Analysis of Paleoethnobotanical Data at the Pirque Alto Site in the Cochabamba Valley of Bolivia: A Comparison to Primary and Secondary Centers

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ABSTRACT

This project focuses on comparing the botanical assemblages recovered from three archaeological sites associated with the Tiwanaku civilization of the central Andean highlands: the small rural community of Pirque Alto, the secondary center of Lukurmata, and the capital city Tiwanaku. The crop densities and ubiquities of maize, quinoa, and parenchyma tissue are systematically compared from the Formative Period and Middle Horizon components of each of these sites in order to illustrate how plant use changed through time at each locale. In order to illustrate finer grained diachronic analysis, change within the Formative Period and Middle Horizon was also examined. From this comparative study it was evident that a non-random favoring of different crops occurred between the periods and the sites. This was seen in the heavy use of quinoa, the growing of maize in the Middle Horizon, and the favoring of tubers at the site of Pirque Alto.

INTRODUCTION

Ethnobotanical data was all but ignored in archaeological site reports of early archaeology, and mentions of plants, despite the obvious importance, were often short and without detail. As paleoethnobotany grows as a sub-field of archaeology, more and more archaeologists are utilizing the information it provides. Plants whether they are used for food, shelter, or even medicinal purposes represent a complex and exceedingly meaningful aspect of human culture (Ford 1979:297). Some of the largest questions archaeologists ask concern topics like the rise of agriculture, the role of ideologies, and many others, in these scenarios fields like paleoethnobotany offer the opportunity to provide strength to theories.

The primary way to gauge differences in culture as it pertains to plants is by looking for variety and change among data sets. For example, one can examine how plant use changed through time at a particular site or evaluate botanical remains from a single time period at multiple sites. Differences in the use of plants can directly show disparities in ways of life, what this shows is that paleoethnobotanical analysis can provide an effective medium through which sites can be compared with respect to diet, environment, adaptation, ideology, and economics (Ford 1979:289).

The site of Pirque Alto is located at the cross-section of three key routes in Cochabamba, Bolivia (Figure 1). These include the Rio Pukina, which leads to the Central Valley of Cochabamba, the Rio Tapacarí which leads to the Titicaca Basin and the Tiwanaku heartland, and a natural corridor which leads directly to the *Altiplano* (McAndrews 2007:4). The excavations at Pirque Alto have targeted the Formative Period (1800BC to 300 AD) and Middle Horizon (600 AC to 1000 AC) components of the site (Moseley 2001:173,223).

From these excavations soil samples were recovered and processed. This yielded the botanical data, which was then analyzed based on ubiquity and density. Data from the different levels of the site was compared to provide a diachronic analysis of plant use through time. I also compared the Pirque Alto botanical data to that recovered from residential sectors at the capital city Tiwanaku and Lukurmata, a secondary center on the banks of Lake Titicaca. After I analyzed the data I looked for patterns between the residential zones of Tiwanaku and Lukurmata to identify and show specific patterns and differences with the Pirque Alto site.

Figure 1. Map of Bolivia Adapted from McAndrews (2009: Figure 1)

This study will help other archaeologists identify factors that influence change in the botanical records of the sites of Tiwanaku, Lukurmata, and Pirque Alto, and it will lead to a better understanding of the Tiwanaku civilization. By comparing small rural sites (Pirque Alto) with large central areas (Tiwanaku and Lukurmata) it is possible to gauge the differences in plant use between them. To accomplish the goals of this study it is first necessary to set the scene and provide the crucial background that is required to appreciate and understand the fields of paleoethnobotany, the available plant resources that would have been available to the inhabitants at Tiwanaku, Lukurmata, and Pirque Alto as well as review the excavations at the three sites and the context from which the paleobotanical remains were recovered. Finally, I present specifics on the nature of the remains from Pirque Alto and the results of my comparison with the data from Tiwanaku and Lukurmata.

BACKGROUND

Paleoethnobotany

Paleoethnobotany is a sub-field of archaeology that examines preserved botanical remains recovered from archaeological contexts in order to reconstruct past environments and evaluate plan use by ancient cultures. The primary form of paleoethnobotanical data are preserved seeds, which because of their hard outer coats usually preserve very well in comparison to many other types of botanical remains. Paleoethnobotany traces its origins to 1895 when Dr. John W. Harshberger presented a lecture to the University of Pennsylvania's Archaeological Association where he referred to the study of cultural plant use as ethnobotany. Before this lecture, plant use was looked at from a botanical and an ethnological perspective but never through the eyes of American archaeology and as time passed more archaeologists began to incorporate ethnobotany into their studies (Ford 1979:291). In 1941 Volney H. Jones changed the field forever when he defined the field as, "the study of the interrelations of primitive man and plants" (Jones 1941:220).

While plants are important in an economic sense, Jones believed they also can also reflect ecological relationships, religion, philosophy, and notions of primitive botany (Ford 1979:294). Other important contributions of paleoethnobotanical research include the study of the origins of agriculture, explaining exchange and migration, reconstructing past environments, identifying human adaptations, and investigating prehistoric ideology (Ford 1979:298). Since the 1980s, the number of sites that have made a priority of recovering botanical remains through screening, flotations, pollen and phytolith samples, and the analysis of these materials has risen and there has been a tremendous increase in the amount of data surrounding early agriculture and diet (Bruhns 1994:91).

Environmental Context of the Sites Under Consideration

The Environment of the Altiplano. The *Altiplano* is a unique and distinct cultural setting that begins at 4,000 meters and continues up to the height of 5,000 meters (Hagen and Morris 1998:17). The climate of the *Altiplano* is greatly influenced by the surrounding mountains, unlike the lowlands, which experience high relatively constant temperatures, the *Altiplano* region of Bolivia has a climate that is much more varied. During the dry season, which falls from May to September, the temperature can fall below freezing at night to over 60°F by midday. Combined, rain, snow, and hail provide around 21 inches of precipitation every year in the *Altiplano*. This precipitation falls primarily during the summer months, which transpire from October until May (Keller 1950:38-39). The quality of the land can be well summarized by Frank Keller who writes, "The *Altiplano* landscape presents a vast, flat to undulating land of disordered sedimentary rocks and infertile stony soils (Keller 1950:40)." As Keller suggested, the land of the *Altiplano* is vast, however vastness in itself can be strength, because the tremendous amount of space in this area lends itself very well to grazing. Generally speaking there are a wide variety of grasses that are grown in the *Altiplano* such as short grasses known as *ichu* and *tola* bushes (Jones 1929:293). These types of grasses and bushes provided food for camelids including llamas and alpacas to graze. The pastoral adaptation was crucial to survival in this area, but many other crops were also imperative to the continued existence of the native inhabitants. These crops provide the focus for this paper, and in combination with pasturage they provided a way of life for the inhabitants of sites like Pirque Alto for thousands of years.

