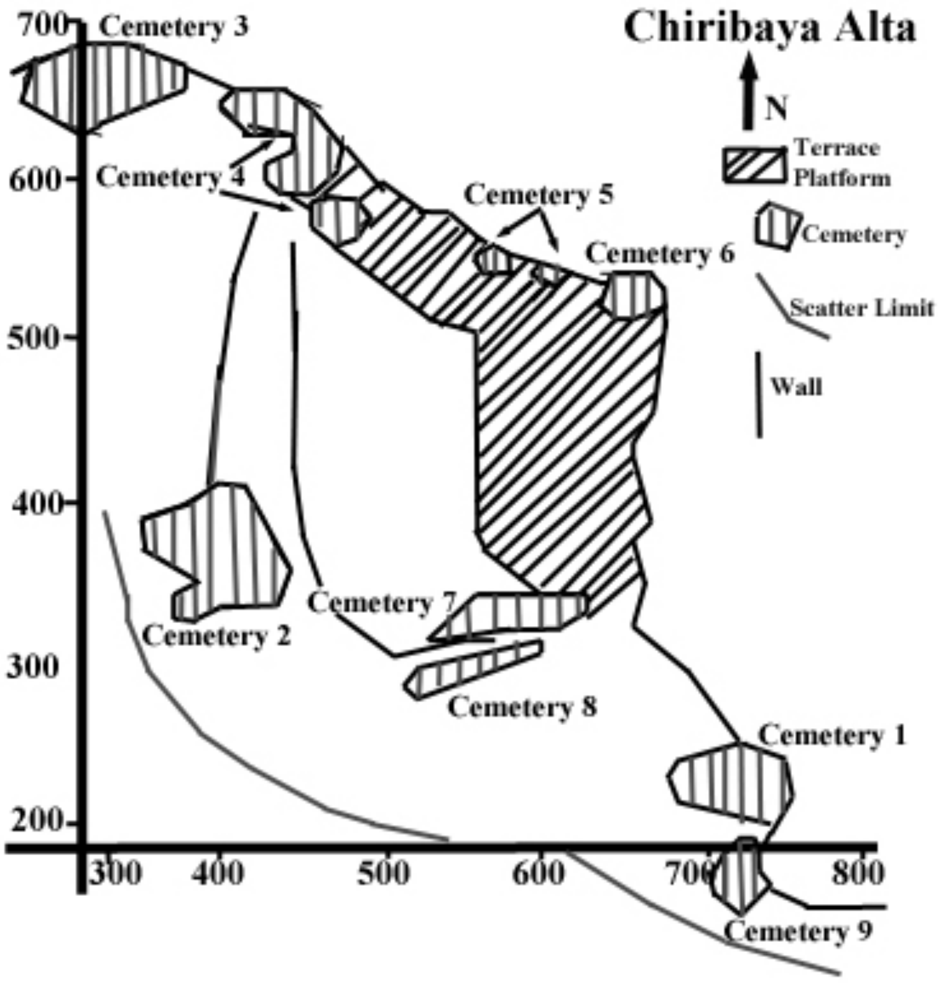

Figure 5.1. *Chiribaya Alta site map* (modified after Buikstra et al, 2005, p. 69).

The main research focus of the Chiribaya Project was bioarchaeological in nature, especially exploring the genetic relationships among individuals interred at Chiribaya cemeteries (Lozada & Buikstra, 2002). To date, the site of Chiribaya Alta is the largest excavated Chiribaya site and considered to be the regional center of Chiribaya political influence (Jessup, 1991; Lozada, 1998; Lozada, 2011; Knudson & Buikstra, 2007; Buikstra et al, 2005; Lozada & Buikstra, 2002). Excavation, which sampled its nine cemeteries, yielded a total of 307 burials (Lozada & Buikstra, 2002, p. 56).

Chiribaya Alta was occupied during the entire Classic Chiribaya period occupation of the Osmore drainage, with evidence of several of the nine cemeteries at the site being in use at the same time (Lozada & Buikstra, 2002; Nystrom & Malcom, 2010; Buikstra et al, 2005). Table 5.1 illustrates the time span of the nine cemeteries at Chiribaya Alta. The date ranges are estimates of calibrated radiocarbon dates reported by Buikstra and colleagues (2005, Fig. 5.6). The burial patterns among the nine cemeteries at Chiribaya Alta are variable in terms of tomb shape, amount and type of grave good inclusions, and artificial cranial deformation styles present. These noted mortuary differences have led some researchers to suggest the presence of distinct sub-groups within the Chiribaya population burying their dead within the nine cemeteries at the site (Jessup, 1990, 1991; Reycraft, 2000; Lozada & Buikstra, 2002).

Early **AD 700-850**	**Middle** **AD 850-1050**	**Late** **AD 1050-1250**
Cemetery 7	Cemetery 9	Cemetery 8
Cemetery 3	Cemetery 5	Cemetery 6
	Cemetery 1	
	Cemetery 2	
	Cemetery 4	

Table 5.1. *Estimated dates of occupation for the nine cemeteries of Chiribaya Alta.* *The date ranges are my estimates based on calibrated radiocarbon date ranges reported by Buikstra et al, 2005, Fig. 5.6.

The mortuary analysis portion of this dissertation research will focus on cemeteries 4 and 7 from Chiribaya Alta and, thus, only two of the three phases of cemetery use. Chiribaya Alta is an ideal choice in which to conduct a mortuary analysis for several reasons. There is extensive documentation, based on bioarchaeological evidence, of the patterns of economic specialization, subsistence, health, residential patterns, and status roles of the individuals who were buried at the cemeteries of Chiribaya (Lozada, 1998, 2011; Buikstra et al, 2005; Tomczak, 2003; Nystrom & Malcom, 2010; Knudson & Buikstra, 2007; Lozada and Rakita, 2013). This means that deeper questions concerning the processes that organize Chiribaya culture can be addressed. Moreover, a complementary mortuary analysis based on archaeological data from Chiribaya Alta has yet to be undertaken. An analysis using archaeological material remains that incorporates published reports based on bioarchaeological data will broaden understanding of the mortuary rituals at Chiribaya cemeteries.

Chiribaya Alta cemeteries 4 and 7, in particular, have high frequencies of recorded burials with associated skeletal data and contextual mortuary information. For these reasons, a mortuary analysis based on archaeological data of Chiribaya Alta cemeteries 4 and 7 will complement the known bioarchaeological evidence. Moreover, an analysis of ceramic design structures from the mortuary context of Chiribaya Alta will complement typological and stylistic analyses, creating a more comprehensive analysis of the functions of ceramics at these mortuary sites. The results of the mortuary analysis and ceramic design analysis will then be compared with the insights from the bioarchaeological reports, adding to the holistic approach to understanding Chiribaya mortuary behavior in the Osmore drainage.

Chiribaya Baja

Chiribaya Baja was first surveyed and partially excavated under the direction of David Jessup from 1987-1989 (Umire & Miranda, 2001). It was excavated a second time as part of the Chiribaya Project, under the direction of Jane Buikstra (Lozada & Buikstra, 2002). Chiribaya Baja is located approximately 7-8 km from the coast and is adjacent to the arable land of the Ilo River Valley floor, just below and within visual range of Chiribaya Alta (see Chapter 2, Figure 2.3; Jessup, 1990; Rice, 1993). Chiribaya Baja is situated at the widest part of the Ilo Valley near a water source, making it an ideal location for agricultural activities (see this chapter, Figure 5.2; Jessup, 1990).

Similar to Chiribaya Alta, Chiribaya Baja contains formally bounded cemeteries near residential terraces and agricultural systems (Buikstra, 1995; Knudson & Buikstra, 2007). It is an expansive site with 13 terrace levels, each containing wood and cane residential architecture (Jessup, 1990; Rice, 1993). In contrast to Chiribaya Alta, the amount and type of grave goods recovered from Chiribaya Baja cemeteries are limited, with typical offerings including wooden spoons, utilitarian ceramics, and gourds (Knudson & Buikstra, 2007). Bioarchaeological and archaeological evidence based on grave goods and stable isotope analysis has determined the dominant subsistence strategy to be maize agricultural production, which was supplemented with the drying and smoking of fish and the exploitation of diverse plant resources (Tomczak, 2003; Knudson & Buikstra, 2007; Rice, 1993: 70).

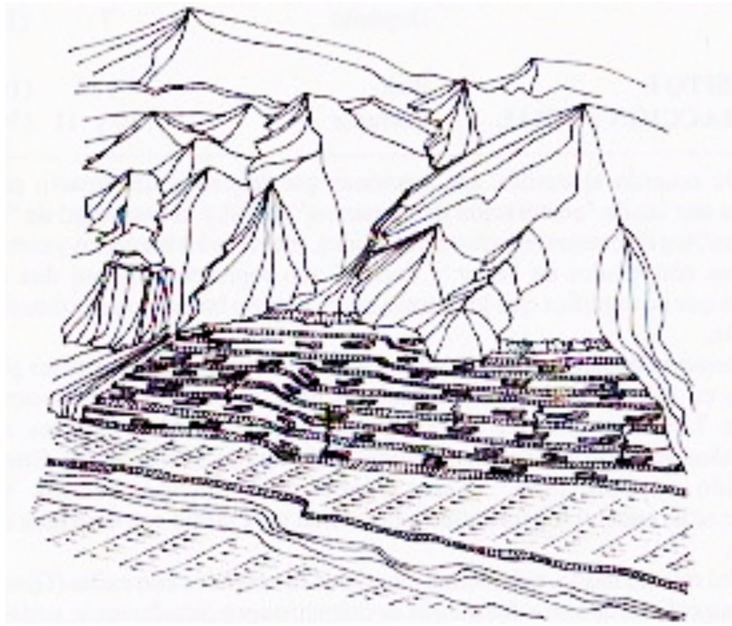

Figure 5.2. *Artist's rendering of Chiribaya Baja* (Umire and Miranda, 2001, p. 70). Reprinted with permission from Adan Umire and Ana Miranda.

The frequencies of burial data from Chiribaya Baja cemetery 1 were too low to incorporate into the mortuary analysis component of this dissertation. However, the number and distribution of ceramic vessels from Chiribaya Baja cemetery 1 are sufficient to be compared with those from Chiribaya Alta. Comparison of ceramic design structures and their associated symmetries from Chiribaya Alta and Chiribaya Baja is important because the known mortuary patterns are markedly different at each site during the Classic Chiribaya period. Grave good type and amount vary at the cemeteries of Chiribaya Alta, in contrast to those associated with individuals at Chiribaya Baja cemeteries who tend to be buried with limited grave inclusions (Buikstra, 1995; Knudson & Buikstra, 2007). An analysis of ceramic design structures from two archaeological sites with documented differences in mortuary patterns will provide fascinating clues about the mortuary behavioral patterns of the Chiribaya in the Osmore drainage.

Chiribaya Ceramic Data

I conducted my field research for one month in 2006. I took a random sample of the ceramics excavated from the cemeteries of Chiribaya Alta and analyzed all ceramics available to me from Chiribaya Baja. There are 586 total ceramic vessels excavated from a mortuary context at Chiribaya Alta. There are 56 total vessels excavated from Chiribaya Baja, cemetery 1. These totals are based on frequency counts of ceramic vessels gathered from the excavation field notes and spreadsheets of the Chiribaya Project[4]. The ceramic dataset for this dissertation is composed of 247 ceramic vessels from the mortuary contexts of cemeteries 1-9 at Chiribaya Alta and cemetery 1 at Chiribaya Baja; 210 ceramic vessels from Chiribaya Alta and 37 from Chiribaya Baja. Figure 5.3 describes the distribution of ceramic vessels in this dataset across the nine cemeteries of Chiribaya Alta. A majority of the vessels are whole with the exception of a few vessel fragments or diagnostic ceramic sherds that were included in the analysis because I was able to reasonably infer the structural pattern and symmetry motions of the entire design.

[4] Excavation field notes and spreadsheets from the Chiribaya Project were provided to me by Dr. Jane Buikstra, Emily Schach, and Christopher Grivas, Center for Bioarchaeological Research, Arizona State University.

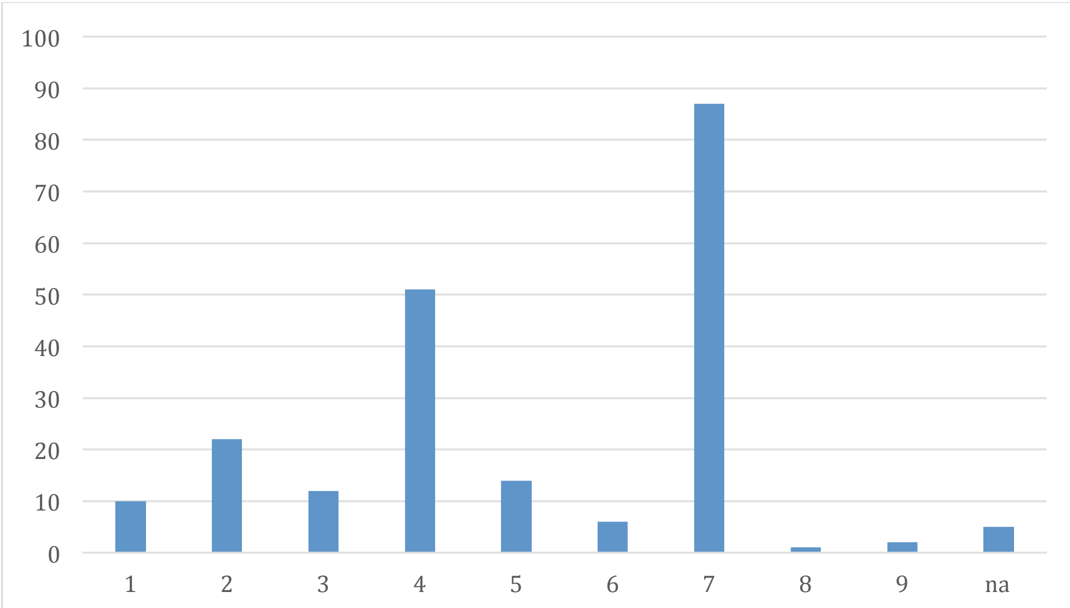

Figure 5.3. *Distribution of ceramic vessels in dataset, Chiribaya Alta cemeteries (n=210).*

Vessel forms

The Figure 5.4 describes the vessel form types included in this dissertation and their frequencies. The vessel frequencies are from Chiribaya Alta and Chiribaya Baja combined. Chiribaya ceramic vessels generally have flat and circular bases (Owen, 1993a). The most common vessel forms in the Chiribaya ceramic vessel assemblage are rounded bowls with or without handles, handled jars, and *cántaros* (see Figure 5.5; Owen, 1993a, p. 390). The vessel forms with the highest frequency in this dissertation dataset mirror this trend: bowls (n = 108); jars (n = 57); *cántaros* (n = 31).

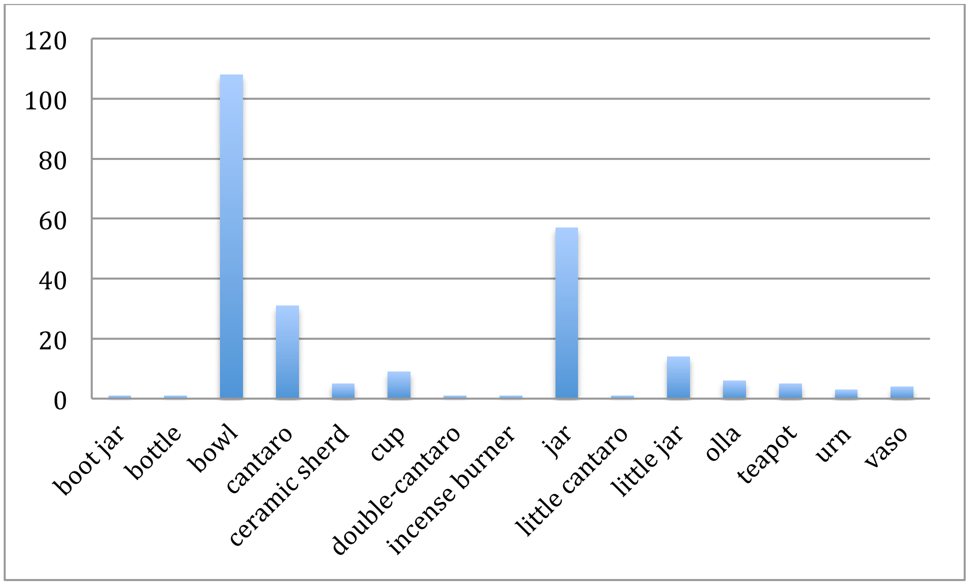

Figure 5.4. *Frequency of vessel form type in the data set.* * Bowls (n = 108); jars (n = 57); cántaros (n = 31).

Names of certain vessel forms were difficult to translate into English, therefore, I retained their names in Spanish. Descriptions of these particular vessel forms are as follows (Umire & Miranda, 2001, p. 29-31):

- *Vaso*: similar in form to cups, but the difference is *vasos* do not have handles. Sometimes there are tiny handles near the rim that look like little knobs or are shaped like lizards.
- *Olla*: these vessel forms have globular bodies with handles on both sides. The necks are short without decoration. Sometimes the handles are placed near the rim and extend to the vessel shoulder and other times the handles are placed in the middle of the vessel body. The vessels usually hold liquids.
- *Cántaros*: this type has an oval-shaped body with a neck that slightly widens at the rim. Decoration is abundant across the vessel body. Sometimes *cántaros* do not have handles; when handles are present, they are usually located in the middle of the body.

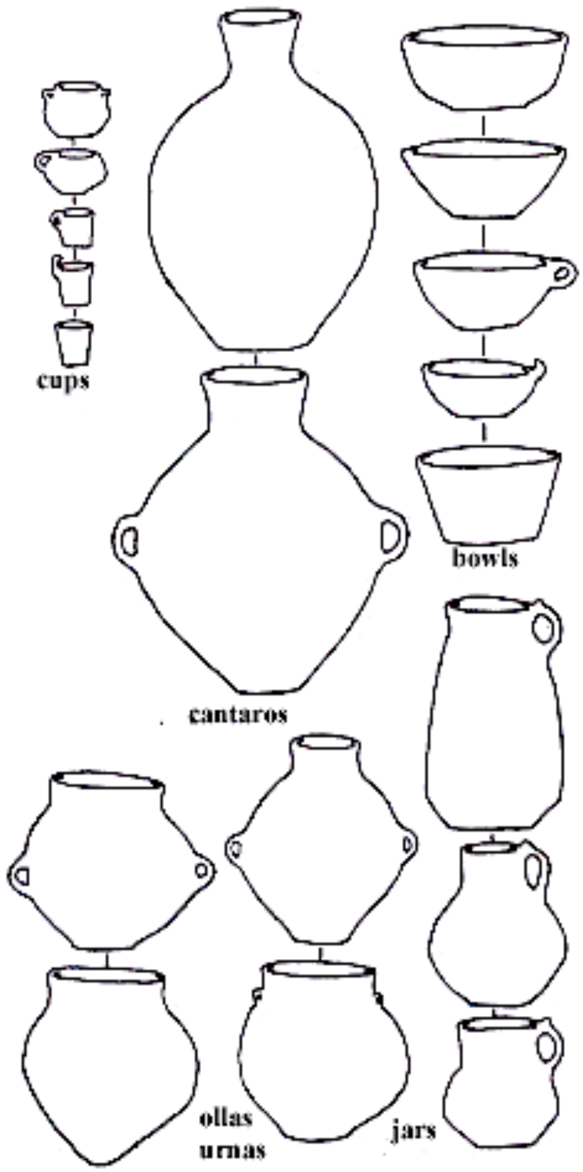

Figure 5.5. *Chiribaya ceramic vessel forms* (modified after Umire and Miranda 2001: 28). Reprinted with permission from Adan Umire and Ana Miranda.

Chiribaya ceramic design

The colorful and elaborate geometric designs found on ceramic vessels is a unique feature of the Chiribaya cultural tradition, with characteristic designs such as a red slip with multi-colored designs and white dots on a black band along the rim (Jessup, 1991, p. 2; Owen, 1993a, p. 390). The most distinctive Chiribaya pattern is a multi-colored step-fret pattern arranged around a semi-circle, either displayed in a trapezoidal panel made up of two converging pairs of step-frets or divided into four sections. A second design unique to Chiribaya pottery consists of colored bands arranged simply, in zigzag patterns, or in combination with alternating semi-circles (Jessup, 1991, p. 3). Typical paint colors of Chiribaya pottery are black, white, orange, and brown (Owen, 1993a, p. 390). Owen (1993a, p. 390) suggests that there seems to be strict rules as to the appropriate use and position of colors on ceramic vessels; this proposition will be explored throughout this dissertation.

The Chiribaya ceramic typology was initially divided into three phases based on stratigraphic distribution from habitation and mortuary contexts and the attributes of vessel form and size, design color, and element arrangement and patterns (Jessup, 1991). The Algarrobal phase is characterized by material and stylistic variety, with common design elements being: bowties, eight-point star, step-fret patterns, and cross-hatched diamonds (see Figures 5.6 – 5.10; Jessup, 1991, p. 4). Common vessel forms during the Algarrobal phase are rounded bowls and handled jars, often with rim protuberances above the handle; all designs are on the exterior of vessels (Owen, 1993a, p. 391). Bowls during this phase were typically painted with pendant semicircles, pendant chevrons, bowties, and vertical sawtooth pattern (Owen, 1993a, p. 391). Jars were commonly decorated with the step-fret motif, with variations of the step-fret element that included more steps and drawn in a more vertical position (Owen, 1993a, p. 391).

Figure 5.6. *Example of an Algarrobal phase bowl with eight-point star design element* (photo by EMD, 2006).

Figure 5.7. *Example of an Algarrobal phase bowl with cross-hatched diamonds design element* (photo by EMD, 2006).

Figure 5.8. *Example of an Algarrobal phase bowl with bowtie design element* (photo by EMD, 2006).

Figure 5.9. *Example of an Algarrobal phase jar with vertical sawtooth and cross-hatched diamond elements* (photo by EMD, 2006).

Figure 5.10. *Example of an Algarrobal phase jar with the step-fret motif* (photo by EMD, 2006).

The Yaral phase is marked by standardization of material and design; the full star is replaced with pendant half stars and jars are decorated exclusively with trapezoidal step-fret panels (see Figures 5.11 – 5.12; Jessup, 1991, p. 5). The formalization of design during this phase is demonstrated in the elements and motifs that decorate bowls and jars. Bowls have only exterior elements; such as pendant half stars of 2, 3, or 4 points and bowties (Owen, 1993a, p. 395). Jars and other similar vessel forms are decorated with the step-fret motif, with step-fret elements having no more than three steps (Owen, 1993a, p. 395). Common vessel forms are rounded bowls and handled jars (Owen, 1993a, p. 394). Owen (1993a, p. 394) observed that the paint colors during the Yaral phase are strong with little variation within or between vessels.

Figure 5.11. *Example of a Yaral phase jar with the step-fret motif* (photo by EMD, 2006).

Figure 5.12. *Example of a Yaral phase bowl with half star design element* (photo by EMD, 2006).

Finally, the San Gerónimo phase is marked by a simplification of designs (see Figures 5.13-5.17; Jessup, 1991). Common vessel forms during the San Gerónimo phase include, but are not limited to, handled bowls and *cántaros* (Owen, 1993a, p. 394). Bowls during this phase are decorated only on the interior with bands arranged in a cross or elements, such as pendant three-point half stars and semicircles (Owen, 1993a, p. 395; Jessup, 1991, p. 6). San Gerónimo phase jars and *cántaros* continued to be decorated with the step-fret motif, but with less frequency (Owen, 1993a, p. 395; Jessup, 1991, p. 6). Instead, jars and similar vessel forms are decorated with simple horizontal and zig-zag band designs; a common motif being a band with alternating semicircles (Owen, 1993a, p. 395; Jessup, 1991, p. 6). Similar to the Yaral phase, paint colors in this later phase are also very strong (Owen, 1993a, p. 394).

Figure 5.13. *Example of a San Gerónimo phase cántaro with a band of semicircles* (photo by EMD, 2006).

Figure 5.14. *Example of a San Gerónimo phase jar with the step-fret pattern* (photo by EMD, 2006).

Figure 5.15. *Example of a San Gerónimo phase bowl with bands of semicircles* (photo by EMD, 2006).

Figure 5.16. *Example of a San Gerónimo phase bowl with half stars* (photo by EMD, 2006).

Figure 5.17. *Example of a San Gerónimo phase bowl with the step-fret pattern* (photo by EMD, 2006).

The Chiribaya ceramic phases were initially created in order to understand the development of Chiribaya ceramic technology and as chronological markers of the Chiribaya occupation of the Osmore drainage (Jessup, 1990, 1991). Radiocarbon tests revealed that the Algarrobal phase and Yaral phase overlap, making the three phases unreliable markers of time (Lozada, 1998; Buikstra et al, 2005). However, the vessel and design attributes of each ceramic phase are still considered the most complete analysis accomplished to date (Owen, 1993a). The analysis of ceramic design structure presented in this dissertation will build on the painstaking work of Jessup (1990, 1991) by providing additional insights into fundamental processes that structure Chiribaya ceramic design.

The geometric designs found on Chiribaya ceramic vessels are an ideal data set for exploring patterned human behavior of mortuary traditions. First, decorated Chiribaya ceramic vessels are a common inclusion in the mortuary record, found in Chiribaya-affiliated cemeteries from the coast to middle valley of the Osmore drainage (Jessup, 1990). Second, Chiribaya ceramics were made in a uniform way: paste, temper, firing, paint, motifs, and organization of design (Jessup, 1990). Third, diagnostic ceramic vessels often show little signs of use when they were placed in the tomb with the deceased (Jessup, 1990) and, moreover, the vessels were often recovered intact during excavations. Finally, the high quantity and quality of intact ceramic vessels makes Chiribaya ceramic designs the perfect candidate for an analysis of ceramic design structures by symmetry analysis.

Chiribaya Burial Data

Burial data is included in this analysis because it is critical for understanding the mortuary context from which the ceramic vessels are found. Burial attributes included in this study are as follows: the individual's orientation inside the tomb, the orientation of the tomb, and the placement of grave goods either on the body or in a pile along the edges of the tomb.

There are 42 tombs from cemetery 4 and 63 tombs from cemetery 7 at Chiribaya Alta, with a total of 105 tombs in this analysis. There are 122 deceased individuals included in this analysis; the higher number of individuals as compared to tombs is due to multiple interments in a single tomb. There are 1505 total grave goods from cemeteries 4 and 7 at Chiribaya Alta. There were a total of 85 disturbed tombs and 20 intact tombs from both cemeteries combined. A disturbed tomb means that it was opened again after the initial burial, either in antiquity or in modern times. An intact tomb means that after the initial burial, the tomb remained sealed until archaeologists excavated it.

Cemeteries 4 and 7 of Chiribaya Alta present an ideal data set in which to investigate consistent mortuary patterns because both cemeteries have high frequencies of burials with associated contextual and bioarchaeological information. Moreover, there is documented variation in the burial patterns at cemeteries 4 and 7 of Chiribaya Alta. Lozada (2011, p. 233-234) argues that individuals interred at cemetery 4 had a high frequency of the annular style of cranial deformation and were frequently buried with San Gerónimo style pottery, while people buried at cemetery 7 had a high frequency of the fronto-occipital cranial deformation style and favored the Algarrobal ceramic style (for illustrations of artificial cranial deformation styles mentioned in this text, see Lozada, 2011, Figures 9.3 and 9.4). If consistent use of certain design structures can be detected among burials from two cemeteries in association with differences in other features of mortuary activity, then cemeteries 4 and 7 may reveal important information regarding underlying rules of funerary ritual at Chiribaya Alta.

Data Biases

At the time of data collection, I was given access to ceramic vessels from the excavation years of 1989, 1990, and 1991 at Chiribaya Baja. Contextual mortuary data from Chiribaya Baja was limited to field notes from the excavation of cemetery 1 during the 1991 field season and, therefore, the analysis of ceramic design structures at Chiribaya Baja is limited to cemetery 1. The role of ceramic design structures from this site is to complement the analysis of ceramic design structures from Chiribaya Alta.