Plant Resource Availability. Almost all of the zones in Bolivia are cultivable with the possible exception of the most mountainous area, as the altitude ascends the number of crops that can be cultivated is greatly reduced. In the *Altiplano*, potatoes and other tubers are grown, olluco, oca, mashwa, and grains like guinoa and quiwicha can all be grown successfully. In contrast, the Bolivian crops of the lower altitude regions show include cotton, squash, gourds, beans, coca, chili peppers, maize, and many more. Areas outside of the *Altiplano*, such as the tropical forest region of the Andes, host an extensive array of exotic plants and birds that could not be cultivated or obtained in the high plateau. As a result there was a great deal of dependence placed on neighboring regions at different altitudes (Hagen and Morris 1998:16-17, Stanish, Cohen, and Aldenderfer 2005:168).

Maize is found at a vast number of sites that lie above its cultivation zone, this can be partially attributed to the ceremonial use of chicha, a traditional maize beer brewed in the Andean region (Hagen and Morris 1998:16). Current evidence shows that maize has been cultivated in South America since 6000 BP, as an important and highly valued high energy grain. (Bruhns 1994:91, Kolata and Sangines 2003:24). Maize has been dated in the Andes to late in the initial period around 3200 BP, however, it is not widely cultivated in the *Altiplano*. When looking at the period, Tiwanaku IV, which occurred around 500 BC in the southern region of the Lake Titicaca Basin, it has been specifically noted that there is a higher ubiquity of maize amongst high status groups (Cohen 1978:121, Stanish, Cohen, and Aldenderfer 2005:168).

Quinoa is the primary variety of *Chenopodium* grown in the Andes and it is the only *Chenopodium* variety found in the Andean archaeological record. The presence of quinoa in the record has been dated in the Andean highlands to 1600 BP similar to the earliest dates of its use which date to 2000 BP in the area of modern day Argentina (Pickersgill, and Heiser 1978:138-139). Quinoa seeds in particular, show the highest density and the greatest ubiquity in a vast majority of sites (Stanish, Cohen, and Aldenderfer 2005:168).

Potatoes are one of the most common examples of tubers, and in the Andes there are more varieties of potatoes than can be accurately described. These near infinite varieties of potatoes range in size, quality, and a spectrum of color from pink to black. It is broadly recognized that the domesticated potato is native to South America, along with a huge variety of other Solanum, which is defined as the group of plants that are associated with tuberous and edible roots (Morrison 1945:264-265). Tubers grow best in moist and well-drained soils as in the sloping hillsides that are prevalent in much of Bolivia. Since potatoes and other tubers are made of soft tissues, they are usually poorly represented in the archaeological record. This is in contrast to materials like seeds, which have hard outer shells that aid in the success of their preservation. When looking at the different levels of preservation between dissimilar crops, there is strong evidence that the amount of the presence of particular crops is only partially representative of their true quantities. Roasted potatoes can result in carbonized remains, which are the most commonly found archaeological sample, but the most typical uses for tubers in the Andes are soups and stews. When preparing tubers in soups and stews or through other methods such as mashing, there is little to no potential for these materials to enter the record (Wright, Hastorf, and Lennstrom 2003:387-388).

Sites Under Consideration

Tiwanaku. Tiwanaku is both the name of a state level society and the name of a site that was first discovered in 1877 (Squier 1877). People began to inhabit the site of Tiwanaku as early as 200 A.D on the Southern banks of Lake Titicaca (Figure 1), at this time the city was not the wondrous array of "stone temples, sunken courts, gateways, and architraves (ornamental bands)." This came 500 years later in the year 700 A.D. and continued for nearly a thousand years (Hagen and Morris 1998:118). Little was known about this monumental empire until the first excavations in the 1950s (Kolata 1996:7), which revealed many of these monumental structures to their full glory. The people of Tiwanaku worshipped both the ancient mountains and Lake Titicaca which played deeply into the archaeology they left behind. The ceremonial core and the residential areas both represent separate key areas at the site of Tiwanaku. The ceremonial core is home to beautiful monuments and residences for the elite whereas the residential core shows a different picture of small unadorned adobe houses that are tightly packed together. Between these sectors and the surrounding area, it is believed that between 20,000 and 40,000 people lived at the site (Hagen and Morris 1998:117-119).

Tiwanaku, as a culture influenced much of the south-central Andean realm, and is believed to have controlled networks of long distance trade from the areas that were productive to areas like the *Altiplano.* Maize was one such crop that Tiwanaku likely controlled, however each area under Tiwanaku control had its own important commodity for trade (Kolata and Sangines 2003:28).

As the title of this work suggests, there are multiple types or levels of sites, these levels can be observed in Figure 2. Tiwanaku functioned as the capital or primary center, followed by two secondary centers, which include sites like Lukurmata that function as regional administrators. In addition, there are tertiary centers and sites like Pirque Alto, which functioned as quaternary loci that focused in agriculture (Kolata 1993:223). The sites are grouped based off the functions they serve and the size (hectares) they encompass (McAndrews et al 1997:73).

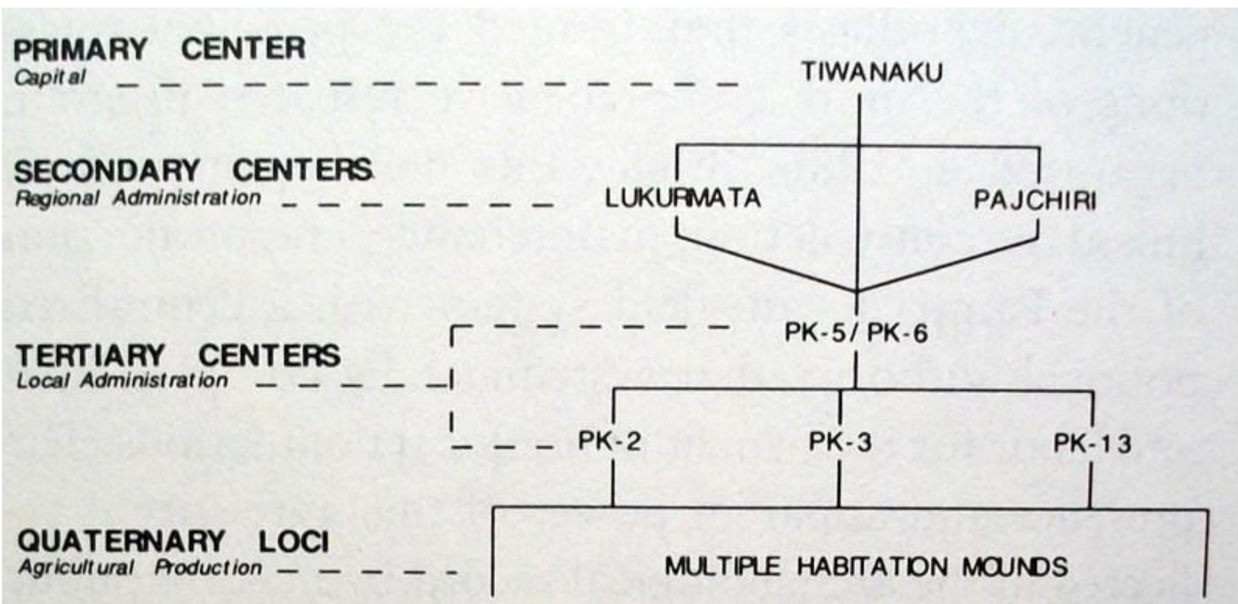

Figure 2. Diagram of Tiwanaku Structure Kolata (1993: Figure 6.11)

Lukurmata

Lukurmata is located 12km away from the site of Tiwanaku. Primary research at the site has been the work of Marc Bermann, who has dated the site to as early as 200 B.C. (1994:59). The site featured public architecture and as a secondary center it would have functioned as the overseer of agricultural production in the region. Lukurmata went through a period of rapid decline in what is considered the post-classic period which dated from 800-1100 A.D. (McAndrews et al 2004:80).