Method: Symmetry Analysis

I have chosen to analyze the geometric designs on the Chiribaya ceramics by systematically analyzing design structure and classifying how elements and/or motifs are arranged and repeated by their plane pattern symmetries to form a pattern within a design field. Symmetries are rigid motions, that is, "distance preserving transformations" that move elements or motifs along and/or across axes so that they superimpose upon themselves (Crowe, 2004). Design structures can be analyzed by these rigid motions (symmetries) if two conditions are met. First, the design structure field must occupy a flat, or plane surface, such as tile or textiles, or on surfaces that can conceptually be flattened, such as ceramics. Second, the design must be composed of figures of the same size and shape so that they can be systematically repeated and superimposed (Shepard, 1948; Washburn and Crowe, 1988).

Symmetric figures can be divided into two or more parts identical in size and shape that differ only in position and orientation (Shepard, 1948, p. 217). The <u>fundamental parts</u> of a symmetric figure are repeated to generate the whole pattern (Shepard, 1948, p. 217; Washburn and Crowe, 1988, p. 53). Designs are composed of combinations of these fundamental parts, which are sometimes called elements. Shepard (1948, p. 217) defines an <u>element</u> as "the simplest complete component of a definable form [or figure]". An element itself may be symmetric, meaning it is composed of a fundamental portion that is repeated to form the element (Shepard, 1948, p. 217). For instance, a square is an element, but one quarter of the square is considered the fundamental portion because it can be repeated to form the square. In this dissertation, I refer to a collection of elements that are symmetrically arranged within a design field as forming a <u>motif</u>.

There are four rigid motions, also called distance-preserving transformations, and their combinations that can be used to move, that is to repeat the fundamental parts, creating a design. These rigid motions across a plane surface are defined by a <u>fundamental theorem</u> of Euclidean geometry which says that "every rigid motion…no matter how complicated in appearance, is one of the four following motions: rotation, translation, mirror reflection, or glide reflection (Crowe, 2004). A description of these <u>four motions</u> follows (see Figure 5.18; Shepard, 1948, Crowe, 2004).

1. <u>Translation</u>: movement along a linear axis by a given distance.
2. <u>Rotation</u>: movement about a given point by a given angle.
3. <u>Reflection</u> (mirror): movement across a line axis. Right and left images are produced across a vertical axis; upper and lower images are produced across a horizontal axis.
4. <u>Glide reflection</u>: mirror reflection followed by translation along a linear axis.

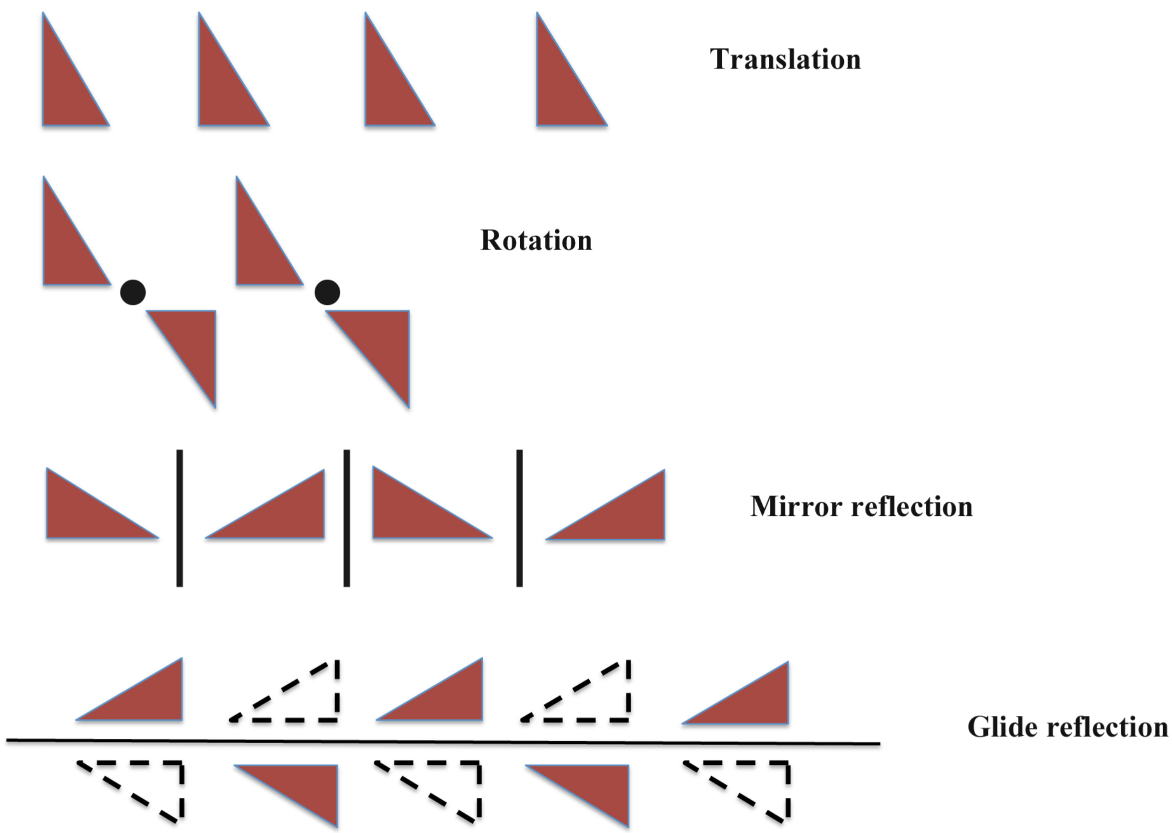

Figure 5.18. *The four motion classes* (drawn by EMD 2016; modified after Washburn, 1999, Figure 1).

These four motions can be combined to produce three axial categories in the plane. To understand the significance of these axial categories, it is important to understand the difference between a design and a pattern. A design is a specific kind of figure, which admits at least one rigid motion. For example, a circle is a design because it has both rotation and reflection symmetry (see Figure 5.19; Washburn and Crowe, 1988, p. 52-53). In contrast, a pattern is a design that has translation symmetry and can conceptually extend to infinity. If a pattern cannot conceptually extend to infinity, then it cannot have translation symmetry. For instance, no bounded figure, such as a circle, is a pattern even though it may have rotation or reflection symmetry because it cannot have translation symmetry and cannot extend to infinity (Washburn and Crowe, 1988, p. 52-53). The three axial categories are as follows:

1. Finite designs: created around a point axis using two rigid motions: rotation and mirror reflection (see Figure 5.19). These designs do not admit any movement in linear directions.

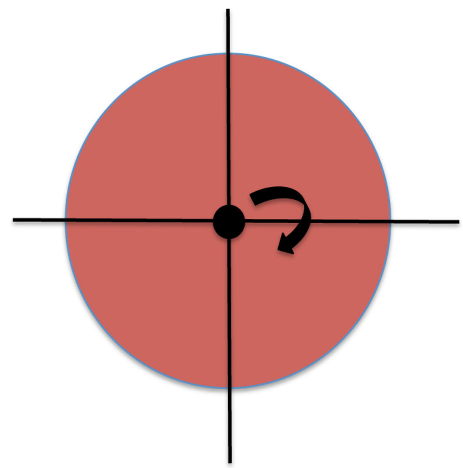

Figure 5.19. *Rotation and mirror reflection motions of a finite design* (drawn by EMD 2016).

According to Washburn and Crowe (1988, p. 57) designs designated "cn" have *n*-fold rotational symmetry around a point axis and no mirror symmetry. Washburn and Crowe (1988, p. 57) describe designs designated as "dn" as having reflection symmetry and *n*-fold rotational symmetry. Theoretically an unlimited number of designs are possible. One example is hubcap designs. The notation for two-color finite designs is as follows (see Figure 5.20; Washburn and Crowe, 1988, p. 68):

- *cn* designs can only be colored by alternating the colors around a point axis. This is designated as *cn'*.
- *dn* designs can be colored in two ways: *d'n* – all reflections reverse colors and all rotations preserve colors; and *dn'* – half of the reflections reverse colors and half preserve colors, rotations by one nth of a full turn reverse colors.

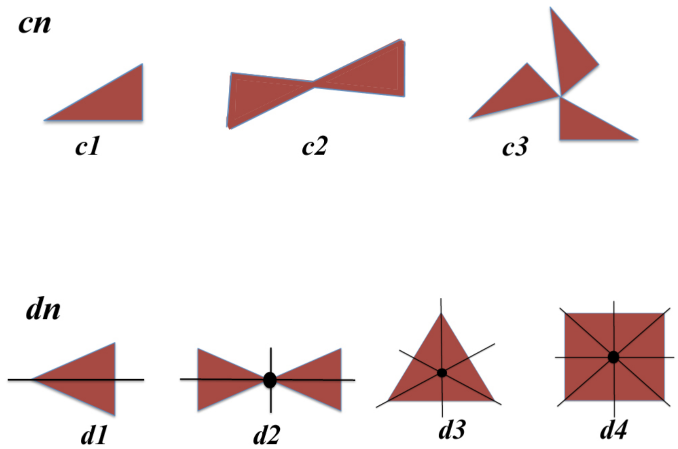

Figure 5.20. *Examples of symmetry motions of finite designs* (drawn by EMD 2016; modified after Washburn, 1999, Figure 2a).

2. <u>One-dimensional infinite patterns</u>: created along a line axis using the four rigid motions in seven combinations (see Figure 5.21). They are often called band or frieze patterns. Example: line of footprints. A description of the notation for the seven one-color, one-dimensional patterns is derived from Washburn and Crowe (1988, p. 57). There is a generally accepted four-symbol notation to describe the symmetry motions of one-dimensional patterns, *pxyz*. Each notation begins with *p*, which represents the translation symmetry motion, and the second, third, and fourth symbols respectively describe symmetry motions, as follows:

   - If there is a vertical reflection *x* is *m* for "mirror"; otherwise *x* is *1*.
   - If there is a horizontal reflection, *y* is *m* for "mirror"; if there is a glide reflection but no horizontal reflection, *y* is *a*; otherwise *y* is *1*.
   - If there is a half-turn, *z* is *2*; otherwise *z* is *1*.

The notation for color reversals of two-color, one-dimensional patterns is described by Washburn and Crowe (1988, p. 69). When a one-dimensional pattern is colored with two interchanging colors, a prime (') is attached to the corresponding symbol to denote the symmetry motion that reverses color. For instance, if the first symbol *p* signifies a translation that does not reverse color, it is left as *p*. However, if a translation does reverse a color, this change is marked as *p'*. Another example is the notation for a vertical reflection, *pm11*. If the vertical reflection does not emit a color reversal it is written as *pm11*. On the other hand, if a vertical reflection does reverse a color, this notation is *pm'11*.

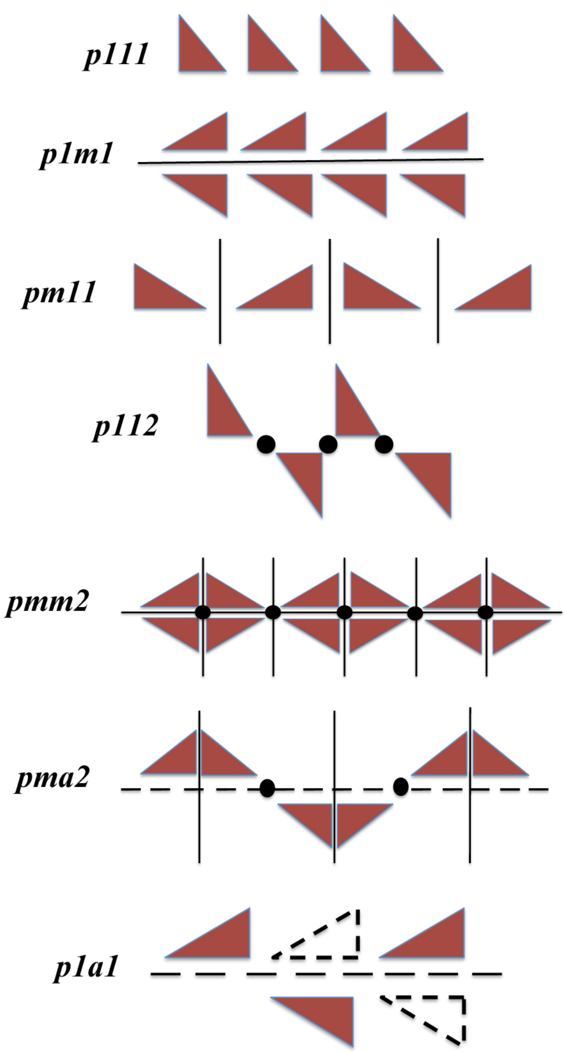

Figure 5.21. *The symmetry motions for one-dimensional patterns* (drawn by EMD 2016; modified after Washburn, 1999, Fig. 2b).

3. Two-dimensional infinite patterns: created along intersecting linear axes using the four rigid motions in seventeen combinations, an example is a wallpaper pattern (for visual examples, see Washburn, 1999, Figure 2c). The notation will not be described in detail here because it does not pertain to this research.

It is important to note that there are seven classes of one-dimensional pattern (Washburn and Crowe, 1988, Fig 2.26) and seventeen classes of two-dimensional pattern (Washburn and Crowe, 1988, Fig 2.28). These describe the number of pattern classes created if the design is not colored, that is, if all the elements being repeated are the same color. Designs can, of course, be colored with different colors. However, they can only be *symmetrically* colored if the different colors systematically interchange. Thus, there are seventeen two-color classes for one-dimensional patterns (Washburn and Crowe, 1988, Fig 3.9) and forty-six classes of two-color classes for two-dimensional patterns (Washburn and Crowe, 1988, Fig 3.11). While, theoretically, designs may be of *n*-fold color classes, in reality most culturally created designs are either one-color or two-color designs. A thorough discussion of color symmetry as it pertains to this research is presented later in this chapter.

The fundamental theorem, the four rigid motions, and the three axial categories, each with a defined number of pattern classes make up the formal rules of symmetry that define the underlying grammar of plane pattern design. This basic grammar describes the structure of all geometrically repeated patterns. A symmetry analysis is based on the assumption that all repeated designs follow these formal rules.

In order to use a design classification system as a methodology to examine general patterns of human behavior, its analytical units must be clearly defined and capable of being reproduced for future studies. An ahistorical ordering system is required to make data comparable, testable and capable of explanation, and to make hypotheses replicable (Dunnell, 1971). This means that units of study must be clearly defined; for instance, as Dunnell (1971, p. 17) suggests, "…necessary and sufficient conditions for membership in a unit." Symmetry analysis fits these criteria.

Symmetry analysis allows the investigator to classify designs based on the symmetric arrangements of the pattern elements and motifs according to a mathematically derived classification system. The methodology allows for systematic appraisal of data and the formation of testable hypotheses. The focus on a single attribute of design structure, its symmetry, enables descriptions of designs by the geometric motion classes that repeat the motifs. Such a method enables the preparation of analyses that can compare databases across time and space as well as on different materials recovered by different investigators. It is an objective way to see cultural preferences for specific arrangements of patterns and to track their continuities and changes within and across cultural systems.

A symmetry analysis of Chiribaya ceramic design structures is an ideal method to address the question of the existence of consistent patterns in Chiribaya mortuary ritual. This dissertation will identify the preferred symmetry classes used to create the Chiribaya ceramic design structures. The consistency of the symmetry classes will be measured by their frequency as they are distributed across the Chiribaya Alta and Chiribaya Baja cemeteries. Examining the consistent patterns in the Chiribaya design structure system will offer another line of evidence for identifying fundamental Chiribaya funerary practices.

Method: Statistical Analysis and Tests of Association

Statistical analysis was conducted using Rstudio, an open source program for statistical computing and graphics. The one-sample (Goodness of Fit) chi-square test was applied when each observation could be assigned to only one of a number of classes (van Emden, 2008, p. 280). A two-sample (Test for Independence) chi-square test was applied when each observation fit into two or more classifications (van Emden, 2008, p. 280). The significance level was 0.05 and the alternate hypothesis was accepted if the p-value was less than 0.05. Each observation that contributed a count to the contingency table was independent of the other observations (see Diez et al, 2014). All frequencies greater than or equal to five were included in chi-square tests (see Diez et al, 2014). However, according to van Emden (2008), frequencies greater than or equal to one can be included and often are included in this analysis. When a contingency table contained multiple observations that were less than five, a Fisher's Exact test was applied in addition to the chi-square test (see van Emden, 2008, p. 291).

Correspondence analysis is used in this dissertation as a graphical representation of the chi-square tested associations. Correspondence analysis is mainly a descriptive tool and data typically used in this type of analysis is derived from two-way contingency tables that consist of nonnegative data (Agresti, 2014; Nenadic and Greenacre, 2007). Simple correspondence analysis is appropriate for data that is nonnegative, such as abundance counts or percentages, and when the data is measured on the same scale (Greenacre and Primicerio, 2013; Nenadic and Greenacre, 2007). Points on the graph represent the rows and columns in two-way contingency tables; the positions of such points indicate associations (Agresti, 2014, p. 396). The graphical representation of correspondence analysis illustrates the estimates of two dimensions: the first dimension and its estimates are displayed along the horizontal axis and the second dimension and its estimates are displayed along the vertical axis (Agresti, 2014, p. 396). The first dimension is more critical than the second because it accounts for "94% of the total squared correlation [and] is adequate for describing the association" (Agresti, 2014, p. 397).

Research Hypotheses

To address the research question "is there detectable patterned human behavior in the mortuary archaeological record at Chiribaya Alta and Chiribaya Baja that results in consistent mortuary ritual practiced by the Chiribaya people of the coastal Osmore drainage?" I will test two sets of hypotheses.

Hypothesis 1

The distribution of the following burial attributes will be consistent across cemeteries 4 and 7 at Chiribaya Alta: the patterned placement of grave goods within the tomb, the orientation of the tombs and the individual's orientation inside the tomb.

Hypotheses 1a: collection and analysis of grave good data

Contextual burial information was gathered from unpublished field notes and spreadsheets recorded by excavators and researchers associated with the Chiribaya Project. The following data was recorded for this dissertation: sex and age of individual, number of individuals per tomb, the individual's position inside the tomb and their orientation, tomb shape, the orientation of the tomb, grave good type, grave good material, and where the grave good was placed inside the tomb.

Sex and age data cited in this dissertation was assigned by an osteologist in a laboratory setting (Buikstra, pers. comm., 2015). I assigned each individual's age to an age group category as described by Buikstra and Ubelaker (1994). Frequency counts related to age and sex data are as follows. There are a total of 26 females, 27 males, and 69 individuals of undetermined sex for a total of 122 individuals included in the dissertation data. The age groups with the highest frequencies of individuals were: birth to five years old, 37 individuals; 20-34 years old, 18 individuals; and 35-49 years old, 27 individuals. These three age groups were included in the chi-square analyses.

In order to analyze the use of space within the tomb at Chiribaya Alta, I coded the placement of grave goods within the tombs from cemeteries 4 and 7 according to whether they were associated with the body or placed in a pile at the edges of the tomb. The locational information of each grave good within the tomb was gathered from unpublished field notes recorded by Chiribaya Project excavators. I define placement of the grave good on the body as an offering that is placed on or near the head, body, or feet of the individual. I define placement of a grave good in a pile as an offering that is placed along the edges of the interior of the tomb. External grave goods were also noted and categorized as "pile, external".

There are a total of 1505 grave goods recorded from cemeteries 4 and 7 of Chiribaya Alta. In order to simplify the grave good analysis, I categorized grave goods into inclusive groups of my creation. I generated 29 total grave good groups; each group includes artifacts that are related by material and/or use. Generally, artifacts were combined into a category if there were fewer than five frequencies counted in cemeteries 4 and 7 of Chiribaya Alta. For example, bird and marine remains were included in the "animal remains" category because there were less than 5 of each found between cemeteries 4 and 7. Some artifacts were coded as their own category because there was a large count of the artifacts found at the cemeteries. For instance, camelid remains and guinea pig remains were excluded from the animal remains category and given their own, separate categories because there was a high count of each type found at cemeteries 4 and 7. Table 5.2 describes each grave good group.

Grave Good Group	Grave good type
1. Animal remains	animal cranium, animal hide, animal remains, animal scapula, animal femur, bird, *loro* (bird), marine animal, sea lion, fish bone
2. Bag	bag, bag of beans, bag of coca, bag of maize, bag of plant remains, bag of plant remains, bag of thread, bag with tools
3. Basketry	basket, basketry weaving kit, basket of maize, wicker basket, *capacho* (Minkes, 2005: basket used to carry children or objects), basket fragment
4. Botanical remains	botanical remains, guayaba, lucuma, maize, molle, pacae, pepper, seeds, yucca, coca leaves, herb, yamate
5. Bowl	bowl
6. Camelid remains	camelid cranium, camelid feet, camelid remains, llama cranium, llama feet, llama ribs, *vichuña*, camelid mandible, camelid wool, llama skin, llama hide, llama remains, and llama mandible
7. *Cántaro*	*cántaro*, Churajón *cántaro*, duck *cántaro*
8. Ceramic container	Basic categories of cooking, storage, and serving: ceramic sherd, broken boot pot, cup, spouted teapot, vase, *olla*
9. Urn	urn

Table 5.2. *Grave good group descriptions.*

Table 5.2 (cont'd)

10. Clothing	leather rope (Minkes, 2005: wrapped around tunic), leather/skin, sandals, shoes, cactus spine pin, belt, hat, red textile belt
11. Personal item	comb, pillow, beads
12. Gourd	calabaza, gourd
13. Human remains	human cranium, human offering, offering of a child
14. Jar	jar, double body jar
15. Kero	kero, wooden jar
16. Matting	cane (Minkes, 2005: used to make matting), litter, mat
17. Metal	metal artifacts, gold piece
18. Miniature offering	little basket, little boat, little raft, little jar, little vase
19. Music	pan pipe, cane pipe, corn pipe, drum
20. Rafting	raft, oar
21. Guinea pig	guinea pig, guinea pig cranium, guinea pig mandible, rodent remains
22. Spoon	spoon
23. Textile	cloth with coca leaves, scarf, textile, cloth, square cloth, *panuelo*
24. Fardo textile	Textile wrapped around deceased individual
25. Tool	foot plow, knife weight, spearthrower, lithic point, tool with shell, axe, *trompo* (Minkes, 2005: spinning top, bottle stopper, or net weight)
26. Fishing tool	harpoon
27. Weaving	needle, weaving tool, cane with thread, balls of thread, thread, spindle, weaving stick, spindle whorl, weaving stick and thread
28. Wooden artifact	wood, wooden artifact, wooden box (Minkes, 2005: used for pigments), stick, stake
29. Stone	rock, stone sculpture

Hypothesis 1b: collection and analysis of orientation data

Data detailing the tomb's orientation and the orientation of the individual in the tomb was gathered from unpublished field notes recorded by excavators of the Chiribaya Project. Orientation data from Chiribaya Alta cemeteries 4 and 7 was recorded, as well as associated age and sex information. The individual's orientation in the tomb was coded as the cardinal direction in which the individual's head was facing at the time of excavation, which is assumed to be the same orientation in which the deceased was placed at the time of burial. The orientation of the tomb was coded as the cardinal direction in which the tomb was oriented lengthwise, such as Northwest to Southeast. In order to compare the use of space at the level of the individual and the level of the cemetery, age and sex data was linked with orientation data in order to detect patterns in the distribution of orientation direction among age and sex groups within and between cemeteries 4 and 7.

Hypothesis 1: statistical analysis

When testing the associations of grave good placement inside the tomb and the orientations of the tomb and the individual inside the tomb, all chi-square tests were run with data from Chiribaya Alta, cemeteries 4 and 7. Correspondence analysis was conducted in order to graphically represent the distributions of grave goods and orientation type across cemeteries 4 and 7. As an added measure in understanding the grave good distributions in cemeteries 4 and 7 of Chiribaya Alta, the nonparametric test Kendall's tau was used to test the strength of association between pairs of grave good groups being buried in the same tomb.

Hypothesis 2

The distribution of Chiribaya ceramic design structures will be consistent across cemeteries 1-9 at Chiribaya Alta and cemetery 1 at Chiribaya Baja.

Hypothesis 2: symmetry analysis of Chiribaya ceramic design structures

The first step in a symmetry analysis of Chiribaya ceramic design structures was to organize each pattern into a design structure category. As discussed in Chapter 3, the design structure is defined as the very basic organization and subdivision of a design field; the design field is the total space on the ceramic vessel that maybe subdivided and is filled with decorative elements and motifs (see Figure 5.22). The terms and definitions of "design structure" and "design field" are based on Anna Shepard's (1948: 227-230) discussion of the construction of one-dimensional infinite bands.

Figure 5.22. *Chiribaya step-fret motif on a bowl exterior.* Note the trapezoidal subdivision of the design structure; the design field is the entire pattern (drawing by EMD 2015).

Understanding the design structure and its subdivisions is an important initial step because the manner in which the structure is or is not divided carries crucial information regarding the limitation of possible choices of symmetry motions used to create the pattern. In order to observe how the geometric elements and motifs were arranged to form the designs and patterns that decorate Chiribaya ceramic vessels, vessel roll-out images were hand-drawn by the author and then colored using Adobe Photoshop Elements. For each ceramic vessel, I noted the vessel form and the design or pattern's location on the ceramic vessel as follows: neck, neck interior, shoulder, body, bowl interior, or bowl exterior.

Next, the geometric patterns were assigned to two different symmetry classifications. According to Washburn and Crowe (1988, p. 56), a pattern should first be classified by the symmetry of its basic underlying structure (referred to in this dissertation as the "symmetry of structure"); and a second classification describing the symmetry of the complete design with all the added embellishments (referred to in this dissertation as the "symmetry of design"). Following the work of Shepard (1948) and Washburn and Crowe (1988) and based on the nature of the Chiribaya ceramic design data set, I developed a definition for the "symmetry of structure" specific for this dissertation research. The symmetry of structure is defined as rigid motions that superimpose major elements onto their mirror images; the rigid motions that organize and arrange the elements across the design field generate the design or pattern. The subdivisions of the design structure are also taken into consideration in the symmetry of structure because the type of subdivision frequently determines the type of possible symmetry motions. In this dissertation, the presence/absence of subdivisions in the design structure and the repetitive motions of major elements make-up the symmetry of structure. Color and added embellishments are excluded when classifying the symmetry of structure.

I developed the next set of definitions to describe different types of elements used in the Chiribaya ceramic design structures. These definitions are based on my own observations. Major elements are defined as elements that seem to be the centerpiece of the pattern and they must repeat across the design field. These elements are critical pieces of common motifs found in the Chiribaya design system, such as half circles or step-frets (see Figure 5.23). Minor elements or fillers are identified as one or all of the following criteria: non-repeating elements; elements that divide the design; elements, often smaller in size than surrounding elements, that reduce the symmetry of the design; and elements that fill the space between the major elements (see Figure 5.24).

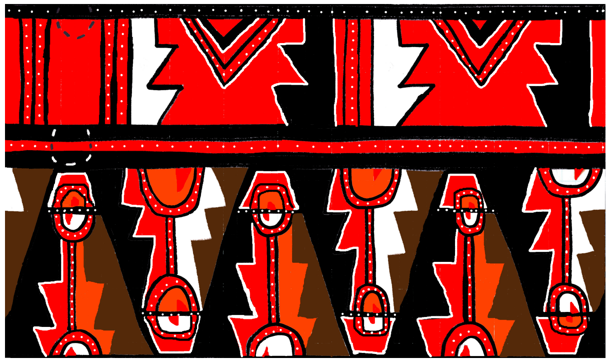

Figure 5.23. *An example of a major element, the step-fret, seen on the jar neck (top design) and the jar body (bottom design)* (drawn by EMD 2016).