Pirque Alto

As mentioned above, the site of Pirque Alto is located at the cross-section of three key routes. These routes include the Rio Tapacari, the Rio Pukina, and a natural corridor, which provided access to the central valley and different regions in the *Altiplano* (Figure 3). The data is being analyzed in this project to identify patterns of plant use dates to the Formative Period (1800 B.C.) and the Middle Horizon (600-1000 A.D.) Studies of the site commenced in 2003 and are still in progress.

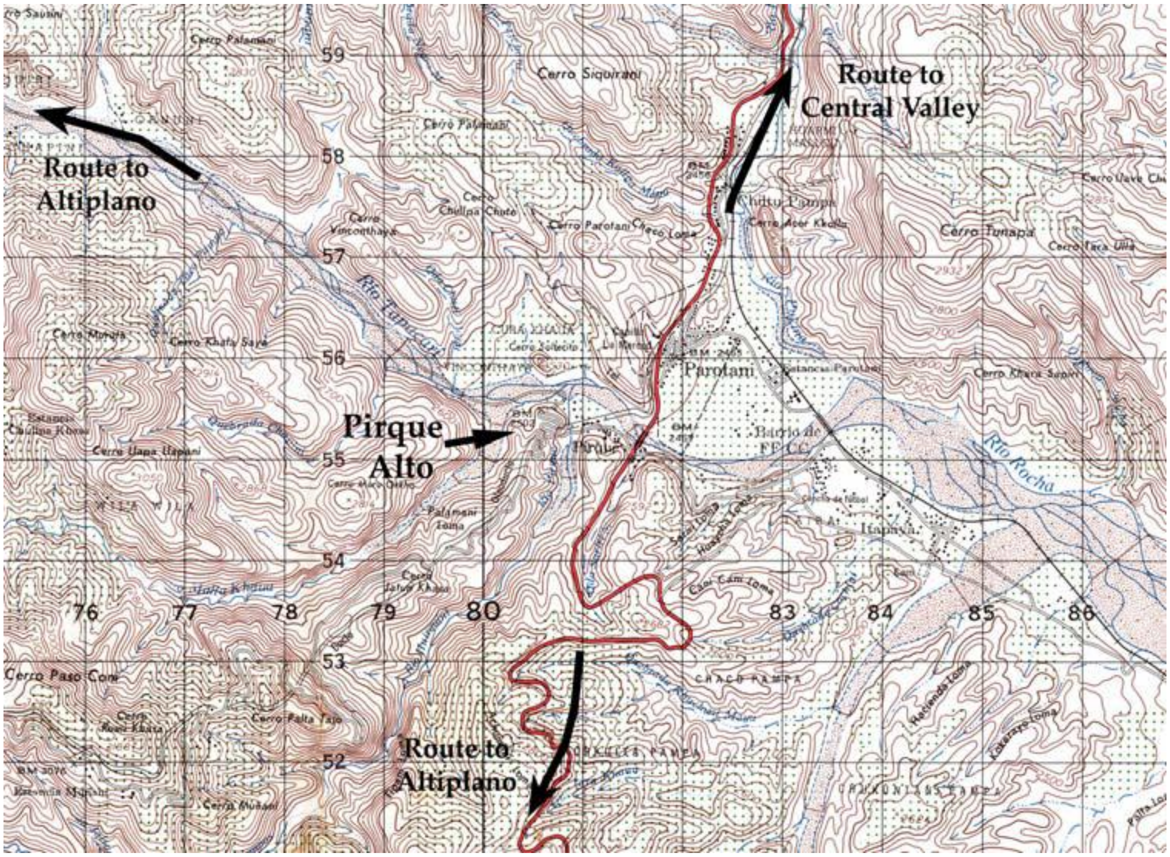

Figure 3. Map of the Key Routes at Pirque Alto McAndrews (2007: Figure 1)

Pirque Alto Fieldwork. Utilized data was obtained during archaeological excavations conducted at the site in June 2007 and took place under the direction of Dr. Timothy McAndrews. In 2005, a detailed surface collection was conducted at the site. From this initial evidence at the surface level, blocks were chosen strategically (not random) in areas of high Formative Period and Middle Horizon (Tiwanaku) surface artifact density. The goal was to locate deposits that had the highest potential to contain stratified deposits that were still intact. This can be problematic because there is a great deal of erosion and many areas of the site were not selected for excavation because artifacts were in positions that suggested they were moved by geological processes (McAndrews 2007).

In 2007, a total of $97m^2$ were excavated in a total of five separate blocks, which are shown in Figure 4. The data set used for this study draws data from blocks three, four, and five, which were analyzed first. The excavations were completed in arbitrary 10cm levels, and all the soil from these levels was screened into a 5mm hardware cloth. Every potentially cultural feature was drawn in scale and photographed to be accurately recorded in plainview. When appropriate, features were divided into controlled sections and excavated in a systematic fashion, as in the standard levels, features were excavated in 10 cm arbitrary levels within the appropriate feature strata. The units that were placed ranged from 1 x 1 m, and 2 x 2 m in size and soil samples were taken in each of these units in correspondence with their size. For each level in a 1 x 1 m unit, 2 liters of soil were taken, in comparison to 8 liters taken from 2 x 2m units to ensure even sampling (McAndrews 2007).

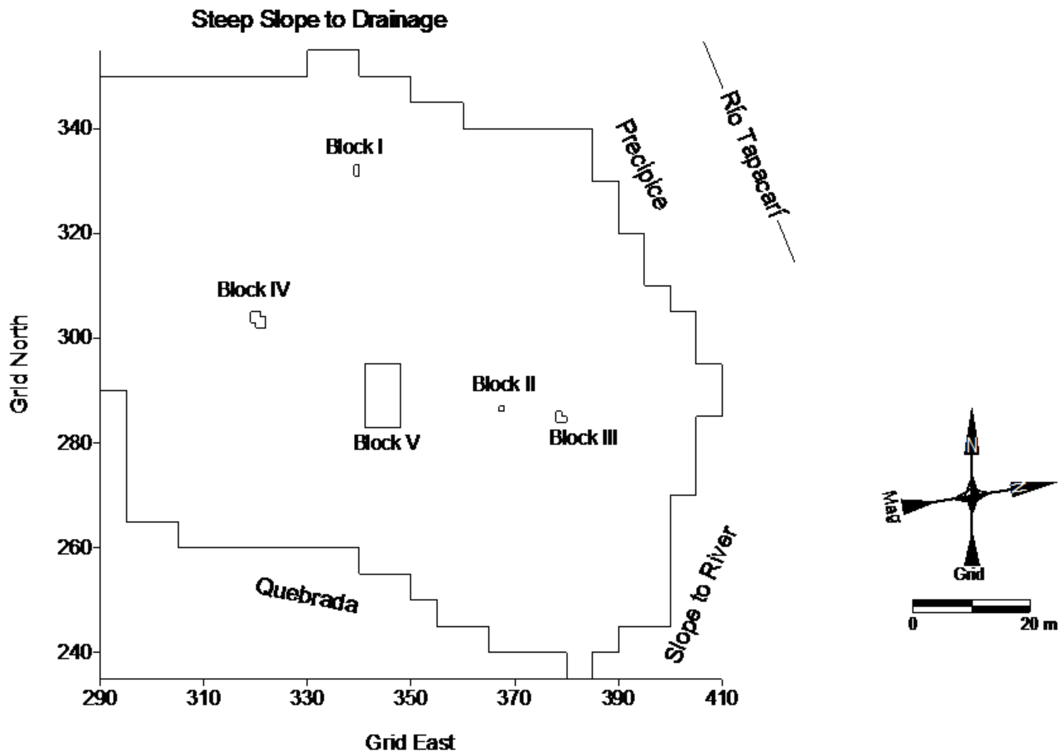

Figure 4. Map showing the location of excavation blocks at Pirque Alto McAndrews (2007: Figure 4)

Flotation Procedure

The contents of the soil samples were floated by means of bucket flotation to recover materials. The supplies used to complete this type of flotation included a bucket, a very fine piece of fabric, and 1mm, 0.5mm, and 0.1mm sieves, these materials are used to ensure that only a minimal loss of light fractions occurs. The process occurs in several steps, which include:

1. The volumes of the soil samples were measured and recorded in the registration of floated samples.
2. Starting with the first sample, they were put one at a time into the 10 liter bucket with water. It was done this way to ensure that the samples were not soaked. Some carbons absorb too much water and will not float. This is a crucial step because if they do not float they cannot be collected accurately.
3. Once the sieves are prepared the flotation can be started. Slowly, the water was decanted out of the bucket until the soil came out. The process was repeated and the bucket was refilled so more samples could be obtained. The procedure was finally completed when no more ecofacts rose to the top. Three sieves are used in this procedure; one at 5mm, 1 and 1 mm, and one at approximately 0.1 mm. The different sizes are used because they collect different sized ecofacts.
4. The bucket was titled so the water would decant to one side of the bucket. This acts as a current, bringing the light fractions to the top. The fabric containing the light fractions (.1 mm) was separated from the rest and given its respective label.
5. The 1mm and 0.5 mm sieves were washed until no soil was left and the sieves were clean. The ecofacts were put into coarse cotton to dry out. Afterwards, they were bagged, labeled, and ready to be sorted and analyzed (Terceros 2009:4-5, Musalem-Perez 2009:47).

Analysis and Classification

There were 102 total soil samples taken at the time of the preliminary release, and of these 102, 16 had been sorted and analyzed. Generally, two types of artifacts were sorted out in the flotation, which included light and heavy fractions. The light fractions were sorted using a XTL-V1 Zoom Stereo Microscope and were size graded using the 2 mm, 1 mm, and 0.5 mm sieves to allow for less difficult separation of the samples. The heavy fraction was screened through only the 2 mm sieve.

To identify the remains, the zoom stereo microscope previously described was used to analyze the samples that were sized below 2 mm and 1 mm. The botanical remains were well preserved and both carbonized and non-carbonized samples were recovered.

Identification proved to be difficult partially due to the fact that few sources exist that delve into detail on identifying the botanical remains recovered in 2007 excavations. From the 16 samples taken, 26 different species were found, and of these 26 species, two carbonized samples have so far been accurately identified and include *Chenopodium quinoa*, and *Zea maize*. The 24 remaining samples include 10 carbonized unidentified species and 14 non-carbonized species. The amount of wood and parenchyma tissue (associated with tubers and potatoes in this work) discovered was also recorded, and is shown in the appendix (Terceros 2009).

Tiwanaku

Field Sampling. The data used from the Tiwanaku were obtained in a similar fashion. It is for this reason that it is an excellent set with which to compare paleoethnobotanical remains with. The Proyecto Wila Jawira excavators (2003) collected immense soil samples and put them through a rigorous flotation procedure to ensure accuracy.

Over the history of excavation at the site the requirements of soil samples underwent a variety of changes. The desired soil taken ranged from 6.3 liters per unit level, feature, or feature level in 1989 to 8.0 liters in 1999 to ensure adequate sampling. The average volume of soil actually taken was 5.7 liters in 1989 all the way up to 7.7 liters in 1991. The averages were under the desired soil volume at a consistent level, which is attributed to the fact that some features simply did not contain the required amount of soil (Wright, Hastorf, and Lennstrom 2003:385-386).

Flotation Procedure

Unlike at Pirque Alto, the soil samples were processed with a mechanized water flotation system which uses a 55 gallon drum as a water container and pumps the ground water up and then through a submerged shower head. As in the bucket method, the lighter fractions float to the surface and can then be poured off and decanted through fine-meshed chiffon which is 0.3-0.5mm in size. Screens were also present to catch remains greater than 0.5mm in size. The barrel was shaken to encourage the remains to float, which allowed the crew to use gravel siphons and tea strainers to capture floating remains. Light fractions were sent back to the University of Minnesota, while the heavy fractions were sorted in the field laboratory. The methods proved to be very precise, and throughout the years the percent accuracy consistently fell in the low 90s (Wright, Hastorf, and Lennstrom 2003:385-386).

Analysis and Identification. When large amounts of plant remains were present in Wila Jawira samples, the exact quantity present in the sample was estimated based on a smaller sub-sample. This approach has been tested in the past and found to be very accurate. A 33% sampling was chosen due to time and economic restraints to do a 33% sampling leading to the analysis and recording of 933 samples to date from the Proyecto Wila Jawira. The data from the site was represented in a variety of ways, however for the uses of my study, using density of artifacts was the most meaningful and easily compared. By using the density it is possible to eliminate errors caused by analyzing smaller or larger soil samples and the variation in total sampling (Wright, Hastorf, and Lennstrom 2003:385-386).