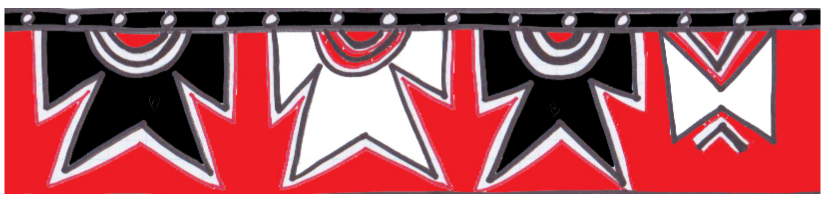

Figure 5.24. *An example of a minor element, the bowtie at the end of the pattern, on the exterior of a Chiribaya bowl* (drawn by EMD 2016).

The Symmetry of Design is defined in this dissertation as the repetitive, symmetrical motions of the major and minor elements. Following the definition of Washburn and Crowe (1988, p. 56) the symmetry of design includes all added embellishments and color changes. This symmetry classification proved quite challenging because, as will be discussed further in this chapter and in the final Discussion/Conclusion Chapter, artists who decorated Chiribaya ceramic vessels frequently added minor elements or used complicated color alternations that, when following the flow chart of color symmetry classifications presented in Washburn and Crowe (1988), reduced the symmetry of the design to asymmetrical or a simple translation. For instance, a common occurrence of one-dimensional patterns on the exterior of bowls was to add one extra minor element that did not repeat and, hence, reduced the symmetry of the design to asymmetrical (see Figure 5.24). When this occurred, I ignored the single additional element and classified the symmetry of design with the elements that repeated across the design field.

However, because deviations from a culture's preferred symmetrical motions can hold cultural significance (Franquemont, 2004; Grünbaum, 2004; Senechal, 2003), these cases were noted.

Color symmetry

The use of color in Chiribaya designs was coded according to its color state, which categorizes the symmetry of color; in other words, rigid motions that interchange colors across the design field (Washburn and Crowe, 1988). Motions that are deemed "consistent with color" are "rigid motions which interchange colors everywhere or rigid motions which move each color onto the same color" (Washburn and Crowe, 1988, p. 64). The types of rigid motions that are consistent with color can be categorized in two ways: motions that preserve color and motions that reverse (or interchange) color.

Motions that preserve colors are defined as "rigid motions that move each color onto the same color" (Washburn and Crowe, 1988, p. 64). One-color patterns or designs preserve colors because all colors admit rigid motions or symmetries onto the same color, the colors do not interchange (see Figure 5.25). There may be more than one color used to generate the one-color design or pattern, but if each color superimposes onto itself; thus, it is considered a color-preserving one-color design. In contrast, motions that reverse colors are defined as "rigid motions that change colors" (Washburn and Crowe, 1988, p. 64). For instance, a two-color design or pattern is a design field in which a symmetric motion interchanges exactly two colors everywhere, such as the black and red colors of a checkerboard (see Figure 5.26; Washburn and Crowe, 1988, p. 64).

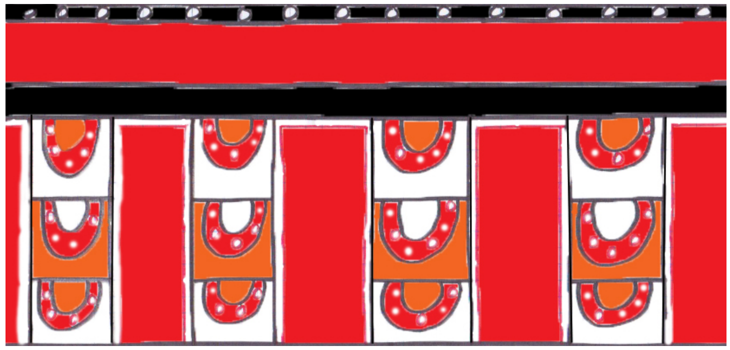

Figure 5.25. *Chiribaya cántaro, one-color pattern* (drawing by EMD 2015).

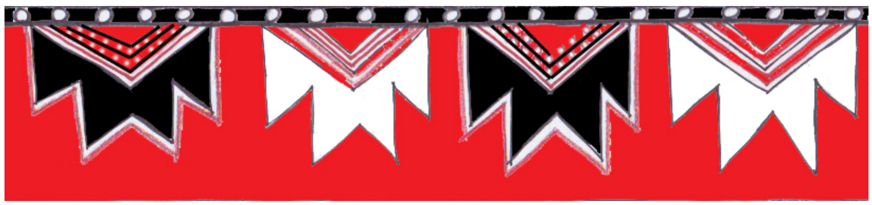

Figure 5.26. *The two-color pattern on a Chiribaya bowl* (drawing by EMD 2015).

A final use of color that was considered in this dissertation is the background color. A section of the design or pattern is considered the "background" when "no rigid motion moves this background onto the pattern proper"; the color of the background does not interchange (Washburn and Crowe, 1988, p. 64-65). For instance, the red color in Figures 5.25 and 5.26 is the background color of the design because it does not (inter)change.

Washburn and Crowe (1988) developed flowcharts in order to categorize the symmetry class of one- and two-dimensional patterns using one to two colors. However, many of the Chiribaya designs and patterns do not fit into the one- or two-color definitions as established by Washburn and Crowe (1988). To remedy this issue, I created new color state categories as follows: 3-color, 4-color, 5-color, and colored. A color state assigned to the 3-, 4-, or 5-color category means that there are 3, 4, or 5 colors in the design or pattern and some colors consistently alternate, while others do not (see Figures 5.27a – 5.27c for an example of the 5-color state). A color state marked as 'colored' means that there are multiple colors, but they do not alternate consistently. In the case when a special color state designation is used, color is included in the symmetry of design classification to signify that the color change exists, even though the interchanging of colors is not systematic as described by Washburn and Crowe (1988). The flowcharts presented in Washburn and Crowe (1988) only describe two-color symmetries and are not sufficient when classifying the multi-color symmetries of Chiribaya ceramic designs. The use of color in the Chiribaya ceramic design structure system is intriguing and complicated. It is beyond the scope of this dissertation to provide a thorough analysis of the color symmetry of Chiribaya ceramic design structures. Preliminary interpretations and questions for future research pertaining to this issue will be discussed in the final Discussion/Conclusion chapter of this dissertation.

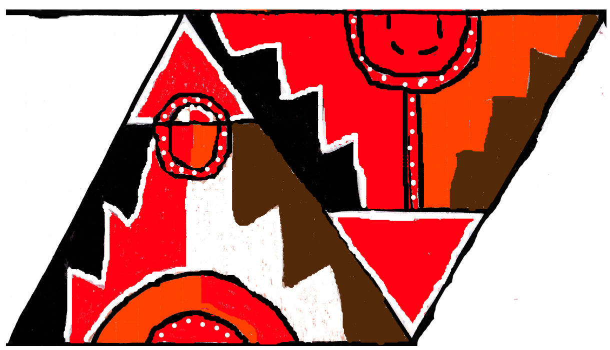

Figure 5.27a. *A section of a pattern showing a five-color state on a Chiribaya jar* (drawing by EMD 2015).

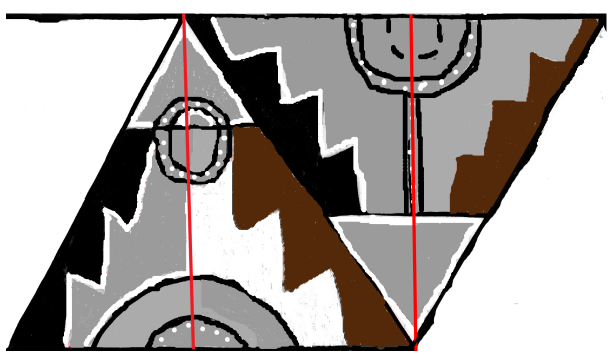

Figure 5.27b. *The five-color state on a Chiribaya jar: the black alternates with brown* (drawing by EMD 2015).

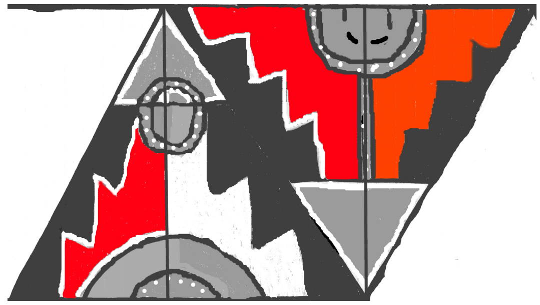

Figure 5.27c. *The five-color state on a Chiribaya jar: the red alternates with either white or orange* (drawing by EMD 2015).

Hypothesis 2: statistical analysis

In order to statistically test preferences for specific symmetry classes in the generation of Chiribaya ceramic design structures, I included all ceramic vessels in my sample from cemeteries 1-9 of Chiribaya Alta and cemetery 1 of Chiribaya Baja (n=247). To test preferences for a specific symmetry class among a segment of the population buried at Chiribaya cemeteries, cemeteries 1-5 and 7 at Chiribaya Alta were included. For example, the distribution of symmetry classes according to age and sex of individuals was compared among cemeteries 1-5, and 7 at Chiribaya Alta because these cemeteries had the highest frequencies of ceramic vessels that I recorded during data collection. Cemeteries with a frequency of greater than five burials and containing the symmetry class in question were included in the analysis. This resulted in different combinations of cemeteries 1-5, and 7 for the chi-square tests. Cemeteries 6, 8, and 9 at Chiribaya Alta were excluded during this stage of analysis because these cemeteries each contained less than five burials and low frequencies of ceramic vessels in the data set. Chiribaya Baja was also excluded from the analysis when testing the association of symmetry class with age and sex data due to low frequencies.

Chapter Summary

Ceramic and burial data from the prehispanic cemeteries of Chiribaya Alta and Chiribaya Baja are examined in order to address the research question: "is there detectable patterned human behavior in the mortuary archaeological record at Chiribaya Alta and Chiribaya Baja that results in consistent mortuary ritual practiced by the Chiribaya people of the coastal Osmore drainage?" This dissertation will test the ability of a symmetry analysis of ceramic design structure data to reveal cultural preferences for certain design symmetries on ceramic vessels from a mortuary context. A mortuary analysis of certain burial attributes is conducted to link the analysis of ceramic design structures with the mortuary practices of Chiribaya people who lived in the coastal Osmore drainage during the Late Intermediate Period. The multidimensional nature of burial ritual is acknowledged by analyzing the mortuary data at two spatial levels: the level of the individual and the level of the cemetery. Tests of association using chi-square analysis and simple correspondence analysis are applied in the following manner: to examine the distribution of preferred symmetry class across the cemetery space; and to test the distribution of specified burial attributes at Chiribaya Alta cemeteries 4 and 7. Results of this analysis will be presented in Chapter 6. A discussion and interpretation of the results will follow in Chapter 7.

CHAPTER 6: RESULTS

Chapter Introduction

In this chapter I will explore the results of the mortuary analysis of Chiribaya burial data and the symmetry analysis of Chiribaya ceramic design structure. A restatement of the research question is as follows: is there detectable patterned human behavior in the mortuary archaeological record at Chiribaya Alta and Chiribaya Baja that results in consistent mortuary ritual practiced by the Chiribaya people of the coastal Osmore drainage? I will restate each hypothesis and discuss the associated statistical testing and results.

Hypothesis 1

The distribution of the following burial attributes will be consistent across cemeteries 4 and 7 at Chiribaya Alta: the patterned placement of grave goods within the tomb, the orientation of the tombs, and the individual's orientation inside the tomb.

<u>Hypothesis 1a</u>

Patterned placement of grave goods within the tomb (either on the body or along the edges of the tomb) will be consistent across cemeteries 4 and 7 at the site of Chiribaya Alta.

<u>Statistical analysis of grave good distribution</u>

The one-sample chi-square test (Goodness of Fit) and two-sample chi-square (Test for Independence) was used to test the association of grave goods placed either on the body or in a pile along the edges of the tomb. I accepted HR if the p-value < 0.05. All frequencies greater than or equal to one observation were included in tests (see van Emden, 2008). The burial dataset from cemeteries 4 and 7 comprises 105 total burials, with 42 (or 40%) from cemetery 4 and 63 (or 60%) from cemetery 7. The unequal number of burials in the cemeteries was taken into account during the chi-square analysis. Rstudio code, contingency tables, and results for each chi-square test can be found in Appendix I.

A total of 1505 grave goods from cemeteries 4 and 7 of Chiribaya Alta were included in this analysis; generating 29 grave good groups. The burial data set contained 466 grave goods from cemetery 4 and 1,039 grave goods from cemetery 7. Grave good distributions were tested at the level of grave good groups, which are described in detail in Chapter 5. A one-sample chi-square test revealed that grave good groups were not equally distributed across cemeteries 4 and 7 of Chiribaya Alta. Results from chi-square analyses indicate a statistically significant association between all grave good groups from both cemeteries combined and placement in piles along the edges of the tomb, as opposed to placing items on or near the body of the individual. Most grave good groups were equally distributed between Chiribaya Alta cemeteries 4 and 7, with an exception being spoons, camelid remains, bags, and basketry items, which were found to be associated with cemetery 7 at the significance level of 0.05.

Kendall's tau was used to examine the probability of pairs of grave good groups being placed in a tomb together and to test the strength of this association. This test combined cemeteries 4 and 7 at Chiribaya Alta. Figure 6.1 demonstrates pairs of grave good groups that have a medium or higher strength of positive association, meaning they are more likely to be placed together as offerings in a tomb. Some examples of an association around the 0.4-0.6 range are: bowls and camelid remains, spoons and bowls, musical instruments and *cántaros*, bags and keros, and textiles and camelid remains.

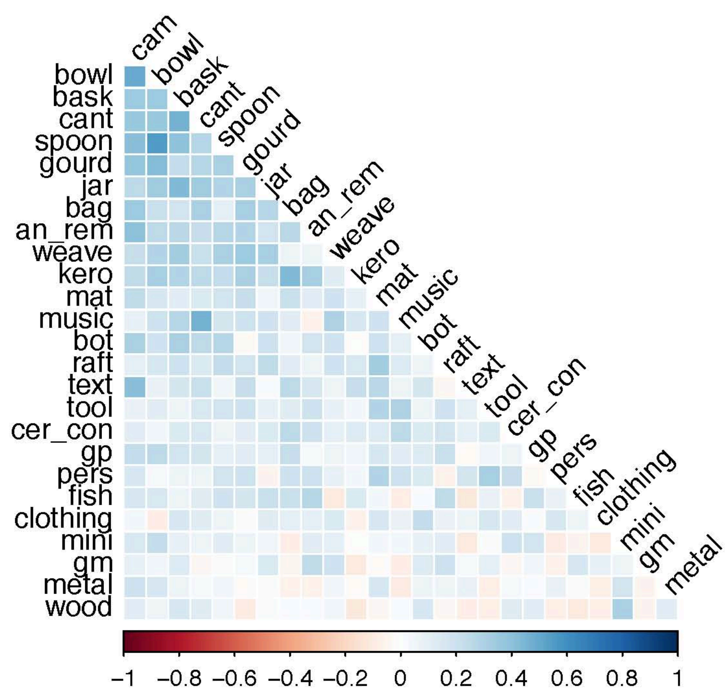

Figure 6.1. *Kendall's tau figure that illustrates the strength of association of pairs of grave good groups buried together.* *Figure created in Rstudio, code by Joseph T. Hefner, PhD.

Hypothesis 1b

The orientation of the tombs and the individual's orientation inside the tomb will be consistent across the cemeteries 4 and 7 at the site of Chiribaya Alta.

Statistical analysis of orientation

Burial data from cemeteries 4 and 7 were combined in order to avoid low frequencies during statistical analysis. The association between individual orientation and age groups was not subjected to chi-square analysis due to low frequencies. Chi-square tests revealed that the individual's orientation (facing N, S, or E) inside the tomb was equally distributed between males and females at cemeteries 4 and 7 of Chiribaya Alta. However, correspondence analysis illustrated variation in the individual's orientation inside the tomb based on sex and cemetery location. Females buried at Chiribaya Alta cemetery 4 were more frequently buried oriented to the North, while males were oriented to the South (see Figure 6.2). In contrast, males buried in

Chiribaya Alta cemetery 7 were more frequently buried oriented to the North and females were oriented either to the South or the East (see Figure 6.3). It should be noted that these results are based on frequencies and are not statistically significant.

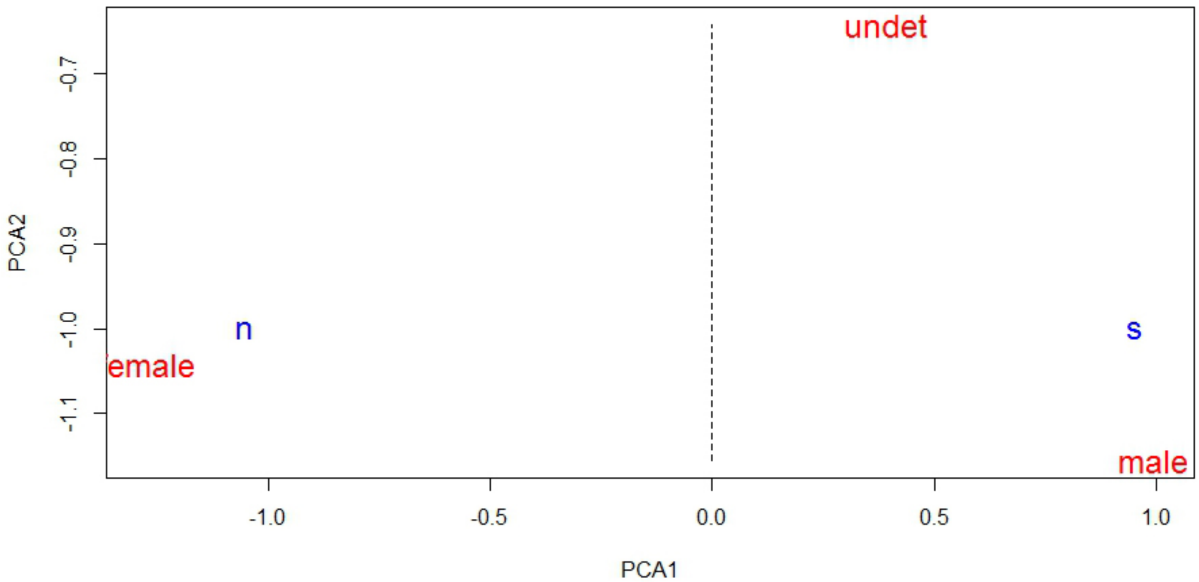

Figure 6.2. *Correspondence analysis demonstrating individual orientation of males, females in the tomb, Chiribaya Alta cemetery 4.* *Figure created in Rstudio, code by Joseph T. Hefner, PhD.

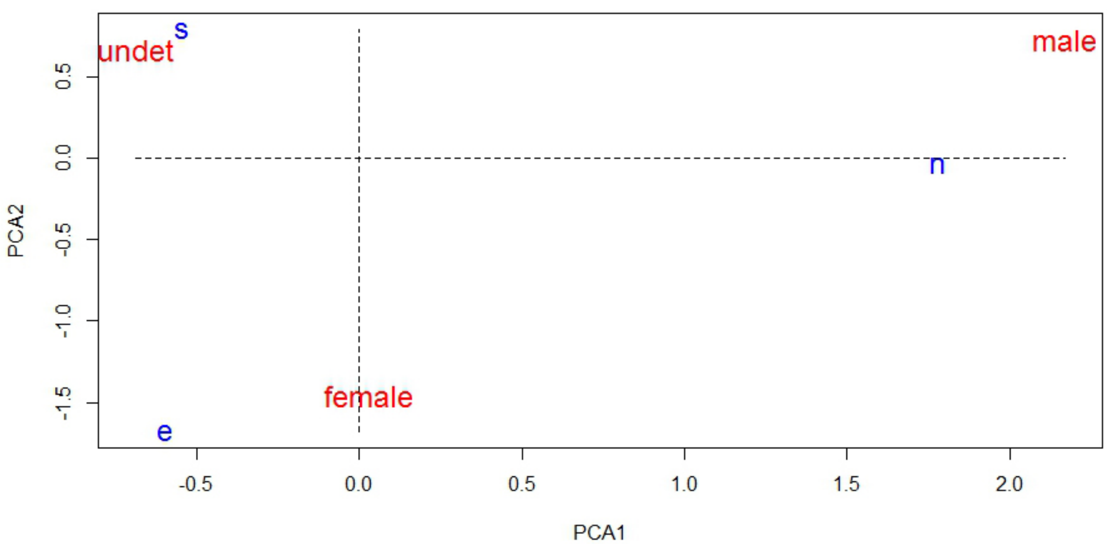

Figure 6.3. *Correspondence analysis demonstrating individual orientation of males, females in the tomb, Chiribaya Alta cemetery 7.* *Figure created in Rstudio, code by Joseph T. Hefner, PhD.

The next set of chi-square tests revealed that tomb orientation (NE-SW, N-S, NW-SE, and W-E) was equally distributed between males and females and among age groups at both cemeteries. Interestingly, a one-sample chi-square test revealed that tomb orientation was not equally distributed among deceased females at cemeteries 4 and 7 and this result was significant at the 0.05 level; tomb orientation was found to be equally distributed among males. Correspondence analysis illustrated that at cemetery 4 the tombs of females were more frequently oriented NE-SW, while the tombs of males were oriented either NW-SW or NE-SW (see Figure 6.4). A correspondence analysis of tomb orientation at cemetery 7 revealed that the tombs of females were more frequently oriented NE-SW and the tombs of males oriented NW-SE, N-S, or NE-SW (see Figure 6.5).

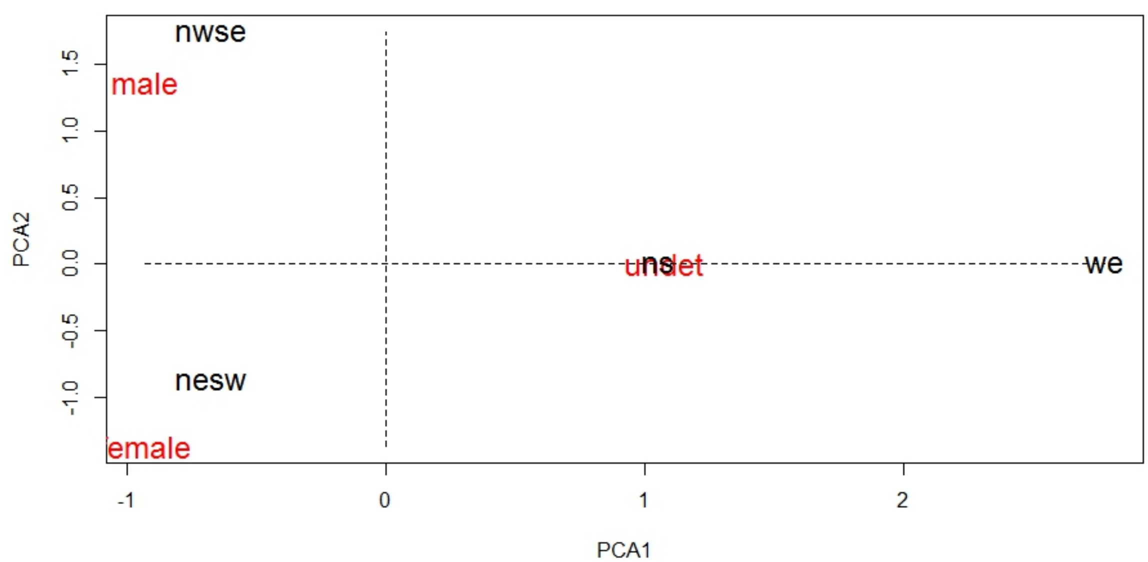

Figure 6.4. *Tomb orientation of males and females at Chiribaya Alta, cemetery 4.* *Figure created in Rstudio, code by Joseph T. Hefner, PhD.

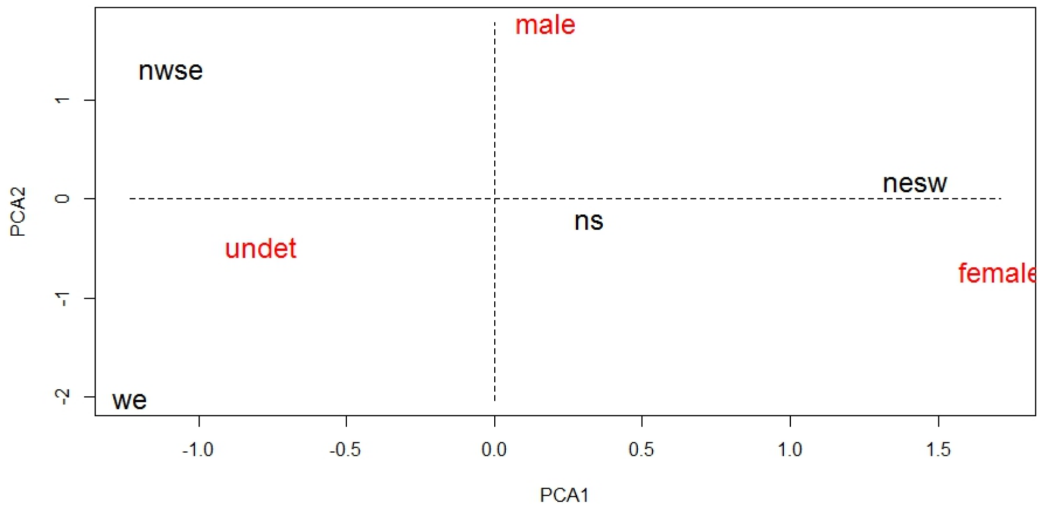

Figure 6.5. *Tomb orientation of males and females at Chiribaya Alta, cemetery 7.* *Figure created in Rstudio, code by Joseph T. Hefner, PhD.

Hypothesis 2

The distribution of Chiribaya ceramic design structures will be consistent across cemeteries 1-9 at Chiribaya Alta and cemetery 1 at Chiribaya Baja.

<u>Hypothesis 2a</u>

There is a preference for specific symmetry classes used to create the Chiribaya ceramic design structure system.

The ceramic data set included 247 ceramic vessels, 210 from Chiribaya Alta and 37 from Chiribaya Baja. I categorized the organization and arrangement of the design structure of Chiribaya ceramic vessels according to the symmetry of structure and the symmetry of design. The location of the design or pattern on the ceramic vessel and the vessel form was noted and compared. Ceramic vessels from cemeteries 1-9 at Chiribaya Alta and cemetery 1 at Chiribaya Baja were included.

A detailed explanation of the Symmetry of Structure and the Symmetry of Design can be found in Chapter 5. A brief re-statement of the definitions is as follows:

- Symmetry of Structure: rigid motions that superimpose major elements onto their mirror images; the rigid motions that organize and arrange the elements across the design field generate the design or pattern.
- Symmetry of Design: the repetitive, symmetrical motions of the major and minor elements, including added embellishments and color changes.

The most common axial categories recorded for Chiribaya ceramic design structures were finite designs and one-dimensional infinite patterns (band patterns). Two-dimensional infinite patterns were extremely rare. The frequency of axial categories is based on observation and was not subjected to chi-square analysis. Ceramic vessels from Chiribaya Alta and Chiribaya Baja were combined in this section of analysis. Each chi-square test accounted for unequal counts of design location, vessel form type, and ceramic style category. Rstudio code, contingency tables, and results for each chi-square test can be found in Appendix II.

The following results demonstrate the association between Symmetry of Structure and design location on vessel. Please refer back to Chapter 5 for a discussion on symmetry notation. They symmetry classes of *pm11* and *pma2* were not equally distributed across vessel design fields. In contrast, the *pmm2* symmetry class was equally distributed across vessel design fields. The results reported below are statistically significant and were obtained with one-sample chi-square tests at a 0.05 significance level. The following set of symmetry classes are found on one-dimensional infinite patterns:

- Vertical mirror reflection (*pm11*) is associated with vessel necks and bowl exteriors (see Figure 6.6).