Lukurmata

Field Excavations. Similar to at Pirque Alto, the first collection done at the site of Lukurmata was a systematic, aligned surface collection in 1986. The goal of the collection was to determine the extent of the settlement. The collection was conducted in a series of 2 m x 2 m units using natural and arbitrary level, more specifically when a level was thicker than 10 cm it was divided into an arbitrary level. All of the soil was screened, mainly through a ¼ inch mesh but deposits that were potentially host to organic remains were put through a fine screening procedure. When excavating a feature, plan views and cross-sections were made for each. Soil samples were taken from each stratum for later dry screening and flotation. More detailed information on the type of flotation used is not currently available for comparison (Bermann 1994:52-53).

METHODOLOGY

Site Selection

The sites that were chosen represent a diverse and interesting course of study, and were individually selected so the changes in the paleoethnobotanical data at sites with different roles could be documented. Tiwanaku, Lukurmata, and Pirque Alto each represent a particular site-size within the larger Andean civilization. Tiwanaku is large and vast, featuring ceremonial centers, tightly packed residential sectors, and a political structure greatly different to its smaller counterparts. Kolata (2003:15) places the population between 15,000 and 20,000 inhabitants but others have placed it as high as 40,000 people. Lukurmata falls in the middle of the pack with an estimated population of 370 occupants in just one of the many residential sectors of the site (Bermann 1994:178). Pirque Alto is a small rural community that would have hosted a relatively small population. In summary the sites chosen demonstrate paleoethnobotanical remains at the 1000s, 100s, and 10s of people.

Analysis of the Sites

Ubiquity. Ubiquity is used to get an overall look at the site, in order to get a level-by-level perspective of plant use. Ubiquity does not show whether one species is used more than another, but it does show the general prevalence of a particular species. Ubiquity shows the presence or absence of a species, by provenience. If looking at the Formative Period Maize ubiquity the data was calculated as followed:

$$\left(\frac{\text{Number of Formative Period Levels with Maize}}{\text{Total Number of Formative Period Levels}}\right) \text{x } 100$$

A higher ubiquity value signified that the species was used in a large number contexts in a given period. In my research, ubiquity was calculated originally for groups of levels by time period (Formative Period and Middle Horizon), thereby providing overall ubiquity values for the Formative Period and Middle Horizon, respectively, for each of the sites discussed above.

Density. Density was used to get a more specific look at the abundance of various species represented at the sites and was calculated as follows:

$$\left(\frac{\text{Quantity of an Ecofact}}{\text{Liters of Soil Sample Taken}}\right)$$

RESULTS

After the analysis was complete, differences between the botanical remains of Pirque Alto and the sites of Lukurmata and Tiwanaku became very visible. The patterns that emerge after the data is calculated and graphed show differences not only between sites but between periods at each individual site.

The Formative Period

The Formative Period, as previously mentioned, is the earlier of the periods in question. From Figure 5, it can be shown that there are several similarities between the three sites. The primary shared trend is that quinoa occurs in a vast majority of all contexts dating to the Formative Period at all three of the sites. By looking at this data it is evident that quinoa was a crucial grain to the survival of the populations. Parenchyma tissue is most likely from tubers, likely potatoes, in the Andean region. There is a huge spike in the ubiquity of parenchyma tissue at the Pirque Alto site compared to the sites of Tiwanaku and Lukurmata, however maize is not present in the Formative period at Pirque Alto and it has a relatively low ubiquity at the sites of Lukurmata and Tiwanaku.

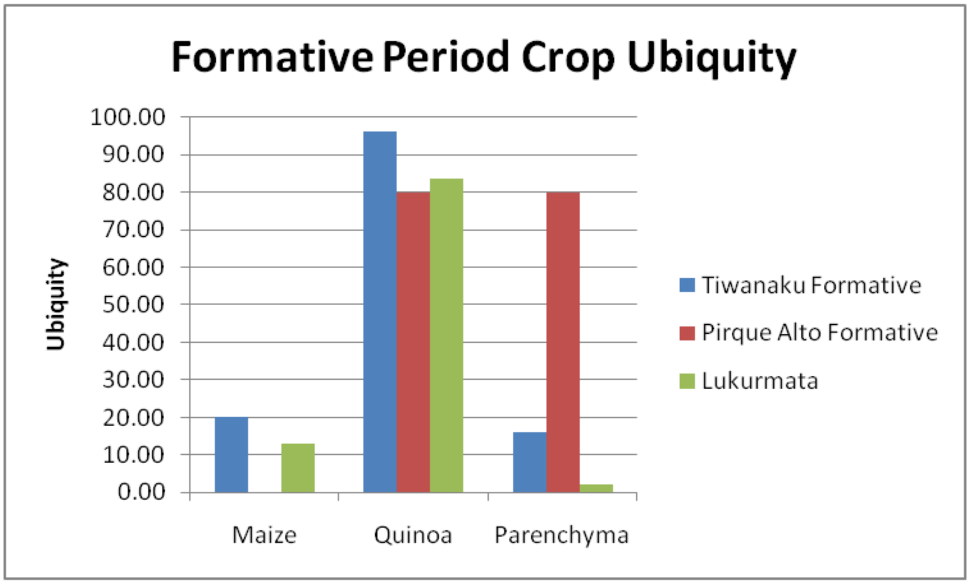

Figure 5. Formative Ubiquity Graph (Adapted from Terceros 2007 and Wright et al 2007)

As shown in Figure 6, the density shows a very different picture than the ubiquity values presented. Several of the trends are still very similar, but they have been altered. One such trend is the use of quinoa, which is still very equal among the sites of Pirque Alto and Tiwanaku. In contrast, at Lukurmata, the density of quinoa is approximately triple that of the other sites. The presence of parenchyma tissue seems much reduced when looking at density at the sites, but it is only large enough to show up on the graph (greater than 1.00) at the site of Pirque Alto. The presence of maize is negligible at all the sites and falls below the value of 1.00.

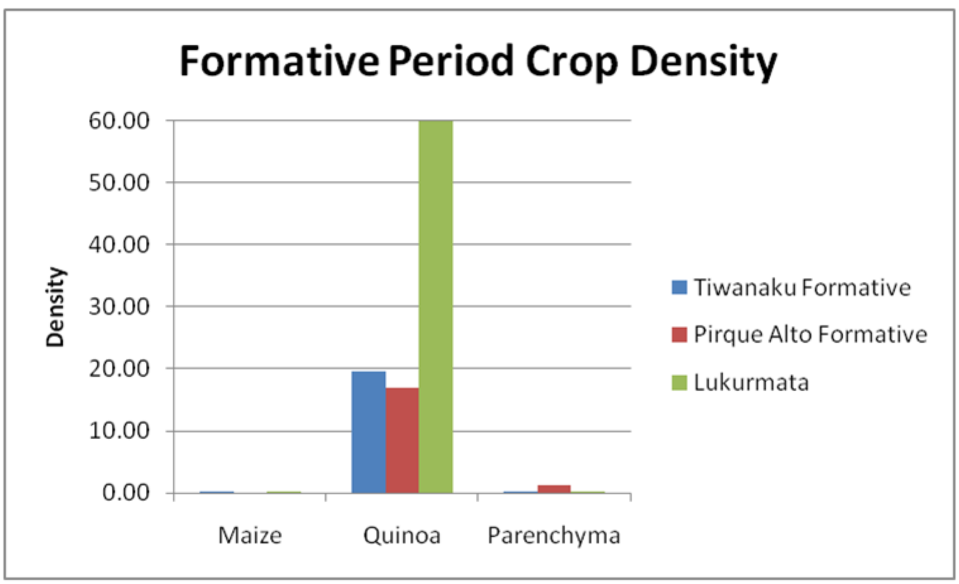

Figure 6. Formative Crop Density Graph (Adapted from Terceros 2007 and Wright et al 2007)