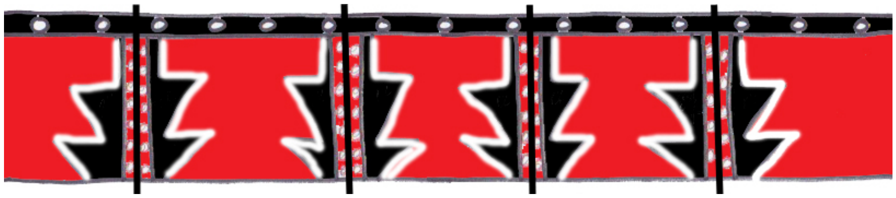

Figure 6.6. *Chiribaya cántaro neck, **pm11** symmetry class.* Black lines denote vertical reflection (drawn by EMD 2015).

- A combination of bifold rotation and vertical reflection (*pma2*) is associated with vessel bodies (see Figure 6.7).

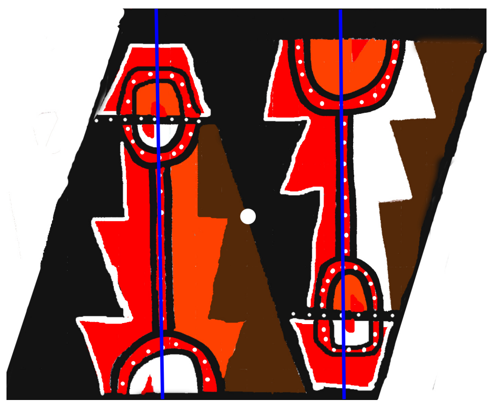

Figure 6.7. *Chiribaya jar body, **pma2** symmetry class.* Blue lines denote vertical reflection and white circle represents rotation point (drawn by EMD 2015).

- A combination of vertical mirror reflection, horizontal mirror reflection, and bifold rotation (*pmm2*) is equally distributed across vessel necks, shoulders, bodies, and bowl exteriors (see Figure 6.8).

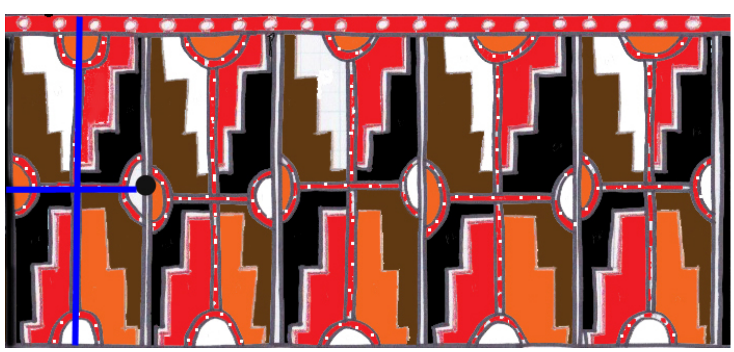

Figure 6.8. *Chiribaya jar body, **pmm2** symmetry class.* Vertical blue line denotes a vertical reflection, horizontal blue line is a horizontal reflection, and the black circle represents a rotation point. These symmetry motions repeat across the design field to form the entire pattern pictured here (drawn by EMD 2015).

Bowl interiors tended to have two different axial categories: finite designs and one-dimensional infinite patterns.

- The mirror reflection of finite designs (*d2,* see Figure 6.9) and the vertical mirror reflection of one-dimensional designs (*pm11*, see Figure 6.10) are equally distributed across bowl interiors.

Figure 6.9. *Chiribaya bowl interior, **d2** symmetry class.* Vertical blue line denotes a vertical reflection, horizontal blue line is a horizontal reflection, and the black circle represents the rotation point (the top half of the pattern rotates down to the bottom half and vice versa) (drawn by EMD 2015).

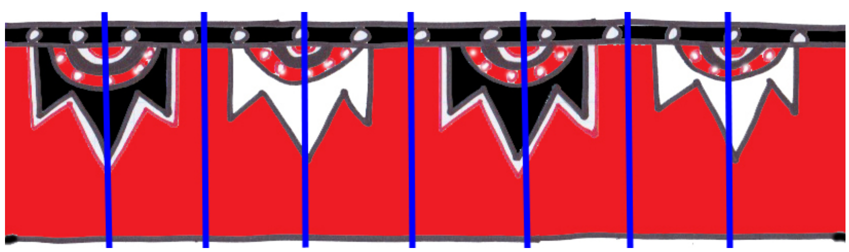

Figure 6.10. *Chiribaya bowl interior, **pm11** symmetry class.* Blue lines denote vertical reflection (drawn by EMD 2015).

A correspondence analysis comparing the association between symmetry class type and design location on the vessel mirrors the above chi-square results with a minor exceptions (see Figure 6.11). For instance, the symmetry class *pmm2* is strongly associated with vessel bodies. Also, the symmetry class *d2* is strongly associated with bowl interiors. The results of the correspondence analysis are not statistically significant and instead graphically display associations among variables.

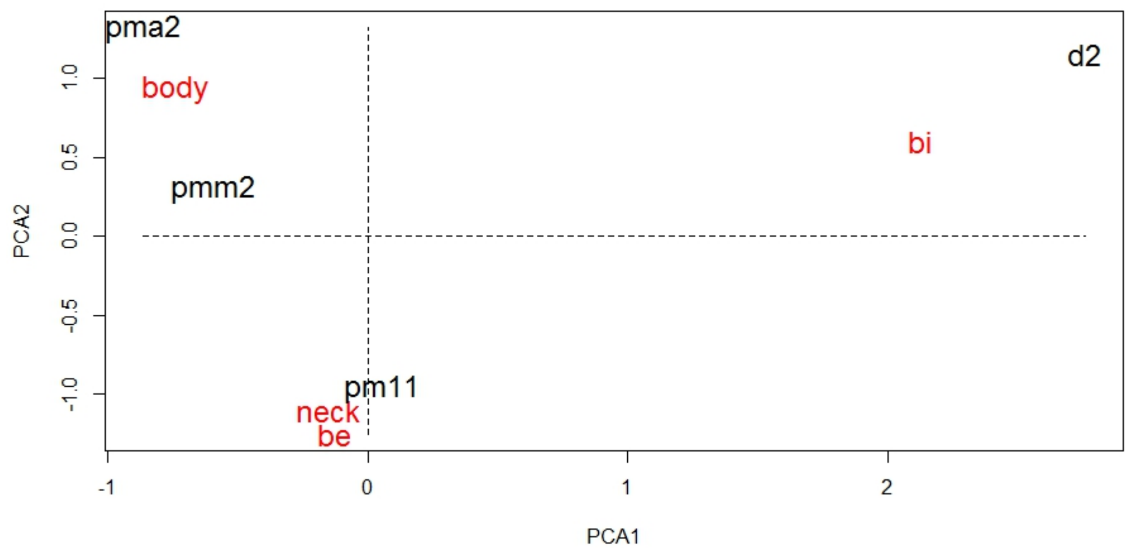

Figure 6.11. *A correspondence analysis comparing the design location on the vessel with the symmetry of structure.* *Body = vessel body; neck = vessel neck; be = bowl exterior; and bi = bowl interior. Figure created in Rstudio, code by Joseph T. Hefner, PhD.

The next set of results list the association between Symmetry of Structure and vessel form. The results reported below were obtained with one-sample chi-square tests; the alternate hypothesis was accepted if the p-value was less than 0.05.

- Vertical mirror reflection (*pm11*) class is not equally distributed across vessel forms and is favored on bowls (see Figure 6.10).
- The symmetry of structure classes of *pm11*, *pmm2*, *pma2*, and *d2* are not equally distributed across bowls. Bowls are associated with the *pm11* and *d2* classes (see Figures 6.9 and 6.10).
- A combination of vertical reflection and bifold rotation (*pma2*) is equally distributed across *cántaros* and jars (see Figure 6.12; for drawing, see Figure 6.7).

Figure 6.12. Chiribaya *cántaro,* ***pma2*** symmetry class on vessel body (photo by EMD 2006).

- A combination of vertical mirror reflection, horizontal mirror reflection, and bifold rotation (*pmm2*) is not equally distributed across vessel form and is associated with jars (see Figure 6.13; for drawing, see Figure 6.8).

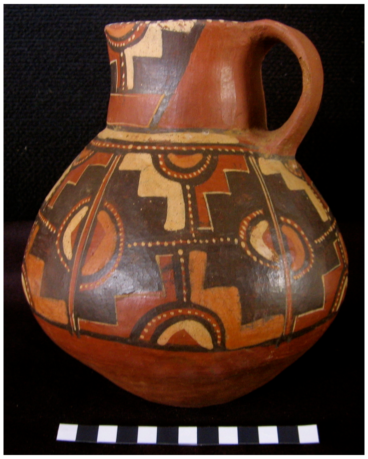

Figure 6.13. Chiribaya jar, ***pmm2*** symmetry class on vessel body (photo by EMD 2006).

The following results list the association between Symmetry of Design and vessel form. Please refer to Chapter 5 to review the notation for color changes as reported in the Symmetry of Design. The results reported below were obtained with one-sample chi-square tests; the alternate hypothesis was accepted if the p-value was less than 0.05.

- *pm11* is favored on bowls.
- *pm'a2'* is favored on jars (see Figure 6.14). This symmetry class refers to the five-color state (the alternation of five colors) described in Chapter 5 (refer to Chapter 5, Figures

5.25a - 5.25c for an illustration demonstrating the color changes of the five color state for the *pm'a2'* symmetry class).

Figure 6.14. Chiribaya jar, ***pm'a2'*** symmetry class on vessel body (photo by EMD 2006).

The association between ceramic style and symmetry class was also tested to determine the preferred underlying structures or rules the artists used when generating the Chiribaya ceramic design styles. The designs or patterns on each ceramic vessel were assigned to a symmetry class category as defined by Washburn and Crowe (1988) and to a stylistic phase category of Algarrobal, Yaral, or San Gerónimo as defined by David Jessup (1990, 1991) and modified by Bruce Owen (1993a). I assigned each ceramic vessel to its ceramic style category according to the published descriptions of Jessup (1990, 1991) and Owen (1993a); any mistakes in this assignment are my own. I used Owen's "Post-Algarrobal" category when the ceramic design was clearly not Algarrobal style, but I could not determine if it was the Yaral or San Gerónimo style. The Ilo-Tumilaca style was assigned to one vessel that exhibited the stylistic traits of the Ilo-Tumilaca/Cabuza material culture. The term "na" (not applicable) was applied when a vessel was plain or did not have repeating elements. The following categories had low frequencies and ceramic designs assigned to this stylistic phase category were ultimately not included when I tested the association between symmetry class and ceramic style category: post-Algarrobal and Ilo-Tumilaca. Figure 6.15 is a correspondence analysis table that demonstrates the distribution of Algarrobal, Yaral, and San Gerónimo ceramic styles across cemeteries 1-7 of Chiribaya Alta, however the results are not statistically significant: Algarrobal is closely associated with cemetery 7, Yaral with cemetery 5, and San Gerónimo with cemetery 4.

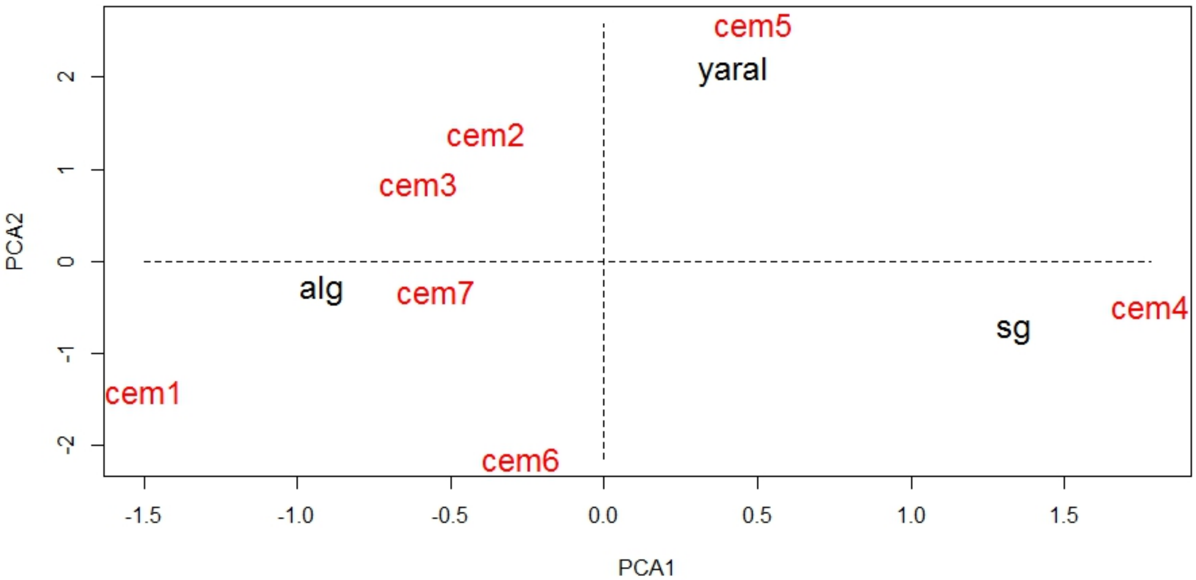

Figure 6.15. *Chiribaya ceramic style distribution across cemeteries 1-7 at Chiribaya Alta.* *Cem# = cemetery #. The three ceramic styles are represented as: alg = Algarrobal, yaral = Yaral, and sg = San Gerónimo. Figure created in Rstudio, code by Joseph T. Hefner, PhD.

The following set of results for **H2a** list the association between Symmetry of Structure and ceramic style category. These results were obtained with one-sample chi-square tests; the alternate hypothesis was accepted if the p-value was less than 0.05. Table 6.1 describes the frequency count of the each symmetry of structure class and its distribution across each Chiribaya ceramic style category; ceramic vessels from Chiribaya Alta and Chiribaya Baja were included.

- Symmetry class *pm11* is not equally distributed across three ceramic styles and is favored with the Algarrobal ceramic style category.
- Symmetry class *pma2* is equally distributed across three ceramic style categories: Algarrobal, Yaral, and San Gerónimo.

- Symmetry class *pmm2* is not equally distributed across three ceramic styles and is associated with the Algarrobal ceramic style category.
- The San Gerónimo ceramic style category does not have equal distribution of four symmetry of structure class categories; the symmetry classes *d2* and *pm11* are both associated with this ceramic style.

Ceramic Style	**Symmetry class**	**% frequency**	**N =**
Algarrobal	Vertical reflection (*pm11*)	46% (*65 vessels*)	141
Yaral	Vertical reflection (*pm11*)	79% *(37 vessels)*	47
San Gerónimo	Vertical reflection (*pm11*)	35% *(26 vessels)*	74
San Gerónimo	Bilateral reflection, bifold rotation (*d2*)	35% *(26 vessels)*	74

Table 6.1. *The frequency of distribution of symmetry of structure class across the three Chiribaya ceramic styles.* *Ceramic vessels from Chiribaya Alta and Chiribaya Baja were included in this table.

The next group of results for **H2a** lists the association between Symmetry of Design and ceramic style category. These results were obtained with one-sample chi-square tests at a 0.05 significance level. Ceramic vessels from Chiribaya Alta and Chiribaya Baja were included.

- Symmetry classes *pm'11* and *pm'a2'* are equally distributed across the Algarrobal and Yaral ceramic style categories.
- Symmetry class *pm11* is equally distributed across the three ceramic style categories of Algarrobal, Yaral, and San Gerónimo.

The final set of results for **H2a** tests the association between the use of color, or color state, and the following categories: design location on vessel, vessel form, and ceramic phase. The chi-square tests account for unequal vessel forms. Ceramic vessels from Chiribaya Alta and Chiribaya Baja are included. The first set of results detail the association between color state and design location on vessel. These results were obtained with one-sample chi-square tests at a 0.05 significance level.

- The 5-color state is not equally distributed across design location on vessels and is favored on vessel bodies (see Figure 6.9).

Figure 6.16. *Chiribaya jar, 5-color state on vessel neck (above the orange band) and body (below the orange band)* (drawing by EMD 2015).

- The one-color state is not equally distributed across design location on vessels and is favored on vessel necks and bowl interiors (see Figures 6.17 and 6.18).

Figure 6.17. *Chiribaya jar, one-color state on vessel neck (top zig-zag pattern)* (drawing by EMD 2015).

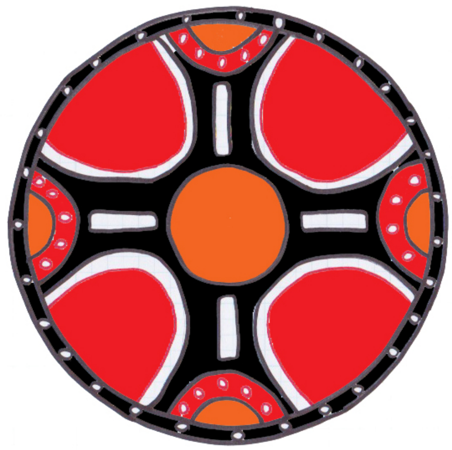

Figure 6.18. *Chiribaya bowl interior, one-color state* (drawing by EMD 2015).

- The two-color state is not equally distributed across design location on vessels and is favored on bowl exteriors (see Figure 6.19).

Figure 6.19. *Chiribaya bowl exterior, two-color state* (drawing by EMD 2015).

This set of results illustrates the association between color state and vessel form. These results were obtained with one-sample chi-square tests at a 0.05 significance level.

- The 5-color state is not equally distributed across vessel forms and is associated with jars.
- The one- and two-color states are not equally distributed across vessel forms and are associated with bowls.

Finally, this set of results describes the association between color state and ceramic style category. These results are statistically significant and were obtained with one-sample chi-square tests at a 0.05 significance level. Figure 6.20 is a correspondence analysis that visually displays the results described by the chi-square analysis.

- The Algarrobal style does not have equal distribution of color states; the one-color state is favored (76 count), followed by the 5-color state (34 count).
- The Yaral style does not have equal distribution of color states; the 5-color state is favored (28 count), followed by the one-color state (19 count), and then by the two-color state (14 count). The Yaral ceramic phase seems to have the most variety in the use of color.
- The San Gerónimo style does not have equal distribution of color states; the one-color state is favored (50 count), followed by the 5-color state (19 count).

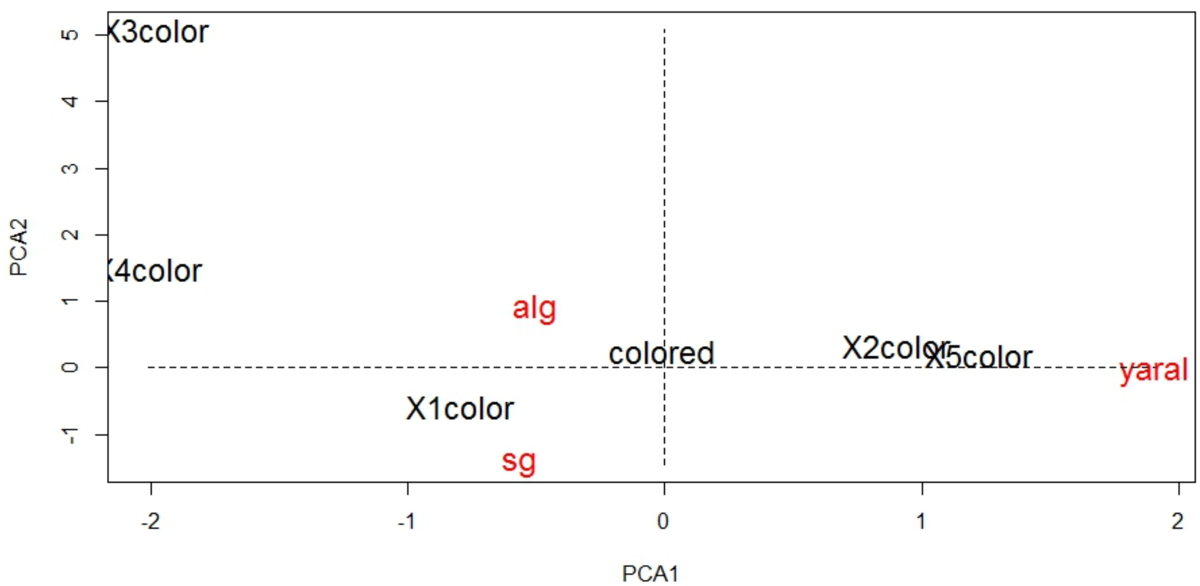

Figure 6.20. *Correspondence analysis comparing the association between Chiribaya ceramic style and color state.* *The three ceramic styles are represented as: alg = Algarrobal, yaral = Yaral, and sg = San Gerónimo. Figure created in Rstudio, code by Joseph T. Hefner, PhD.

Hypothesis 2b

The distribution of symmetry classes will be consistent across cemeteries 1-9 at the site of Chiribaya Alta and cemetery 1 at Chiribaya Baja.

In order to understand the distribution of specific symmetry class types across the various cemeteries of Chiribaya Alta and Chiribaya Baja, the association between the Symmetry of Structure and cemetery location was tested with chi-square analysis. Combinations of Chiribaya

Alta cemeteries 1-5 and 7 were subjected to the chi-square test if each observation was equal to or greater than five. Chiribaya Alta cemeteries 6, 8, and 9 were excluded from this part of the analysis due to low frequency count. Ceramic vessels and their associated design structures from Chiribaya Alta and Chiribaya Baja were separated in this section of analysis. Each chi-square test accounts for unequal counts of burials at each cemetery.

The first set of chi-square tests examines the association between cemetery location at Chiribaya Alta and the Symmetry of Structure. The results reported below are statistically significant and were obtained with one-sample chi-square tests at a 0.05 significance level.

- Vertical mirror reflection (*pm11*) is equally distributed across Chiribaya Alta cemeteries 1, 2, 3, 4, 5, and 7.
- The symmetry class *d2* is **not** equally distributed across cemeteries 4 and 7 at Chiribaya Alta; it is favored at Chiribaya Alta cemetery 4.
- The combination of vertical reflection and bifold rotation (*pma2*) is equally distributed across Chiribaya Alta cemeteries 2, 4, and 7.
- Vertical and horizontal mirror reflection (*pmm2*) is equally distributed across Chiribaya Alta cemeteries 2, 4, and 7.
- Symmetry of structure classes are **not** equally distributed across Chiribaya Alta cemetery 7, *pm11* is favored.

A correspondence analysis of the aforementioned chi-square tests mirrored the results with slightly more detail (see Figure 6.21). Chiribaya Alta cemeteries 1-7 were included in the correspondence analysis for a more holistic picture of the distribution of symmetry class related to symmetry of structure. Chiribaya Alta cemeteries 8 and 9 were excluded from the correspondence analysis due to low frequency counts. The symmetry class *pm11* is strongly associated with cemeteries 5 and 7. The symmetry class *d2* stands out because its strongest association is with cemetery 4. The symmetry class *pma2* also has a strong association with cemeteries 5 and 7. Finally, the symmetry class *pmm2* is strongly associated with cemeteries 5 and 7 as compared to the other six cemeteries at Chiribaya Alta.

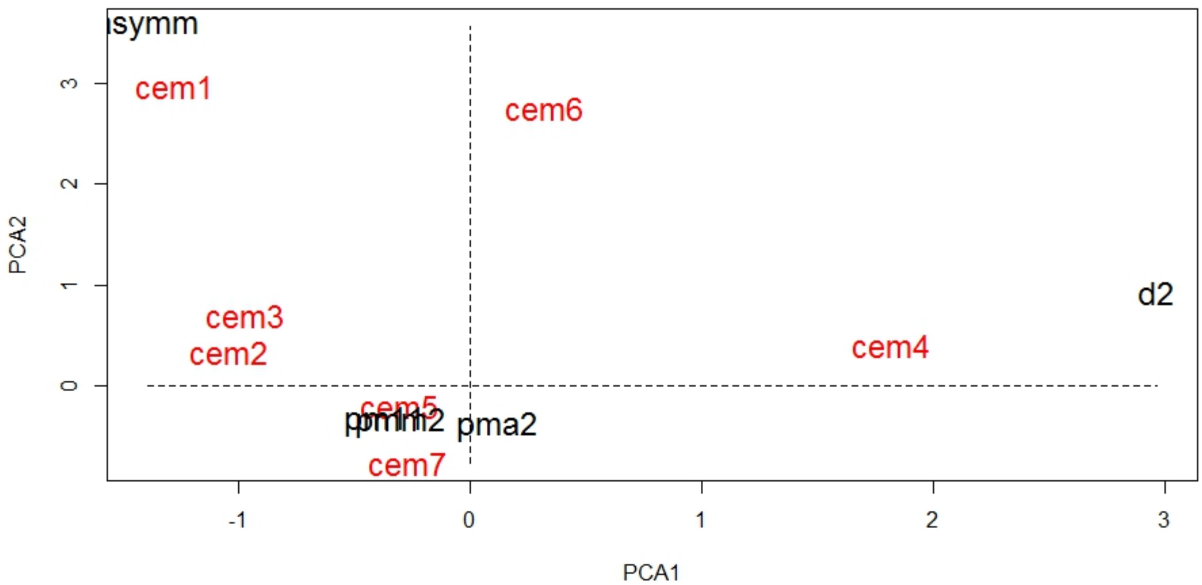

Figure 6.21. *A correspondence analysis of the symmetry of structure distribution across Chiribaya Alta cemeteries 1-7.* *Note the cluster of symmetry structures in the lower left corner, they are *pm11*, *pmm2*, and *pma2*. Figure created in Rstudio, code by Joseph T. Hefner, PhD.

The second set of chi-square tests examines the association between cemetery location at Chiribaya Alta and the Symmetry of Design. These results were obtained with one-sample chi-square tests at a 0.05 significance level.

- The following symmetry classes were equally distributed across Chiribaya Alta cemeteries 1-5 and 7: *pm'11*, *pm'a2'*, *pm11*, *pma2*, *d2*, *d'2*, and *pmm2*.

The results below describe the chi-square tests that examine the association between cemetery 1 at Chiribaya Baja and the Symmetry of Structure. A correspondence analysis was not conducted when comparing the distributions of symmetry class at Chiribaya Baja because data from only one cemetery was analyzed making a comparison of cemetery location and symmetry class inappropriate. These results were obtained with one-sample chi-square tests and are statistically significant at the 0.05 level.

- Symmetry of structure class is **not** equally distributed across Chiribaya Baja cemetery 1; vertical mirror reflection (*pm11*) is favored over glide reflection (*pma2*).

These results describe the chi-square tests that examine the association between cemetery 1 at Chiribaya Baja and the Symmetry of Design. Again, a correspondence analysis was not conducted when comparing the distributions of symmetry class at Chiribaya Baja because data from only one cemetery was analyzed. These results were obtained with one-sample chi-square tests; the alternate hypothesis was accepted if the p-value was less than 0.05.

- Symmetry classes *p'm11* and *pm11* are equally distributed in Chiribaya Baja cemetery 1.

The cemeteries at Chiribaya Alta exhibit marked variation among the distribution of symmetry class as evidenced by the aforementioned chi-square tests and correspondence analyses. The highest degree of variation in the distribution of symmetry classes was observed in cemeteries 4 and 7. A statistically significant association was recorded between cemetery 4 and the finite symmetry classification of *d2*. In contrast, a statistically significant correlation was documented between cemetery 7 and the one-dimensional symmetry classification of *pm11*. In light of these stark contrasts, I conducted a visual inspection of the distribution of symmetry class across cemeteries 4 and 7 of Chiribaya Alta in order to observe if symmetry class varied by location *within* each cemetery. A scatterplot of Chiribaya Alta cemetery 4 revealed that the clusters of symmetry groups in Figure 6.22 mirrored the clusters of burials in Figure 6.23 observed in Chiribaya Alta cemetery 4. The same can be reported for Chiribaya Alta cemetery 7 (see Figures 6.24 and 6.25). This demonstrates that symmetry structure type was equally distributed across cemeteries 4 and 7 at Chiribaya Alta.

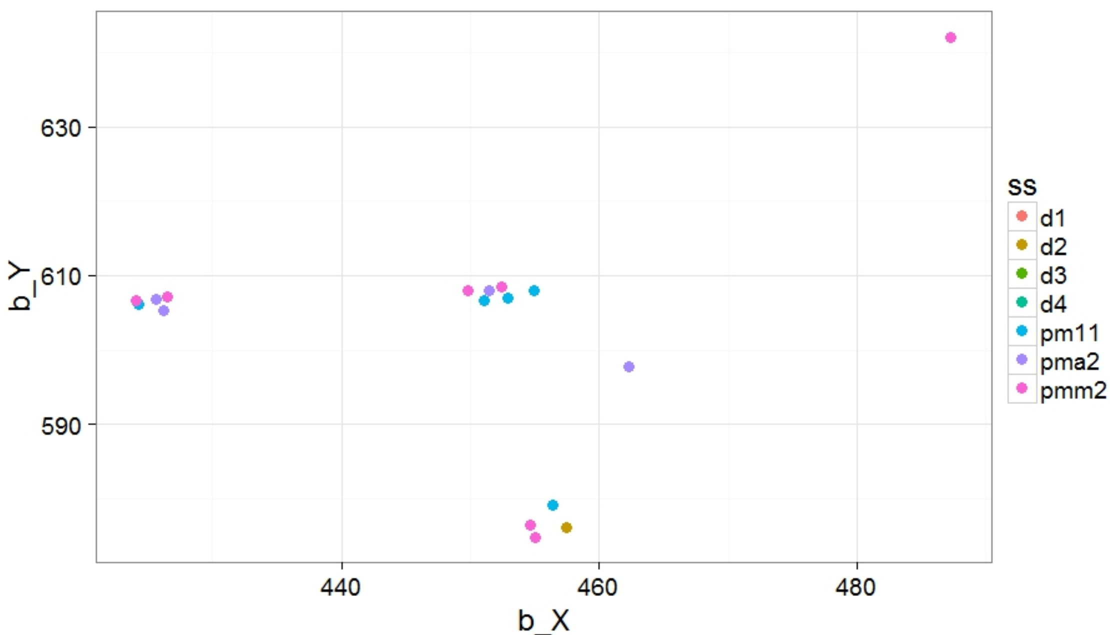

Figure 6.22. *The distribution of symmetry of structure by burial at Chiribaya Alta cemetery 4.*
*The burial y coordinate is represented by "b_Y" and the burial x coordinate is represented by "b_X". Scatterplot created in Rstudio, code by Joseph T. Hefner, PhD.

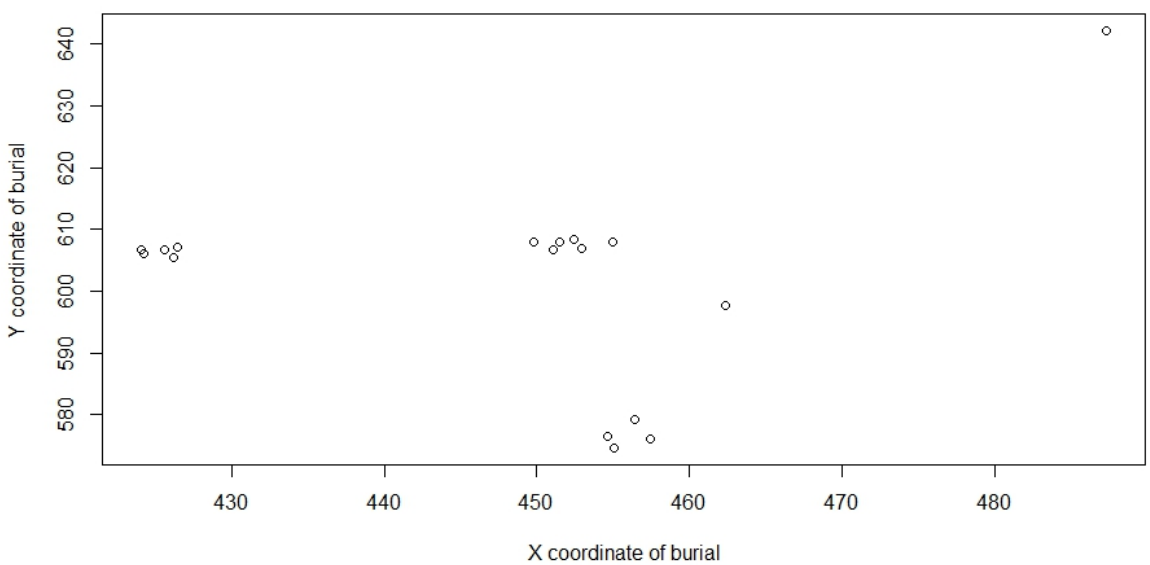

Figure 6.23. *The distribution of burials at Chiribaya Alta cemetery 4.*

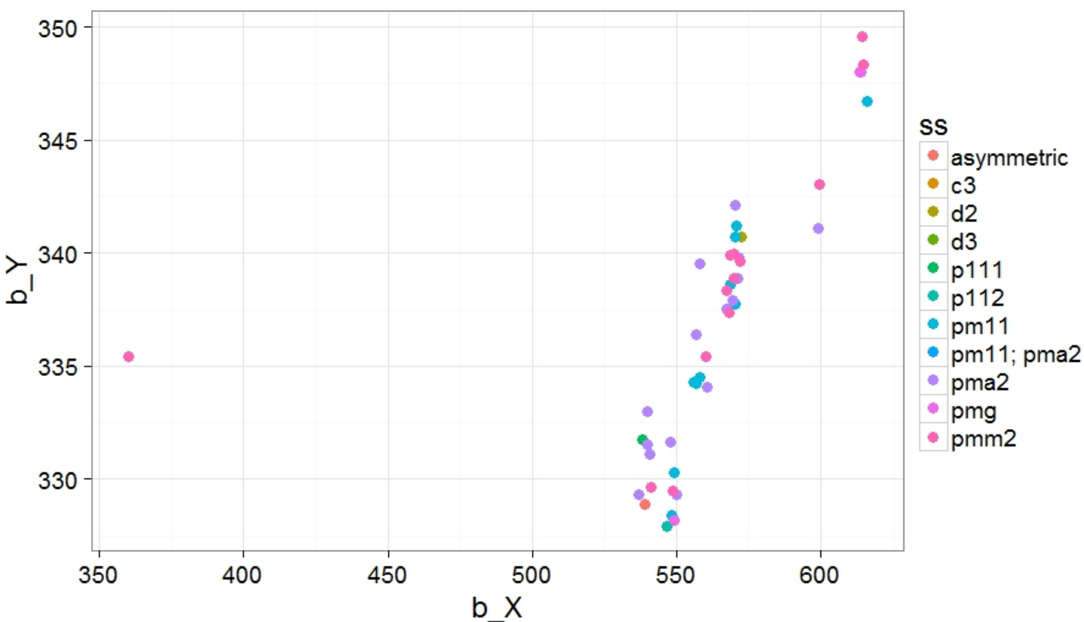

Figure 6.24. *The distribution of symmetry of structure by burial at Chiribaya Alta cemetery 7.*
*The burial y coordinate is represented by "b_Y" and the burial x coordinate is represented by "b_X". Scatterplot created in Rstudio, code by Joseph T. Hefner, PhD.

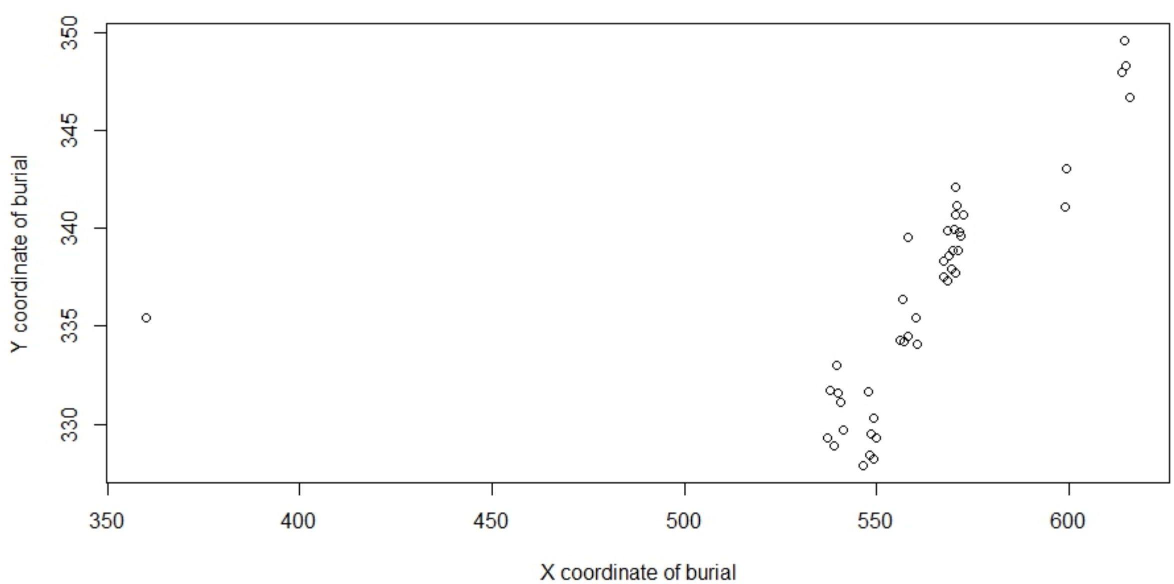

Figure 6.25. *The distribution of burials at Chiribaya Alta cemetery 7.*

Hypothesis 2c

The distribution of symmetry classes will be consistent according to age and sex of individuals buried at the cemeteries of Chiribaya Alta. This distribution of symmetry class according to age and sex will be consistent across cemeteries 1-9 at Chiribaya Alta. Data from Chiribaya Baja has frequencies that are too low for chi-square.

Sex

In order to understand the distribution of symmetry class type among the sexes at the cemeteries of Chiribaya Alta, the association between the Symmetry of Structure/Symmetry of Design and sex was tested with one- and two-sample chi-square analyses. All nine cemeteries from Chiribaya Alta were combined and included in this section of the analysis. The chi-square tests accounted for unequal counts of males and females in the cemeteries.

- Symmetry of Structure classes *pm11*, *pma2*, and *pmm2* were equally distributed between males and females in Chiribaya Alta cemeteries.
- Symmetry of Design classes *pm'11*, *pm'a2'*, *pm11*, and *pmm2* are equally distributed between males and females at Chiribaya Alta cemeteries.

Age

In order to understand the distribution of symmetry class type among the age groups at the cemeteries of Chiribaya Alta, the association between the Symmetry of Structure/Symmetry of Design and age was tested with one- and two-sample chi-square analyses. Due to a high incidence of low frequency counts, only three age groups were subjected to chi-square testing: birth to 5 years old, 20-34 years old, and 35-49 years old. All nine cemeteries from Chiribaya Alta were combined and included in this section of the analysis. The chi-square tests accounted for unequal counts of age groups in the cemeteries. This first set of results describes the association between Symmetry of Structure and age.

- The symmetry class *d2* is equally distributed among the following age groups: birth to 5, 20-34, and 35-49.

- The symmetry classes of *pm11*, *pma2*, and *pmm2* are **not** equally distributed across age groups and are favored in the burials of the birth to 5 years old age group.

This second set of results describes the association between Symmetry of Design and age.

- The symmetry class *d'2* is equally distributed among the following age groups: birth to 5, 20-34, and 35-49.
- The symmetry classes of *pm'11*, *pma2*, *pm11* and *pmm2* are **not** equally distributed across age groups and are favored in the burials of the birth to 5 years old age group.

Chapter Summary

Tomb orientation and individual orientation in the tomb are each equally distributed across sex and age groups. However, correspondence analysis revealed that males have access to more types of tomb and individual orientations than females. Overall, grave goods were equally distributed across cemeteries 4 and 7, with the exception of a statistically significant association between cemetery 7 and spoons, bags, basketry, and camelid remains. Grave goods were also more likely to be placed in a pile along the edges of the tomb as opposed to being placed on the body. This pattern was equally distributed across Chiribaya Alta cemeteries 4 and 7.

The basic design structure used during the Classic Chiribaya period is mirror reflection symmetry with a bifold rotation as evidenced by the dominant symmetry classes of *pm11*, *pma2*, *pmm2*, and *d2*. The symmetry class *pm11* is closely associated with bowl exteriors, while *d2* is strongly associated with bowl interiors. The symmetry class *pma2* is strongly associated with jar bodies; this symmetry structure along with *pmm2* is equally distributed across Chiribaya Alta cemeteries 2, 4, and 7. The symmetry class *pm11* was equally distributed across the Chiribaya

Alta cemeteries and Chiribaya Baja cemetery 1. However, when the distribution of symmetry structures was isolated to Chiribaya Alta cemetery 7, a statistically significant association between cemetery 7 and *pm11* symmetry structure was obtained. A statistically significant association between Chiribaya Alta cemetery 4 and the finite symmetry class, *d2*, was observed. Symmetry class type was equally distributed across males and females; however, it was not equally distributed across age groups. These results were statistically significant at the 0.05 level. A discussion and interpretation of these results will be discussed in Chapter 7.

CHAPTER 7: DISCUSSION AND CONCLUSION

Chapter Introduction

In this final chapter, I synthesize the results presented in Chapter 6 with a discussion that integrates the symmetry analysis and the mortuary analysis. The preferred design structures, resulting from the symmetry of structure section of the analysis, will be discussed first and incorporated with the mortuary data. The symmetry of design, which includes the color symmetry, proved to be a complex issue and will be discussed later in this chapter. I present a case that the color symmetry of Chiribaya ceramic design structures contains important cultural knowledge regarding principles that organize Chiribaya mortuary ritual. This hypothesis will form the basis for future research.

Discussion: Results of Symmetry Analysis and Mortuary Analysis

This dissertation research highlighted consistent practices underlying the Chiribaya ceramic designs and in the mortuary traditions. A symmetry analysis of Chiribaya geometric design structures revealed that preferred ceramic design structures incorporated variations of the motions of mirror reflection and bifold rotation to generate one-dimensional band patterns and finite designs. The type of design structure used was correlated with vessel form type. Designs on bowls were structured with a simple vertical reflection in one-dimensional band patterns (see Figures 7.1a and 7.1b) or bilateral mirror reflections in finite designs (see Figures 7.2a and 7.2b). The one-dimensional band patterns were placed on the exterior or interior of bowls and extended from the rim to half way down the body of the vessel. Finite designs frequently used the entire interior of the bowl as the design field. Jars and *cántaros* were decorated with a combination of vertical reflection and bifold rotation (*pma2*) on the bodies of these ceramic vessels (see Figures

7.3a and 7.3b). A second design structure was also common on jars, a combination of horizontal and vertical reflection with a bifold rotation (*pmm2*) (see Figures 7.4a and 7.4b). Unlike the other design structures, this mirror reflection and bifold rotation design structure (*pmm2*) was equally distributed across all design locations on jars (neck, shoulder, and body) and on bowl exteriors.

Figure 7.1a. *Vertical reflection pattern (pm11), Chiribaya bowl exterior* (photo by EMD 2006).

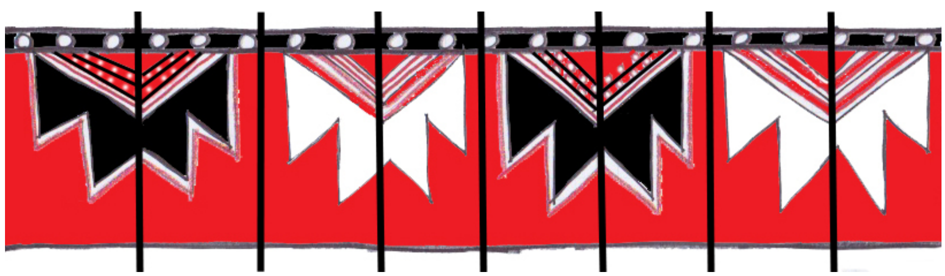

Figure 7.1b. *Vessel roll-out; vertical reflection pattern (pm11), Chiribaya bowl exterior.* Solid black lines represent vertical reflection (drawing by EMD 2015).

Figure 7.2a. *Bilateral reflection and bifold rotation (d2), Chiribaya bowl interior* (photo by EMD 2006).

Figure 7.2b. *Vessel roll-out; bilateral reflection and bifold rotation design (d2), Chiribaya bowl interior.* Solid black lines represent bilateral reflection and central dot represents rotation axis point (drawing by EMD 2015).

Figure 7.3a. *Vertical reflection and bifold rotation (pma2) on vessel body, Chiribaya jar* (photo by EMD 2006).

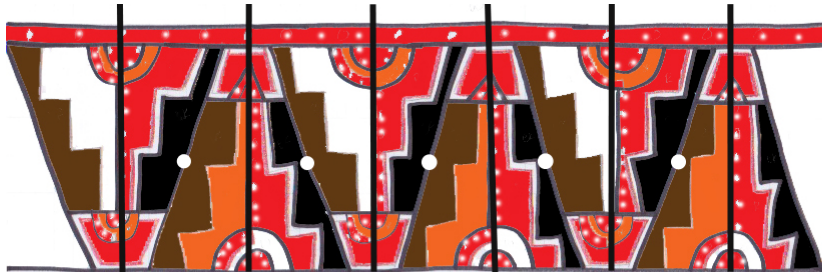

Figure 7.3b. *Vessel roll-out; vertical reflection and bifold rotation pattern (pma2), Chiribaya jar body.* Solid black lines represent vertical reflection and central white dots represent bifold rotation axis point (drawing by EMD 2015).

Figure 7.4a. *Mirror reflection and bifold rotation (pmm2) on vessel body, Chiribaya cántaro* (photo by EMD 2006).

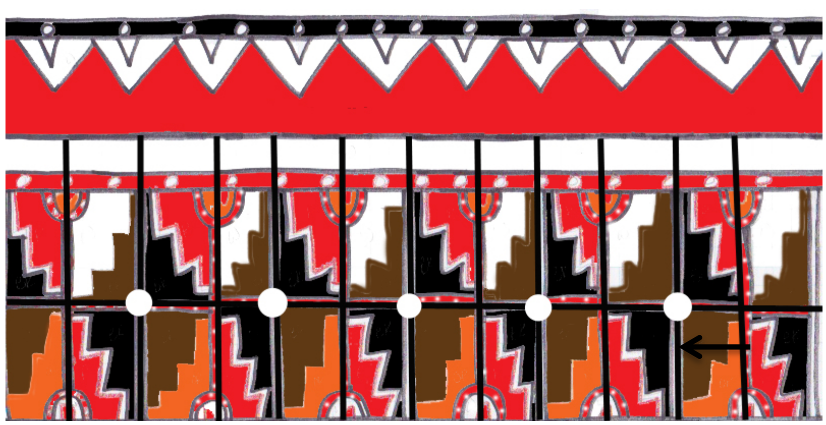

Figure 7.4b. *Vessel roll-out; mirror reflections and bifold rotation pattern (pmm2), Chiribaya cántaro body (below white band).* Solid black lines represent vertical and horizontal reflections and central white dots represent bifold rotation axis point (drawing by EMD 2015).

Despite documented variation in ceramic design style (Jessup, 1990, 1991; Owen, 1993a), symmetry analysis revealed that the basic design structures of all three Chiribaya design style phases form combinations of mirror reflections and bifold rotation. Algarrobal style ceramics are noted for their variety in design elements and motifs, while the San Gerónimo style exhibits a simplified use of a limited set of elements and motifs (Jessup, 1991; Owen, 1993a). Although the finite axial arrangement (the bilateral reflection and bifold rotation, *d2*) is absent in the Algarrobal style, but present in the San Gerónimo style, there is a statistically significant association of vertical reflection (*pm11*) throughout the Algarrobal and San Gerónimo phases. This structural arrangement (*pm11*) demonstrates a continuity in the designs from one stylistic phase to the next. This consistency in design structures is further underscored by the equal presence of the vertical reflection and bifold rotation symmetry structure (*pma2*) among all three Chiribaya styles (Algarrobal, Yaral, and San Gerónimo).

The vertical reflection design structure (*pm11*) was equally distributed across cemeteries 1-5 and 7 of Chiribaya Alta and cemetery 1 of Chiribaya Baja. Moreover, the vertical reflection and bifold rotation (*pma2*) and the vertical and horizontal mirror reflection and bifold rotation (*pmm2*) design structures are equally distributed across Chiribaya Alta cemeteries 2, 4, and 7. The reported statistically significant distributions of a limited set of preferred symmetry structures across the cemeteries at Chiribaya Alta and Chiribaya Baja illustrate that these design structure types formed the fundamental rules that artists followed for 659 years (AD 700 – AD 1359) when generating Classic Chiribaya designs.

Fundamental rules in the Chiribaya mortuary system existed and were also equally distributed among the deceased population buried at the cemeteries of Chiribaya Alta and Chiribaya Baja. The mortuary analysis revealed that placing grave goods in piles along the edges of the tomb was a common practice at Chiribaya Alta cemeteries 4 and 7. Moreover, the strongest association among pairings of grave goods found in tombs at cemeteries 4 and 7 were between serving and storage containers, such as bags and *cántaros,* spoons and bowls, and jars and baskets. These results support Ghersi's (1956) observation and Minkes's (2005) statement that feeding or making food offerings to the deceased was an important part of Chiribaya mortuary practices.

Patterns in tomb orientation at cemeteries 4 and 7 of Chiribaya Alta also demonstrate a consistency of tombs oriented to the N-S, another indicator of a basic rule in Chiribaya mortuary ritual that was generally applied to the deceased at these two cemeteries. A speculative explanation for this orientation pattern can be explored with a closer visual inspection of Chiribaya Alta cemetery 7. Cemetery 7 is located in the south central section of Chiribaya Alta (see Chiribaya Alta site map in Chapter 5, Figure 1) and is elongated, stretching west to east. It is directly below the terrace platform and is in between walls that encircle most of the site. The scatterplot of burials from cemetery 7 (see Chapter 6, Table 6.11) demonstrates that tombs were constructed and grouped in an almost linear fashion aligned north to south. One explanation for the organization of tombs in cemetery 7 could be due to sampling and excavation strategies of the Chiribaya Project. Another explanation is that the spatial arrangement and placement of tombs in this cemetery in rows along a general north-south axis could be to align the dead with structures on the site. This inference is speculative and would need to be tested with a larger sample of burial and spatial data from several of the Chiribaya Alta cemeteries. However, this result does demonstrate that space did play an important role in the organization of burial practices at Chiribaya Alta.

This dissertation research indicates that fundamental rules structured the Classic Chiribaya ceramic design system and organized the mortuary practices at Chiribaya Alta cemeteries 4 and 7. At the same time, however, variations of these underlying principles did exist. The mortuary practice of orienting the tombs in a N-S direction varied according to the sex of the individual. Tombs of females tended to be oriented to the NE-SW, while tombs of males tended to be oriented to the NE-SW, NW-SE, and N-S. A simple vertical reflection symmetry structure was associated with the Algarrobal and San Gerónimo ceramic styles. On the other hand, differential distribution of certain ceramic design structures is associated with ceramic style. The finite symmetry structure of bilateral reflections and a bifold rotation (*d2*) was significantly associated with the San Gerónimo ceramic style. A one-dimensional band pattern composed of a mirror reflection and bifold rotation (*pmm2*) symmetry structure was significantly associated with the Algarrobal stylistic phase.

The variation in Chiribaya mortuary practices is most apparent when comparing the results between Chiribaya Alta cemeteries 4 and 7. Individuals interred at Chiribaya Alta cemetery 4 were frequently buried with bowls composed with the finite design structure, *d2*, bilateral reflection and bifold rotation. In contrast, a vertical reflection (*pm11*) generating a one-dimensional band pattern was predominately found on ceramic vessels from burials in Chiribaya Alta cemetery 7. These symmetry results were statistically significant at the 0.05 level. Correspondence analysis demonstrated that the Algarrobal ceramic style was closely associated with cemetery 7 and the San Gerónimo ceramic style corresponded with cemetery 4 (see Chapter 6, Table 6.5). Finally, correspondence analysis also revealed that the individual's orientation in tombs at the two cemeteries differed between males and females. Females buried at Chiribaya Alta cemetery 4 were more frequently oriented to the North and males to the South. In contrast, males buried in Chiribaya Alta cemetery 7 were more frequently oriented to the North and females to the South or the East (see Chapter 6, Tables 6.2 and 6.3). While these results are based on frequencies and are not statistically significant, they do highlight potentially important differences in the use of space between the two cemeteries.

Time cannot be ruled out as a factor when considering the variation in the burial program between Chiribaya Alta cemeteries 4 and 7. According to calibrated radiocarbon dates reported by Buikstra and colleagues (2005, Fig. 5.6), cemetery 7 was in use early during the Classic Chiribaya occupation of the lower Osmore drainage, beginning around AD 700 until approximately AD 850. In contrast, cemetery 4 was in use from approximately AD 850 to AD 1050. The apparent diversity in mortuary behavior between Chiribaya Alta cemeteries 7 and 4 may be the result of a shift over time in preferences for certain burial treatments, such as the inclusion of certain ceramic design structures and the individual's orientation in the tomb.

However, the varying distribution of symmetry structure according to cemetery location is intriguing when the differential distribution of artificial cranial deformation style observed by Lozada (1998, 2011) is considered. Lozada (2011: 228) defines artificial cranial deformation as the "sustained molding of the [human] cranium for long periods of time during infancy". This is a permanent, visible modification of the human cranium that remains with an individual throughout his or her lifetime. Chiribaya Alta cemetery 4 has a statistically significant correlation with the annular cranial deformation style (Lozada, 1998, 2011). The finite design structure, *d2*, frequently decorated ceramic vessels buried with individuals at this cemetery. In contrast, Chiribaya Alta cemetery 7 had a statistically significant correlation with the fronto-occipital cranial deformation style (Lozada, 1998, 2011). Ceramic vessels with a one-dimensional band pattern formed by a vertical reflection (*pm11*) were associated with burials from Chiribaya Alta cemetery 7. One explanation that may be inferred based on the results of a symmetry analysis of ceramic data combined with published bioarchaeological data is the presence of different groups, with preferences for contrasting head shapes and ceramic design structure systems, burying their dead at two separate Chiribaya Alta cemeteries. However, this inference is only part of the story and does not sufficiently explain the intricacies of Chiribaya mortuary practices.

The picture that is emerging of Chiribaya funerary ritual is that consistent underlying rules structured the burial practices, but the rules were altered possibly to metaphorically encode different information that was important to the inhabitants of the lower Osmore drainage. The design structures of *d2* (bilateral reflection and bifold rotation) and *pm11* (vertical reflection) that are each significantly associated with cemetery 4 and cemetery 7 at Chiribaya Alta, respectively, are both structured by a similar symmetry motion – mirror reflection symmetry. While tomb orientation varies according to the sex of the individual, the orientations share an underlying commonality of a N-S axis. I argue that despite the presence of intra-group variation in different cultural mediums employed as part of the Chiribaya burial tradition (Lozada, 1998, 2011; Lozada and Buikstra, 2002; Boytner, 1998; Nigra, 2009), the underlying consistency in certain funerary customs, particularly the Chiribaya ceramic design structure system, is marked by structured and fundamental bilateral organizing principles. What these organizing principles represent, whether they signal references to social, economic, or cosmological dimensions - is still to be determined. What I have discovered and reported in this dissertation is the prevailing existence of such a bilateral system that is manifest in design structure and mortuary ritual. Further, I argue that important clues to the significance of these organizing principles and what they indicate can be found in the color symmetry of the ceramic designs.