For the Formative Period as a whole there are two particular trends that will be discussed in detail in the coming sections. The first is that the presence of quinoa is regionally important, and that despite the size of the population or site size, quinoa plays a large role. The confidence of this statement can be observed in the densities and ubiquities of quinoa found in the record. The second trend identified is that parenchyma tissue is found to be most prevalent at Pirque Alto using both ubiquity and density measures. The third is that maize is not found at Pirque Alto, and by taking a closer look, it is evident that maize is not used extensively at any of the sites during the Formative Period.

Middle Horizon

As can be seen in Figure 7, the sites each represent a very exclusive pattern of crop ubiquities in the Middle Horizon, and as a result there is not a crop in which all the sites have an equal reliance. The use of maize is most substantial at Tiwanaku in terms of ubiquity and a substantial occurrence of maize is evident at Pirque Alto and Lukurmata. In contrast quinoa is prevalent at Tiwanaku and Lukurmata, but it appears fairly infrequently at Pirque Alto. Parenchyma tissue is found in more than eighty percent of all levels at Pirque Alto and at a much lower level at Tiwanaku and Lukurmata.

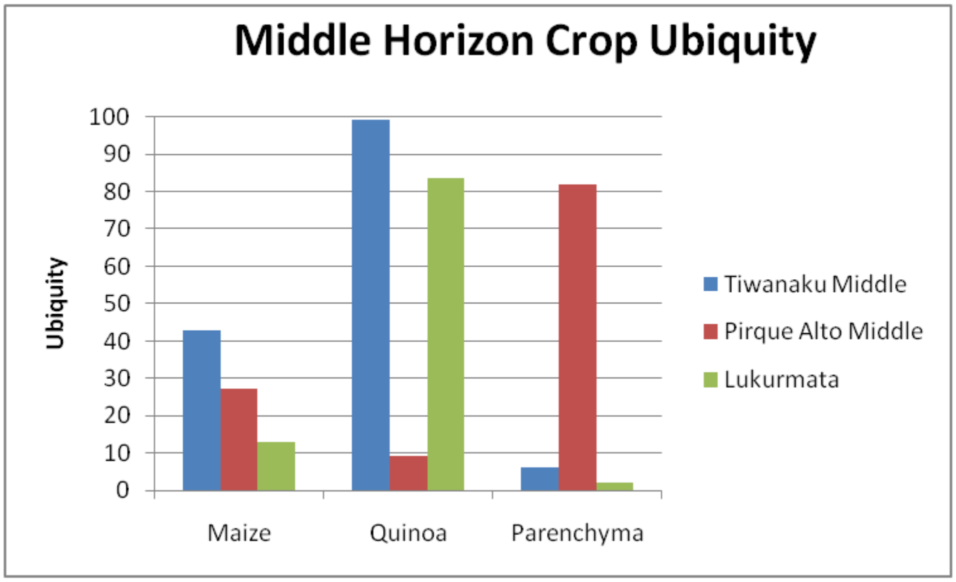

Figure 7. Middle Horizon Crop Ubiquity Graph (Adapted from Terceros 2007 and Wright et al 2007)

The densities show low levels of maize at Tiwanaku, and the density of maize at Pirque Alto is more than two times greater than that of Tiwanaku as is shown in Figure 8. Quinoa is very dense at Lukurmata and is still fairly dense at Tiwanaku, while quinoa has a very low density at the site of Pirque Alto. Parenchyma is nearly undetectable at the sites of Lukurmata and Tiwanaku and has a low density at Pirque Alto.

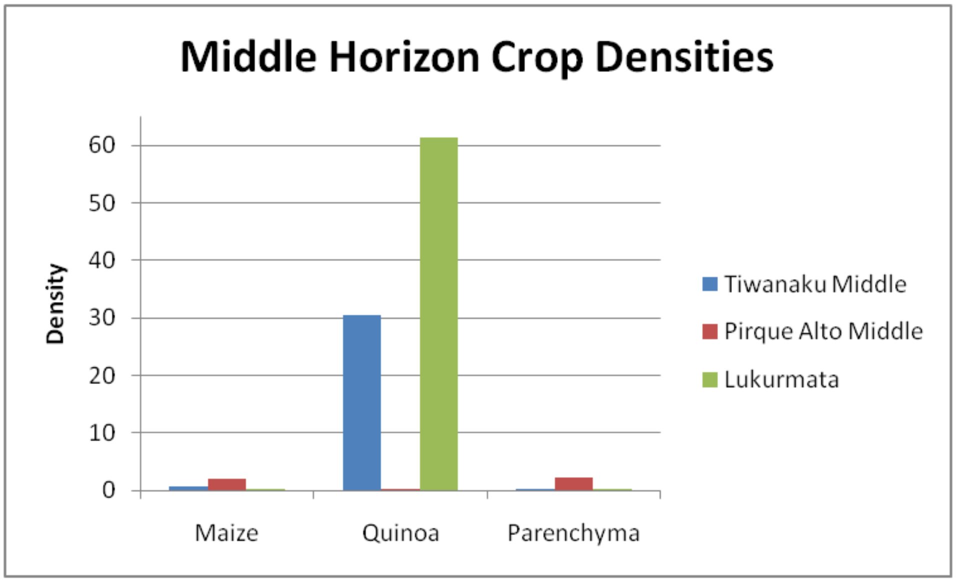

Figure 8. Middle Horizon Crop Density Graph (Adapted from Terceros 2007 and Wright et al 2007)

Pirque Alto

The changes that occur over time at one site are equally significant, so the data from Pirque Alto will be looked at individually through time (Figure 9). At the site of Pirque Alto there is a very low reliance on maize, and levels dating to the Formative Period showed no evidence of maize use. By the time of the Middle Horizon it is found in 27% of all levels dating to this time period. In the absence of maize in the Formative there are a vast majority of levels containing quinoa. When maize enters the data in the Middle Horizon the level of quinoa used was massively reduced. This trend suggests that the appearance of maize and the decrease in the occurrence of quinoa could be related and will be discussed in depth. The number of levels containing parenchyma tissue remained fairly constant between the periods suggesting that is was a stable staple crop at Pirque Alto.

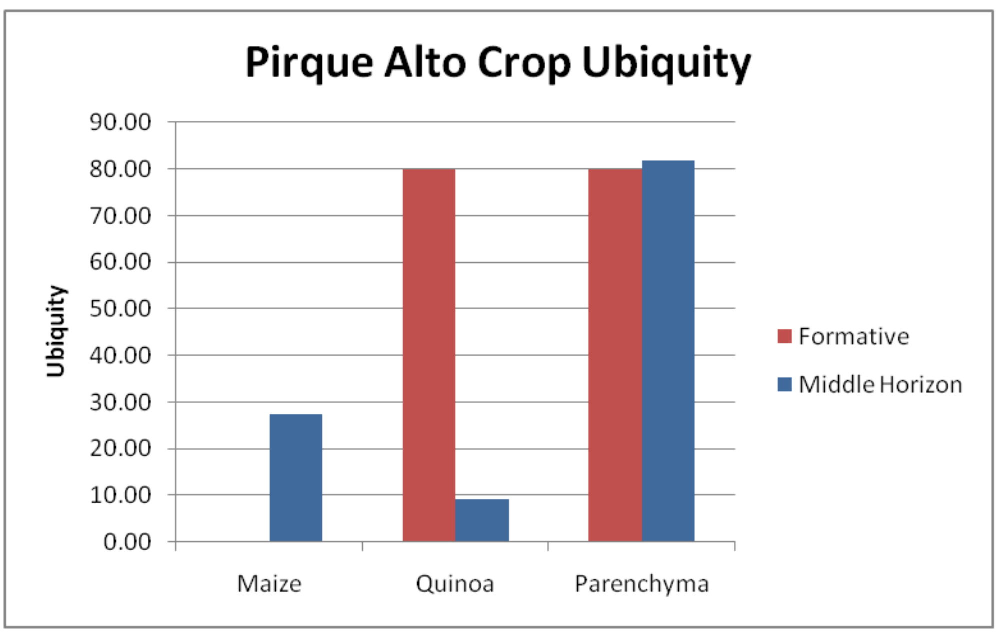

Figure 9. Graph of Pirque Alto Crop Ubiquity (Adapted from Terceros 2007)

When comparing the densities of the different botanical remains, very different trends appear as can be seen in Figure 10. Maize still is not present in the Formative period, but in the Middle Horizon it is present in the largest numbers. The amount of quinoa present seems much reduced when looking at density, but the general trend behind the data is constant. As maize increases the density of quinoa is decreased. When looking at the amount of parenchyma tissue recovered from the Formative and the Middle Horizon, the numbers appear much reduced. Despite being present in the majority of levels, parenchyma tissue is found consistently at low densities.

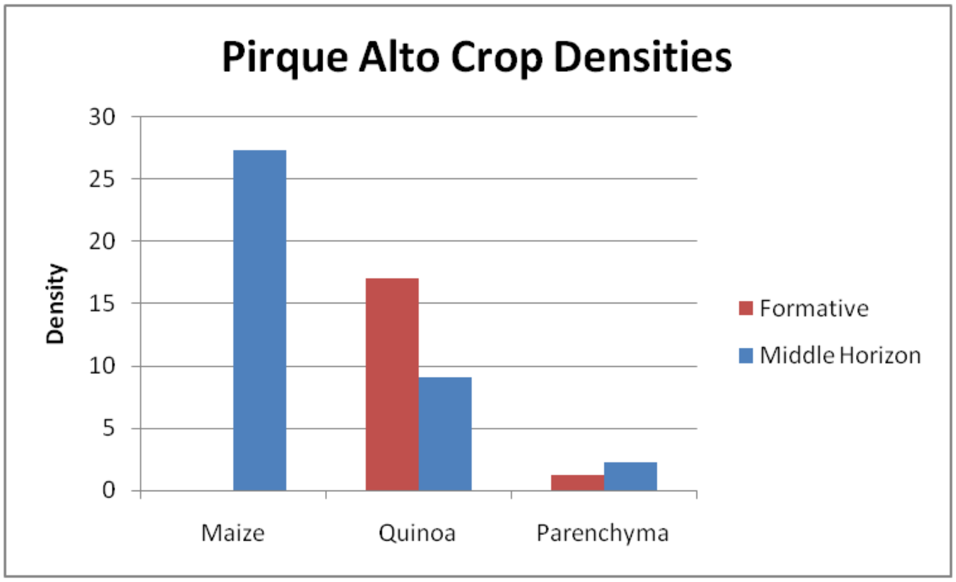

Figure 10. Graph of Pirque Alto Crop Densities (Adapted from Terceros 2007)

DISCUSSION

The data shown represents a diverse use of crops through time and shows tremendous variation between sites during the same span of time. Very few of the variables show uniformity between the sites. This represents a great deal of cultural variety in terms of which crops were used most heavily and it suggests that there was very little regional influence.

Of the three sites, the two that share the most common ground are Tiwanaku and Lukurmata. They both are found on the shores of Lake Titicaca and reside only 12km apart. What this shows is that the differences between these two sites cannot be attributed to the environment. They occurred in the same conditions, were situated at similar elevations, and had similar resources available. Additionally, both of the sites were relatively high in the settlement hierarchy and could easily have controlled the resources coming in and out to ensure that all desired goods were obtained.

Maize

When looking at the absence of maize during the Formative Period at Pirque Alto, it appears that perhaps maize was only available at higher level sites. Historically maize has been viewed as a high energy grain that was desired among people not only for its nutritional benefits but also for its role in the making of chicha, a traditional Andean beer still produced in the Andes. Janusek (2008:158) suggests that maize was most common in residential settings where exotic goods were also found. He adds that status was not the sole factor that determined the presence or absence of valued foods (Janusek 2008:158).

Contrary to the views of many scholars when maize appears in the Pirque Alto Middle Horizon it is more ubiquitous than at Lukurmata, and has the highest density per level of all of the three sites. In the Peruvian Andes between A.D. 500 and 1500 it is shown that maize shifts from a basic culinary item to a symbolic food that was made into beer that also had political meanings. It is argued by Hastorf and Johannessen (1993:115) that shifts in foodways can show transitions in social and political systems. This type of shift would suggest that sites involved with the largest roles in social and political systems would show the largest amount of maize without exception. This is not the case in the Bolivian Andes so this proposed model does not explain the differences.

Sometimes the most complicated questions can have the most simple solutions. Maize does not grow well above 3,400 meters, however early maize agriculture was limited to about 2,900 meters above sea level without the invention of terraced fields (Janusek 1981:43). The Tiwanaku Valley averages an altitude of 3812 meters above sea level, which is well above the appropriate growing levels and could not grown maize at the site (Albarracin-Jordan 2003:100, and Williams 2002:362). The sites in the Cochabamba Valley lie lower than those of the Tiwanaku Valley. Due to the pre-mentioned variation I propose that the Tiwanaku were trading for the maize they had at the site, which they would have received on a regular basis but in reduced amounts. If maize was as coveted as scholars believe, then it stands to reason that those with money or prestige would want to have maize and its associated products as frequently as possible, but they would not necessarily have a great deal of it at any given time. It is believed in this study that areas that grow a certain crop will have more of it in terms of density, than those who have to trade, or transport it longer distances.