Color Symmetry

A symmetry analysis of Chiribaya ceramic design structures revealed that artists preferred the specific symmetry motions of mirror reflection and bifold rotation in order to arrange and organize the elements and motifs that decorated ceramic vessels. I posit that the symmetry motions of mirror reflection and bifold rotation encompass the underlying rules or the grammar that structure the elements and motifs that generate Chiribaya ceramic design. Furthermore, I propose that these preferred design structures metaphorically encode organizing principles that are fundamental to Chiribaya social and settlement systems. In this dissertation I have demonstrated that there is a statistically significant consistency in the use of these preferred ceramic design structures on ceramic vessels found in burials across the cemeteries of Chiribaya Alta and Chiribaya Baja. In particular, the color symmetry and the ways in which it structures the organization of elements and motifs in the ceramic designs are key to illuminating the information that these designs contain. I propose that this core information is metaphorically encoded in the Chiribaya ceramic design system, goes beyond group affiliation, and instead refers to how Chiribaya people organized themselves in their physical and social environment.

<u>Ethnographic and archaeological examples</u>

Key ethnographic accounts from modern villages in the central and southern Andean highlands have shown that design systems can be read as texts of critical knowledge regarding patterns in solar observations and subsistence activities (Silverman-Proust, 1998; Arnold, 1983). Silverman-Proust's (1998) ethnographic research in the central highland Andean town of Q'ero demonstrates how the use of contrasting colors in textile designs metaphorically encodes critical cultural knowledge about spatial and temporal concepts based on observations of sunlight and shadow. The author describes two distinct weaving techniques, each employing contrasting colors to relay different information about the temporal and spatial organization of the village. The first weaving technique, called the *kinsamanta* technique, produces a Q'ero motif type, called Q'ero *pallay*, that uses two contrasting colors plus white. This technique creates a two-faced cloth "in which the design woven on the front of the textile appears on the back of the same fabric but in reverse" (Silverman-Proust, 1998, p. 207). The second weaving technique is called the *iskaymanta* and creates a motif type called *Qheswa pallay*. This weaving technique uses two contrasting colors to producing a one-faced cloth and does not have a motif woven on the opposite face of the textile (Silverman-Proust, 1998, p. 208). The two-faced cloth is considered valuable by Q'ero people because it symbolizes the cosmological concepts of the residents by "record[ing] spatial and temporal concepts based on observations of sunlight and shadow" (Silverman-Proust, 1998, p. 208). In contrast, the one-face cloth lacks the decorative display necessary to represent ideas about light and shadow and, thus, is not considered valuable. The *Qheswa pallay* motif type used on one-face cloth only represents spatial concepts (Silverman-Proust, 1998, p. 208-209).

Specifically, Q'ero weavers use the colors brown and black to color chevrons that represent mountain peaks (Silverman-Proust, 1998, p. 221). The mountain peaks are critical features of the landscape because they not only serve as boundary markers that separate one Q'ero village from another but also are used by residents of this region to tell daily time by observing the shadow on the side of the mountains (Silverman-Proust, 1998, p. 223-228). Through interviews with local weavers, Silverman-Proust (1998) learned that light colors are used to denote the sunrise and dark colors are used to symbolize the sunset. In this way the observations by residents of the movements of shadows is an integral piece of knowledge that is woven into the Q'ero textiles. Furthermore, not only do residents use solar observations to tell daily time, but light and shadow patterns in the rising and setting sun are also used to mark the seasons, thus providing information about the best time to plant specific crops.

Arnold (1983) conducted ethnographic research among ceramic potters in the village of Quinua, located in the south central Peruvian highlands. He found that ceramic vessels were consistently decorated with patterns organized by the same structural principles that organized the four levels of environment and social spaces in the community. Five techno-ecological zones that surround the village are exploited for their resources. They are represented on ceramic jars as vertically arranged horizontal design fields (Arnold, 1983, Fig 5.6). The community is divided into two barrios, each with an irrigation system. A low ridge separating the two drainage systems is depicted on the interior of ceramic bowls and the exterior body of jars by a vertical line subdividing the hemispherical motifs. Conceptually, a bilateral division effectively separates urban versus rural people. Similarly, within the family the bilateral kinship system creates dual affiliations.

These two ethnographic examples indicate that nonrandom preferences in color contrasts and symmetry motions used to structure designs have cultural correlates in social, spatial and temporal concepts. They present observed situations in which people are using the resources in their environment in very specific ways. Moreover, they depict these practices on their ceramics and textiles in very structured and nonrandom ways. While these ethnographic examples describe how people in modern villages in the Andean highlands colored and structured their textiles and ceramic vessels, these two cases provide a framework with which to investigate material correlates in the archaeological record for coastal prehispanic social groups. As archaeologists, we only have material remains of a culture with which to infer cultural meanings. Our first line of inquiry must be to search for evidence of consistencies and trends in our data and then to ask what these trends mean. Specifically, in the case of the Chiribaya, I am asking whether individuals embedded, in a structured and patterned manner, the ways in which they perceived and interacted with their social and physical environment on their ceramic designs.

There is archaeological evidence that prehispanic coastal cultures recorded what they observed in their surrounding environment and used specific design structures to record these observations. Frame (2004) argues that a spiral or glide symmetrical motion used to weave asymmetrical zoomorphic and anthropomorphic figures into Nasca textiles is a metaphor for the animal in motion. That is, the Nasca patterns depict, metaphorically, how an animal moves in nature. Peters (1991) analyzed embroidered textiles excavated from the Paracas Necropolis and describes design elements of anthropomorphic and zoomorphic figures that decorate the cloth found in burials as containing specific information about complex ecological and social relationships. For example, in one element "the front paw of a feline is a hand grasping a gold forehead ornament, and the spots on its body are kenned beans" (Peters 1991: 303). Peters (1991) suggests that this particular figure is possibly relating information regarding human social or ritual status, predation, and agricultural yield. Moreover, Frame (1991) analyzed the symmetry of motif arrangements found on textile headbands from the Paracas Necropolis and argues that the symmetrical arrangement on the headbands serve as a template for the repeating patterns, which include human and animal figures, found on embroidered fabrics.

The elements and motifs on Chiribaya textiles and some of the ceramic vessel forms appear to be depictions of animals that lived in and around the coastal Osmore drainage during the Late Intermediate Period. Umire and Miranda (2001: 59-61) describe zoomorphic creatures woven into Chiribaya textiles, such as snakes, birds, wild cats, frogs, and other reptiles (see Figures 7.5 and 7.6). During data collection for this research, I observed ceramic vessels in the shapes of ducks and little birds (see Figure 7.7). If Chiribaya people were using images of animals that they observed in their environment to form ceramic vessels and to decorate textiles, might it be possible that other prominent environmental features were also recorded? And is it possible that these environmental features have cultural correlates that are associated with principles that organized their social group? Future research will address these questions.

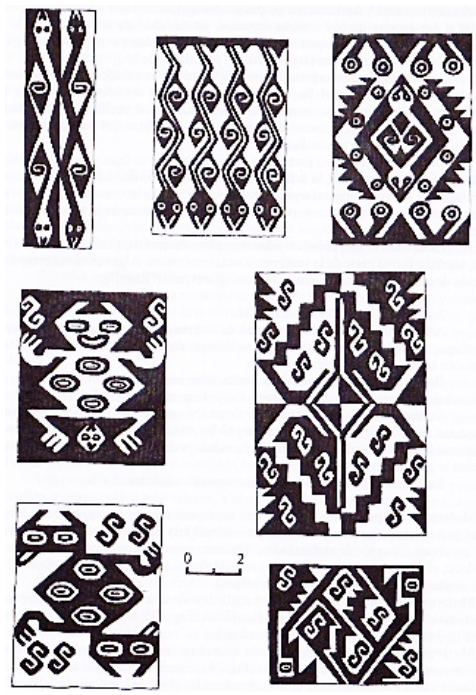

Figure 7.5. *Examples of design motifs on Chiribaya textiles* (Umire and Miranda 2001: Fig.33). Reprinted with permission from Adan Umire and Ana Miranda.

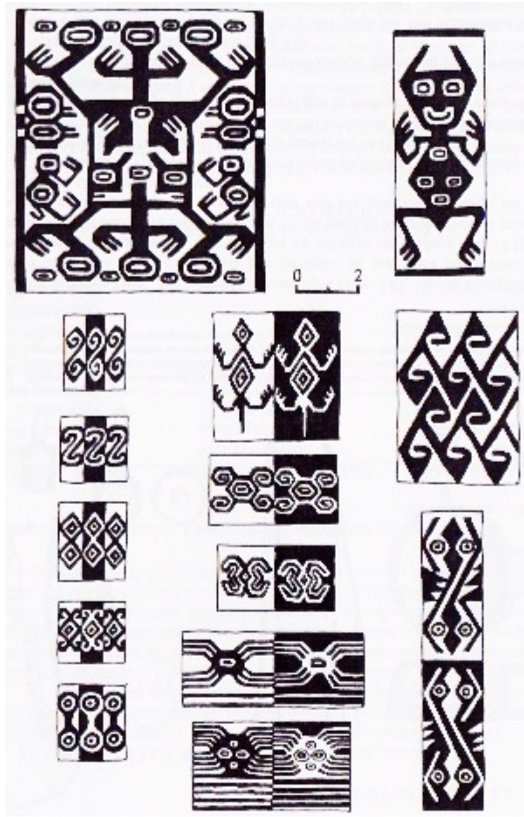

Figure 7.6. *Examples of design motifs on Chiribaya textiles* (Umire and Miranda 2001: Fig. 34). Reprinted with permission from Adan Umire and Ana Miranda.

Figure 7.7. *Small jars in the shape of birds, Chiribaya Alta cemetery 7* (photo by EMD 2006).

<u>The step-fret motif</u>

The color symmetry of two Chiribaya motifs, the step-fret and the crossed-bands, demonstrate potential clues to uncovering the cultural messages that Chiribaya geometric ceramic design may contain. The step-fret motif is composed of multiple geometric elements and is common to jar bodies. The elements consist of two step-fret or stair-like figures set in opposition to each other. The two step-frets are colored in contrasting brown and black. The space next to the step-fret elements is filled with one of three colors, set in opposition to each other: red, white, or orange (see Figure 7.8). Generally, the placement of these three colors is as follows: red fills the left side of the motif and either white or orange fills the right side. Occasionally, the red fills the space on the right side of the motif and the white or orange fills the left side. What is consistent is the contrasting nature of these colors. Generally, red opposes white or orange and black opposes brown. The motif is often, but not always, divided by a thick black vertical line that is filled-in with either black or red and with white dots down its center. At the top of this vertical line is a half circle framed by black lines with white dots; the center of the half circle is filled with one or a combination of two out of the three colors – red, white, or orange. Sometimes, but not always, there is a second half circle at the bottom of vertical line that is organized the same way as the top.

Figure 7.8. *The Chiribaya step-fret motif pattern on the vessel neck (A) and vessel body (B) Chiribaya jar* (drawing by EMD 2015).

The symmetry of the structure of this motif is fairly straightforward, but the symmetry of design, which includes color, is quite complicated. The symmetry of structure of the step-fret motif is typically a vertical reflection and bifold rotation (*pma2*), which is common to Chiribaya jar bodies. The motif is organized as a zig-zag line (see Figure 7.9).

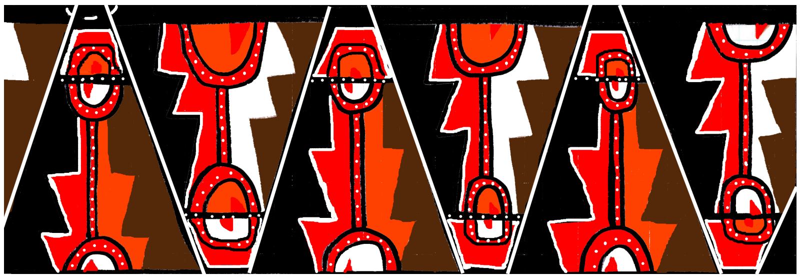

Figure 7.9. *The zig-zag lines (thick white lines) that outline the step-fret motif on a Chiribaya jar* (drawing by EMD 2015).

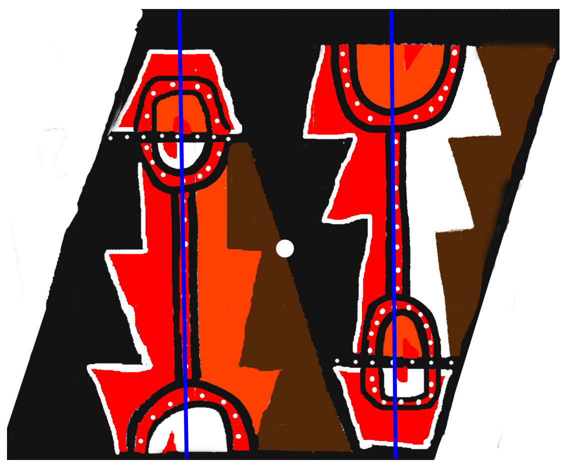

Figure 7.10. *The motions of the pma2 symmetry structure: the vertical reflection (represented by the solid blue lines) and bifold rotation (large white dot) on a Chiribaya ceramic jar body* (drawing by EMD 2015).

The symmetrical arrangement reflects the major elements (the step-fret and half circle) across a vertical line and rotates these elements around a central axis point to generate a one-dimensional band pattern (see Figure 7.10). This motif is categorized as a five-color state because five colors interchange (black, brown, red, white, and orange), but they do not alternate in the same way (see also Chapter 5 for a discussion on the five-color state). I developed a preliminary analysis that tracks the movement of each color across the pattern. It revealed that the contrasting black and brown step-frets are repeated in a traditional two-color state, as defined by Washburn and Crowe (1988). This means that black always interchanges with brown in motifs of the same symmetry motion and shape. However, the interchanging of red, white, and orange in the spaces next to the step-fret and inside the half circles involves a three-color change. Furthermore, although the three colors do interchange with figures of the same symmetry motions and shapes, the colors do not equally alternate: red will alternate with either orange or white (see also Chapter 5, Figures 5.25a - 5.25c). This is the first description of this type of systematic three-color change for a body of decorated Peruvian ceramics.

This structural and coloring design system was consistently used to color and arrange step-fret motifs in other symmetry structures that generated designs in the Chiribaya ceramic assemblage. For instance, the bilateral and bifold rotation (*d2*) of finite designs on the interior of bowls and the mirror reflections and bifold rotation one-dimensional pattern (*pmm2*) common to Chiribaya jar and *cántaro* exteriors (see Figures 7.11 and 7.12). As is evident in Figures 9 and 10, the alternation of colors in the finite design is consistent with its one-dimensional counterpart.

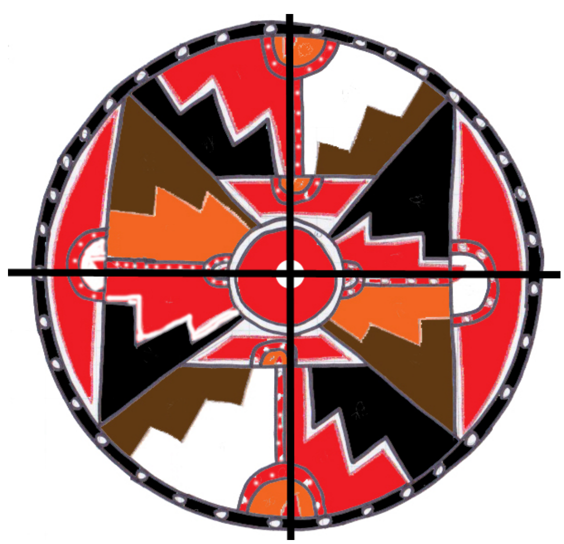

Figure 7.11. *The step-fret motif in a finite design, Chiribaya bowl interior.* The black lines represent bilateral reflections and the central white dot represents the rotation axis point for the bifold rotation (drawing by EMD 2015).

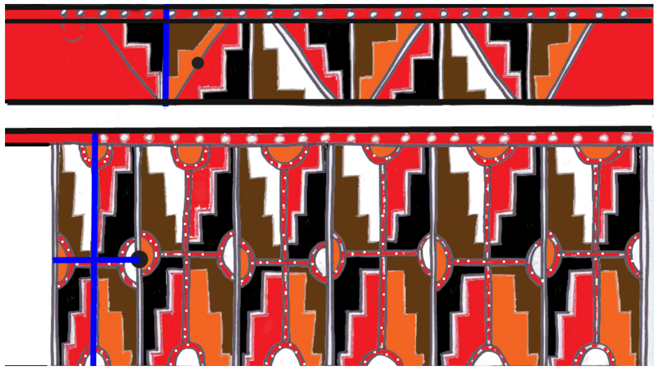

Figure 7.12. *The step-fret motif in two one-dimensional pattern types.* 1) Vessel neck (above the white band): vertical reflection across blue vertical lines and a bifold rotation around black axis points (*pma2*); and 2) vessel body (below white band): mirror reflections across vertical and horizontal blue reflection lines and bifold rotations around black axis points (*pmm2*). Chiribaya jar exterior (drawing by EMD 2015).

On occasion, the elements may be colored differently; for instance, the step-frets may be red with contrasting orange or white and the space next to the step-frets is either black or brown (see the vessel neck section of Figure 12). Additional minor elements may be present or the half circles may be absent. However, regardless of which elements may be included and the color changes that were employed, the symmetry motions that structure the pattern do not change. The underlying structure that arranges and colors the elements in this step-fret motif is a mirror reflection and a bifold rotation that form this particular design. The question is: what is the cultural significance of this preferred design structure?

The crossed-bands motif

The crossed-bands motif is found on the interior of ceramic bowls and is composed of two wide bands, one horizontal and one vertical, that divide the interior of the bowl and cross in the center. The coloring of the bands, such as whether the band interiors are left plain with black borders or colored, and the presence/absence of minor elements, such as half circles, white dots, or lines, varies. When the bands are colored they are painted either white or orange. Bands that are exclusively painted orange have not been observed in this data set. When half circles are present they are drawn along the edges of the band in an alternating fashion (see Figure 7.13).

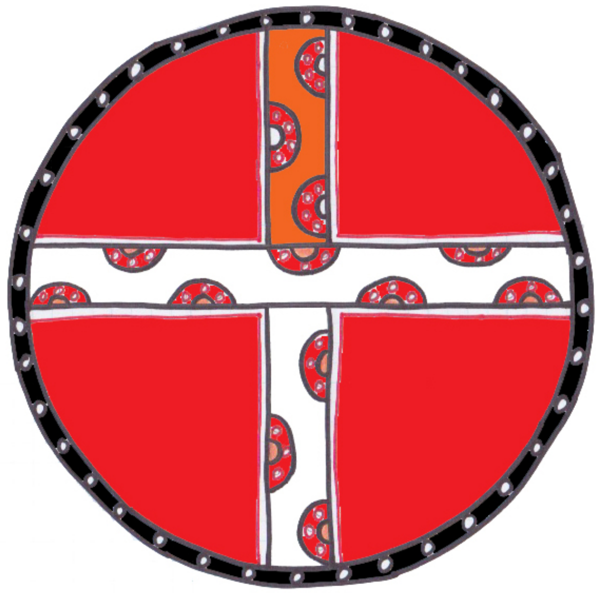

Figure 7.13. *Chiribaya crossed-bands motif.* Top band is orange-filled, the three remaining bands are white. Alternating half circles along the band borders. Chiribaya bowl, interior (drawing by EMD 2015).

Half circles do not always appear in this motif and when they do the symmetry of the design structure is reduced. For these reasons, I considered the half circles a minor element (see definition in Chapter 5) and did not include them when determining the symmetry of structure of the crossed-bands motif. The half circles and color symmetry was included when assigning the symmetry of design.

The symmetry of structure for the crossed-bands motif can be described as a bilateral reflection and a bifold rotation (see Figure 7.14).

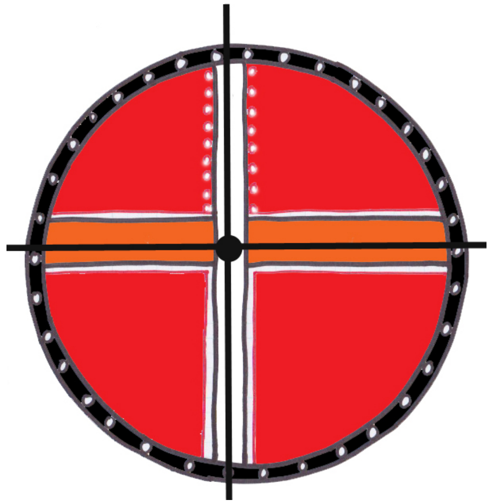

Figure 7.14. *Chiribaya crossed-bands motif, bilateral and bifold rotation symmetry structure (d2).* The vertical and horizontal black lines depict mirror reflection lines and the central black dot is the point axis around which half of the design rotates. Chiribaya bowl, interior (drawing by EMD 2015).

Two mirror reflections divide the bands across vertical and horizontal lines, while half of the figure rotates twice around a central axis point, generating a finite design. The bands are frequently colored in one of three ways: 1) one band is white and the other is orange; 2) one band is white and half of the underlying band is orange; or 3) both bands are white. Often the underlying band is slightly off center. The symmetry of design is complex because when minor elements, such as half circles, and color changes are considered, the choices for possible symmetrical motions are greatly reduced. For example, a crossed-band motif with orange and white bands that include half circles has a symmetry structure of bilateral reflection and bifold rotation (*d2*) – a combination of two symmetry motions (see Figure 7.15a). In this case, the half circles are considered a minor element and, along with the color changes, are not factored into the classification of the symmetry of structure. On the other hand, the orange/white color change and the half circles must be included when classifying the symmetry of design. Therefore, the symmetry of design for the vessel shown in Figure 7.15b is a bifold rotation (*c2*) because the half circles reduce the possibilities to one symmetry motion – rotation. Even though the use of color and elements in this motif tend to reduce its symmetry, the specific arrangement of elements and color figure prominently in the way the design is structured.

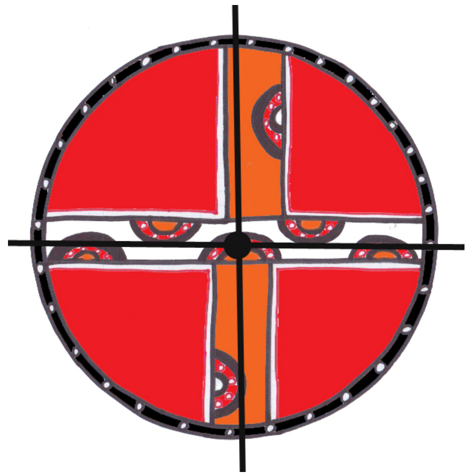

Figure 7.15a. *Chiribaya crossed-bands motif, bilateral and bifold rotation symmetry of structure (d2).* The vertical and horizontal black lines depict mirror reflection lines and the central black dot is the point axis around which half of the design rotates. Chiribaya bowl, interior (drawing by EMD 2015).

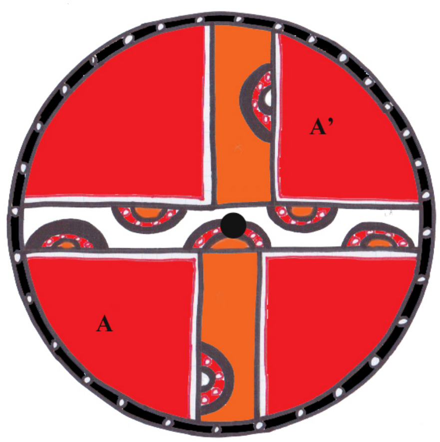

Figure 7.15b. *Chiribaya crossed-bands motif, bifold rotation symmetry of design (c2).* The central black dot is the point axis around which half of the design rotates. For a point of reference, A moves half of the design, a half section of the white and orange bands with associated semicircles, onto A', by way of bifold rotation. Chiribaya bowl, interior (drawing by EMD 2015).

Future Research: Cultural Significance of the Step-fret and Crossed-bands Motifs

I propose that future research can begin with the following hypothesis: the step-fret and the crossed-bands motifs (and the symmetry structures that generate these designs) metaphorically encode critical spatial and temporal knowledge referring to the physical environment and solar observations. This cultural knowledge informs the mortuary practices of Chiribaya people and relates to core organizing principles of the Chiribaya culture. In order to appreciate the forthcoming scenarios, the physical landscape of the coastal Osmore plain and lower Ilo River valley must be revisited. Three distinct micro-environments characterize the coastal Osmore plain: the abundant marine resources of the ocean; the coastal springs that supported small scale irrigation agriculture; and the small game hunting and herding afforded by the *lomas* vegetation (Reycraft, 1998, 2000; Umire & Miranda, 2001; Owen 2005). The Ilo river valley has sheer walls that form a "V" shape and reduce the amount of land available for farming (see Figure 16; Reycraft, 1998; Owen 2005). Residents made optimal use of accessible land for agricultural purposes by constructing a 9 km long irrigation canal into the rock face of the valley wall (Reycraft, 2000).

Figure 7.16. *Ilo valley, facing east* (photo by EMD 2006).

The towering Ilo valley walls also would have cast distinct shadows on the land. This limited daylight coupled with the hyper-arid climate of this region meant that people would have had to have a method for keeping track of the amount of daily sunlight and the change in wet and dry seasons in order to know the best time to plant crops. While the Chiribaya ceramic assemblage was used by a prehispanic population on the southern coast of Peru and the ethnographic accounts described by Silverman-Proust (1998) and Arnold (1983) are centered on modern populations that live in the central and southern Andean highlands, what these three populations have in common is a need to adapt an agricultural subsistence strategy in the dry and often harsh Andean mountain range.

Silverman-Proust (1998) reports discussions with local Quechua-speaking astronomers, from the central highland village of Q'ero and its neighboring regions, who describe how modern and ancient people used the shadows cast by the sun on the sides of mountains to tell daily time. In particular, Q'ero people recorded solar observations on two-faced cloth using specific colors to denote light and shadow and, in this way, stored critical temporal knowledge about the best time to conduct planting and harvesting activities (Silverman-Proust, 1998, p. 238). For instance, Silverman-Proust (1998: 229) describes Q'ero weavers as using black and brown colors to signify the shadow on the mountains and cites the work of Casaverde Rojas (1970) and Ossio (1976) to indicate Andean weavers from other central highland communities as using dark colors to symbolize the West and sunset and light colors as representing the East and sunrise.

Water, as a critical resource for daily survival, also plays a prominent role in the type of spatial knowledge stored in ceramic and textile motifs. Arnold (1983) describes the irrigation canal that bisects the southern highland village of Quinua as socially dividing the community into two barrios. This spatial organization of the town manifests itself in the ceramic design system as a vertical band that divides the interior, horizontal space of bowls (Arnold, 1983, p. 69). Moreover, Arnold (1983) suggests that an additional intersecting horizontal band (thereby creating a crossed-band design) may represent the division of the upper and lower savannah ecological zones according to irrigation functions. Silverman-Proust (1998, p. 222) describes long lines placed in the center of certain textile motifs as symbolizing a river that divides the community of Q'ero into upper and lower moieties. Given a prehispanic population in which knowledge about ocean currents, fresh water usage, and the amount of daily sunlight needed for the successful planting and harvesting of crops, I present the possibility that the Chiribaya step-fret and crossed-bands motifs share similar element and color arrangement that structured ceramic designs as described in these ethnographic accounts.

I suggest that the step-fret motif that prominently decorates the exterior bodies of ceramic jars and *cántaros* and the interior of bowls holds specific temporal and spatial information based on observations of the physical environment in the Ilo Valley. As a speculative example, I present the following scenario. A black step-fret, representing mountain peaks and surrounded by a red sky encompass the left side of the motif, possibly symbolizing the West and sunset. A vertical line (possibly the Ilo River or the irrigation canal) divides the motif with a half circle placed at the top, center – a representation of the sun. On the right side of the motif, is a brown step-fret, again representing mountain peaks, surrounded by an alternating white or orange sky. I propose that this motif is depicting contrasting pictures of how the sky and mountains look with different amounts of sunlight. The shadow on the mountains alternate in a two-color pattern of brown and black and the changing colors of sunlight alternate in a three-color pattern of red, white, and orange. Silverman-Proust (1998) describes a similar use of three contrasting colors (two colors plus white) in the *kinsamanta* weave that produced the two-faced cloth, with one side of the cloth depicting sunlight and the opposite side of the cloth illustrating shadow. In contrast to textiles, ceramic vessels only have one side in which to display cultural information.

Therefore, in the case of the step-fret motif on Classic Chiribaya vessels, the depictions of sunlight must contrast in a three-color alternating pattern in order to store all of the necessary information pertaining to the rising and setting of the sun.

Next, I suggest that the crossed-bands motif that exclusively decorates the interior of bowls contains key information regarding water and solar observations. The white band may represent how the water looks during sunrise and the orange portions of the second band may represent the sun's shadow on the water, possibly the ocean. When half circles are present on the band, the interiors of the circles are colored white when they appear on an orange band and orange when the circles appear on a white band. The half circles and their specific color arrangement could represent the color of the sun at different times of the day.

The step-fret motif is arranged and structured by the symmetry motions of mirror reflections and a bifold rotation (*pma2*, *pmm2*). The two symmetry structures that generate this motif as a one-dimensional band pattern are equally distributed across Chiribaya Alta cemeteries 2, 4, and 7. The step-fret motif also appears on bowl interiors and is organized by bilateral reflections and a bifold rotation (*d2*). This particular symmetry structure arranges the step-fret motif into a finite design, which has a statistically significant correlation with Chiribaya Alta cemetery 4. The vessel forms common to the step-fret motif are jars, *cántaros*, and bowls, vessel forms that are common in all the Chiribaya ceramic assemblages and are ubiquitous offerings in tombs. The symmetry of design classes, which track the symmetrical motions of color that structure design, were found to be equally distributed at the 0.05 significance level across Chiribaya Alta cemeteries 1-5 and 7. These results suggest that similar information, which included the specific arrangement of color, was being encoded in three different symmetry structures (*pma2*, *pmm2*, and *d2*). This also implies that these ideas were held by the general population buried at Chiribaya Alta rather than being known only by a specific group.

Interestingly, the seemingly pervasive nature of the step-fret motif is countered by the apparent limited distribution of the crossed-bands motif. While the step-fret motif can be arranged according to three different symmetry structures, on three different vessel forms, and is equally distributed across cemeteries 2, 4, and 7 at Chiribaya Alta, the intersection of two bands, with accompanying minor elements and color changes, is only present in specific circumstances. The crossed-bands motif is structured by bilateral reflections and a bifold rotation that is only found on bowl interiors. Moreover, the symmetry structure that creates this design is significantly associated with Chiribaya Alta cemetery 4. Why does the step-fret motif seem omnipresent while the crossed-band motif is restricted to a certain cemetery space and vessel form? To begin to address this question, we must again consider time.

Published results from stable isotope analyses indicate that early during the Chiribaya occupation of the Osmore drainage several Chiribaya Alta cemeteries show a dependence on marine resources, such as cemetery 7 (Tomczak 2003; Buikstra et al 2005; Knudson et al 2007). Diversity in the subsistence of marine and terrestrial resources characterized the later portion of the Classic Chiribaya phase; cemetery 4 was in use during this time, from approximately AD 850-1050, and had the strongest dependence on marine resources out of all nine cemeteries at Chiribaya Alta (Tomczak 2003; Buikstra et al 2005; Knudson et al 2007). The *d2* symmetry class that generates the crossed-bands motif, which may metaphorically encode information related to water and solar observations, and its significant association with cemetery 4 may indicate that individuals buried at this cemetery had a special knowledge of water resources, such as the ocean. Moreover, the *d2* symmetry class organized both the step-fret motif and the crossed-bands motif, which could indicate that marine-resource oriented people felt compelled to bury their dead with ceramics that carried information about the ocean and the valley.

It is important to note the major disruptions experienced by the Chiribaya people as a result of the disastrous El Nino event around AD 1359. Torrential rains and mudflows decimated settlements, destroyed the irrigation canal that was crucial to their agricultural livelihood, and caused massive depopulation of the Ilo Valley (Reycraft, 1998, 2000). During this Terminal Chiribaya phase, the valley remained only sparsely populated; Chiribaya Alta and the 9 km long irrigation canal that once supported the expansive agricultural terraces near the valley bottom were abandoned and never rebuilt (Reycraft, 2000). Terminal Chiribaya phase settlements were characterized by small habitation sites built on the coastal Osmore plain for optimal exploitation of the three micro-environments found in this region – the ocean, the coastal springs and the *lomas* region (Reycraft, 2000; Zaro et al, 2010).

Despite shared attributes of paste, vessel form, and slip color (red) between Classic and Terminal Chiribaya ceramic assemblages, Reycraft (2005) reported a near total loss of decorative elements on Chiribaya ceramics. Reycraft (2005, p. 59) cites Bawden (personal communication, 1997) stating that up to 40% of all ceramics found in Classic Chiribaya domestic middens were decorated. In contrast, the Terminal phase ceramic assemblage contained only about 1% decorated wares (Reycraft, 2005). Relevant to this dissertation, Reycraft (2005, p. 59) states that bowls are the most commonly decorated form and are often decorated with the "simple cross-ribbon design on the vessel interior". In other words, the crossed-bands motif as described in this chapter. Jars and *cántaros* are very rarely decorated. I propose that the replacement of the once prominent step-fret motif by the crossed-bands motif during the Terminal Chiribaya phase may indicate the Chiribaya people recorded a shift in critical knowledge related to their physical environment, possibly in resource procurement – from the agricultural potential of the valley to the plentiful marine resources of the ocean.

In this chapter, I presented an analogy that describes the possibility that the crossed-bands motif holds knowledge related to water and solar observations. In addition, if the step-fret motif is a text that holds key information related to sunrise/sunset over the mountainous valley, the fact that this motif type is organized by a symmetry structure that is strongly associated with Chiribaya Alta cemetery 4, which was dominated by marine resources (Tomczak, 2003), could indicate that marine-resource oriented people felt compelled to bury their dead with ceramics that carried information about the ocean and the valley. If the step-fret and crossed-bands motifs hold critical temporal information related to the land and ocean, respectively, this suggests two important hypotheses for future research. First, the presence of both motif types at Chiribaya Alta cemetery 4 may indicate that critical knowledge regarding the land, water, and solar observations were stored in the ceramic design structure system (see Figures 7.17a and 7.17b), despite a reported dependence on marine resources at this cemetery as reported by Tomczak (2003) and Buikstra and colleagues (2005). Second, the replacement of the step-fret motif by the crossed-bands motif after the El Nino of AD 1359, could be another line of evidence in the shift in resource dependence that occurred during the Terminal Chiribaya phase, from a dependence on irrigation agriculture in the Ilo Valley to the diversity of resources offered by the coastal Osmore plain, as reported by Reycraft (1998, 2000) and Zaro and colleagues (2005, 2010).

Figure 7.17a. *Chiribaya step-fret motif, bilateral and bifold rotation symmetry structure (d2).* The vertical and horizontal black lines depict mirror reflection lines and the central black dot is the point axis around which half of the design rotates. Chiribaya bowl, interior (drawing by EMD 2015).

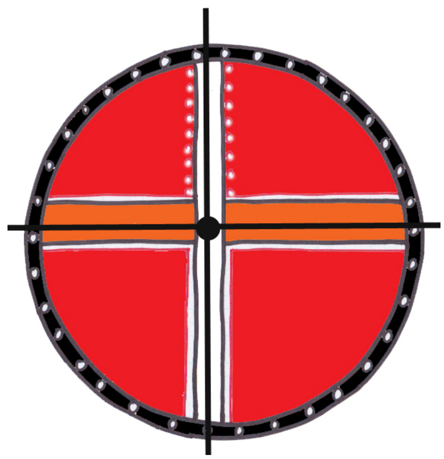

Figure 7.17b. *Chiribaya crossed-bands motif, bilateral and bifold rotation symmetry structure (d2).* The vertical and horizontal black lines depict mirror reflection lines and the central black dot is the point axis around which half of the design rotates. Chiribaya bowl, interior (drawing by EMD 2015).

Chapter Summary

A symmetry analysis of Chiribaya ceramic design structures and a mortuary analysis of burial attributes revealed complex and multiple layers of the burial program at Chiribaya Alta. At one level, fundamental rules organized the mortuary practices at Chiribaya Alta cemeteries 4 and 7 and structured the Classic Chiribaya ceramic design system. A symmetry analysis of ceramic design structures uncovered uniformity in the manner in which the patterns were generated. A mirror reflection and bifold rotation symmetrically arranged and organized elements into motifs, which were symmetrically repeated to form the designs on Chiribaya ceramic vessels. Likewise, a mortuary analysis of cemeteries 4 and 7 at Chiribaya Alta revealed consistent patterns in the mortuary ritual when the use of space was considered at the level of the individual and at the level of the cemetery. Grave goods, often pairings of serving or storage containers, were consistently placed in piles along the edges of the tomb as offerings to the deceased. The orientation of individuals in tombs and the collective orientation of groups of tombs generally followed a North-South axis. At another level, nuances in the burial traditions at Chiribaya Alta could be detected when the distribution of ceramic design structures was compared across cemetery locations, with the most striking differences observed between Chiribaya Alta cemeteries 4 and 7.

In conclusion, I argue that future research can begin with the analysis of the use of color in ceramic designs from a mortuary context. The vibrant geometric designs that decorated Chiribaya ceramic vessels were, in their structures and colors, embedded with critical information about Chiribaya practices. Future analyses of the color symmetries of adjacent prehistoric communities coupled with reference to ethnohistoric sources and more contemporary ethnographic research will further explore the significant structural and color consistencies in ceramic design described in this dissertation.

This dissertation research demonstrated that a merger of a symmetry analysis of ceramic design structures with mortuary, spatial, and bioarchaeological data provides critical information beyond identifying patterns in mortuary behavior to identifying patterns in the social structure and social messaging of a prehispanic coastal culture. This is the first analysis of this kind to date; broadening the kinds of questions related to social messages and processes of social change that can be addressed using data from a mortuary context.

APPENDICES

APPENDIX I: Burial attributes of Chiribaya Alta cemeteries 4 and 7, chi-square results

Chi-square tests were conducted in Rstudio. Listed below are the categories of each chi-square test with corresponding code and results.

<u>SEX, TOMB ORIENTATION</u>

```
sexTOtable

               nesw ns nwse
  female        13  9    3
  male           9  8    9
  undetermined  12 21   14
> length(sexTO$sex)
[1] 98
> chisq.test(sexTOtable)

        Pearson's Chi-squared test

data:  sexTOtable
X-squared = 7.0156, df = 4, p-value = 0.1351

sexTO2table

         nesw ns nwse
  female   13  9    3
  male      9  8    9
> length(sexTO2$sex)
[1] 51
> chisq.test(sexTO2table)

        Pearson's Chi-squared test

data:  sexTO2table
X-squared = 3.7679, df = 2, p-value = 0.152
#H0: both sexes had equal access to 3 tomb orientation directions
#HR: both sexes did not have equal access to 3 tomb orientation directions
#Conclusion: HO
```

<u>FEMALE, TOMB ORIENTATION</u>

```
femTOtable <- xtabs(~ femTO$tomb_or)
> femTOtable
femTO$tomb_or
nesw   ns nwse   we
  13    9    3    1
> chisq.test(femTOtable, p=c(.25, .25, .25, .25))
```

```
        Chi-squared test for given probabilities

data:  femTOtable
X-squared = 14, df = 3, p-value = 0.002905
#H0: females had equal access to 4 tomb orientation directions
#HR: females did not have equal access to 4 tomb orientation directions
#Conclusion: HR
```

MALE, TOMB ORIENTATION

```
maleTOtable <- xtabs(~ maleTO$tomb_or)
> maleTOtable
maleTO$tomb_or
nesw   ns nwse   we
   9    8    9    1
> chisq.test(maleTOtable, p=c(.25, .25, .25, .25))

        Chi-squared test for given probabilities

data:  maleTOtable
X-squared = 6.6296, df = 3, p-value = 0.08469
#HO: males had equal access to 4 tomb orientation directions
#HR: males did not have equal access to 4 tomb orientation directions
#Conclusion: HO
```

FEMALE, ORIENTATION OF THE HEAD

```
femOtable <- xtabs(~ femO$orien)
> femOtable
femO$orien
N S
7 5
> chisq.test(femOtable, p=c(.50, .50))

        Chi-squared test for given probabilities

data:  femOtable
X-squared = 0.3333, df = 1, p-value = 0.5637
#H0: females had equal access to 2 orientation directions
#HR: females did not have equal access to 2 orientation directions
#Conclusion: HO
```

MALE, ORIENTATION OF THE HEAD

```
maleOtable <- xtabs(~ maleO$orien)
> maleOtable
maleO$orien
N S
```

```
5 6
> chisq.test(maleOtable, p=c(.50, .50))

        Chi-squared test for given probabilities

data:  maleOtable
X-squared = 0.0909, df = 1, p-value = 0.763
#H0: males had equal access to 2 orientation directions
#HR: males did not have equal access to 2 orientation directions
#Conclusion: HO
```

<u>SEX, ORIENTATION OF THE HEAD</u>

```
sexORtable

               N  S
  female       7  5
  male         5  6
  undetermined 3 12
> length(sexOR$sex)
[1] 38
> chisq.test(sexORtable)

        Pearson's Chi-squared test

data:  sexORtable
X-squared = 4.332, df = 2, p-value = 0.1146

Warning message:
In chisq.test(sexORtable) : Chi-squared approximation may be incorrect
> fisher.test(sexORtable)

        Fisher's Exact Test for Count Data

data:  sexORtable
p-value = 0.106
alternative hypothesis: two.sided

sexOR2table

         N S
  female 7 5
  male   5 6
> length(sexOR2$sex)
[1] 23
> chisq.test(sexOR2table)
```

```
	Pearson's Chi-squared test with Yates' continuity correction

data:  sexOR2table
X-squared = 0.0399, df = 1, p-value = 0.8416
#H0: both sexes had equal access to 2 orientation directions
#HR: both sexes did not have equal access to 2 orientation directions
#Conclusion: HO
```

<u>FEMALE, BODY LOCATION IN THE TOMB</u>

```
femBloctable <- xtabs(~ femBloc$body_loc_tomb)
> femBloctable
femBloc$body_loc_tomb
 N  S
10  8
> chisq.test(femBloctable, p=c(.50, .50))

	Chi-squared test for given probabilities

data:  femBloctable
X-squared = 0.2222, df = 1, p-value = 0.6374
#H0: the individual's location in the tomb is equally distributed among females
#HR: the individual's location in the tomb is not equally distributed among females
#Conclusion: HO
```

<u>MALE, BODY LOCATION IN THE TOMB</u>

```
maleBloctable <- xtabs(~ maleBloc$body_loc_tomb)
> maleBloctable
maleBloc$body_loc_tomb
N S
9 9
> chisq.test(maleBloctable, p=c(.50, .50))

	Chi-squared test for given probabilities

data:  maleBloctable
X-squared = 0, df = 1, p-value = 1
#H0: the individual's location in the tomb is equally distributed among males
#HR: the individual's location in the tomb is not equally distributed among males
#Conclusion: HO
```

<u>SEX, BODY LOCATION IN THE TOMB</u>

```
sexBLtable


          N  S
 female  10  8
 male     9  9
```

```
  undetermined 22 10
> length(sexBL$sex)
[1] 68
> chisq.test(sexBLtable)

	Pearson's Chi-squared test

data:  sexBLtable
X-squared = 1.9213, df = 2, p-value = 0.3826
```

```
sexBL2table
        
         N  S
  female 10  8
  male    9  9
> chisq.test(sexBL2table)

	Pearson's Chi-squared test with Yates' continuity correction

data:  sexBL2table
X-squared = 0, df = 1, p-value = 1
#H0: the individual's location in the tomb is equally distributed between the sexes
#HR: the individual's location in the tomb is not equally distributed between the sexes
#Conclusion: HO
```

<u>AGE, TOMB ORIENTATION</u>

```
ageTOtable
       
        nesw ns nwse we
  20-34    8  7    3  0
  35-49   15  5    5  2
  b-5      6 12    7  0
> length(ageTO$age)
[1] 70
> chisq.test(ageTOtable)

	Pearson's Chi-squared test

data:  ageTOtable
X-squared = 10.5998, df = 6, p-value = 0.1016

Warning message:
In chisq.test(ageTOtable) : Chi-squared approximation may be incorrect
> fisher.test(ageTOtable)

	Fisher's Exact Test for Count Data
```

```
data:  ageTOtable
p-value = 0.09635
alternative hypothesis: two.sided
#H0: age and tomb orientation are not associated
#HR: age and tomb orientation are associated
#Conclusion: HO
```

AGE, BODY LOCATION IN THE TOMB

```
ageBLtable

         N  S
 20-34  5  6
 35-49 12  9
 b-5   16  6
> length(ageBL$sex)
[1] 54
> chisq.test(ageBLtable)

        Pearson's Chi-squared test

data:  ageBLtable
X-squared = 2.5229, df = 2, p-value = 0.2832

Warning message:
In chisq.test(ageBLtable) : Chi-squared approximation may be incorrect
> fisher.test(ageBLtable)

        Fisher's Exact Test for Count Data

data:  ageBLtable
p-value = 0.3002
alternative hypothesis: two.sided
#H0: age and individual’s location in the tomb are not associated
#HR: age and individual’s location in the tomb are associated
#Conclusion: HO
```

APPENDIX II: Symmetry analysis of ceramic vessels, chi-square results

Chi-square tests were conducted in Rstudio. Listed below are the categories of each chi-square test with corresponding code and results.

SYMMETRY OF STRUCTURE CLASS AND DESIGN LOCATION ON VESSELS

```
##pm11; one sample chi-square
pm11LOCtable <- xtabs(~ pm11LOC$d_loc)
> pm11LOCtable
pm11LOC$d_loc
  be   bi body neck
  38   17   26   46
> chisq.test(pm11LOCtable, p=c(.17, .19, .42, .22))

            Chi-squared test for given probabilities

data:  pm11LOCtable
X-squared = 40.2667, df = 3, p-value = 9.354e-09
#H0: pm11 symmetry class is equally distributed across 4 vessel design locations
#HR: pm11 symmetry class is not equally distributed across 4 vessel design locations
#Conclusion: HR

##pma2; one sample chi-square
pma2LOCtable <- xtabs(~ pma2LOC$d_loc)
> pma2LOCtable
pma2LOC$d_loc
    body     neck shoulder
      52        6       10
> chisq.test(pma2LOCtable, p=c(.59, .31, .10))

            Chi-squared test for given probabilities

data:  pma2LOCtable
X-squared = 15.8115, df = 2, p-value = 0.0003686
#H0: pma2 symmetry class is equally distributed across 3 vessel locations
#HR: pma2 symmetry class is not equally distributed across 3 vessel locations
#Conclusion: HR

##pmm2; one sample chi-square
pmm2LOCtable <- xtabs(~ pmm2LOC$d_loc)
> pmm2LOCtable
pmm2LOC$d_loc
      be     body     neck shoulder
      10       29        7        7
> chisq.test(pmm2LOCtable, p=c(.20, .47, .25, .08))
```

```
            Chi-squared test for given probabilities

data:  pmm2LOCtable
X-squared = 5.4502, df = 3, p-value = 0.1416

Warning message:
In chisq.test(pmm2LOCtable, p = c(0.2, 0.47, 0.25, 0.08)) :
  Chi-squared approximation may be incorrect
#H0: pmm2 symmetry class is equally distributed across 4 vessel design locations
#HR: pmm2 symmetry class is not equally distributed across 4 vessel design locations
#Conclusion: HO

##vessel bowl exterior (BE); one sample chi-square
ssBEtable <- xtabs(~ ssBE$ss)
> ssBEtable
ssBE$ss
pm11 pmm2
  38   10
> chisq.test(ssBEtable, p=c(.50, .50))

            Chi-squared test for given probabilities

data:  ssBEtable
X-squared = 16.3333, df = 1, p-value = 5.312e-05
#H0: 2 symmetry classes (pm11, pmm2) are equally distributed across vessel bowl exteriors
#HR: 2 symmetry classes (pm11, pmm2) are not equally distributed across vessel bowl exteriors
#Conclusion: HR

##vessel bowl interior (BI); one sample chi-square
ssBItable <- xtabs(~ ssBI$ss)
> ssBItable
ssBI$ss
  d2 pm11
  26   17
> chisq.test(ssBItable, p=c(.50, .50))

            Chi-squared test for given probabilities

data:  ssBItable
X-squared = 1.8837, df = 1, p-value = 0.1699
#H0: 2 symmetry classes (pm11, d2) are equally distributed across vessel bowl interiors
#HR: 2 symmetry classes (pm11, d2) are not equally distributed across vessel bowl interiors
#Conclusion: HO
##vessel body; one sample chi-square
ssBODYtable <- xtabs(~ ssBODY$ss)
> ssBODYtable
```

```
ssBODY$ss
asymmetric      pm11      pma2      pmm2
       14         26         52         29
> chisq.test(ssBODYtable, p=c(.25, .25, .25, .25))

              Chi-squared test for given probabilities

data:  ssBODYtable
X-squared = 25.0165, df = 3, p-value = 1.532e-05
#H0: Asymmetry and 3 symmetry classes (pm11, pma2, pmm2) are equally distributed across ve
ssel bodies
#HR: Asymmetry and 3 symmetry classes (pm11, pma2, pmm2) are not equally distributed acros
s vessel bodies
#Conclusion: HR

##vessel neck; one-sample chi-square
ssNECKtable <- xtabs(~ ssNECK$ss)
> ssNECKtable
ssNECK$ss
pm11 pmm2
  46    7
> chisq.test(ssNECKtable, p=c(.50, .50))

              Chi-squared test for given probabilities

data:  ssNECKtable
X-squared = 28.6981, df = 1, p-value = 8.459e-08
#H0: 2 symmetry classes (pm11, pmm2) are equally distributed across vessel necks
#HR: 2 symmetry classes (pm11, pmm2) are not equally distributed across vessel necks
#Conclusion: HR

##vessel shoulder; one sample chi-square
ssSHLDRtable <- xtabs(~ ssSHLDR$ss)
> ssSHLDRtable
ssSHLDR$ss
pma2 pmm2
  10    7
> chisq.test(ssSHLDRtable, p=c(.50, .50))

              Chi-squared test for given probabilities

data:  ssSHLDRtable
X-squared = 0.5294, df = 1, p-value = 0.4669
#H0: 2 symmetry classes (pmm2, pma2) are equally distributed across vessel shoulders
#HR: 2 symmetry classes (pmm2, pma2) are not equally distributed across vessel shoulders
#Conclusion: HO
```

SYMMETRY OF DESIGN CLASS AND DESIGN LOCATION ON VESSELS

```
##pm'11; one sample chi-square
pm.11LOCtable <- xtabs(~ pm.11LOC$d_loc)
> pm.11LOCtable
pm.11LOC$d_loc
body neck
  15   19
> chisq.test(pm.11LOCtable, p=c(.66, .34))

        Chi-squared test for given probabilities

data:  pm.11LOCtable
X-squared = 7.2551, df = 1, p-value = 0.00707
#H0: pm.11 symmetry class is equally distributed across 2 vessel locations
#HR: pm.11 symmetry class is not equally distributed across 2 vessel locations
#Conclusion: HR

##pm'a2'; one sample chi-square
pm.a2.LOCtable <- xtabs(~ pm.a2.LOC$d_loc)
> pm.a2.LOCtable
pm.a2.LOC$d_loc
body neck
  42    4
> chisq.test(pm.a2.LOCtable, p=c(.66, .34))

        Chi-squared test for given probabilities

data:  pm.a2.LOCtable
X-squared = 13.1258, df = 1, p-value = 0.0002913
#H0: pm.a2. symmetry class is equally distributed across 2 vessel locations
#HR: pm.a2. symmetry class is not equally distributed across 2 vessel locations
#Conclusion: HR
##pm11; one sample chi-square
pm11LOCtable <- xtabs(~ pm11LOC$d_loc)
> pm11LOCtable
pm11LOC$d_loc
  be   bi body neck
  21   15   12   26
> chisq.test(pm11LOCtable, p=c(.17, .19, .42, .22))

        Chi-squared test for given probabilities

data:  pm11LOCtable
X-squared = 23.215, df = 3, p-value = 3.642e-05
#H0: pm11 design symmetry class is equally distributed across 4 vessel locations
#HR: pm11 design symmetry class is not equally distributed across 4 vessel locations
```

```
#Conclusion: HR

##pma2; one sample chi-square
pma2LOCtable <- xtabs(~ pma2LOC$d_loc)
> pma2LOCtable
pma2LOC$d_loc
    body shoulder
       7        9
> chisq.test(pma2LOCtable, p=c(.86, .14))

                Chi-squared test for given probabilities

data:  pma2LOCtable
X-squared = 23.7218, df = 1, p-value = 1.113e-06

Warning message:
In chisq.test(pma2LOCtable, p = c(0.86, 0.14)) :
  Chi-squared approximation may be incorrect
#H0: pma2 symmetry of design class is equally distributed across 2 vessel locations
#HR: pma2 symmetry of design class is not equally distributed across 2 vessel locations
#Conclusion: HR

##pmm2; one sample chi-square
pmm2LOCtable <- xtabs(~ pmm2LOC$d_loc)
> pmm2LOCtable
pmm2LOC$d_loc
      be     body     neck shoulder
       6       10        5        7
> chisq.test(pmm2LOCtable, p=c(.20, .47, .25, .08))

                Chi-squared test for given probabilities

data:  pmm2LOCtable
X-squared = 11.4738, df = 3, p-value = 0.009421

Warning message:
In chisq.test(pmm2LOCtable, p = c(0.2, 0.47, 0.25, 0.08)) :
  Chi-squared approximation may be incorrect
#H0: pmm2 symmetry of design class is equally distributed across 4 vessel design
locations
#HR: pmm2 symmetry of design class is not equally distributed across 4 vessel design locations
#Conclusion: HR

##bowl interior (BI); one sample chi-square
sdBItable <- xtabs(~ sdBI$sd)
> sdBItable
```

```
sdBI$sd
 d.2   d1   d2 pm11
  12    5    8   15
> chisq.test(sdBItable, p=c(.25, .25, .25, .25))

        Chi-squared test for given probabilities

data:  sdBItable
X-squared = 5.8, df = 3, p-value = 0.1218
#H0: 4 symmetry classes are equally distributed across bowl interiors
#HR: 4 symmetry classes are not equally distributed across bowl interiors
#Conclusion: HO

##vessel body; one sample chi-square
sdBODYtable <- xtabs(~ sdBODY$sd)
> sdBODYtable
sdBODY$sd
asymmetric      pm.11     pm.a2.     pm.m.2       pm11
        16         15         42         13         12
> chisq.test(sdBODYtable, p=c(.20, .20, .20, .20, .20))

        Chi-squared test for given probabilities

data:  sdBODYtable
X-squared = 32.5102, df = 4, p-value = 1.505e-06
#H0: Asymmetry and 4 symmetry classes are equally distributed across vessel bodies
#HR: Asymmetry and 4 symmetry classes are not equally distributed across vessel bodies
#Conclusion: HR

##vessel neck; one sample chi-square
sdNECKtable <- xtabs(~ sdNECK$sd)
> sdNECKtable
sdNECK$sd
 pm.11 pm.a2.   pm11   pmm2
    19      4     26      5
> chisq.test(sdNECKtable, p=c(.25, .25, .25, .25))

        Chi-squared test for given probabilities

data:  sdNECKtable
X-squared = 25.8519, df = 3, p-value = 1.024e-05
#H0: Asymmetry and 3 symmetry classes are equally distributed across vessel necks
#HR: Asymmetry and 3 symmetry classes are not equally distributed across vessel necks
#Conclusion: HR
```