In the high regions of the *Altiplano* the human body needs more energy to survive than in other areas. Due to the altitude the body is forced to work harder to overcome the pressures it faces. As a high energy grain maize could have helped to fill that need, and provided the additional stamina that is required to survive. As a local and stable crop the use of maize at agricultural villages would have served primarily for food. Certainly some maize would be made into chicha, but not to the extent as Lukurmata, and much less than at the site of Tiwanaku. As a result, the distributions that we see between Pirque Alto and the other sites are different due to the alternate function it served in each society.

The Maize-Quinoa Relationship

In the course of studying these results one very peculiar trend became obvious. In the Formative Period at Pirque Alto there was no maize recovered from the site. However, during this time there was a very strong presence of quinoa at the site; 80% of all levels dating to the Formative Period contained quinoa. There are several possibilities behind this proposed relationship. It could be argued that the people at Pirque Alto lacked the knowledge to grow maize, but this seems unlikely. It is possible that all of the maize that they grew was traded or sent to the capital or a secondary center, but sending every last kernel and none making its way into the record would require a very large leap of faith. The only possibility that seems to combine any sort of reasoning with fact is that the people at the site simply did not need maize. As mentioned previously the importance of maize started increasing from 500-1500 A.D. This time span is very close to the dates of the Middle Horizon, which began in 600 A.D (Hastorf and Johannessen 1993:115). The impression that this gives is that maize was a useful crop, but it was more important in the realms of society and ideology.

In the Middle Horizon maize is found in 27.27% of all the levels at Pirque Alto. The ubiquity of quinoa at the site plummets and the density of the quinoa found in the record was halved based on the Formative numbers. It is my belief that this is not a coincidence. Once maize became an increasingly important aspect of the Tiwanaku culture it is likely that a switch would occur that would allow for the use of maize agriculture at the site. This indicates that the pattern observed between maize and quinoa does not represent a correlation but causation. When looking at the facts, there is only so much time in a growing season that can be used for agriculture. I am arguing that potatoes and tubers were the primary crop at the site, (discussed in the following section) which does not change through time and seems unaffected by the emergence of maize. The only remaining option in terms of altering their agricultural pursuits would be to devote less time and space towards the production of quinoa and to take that time, energy, and newly freed land to plant and cultivate maize.

Parenchyma Tissue

The presence of high levels of parenchyma tissue in the record is an indicator of excellent preservation. Soft tissues are not renowned for their excellent preservation in the record contrary to seeds, the hard part of fruits (for example pits), wood, and pollen which preserve well due to their tougher exteriors (Hather 1990:661-662). The most typical uses of potatoes were in stews and soups, unfortunately this type of use is not likely to show up in the record. Crops like maize and quinoa are often roasted to make traditional dishes and would be more represented in the record. The primary way in which tubers were stored in the Andes was through a method called chuño, which are free-dried potatoes, and the preparation of this dish is shown below in Figure 11. The process exploits the natural temperature variation that occurs in the Andes, and more specifically the sun in the Andean Mountains is capable of extreme heat, very suitable for drying out a variety of crops. The cold night also offer the freezing temperatures that allow this process to be possible. This process allows for longer term use of the potatoes and tubers over the cold dry season, but it does not allow for preservation over hundreds of years.

Figure 11. The Making of Chuño Janusek (2008: Figure 2.3)

If the parenchyma tissue is found in 80% of all Formative Period levels and an even greater extent during the Middle Horizon it is safe to assume that tubers would have been the staple crop of the residents at Pirque Alto. The difference that is shown between Figures 9 and 10 between ubiquity and density at the site are most effectively attributed to the manner in which potatoes and tubers were handled, and the general nature of soft tissues to decompose faster than other materials. Because more of the tissue breaks down, it was found in most of the levels, but at a reduced quantity. If preservation of soft tissues was larger, the densities of parenchymous tissue in the record would be much higher.

This trend is also supported by the sites of Tiwanaku and Lukurmata even though the initial ubiquities of parenchyma tissue are lower they are barely visible on the graph when densities are compared. Looking at the broader picture, this trend is conserved between all the sites over all the periods. With such conformity in the data, this theory is not only logical, it is also well-supported. The general idea that can be taken from this is that the density of parenchyma tissues will appear greatly reduced in comparison to the ubiquity. This does not necessarily represent a limited use of these plants but an issue with preservation.

CONCLUSION

The primary goal of this research was to determine if there were differences between the botanical remains left behind by the inhabitants of Tiwanaku, Lukurmata, and Pirque Alto. The answer to this question is inarguably, yes. Primary centers, secondary centers, and rural communities did rely on different types of plants.

The inhabitants of Tiwanaku used maize and tubers at relatively low levels and focused on the use of quinoa during the Formative Period and this emphasis on quinoa continued into the Middle Horizon along with an increased use of maize and a decrease in the use of tubers. Quinoa is the primary crop at Tiwanaku throughout time, and a similar trend is evident at Lukurmata. Lukurmata favored the use of quinoa, but at an increased level, along with this pattern the inhabitants of Lukurmata apparently used less maize and tubers than the inhabitants of Tiwanaku.

The site of Pirque Alto contained the most variation of the three sites. Maize was absent in the site’s Formative Period component while quinoa and tubers were present at fairly high levels. During the Middle Horizon the levels of maize increased substantially, the quinoa levels plummeted, and the levels of tubers stayed very high.

While the centers of Tiwanaku and Lukurmata were focused on the growing of quinoa, the site of Pirque Alto responded to the increase in the desirability of maize. Due to growing restraints in the higher regions of Bolivia, the conditions at Pirque Alto would have allowed for maize agriculture, which then could be traded or used by the inhabitants. Since the maize was grown near the site it stands to reason that more of the maize would have been available to each individual. In theory, Tiwanaku would have brought in maize from many sites far more than Lukurmata and as a result it had higher levels of maize.

Maize did not come without a price to the people at Pirque Alto, and in order to accommodate the growing of a new crop, the focus at the site needed to shift. There would have been time and resources diverted to allow for maize agriculture, and as a result, the levels of each are directly affected by the other. The people maintained the production of their staple potato crop which was shown as having the highest ubiquity, however due to preservation this trend was not as evident in the density calculations.

The differences between the remains found at the three sites are shown to be both environmental and cultural. When large changes occur in the customs of a people it is bound to show up in some form in the archaeological record. The changes that occur here are attributed to an increase in the ritual complexity especially with its relationship to maize and chicha. Plants are at the root of the food chain, and they are often at the root of archaeological change.

Future Research

In the Tiwanaku polity there is still much to be learned about the complicated use patterns of different plants. A more concrete set of conclusions could be obtained by the inclusion of additional rural sites. By comparing more sites it would be possible to observe whether or not the trends identified throughout this work represent an outlier, or if they show a deeper pattern in the Tiwanaku hierarchy. Furthermore, these trends could similarly be strengthened by adding in more data as it becomes available from the site in the coming years.

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