SYMMETRY OF STRUCTURE CLASS AND CERAMIC STYLE

```
##pm11; one sample chi-square
pm11CCtable <- xtabs(~ pm11CC$cer_chron)
> pm11CCtable
pm11CC$cer_chron
  Algarrobal San Geronimo       Yaral
        65          26          37
> chisq.test(pm11CCtable, p=c(.50, .30, .20))

        Chi-squared test for given probabilities

data:  pm11CCtable
X-squared = 9.0964, df = 2, p-value = 0.01059
#H0: pm11 symmetry class is equally distributed across 3 ceramic chronology categories
#HR: pm11 symmetry class is not equally distributed across 3 ceramic chronology categories
#Conclusion: HR

##pma2; one sample chi-square
pma2CCtable <- xtabs(~ pma2CC$cer_chron)
> pma2CCtable
pma2CC$cer_chron
  Algarrobal San Geronimo       Yaral
        27          16          16
> chisq.test(pma2CCtable, p=c(.50, .30, .20))

        Chi-squared test for given probabilities

data:  pma2CCtable
X-squared = 1.8701, df = 2, p-value = 0.3926
#H0: pma2 symmetry class is equally distributed across 3 ceramic chronology categories
#HR: pma2 symmetry class is not equally distributed across 3 ceramic chronology categories
#Conclusion: HO

##pmm2; one sample chi-square
pmm2CCtable <- xtabs(~ pmm2CC$cer_chron)
> pmm2CCtable
pmm2CC$cer_chron
  Algarrobal San Geronimo       Yaral
        34           4          10
> chisq.test(pmm2CCtable, p=c(.50, .30, .20))

        Chi-squared test for given probabilities

data:  pmm2CCtable
X-squared = 11.6944, df = 2, p-value = 0.002888
#H0: pmm2 symmetry class is equally distributed across 3 ceramic chronology categories
```

```
#HR: pmm2 symmetry class is not equally distributed across 3 ceramic chronology categories
#Conclusion: HR

##Algarrobal, symmetry structure class; one sample chi-square
ssALGtable <- xtabs(~ ssALG$ss)
> ssALGtable
ssALG$ss
asymmetric       pm11       pma2       pmm2
        15          65         27          34
> chisq.test(ssALGtable, p=c(.25, .25, .25, .25))

	Chi-squared test for given probabilities

data:  ssALGtable
X-squared = 38.7163, df = 3, p-value = 1.993e-08
#H0: Algarrobal has equal distribution of asymmetry and 3 symmetry classes (pm11, pma2, pm
m2)
#HR: Algarrobal does not have equal distribution of asymmetry and 3 symmetry classes (pm11,
pma2, pmm2)
#Conclusion: HR

##Yaral, symmetry structure class; one sample chi-square
ssYARtable <- xtabs(~ ssYAR$ss)
> ssYARtable
ssYAR$ss
pm11 pmm2
  37   10
> chisq.test(ssYARtable, p=c(.50, .50))

	Chi-squared test for given probabilities

data:  ssYARtable
X-squared = 15.5106, df = 1, p-value = 8.204e-05
#H0: Yaral has equal distribution of 2 symmetry classes (pm11, pmm2)
#HR: Yaral does not have equal distribution of 2 symmetry classes (pm11, pmm2)
#Conclusion: HR

##San Geronimo, symmetry structure class; one sample chi-square
ssSGtable <- xtabs(~ ssSG$ss)
> ssSGtable
ssSG$ss
  d2   d4 pm11 pma2
  26    6   26   16
> chisq.test(ssSGtable, p=c(.25, .25, .25, .25))

	Chi-squared test for given probabilities
```

```
data:  ssSGtable
X-squared = 14.8649, df = 3, p-value = 0.001936
#H0: San Geronimo has equal distribution of 4 symmetry classes
#HR: San Geronimo does not have equal distribution of 4 symmetry classes
#Conclusion: HR
```

<u>SYMMETRY OF DESIGN CLASS AND CERAMIC STYLE</u>

```
##pm'11; one-sample chi-square
pm.11CCtable <- xtabs(~ pm.11CC$cer_chron)
> pm.11CCtable
pm.11CC$cer_chron
Algarrobal      Yaral
        27          7
> chisq.test(pm.11CCtable, p=c(.71, .29))

        Chi-squared test for given probabilities

data:  pm.11CCtable
X-squared = 1.1684, df = 1, p-value = 0.2797
#H0: pm'11 symmetry class is equally distributed across 2 ceramic chronology categories
#HR: pm'11 symmetry class is not equally distributed across 2 ceramic chronology
categories
#Conclusion: HO

##pm'a2.; one sample chi-square
pm.a2.CCtable <- xtabs(~ pm.a2.CC$cer_chron)
> pm.a2.CCtable
pm.a2.CC$cer_chron
Algarrobal      Yaral
        20         14
> chisq.test(pm.a2.CCtable, p=c(.71, .29))

        Chi-squared test for given probabilities

data:  pm.a2.CCtable
X-squared = 2.4483, df = 1, p-value = 0.1177
#H0: pm.a2.CC symmetry class is equally distributed across 2 ceramic chronology categories
#HR: pm.a2.CC symmetry class is not equally distributed across 2 ceramic chronology
categories
#Conclusion: HO

##pm11; one sample chi-square
pm11CCtable <- xtabs(~ pm11CC$cer_chron)
> pm11CCtable
pm11CC$cer_chron
  Algarrobal San Geronimo        Yaral
```

```
     35        23        19
> chisq.test(pm11CCtable, p=c(.50, .30, .20))

          Chi-squared test for given probabilities

data:  pm11CCtable
X-squared = 1.1602, df = 2, p-value = 0.5598
#H0: pm11 symmetry design class is equally distributed across 3 ceramic chronology categories
#HR: pm11 symmetry design class is not equally distributed across 3 ceramic chronology catego
ries
#Conclusion: HO

##Algarrobal, symmetry design class; one sample chi-square
sdALGtable <- xtabs(~ sdALG$sd)
> sdALGtable
sdALG$sd
asymmetric     pm.11     pm.a2.      pm11      pmm2
      17        27        20        35        25
> chisq.test(sdALGtable, p=c(.20, .20, .20, .20, .20))

          Chi-squared test for given probabilities

data:  sdALGtable
X-squared = 7.7742, df = 4, p-value = 0.1002
#H0: Algarrobal has equal distribution of asymmetry and 4 symmetry classes
#HR: Algarrobal does not have equal distribution of asymmetry and 4 symmetry classes
#Conclusion: HO

##Yaral, symmetry design class; one sample chi-square
sdYARtable <- xtabs(~ sdYAR$sd)
> sdYARtable
sdYAR$sd
 p.m11  pm.11 pm.a2. pm.m.2   pm11
   11      7     14      9     19
> chisq.test(sdYARtable, p=c(.20, .20, .20, .20, .20))

          Chi-squared test for given probabilities

data:  sdYARtable
X-squared = 7.3333, df = 4, p-value = 0.1193
#H0: Yaral has equal distribution of 5 symmetry classes
#HR: Yaral does not have equal distribution of 5 symmetry classes
#Conclusion: HO

##San Geronimo, symmetry design class; one sample chi-square
sdSGtable <- xtabs(~ sdSG$sd)
```

```
> sdSGtable
sdSG$sd
 d.2   d2 pm11 pma2 
  12    8   23   10 
> chisq.test(sdSGtable, p=c(.25, .25, .25, .25))

	Chi-squared test for given probabilities

data:  sdSGtable
X-squared = 10.1698, df = 3, p-value = 0.01718
#H0: San Geronimo has equal distribution of 4 symmetry classes
#HR: San Geronimo does not have equal distribution of 4 symmetry classes
#Conclusion: HR
```

SYMMETRY OF STRUCTURE CLASS AND VESSEL FORM

```
##pm11; one sample chi-square
##accounting for unequal vessel form counts
pm11VFtable <- xtabs(~ pm11VF$vf)
> pm11VFtable
pm11VF$vf
      bowl    cantaro        jar little jar 
        55         14         41          7 
> chisq.test(pm11VFtable, p=c(.38, .39, .16, .07))

	Chi-squared test for given probabilities

data:  pm11VFtable
X-squared = 51.114, df = 3, p-value = 4.626e-11
#H0: pm11 symmetry class is equally distributed across 4 vessel form types
#HR: pm11 symmetry class is not equally distributed across 4 vessel form types
#Conclusion: HR

##pma2; one sample chi-square
##accounting for unequal vessel form counts
pma2VFtable <- xtabs(~ pma2VF$vf)
> pma2VFtable
pma2VF$vf
cantaro     jar 
     12      37 
> chisq.test(pma2VFtable, p=c(.30, .70))

	Chi-squared test for given probabilities

data:  pma2VFtable
X-squared = 0.7085, df = 1, p-value = 0.4
#H0: pma2 symmetry class is equally distributed across 2 vessel form types
```

```
#HR: pma2 symmetry class is not equally distributed across 2 vessel form types
#Conclusion: HO

##pmm2; one sample chi-square
##accounting for unequal vessel form counts
pmm2VFtable <- xtabs(~ pmm2VF$vf)
> pmm2VFtable
pmm2VF$vf
     bowl    cantaro       jar little jar
       11         10        21          3
> chisq.test(pmm2VFtable, p=c(.38, .39, .16, .07))

             Chi-squared test for given probabilities

data:  pmm2VFtable
X-squared = 31.8812, df = 3, p-value = 5.544e-07

Warning message:
In chisq.test(pmm2VFtable, p = c(0.38, 0.39, 0.16, 0.07)) :
  Chi-squared approximation may be incorrect
#H0: pmm2 symmetry class is equally distributed across 4 vessel form types
#HR: pmm2 symmetry class is not equally distributed across 4 vessel form types
#Conclusion: HR

##bowl; one sample chi-square
ssBOWLtable <- xtabs(~ ssBOWL$ss)
> ssBOWLtable
ssBOWL$ss
  d2   d4 pm11 pmm2
  26    6   55   11
> chisq.test(ssBOWLtable, p=c(.25, .25, .25, .25))

             Chi-squared test for given probabilities

data:  ssBOWLtable
X-squared = 59.4694, df = 3, p-value = 7.631e-13
#H0: 4 symmetry structure classes are equally distributed across bowls
#HR: 4 symmetry structure classes are not equally distributed across bowls
#Conclusion: HR
##This could be due to the high count of Algarrobal vessels

##cantaro; one sample chi-square
ssCANTtable <- xtabs(~ ssCANT$ss)
> ssCANTtable
ssCANT$ss
asymmetric       pm11       pma2       pmm2
```

```
       4         14         12         10
> chisq.test(ssCANTtable, p=c(.25, .25, .25, .25))

        Chi-squared test for given probabilities

data:  ssCANTtable
X-squared = 5.6, df = 3, p-value = 0.1328
#H0: asymmetry and 3 symmetry structure classes are equally distributed across cantaros
#HR: asymmetry and 3 symmetry structure classes are not equally distributed across
cantaros
#Conclusion: HO

##jar; one sample chi-square
ssJARtable <- xtabs(~ ssJAR$ss)
> ssJARtable
ssJAR$ss
asymmetric       pm11       pma2       pmm2
       5         41         37         21
> chisq.test(ssJARtable, p=c(.25, .25, .25, .25))

        Chi-squared test for given probabilities

data:  ssJARtable
X-squared = 31.2308, df = 3, p-value = 7.601e-07
#H0: asymmetry and 3 symmetry structure classes are equally distributed across jars
#HR: asymmetry and 3 symmetry structure classes are not equally distributed across jars
#Conclusion: HR
```

<u>SYMMETRY OF DESIGN CLASS AND VESSEL FORM</u>

```
##bowl; one sample chi-square
sdBOWLtable <- xtabs(~ sdBOWL$sd)
> sdBOWLtable
sdBOWL$sd
 d.2    d2 p.m11  pm11  pmm2
  12     8    16    36     7
> chisq.test(sdBOWLtable, p=c(.20, .20, .20, .20, .20))

        Chi-squared test for given probabilities

data:  sdBOWLtable
X-squared = 35.4937, df = 4, p-value = 3.678e-07
#H0: 5 symmetry structure classes are equally distributed across bowls
#HR: 5 symmetry structure classes are not equally distributed across bowls
#Conclusion: HR

##jar; one sample chi-square
```

```
sdJARtable <- xtabs(~ sdJAR$sd)
> sdJARtable
sdJAR$sd
 pm.11 pm.a2. pm.m.2   pm11   pmm2
    22     29      8     19     11
> chisq.test(sdJARtable, p=c(.20, .20, .20, .20, .20))

        Chi-squared test for given probabilities

data:  sdJARtable
#H0: 5 symmetry structure classes are equally distributed across jars
#HR: 5 symmetry structure classes are not equally distributed across jars
#Conclusion: HR
X-squared = 16.1124, df = 4, p-value = 0.002872
```

<u>SYMMETRY OF STRUCTURE CLASS AND CHIRIBAYA ALTA CEMETERIES</u>

```
##accounting for unequal counts in cemeteries
##pm11; one-sample chi-square
pm11CEMtable <- xtabs(~ pm11CEM$cem)
> pm11CEMtable
pm11CEM$cem
 1  2  3  4  5  7
 5 15  8 17  7 52
> chisq.test(pm11CEMtable, p=c(.05, .11, .07, .22, .07, .48))

        Chi-squared test for given probabilities

data:  pm11CEMtable
X-squared = 2.7953, df = 5, p-value = 0.7315
#H0: pm11 symmetry class is equally distributed across 6 ChA cemeteries
#HR: pm11 symmetry class is not equally distributed across 6 ChA cemeteries
#Conclusion: HO

##accounting for unequal counts in cemeteries
##d2; one-sample chi-square
d2CEMtable <- xtabs(~ d2CEM$cem)
> d2CEMtable
d2CEM$cem
 4  7
15  6
> chisq.test(d2CEMtable, p=c(.31, .69))

        Chi-squared test for given probabilities

data:  d2CEMtable
X-squared = 16.0467, df = 1, p-value = 6.18e-05
```

```
#H0: d2 symmetry class is equally distributed across 2 ChA cemeteries
#HR: d2 symmetry class is not equally distributed across 2 ChA cemeteries
#Conclusion: HR

##accounting for unequal counts in cemeteries
##pma2; one-sample chi-square
pma2CEMtable <- xtabs(~ pma2CEM$cem)
> pma2CEMtable
pma2CEM$cem
 4  7
13 32
> chisq.test(pma2CEMtable, p=c(.31, .69))

        Chi-squared test for given probabilities

data:  pma2CEMtable
X-squared = 0.0938, df = 1, p-value = 0.7594
#H0: pma2 symmetry class is equally distributed across 2 ChA cemeteries
#HR: pma2 symmetry class is not equally distributed across 2 ChA cemeteries
#Conclusion: HO

##accounting for unequal counts in cemeteries
##pmm2; one-sample chi-square
pmm2CEMtable <- xtabs(~ pmm2CEM$cem)
> pmm2CEMtable
pmm2CEM$cem
 2  4  7
 6  7 26
> chisq.test(pmm2CEMtable, p=c(.13, .27, .60))

        Chi-squared test for given probabilities

data:  pmm2CEMtable
X-squared = 1.6429, df = 2, p-value = 0.4398
#H0: pmm2 symmetry class is equally distributed across 3 ChA cemeteries
#HR: pmm2 symmetry class is not equally distributed across 3 ChA cemeteries
#Conclusion: HO

##ChA cem 2; one sample chi-square
ssCEM2table <- xtabs(~ ssCEM2$ss)
> ssCEM2table
ssCEM2$ss
pm11 pmm2
  15    6
> chisq.test(ssCEM2table, p=c(.50, .50))
```

```
        Chi-squared test for given probabilities

data:  ssCEM2table
X-squared = 3.8571, df = 1, p-value = 0.04953
#H0: 2 symmetry classes are equally distributed across ChA cem 2
#HR: 2 symmetry classes are not equally distributed across ChA cem 2
#Conclusion: HO, note pvalue = 0.049

##ChA cem 4; one sample chi-square
ssCEM4table <- xtabs(~ ssCEM4$ss)
> ssCEM4table
ssCEM4$ss
  d2 pm11 pma2 pmm2
  15   17   13    7
> chisq.test(ssCEM4table, p=c(.25, .25, .25, .25))

        Chi-squared test for given probabilities

data:  ssCEM4table
X-squared = 4.3077, df = 3, p-value = 0.2301
#H0: 4 symmetry classes are equally distributed across ChA cem 4
#HR: 4 symmetry classes are not equally distributed across ChA cem 4
#Conclusion: HO

##ChA cem 7; one sample chi-square
ssCEM7table <- xtabs(~ ssCEM7$ss)
> ssCEM7table
ssCEM7$ss
asymmetric         d2       pm11       pma2       pmm2
         5          6         52         32         26
> chisq.test(ssCEM7table, p=c(.20, .20, .20, .20, .20))

        Chi-squared test for given probabilities

data:  ssCEM7table
X-squared = 63.5041, df = 4, p-value = 5.315e-13
#H0: asymmetry and 4 symmetry classes are equally distributed across ChA cem 7
#HR: asymmetry and 4 symmetry classes are not equally distributed across ChA cem 7
#Conclusion: HR

ssCEM7btable <- xtabs(~ ssCEM7b$ss)
> ssCEM7btable
ssCEM7b$ss
  d2 pm11 pma2 pmm2
   6   52   32   26
> chisq.test(ssCEM7btable, p=c(.25, .25, .25, .25))
```

```
        Chi-squared test for given probabilities

data:  ssCEM7btable
X-squared = 37.1034, df = 3, p-value = 4.375e-08
#H0: 4 symmetry classes are equally distributed across ChA cem 7
#HR: 4 symmetry classes are not equally distributed across ChA cem 7
#Conclusion: HR
```

SYMMETRY OF DESIGN CLASS AND CHIRIBAYA ALTA CEMETERIES

```
##accounting for unequal counts in cemeteries
##pm.11; one-sample chi-square
pm.11CEMtable <- xtabs(~ pm.11CEM$cem)
> pm.11CEMtable
pm.11CEM$cem
 1  2  7
 5  5 21
> chisq.test(pm.11CEMtable, p=c(.08, .17, .75))

        Chi-squared test for given probabilities

data:  pm.11CEMtable
X-squared = 2.7922, df = 2, p-value = 0.2476
#H0: pm.11 symmetry design class is equally distributed across 3 ChA cemeteries
#HR: pm.11 symmetry design class is not equally distributed across 3 ChA cemeteries
#Conclusion: HO

##accounting for unequal counts in cemeteries
##pm.a2.; one-sample chi-square
pm.a2.CEMtable <- xtabs(~ pm.a2.CEM$cem)
> pm.a2.CEMtable
pm.a2.CEM$cem
 4  7
 8 22
> chisq.test(pm.a2.CEMtable, p=c(.31, .69))

        Chi-squared test for given probabilities

data:  pm.a2.CEMtable
X-squared = 0.2634, df = 1, p-value = 0.6078
#H0: pm.a2. symmetry design class is equally distributed across 2 ChA cemeteries
#HR: pm.a2. symmetry design class is not equally distributed across 2 ChA cemeteries
#Conclusion: HO

##accounting for unequal counts in cemeteries
##pm11; one-sample chi-square
pm11CEMtable <- xtabs(~ pm11CEM$cem)
```

```
> pm11CEMtable
pm11CEM$cem
 2  3  4  5  7 
 8  5 14  6 26 
> chisq.test(pm11CEMtable, p=c(.11, .07, .23, .08, .51))

	Chi-squared test for given probabilities

data:  pm11CEMtable
X-squared = 1.4513, df = 4, p-value = 0.8352

Warning message:
In chisq.test(pm11CEMtable, p = c(0.11, 0.07, 0.23, 0.08, 0.51)) :
  Chi-squared approximation may be incorrect
#H0: pm11 symmetry design class is equally distributed across 5 ChA cemeteries
#HR: pm11 symmetry design class is not equally distributed across 5 ChA cemeteries
#Conclusion: HO

##accounting for unequal counts in cemeteries
##pma2; one-sample chi-square
pma2CEMtable <- xtabs(~ pma2CEM$cem)
> pma2CEMtable
pma2CEM$cem
4 7 
5 8 
> chisq.test(pma2CEMtable, p=c(.31, .69))

	Chi-squared test for given probabilities

data:  pma2CEMtable
X-squared = 0.3384, df = 1, p-value = 0.5608
#H0: pma2 symmetry design class is equally distributed across 2 ChA cemeteries
#HR: pma2 symmetry design class is not equally distributed across 2 ChA cemeteries
#Conclusion: HO

##ChA cem 4; one sample chi-square
sdCEM4table <- xtabs(~ sdCEM4$sd)
> sdCEM4table
sdCEM4$sd
   d.2     d2 pm.a2.   pm11   pma2 
     6      6      8     14      5 
> chisq.test(sdCEM4table, p=c(.20, .20, .20, .20, .20))

	Chi-squared test for given probabilities

data:  sdCEM4table
```

```
X-squared = 6.7692, df = 4, p-value = 0.1486
#H0: 5 symmetry classes are equally distributed across ChA cem 4
#HR: 5 symmetry classes are not equally distributed across ChA cem 4
#Conclusion: HO

##ChA cem 7; one sample chi-square
sdCEM7table <- xtabs(~ sdCEM7$sd)
> sdCEM7table
sdCEM7$sd
 pm.11 pm.a2.   pm11   pma2   pmm2
    21     22     26      8     19
> chisq.test(sdCEM7table, p=c(.20, .20, .20, .20, .20))

        Chi-squared test for given probabilities

data:  sdCEM7table
X-squared = 9.5208, df = 4, p-value = 0.04932
#H0: 5 symmetry classes are equally distributed across ChA cem 7
#HR: 5 symmetry classes are not equally distributed across ChA cem 7
#Conclusion: cautious HR, pvalue = 0.049
```

SYMMETRY OF STRUCTURE CLASS AND CHIRIBAYA BAJA CEMETERY 1

```
##ChB cem 1; one sample chi-square
ssCHB1table <- xtabs(~ ssCHB1$ss)
> ssCHB1table
ssCHB1$ss
pm11 pma2
  18    5
> chisq.test(ssCHB1table, p=c(.50, .50))

        Chi-squared test for given probabilities

data:  ssCHB1table
X-squared = 7.3478, df = 1, p-value = 0.006714
#H0: 2 symmetry classes are equally distributed across ChB cem 1
#HR: 2 symmetry classes are not equally distributed across ChB cem 1
#Conclusion: HR
```

SYMMETRY OF DESIGN CLASS AND CHIRIBAYA BAJA CEMETERY 1

```
##ChB cem 1; one sample chi-square
sdCHB1table <- xtabs(~ sdCHB1$sd)
> sdCHB1table
sdCHB1$sd
p.m11  pm11
    7    11
> chisq.test(sdCHB1table, p=c(.50, .50))
```

```
        Chi-squared test for given probabilities

data:  sdCHB1table
X-squared = 0.8889, df = 1, p-value = 0.3458
#H0: 2 symmetry design classes are equally distributed across ChB cem 1
#HR: 2 symmetry design classes are not equally distributed across ChB cem 1
#Conclusion: HO
```

COLOR STATE (Chiribaya Alta and Chiribaya Baja; all vessel forms and all design locations on vessels)

Ceramic style and color state

```
##Algarrobal; one sample chi-square
csALGtable <- xtabs(~ csALG$color)
> csALGtable
csALG$color
  3 color   5 color   colored one-color two-color
       7        34         7        76        20
> chisq.test(csALGtable, p=c(.20, .20, .20, .20, .20))

        Chi-squared test for given probabilities

data:  csALGtable
X-squared = 113.9861, df = 4, p-value < 2.2e-16
#H0: Algarrobal has equal distribution of 5 different color states
#HR: Algarrobal does not have equal distribution of 5 different color states
#Conclusion: HR

##Yaral; one sample chi-square
csYARtable <- xtabs(~ csYAR$color)
> csYARtable
csYAR$color
  5 color   colored one-color two-color
      28         3        19        14
> chisq.test(csYARtable, p=c(.25, .25, .25, .25))

        Chi-squared test for given probabilities

data:  csYARtable
X-squared = 20.375, df = 3, p-value = 0.0001419
#H0: Yaral has equal distribution of 4 different color states
#HR: Yaral does not have equal distribution of 4 different color states
#Conclusion: HR
##San Geronimo; one sample chi-square
csSGtable <- xtabs(~ csSG$color)
> csSGtable
```

```
csSG$color
  5 color   colored one-color two-color 
       19          4         50         11 
> chisq.test(csSGtable, p=c(.25, .25, .25, .25))

	Chi-squared test for given probabilities

data:  csSGtable
X-squared = 58.7619, df = 3, p-value = 1.081e-12
#H0: San Geronimo has equal distribution of 4 different color states 
#HR: San Geronimo does not have equal distribution of 4 different color states
#Conclusion: HR
```

Vessel form and color state

```
##accounting for unequal vessel form counts
##5 color, vessel form
c5VFtable <- xtabs(~ c5VF$vf)
> c5VFtable
c5VF$vf
   bowl cantaro     jar 
     14      12      49 
> chisq.test(c5VFtable, p=c(.42, .41, .17))

	Chi-squared test for given probabilities

data:  c5VFtable
X-squared = 124.2189, df = 2, p-value < 2.2e-16
#H0: 5 color color state is equally distributed across 3 vessel forms
#HR: 5 color color state is not equally distributed across 3 vessel forms
#Conclusion: HR
##1 color, vessel form
c1VFtable <- xtabs(~ c1VF$vf)
> c1VFtable
c1VF$vf
      bowl    cantaro        jar little jar       olla 
        65         20         38         11          5 
> chisq.test(c1VFtable, p=c(.38, .36, .16, .07, .03))

	Chi-squared test for given probabilities

data:  c1VFtable
X-squared = 32.3413, df = 4, p-value = 1.629e-06
#H0: 1 color color state is equally distributed across 5 vessel forms
#HR: 1 color color state is not equally distributed across 5 vessel forms
#Conclusion: HR
```

```
##2 color, vessel form
c2VFtable <- xtabs(~ c2VF$vf)
> c2VFtable
c2VF$vf
   bowl cantaro     jar
     26       6       6
> chisq.test(c2VFtable, p=c(.42, .41, .17))

        Chi-squared test for given probabilities

data:  c2VFtable
X-squared = 12.2393, df = 2, p-value = 0.002199
#H0: 2 color color state is equally distributed across 3 vessel forms
#HR: 2 color color state is not equally distributed across 3 vessel forms
#Conclusion: HR

Design location on vessel and color state
##accounting for unequal vessel form counts
##5 color, design location on vessel
c5LOCtable <- xtabs(~ c5LOC$d_loc)
> c5LOCtable
c5LOC$d_loc
  bi body neck
  13   62   16
> chisq.test(c5LOCtable, p=c(.23, .51, .26))

        Chi-squared test for given probabilities

data:  c5LOCtable
X-squared = 10.7215, df = 2, p-value = 0.004697
#H0: 5 color color state is equally distributed across 3 vessel design locations
#HR: 5 color color state is not equally distributed across 3 design locations
#Conclusion: HR
##1 color, design location on vessel
c1LOCtable <- xtabs(~ c1LOC$d_loc)
> c1LOCtable
c1LOC$d_loc
      be       bi     body     neck shoulder
      30       35       33       35       19
> chisq.test(c1LOCtable, p=c(.16, .17, .39, .21, .07))

        Chi-squared test for given probabilities

data:  c1LOCtable
X-squared = 23.0899, df = 4, p-value = 0.0001215
#H0: 1 color color state is equally distributed across 4 vessel design locations
```

```
#HR: 1 color color state is not equally distributed across 4 vessel design locations
#Conclusion: HR

##2 color, design location on vessel
c2LOCtable <- xtabs(~ c2LOC$d_loc)
> c2LOCtable
c2LOC$d_loc
  be   bi body neck
  20    6   11    7
> chisq.test(c2LOCtable, p=c(.17, .19, .42, .22))

        Chi-squared test for given probabilities

data:  c2LOCtable
X-squared = 25.3918, df = 3, p-value = 1.279e-05
#H0: 2 color color state is equally distributed across 4 vessel design locations
#HR: 2 color color state is not equally distributed across 4 vessel design locations
#Conclusion: HR
```

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