AN ANDEAN DOMESTICATE ADAPTS TO CLIMATE CHANGE

Matthew Sayre
Department of Anthropology
University of South Dakota
Vermillion, SD 57069
Corresponding author email: Matthew.Sayre@usd.edu

ABSTRACT

The cultivated potato (*Solanum tuberosum*) is one of the staples of international agriculture. This paper presents two approaches to analyze changing cultivation practices of the potato over time. The first is a paleoethnobotanical analysis of past plant use at the pre-Inka site of Chavín de Huántar in Peru. The second is a survey of changing planting and cultivation techniques in the *Parque de la Papa* (Potato Park), an area of indigenous bio-cultural patrimony, located above the Peruvian town of Pisac in the Sacred Valley of the Inka. The initial survey of planting practices at the Potato Park revealed that potatoes were grown primarily in the upslope areas of the park not on the valley bottoms, which were primarily planted with maize. The changing climate is forcing farmers to plant further upslope in areas that were not previously cultivated. As farmers search for colder environments for their distinct varieties of potatoes they are running into the limits of cultivatable land. The successful adaptations of farmers in the pre-Hispanic past demonstrated the resilience of traditional agricultural practices, but modern farmers are facing unique new challenges. Places like the Potato Park that seek to preserve cultural and ecological diversity are of tremendous importance to a rapidly changing world.

Keywords

Potato, Climate Change, Peru, Archaeology

INTRODUCTION

The cultivated potato (*Solanum tuberosum*) is one of the staples of international agriculture. This plant, which is commonly associated with Ireland and other European countries, originated in the Andean region of South America. Recent research places its likely center of domestication in southern Peru (Smith 1998; Spooner et al. 2005). However, the likely high altitude origins of the potato have not limited its success in a wide range of environments across the globe (FAO 2008). While, the center of origin of potato exhibits a wide varietal diversity, much of the world only grows a limited number of varieties (FAO 2008).

This paper presents two approaches to analyze changing cultivation practices of the potato over time. The first is a paleoethnobotanical analysis of past plant use at the site of Chavín de Huántar in Peru. The second source of analysis is a survey of changing planting and cultivation techniques in the *Parque de la Papa* (Potato Park) located above the Peruvian town of Pisac in the Sacred Valley of the Inka, an area of indigenous bio-cultural patrimony. This region of the world is a biodiversity hotspot whose preservation would greatly enhance global conservation planning (Myers et al. 2000).

Chavín de Huántar is a ceremonial site in the Central Andean highlands, that functioned as a center from roughly 1200 BCE – 500 BCE (Sayre 2010: 46-50; Rick et al. 2011). The steep ecology of the land surrounding the site, which is located on a valley bottom at 3100 masl, means that different climate regimes are present within a short horizontal distance (Piperno and Pearsall 1998). The surrounding mountains of the Cordillera Blanca often reach 6000 m of elevation, thus fields from 2000-4000 masl could have been cultivated by past residents of the areas surrounding the temple.

The Potato Park is a unique project in the Sacred Valley of the Inka. The park attempts to preserve not only the land and its related biodiversity but also the cultural diversity of human practices observed in the region. This park is a center of potato landrace diversity and its inhabitants preserve hundreds of varieties of potatoes (FAO 2008) as well as diverse methods of preserving and consuming this resilient crop (Figure 1). One method in particular, the production of freeze-dried potatoes locally known as *ch'uñu* or *chuño,* is a source of particular pride. This preservation technique was used by the Inka to maintain a five year supply of surplus food for the inhabitants of their empire (D'Altroy 2002). It is a process that relies on freezing nighttime temperatures to remove excess moisture from the potato, which makes it particularly dependent upon climatic stability. Finally, the park is one of the few sites in the world in which an indigenous community, composed of members of the villages of Sacaca, Chawaytire, Pampallaqta, Paru Paru and Amaru, have sent seed samples to the International Seed Bank to preserve their bio-cultural knowledge for perpetuity. The community is making an explicit connection between their customs and traditional knowledge and the scientific attempts to preserve and document genetic variety.

METHODS

This research was focused on both past and present practices. The past cultivation practices of potato farmers are visible in the archaeological record through paleoethnobotanical analysis, which focuses on the preserved and carbonized remains of past plant material that is gathered through the flotation process (Pearsall 2010; and see Sayre 2010: 110-115 for precise details). Parenchyma, or storage cells of tubers, is preserved carbonized starch that is indicative of past consumption practices. While tubers other than potatoes were consumed in the Andes in the past these other tubers rarely dominated archaeological finds at mid-elevation sites.

Figure 1. Diversity of native potato varieties at the Potato Park, Peru. Photo by author.

Changes to traditional practices were particularly visible at the Potato Park. In this location it was possible to geographically confirm evolving agricultural patterns. Site visits were initially employed to determine current planting practices. Photographic documentation was combined with remote sensing data to determine changing cultivation patterns over time.

RESULTS

Paleoethnobotanical research at the site of Chavín de Huántar, Peru revealed uneven distribution of quantities and densities of carbonized plant materials at the site. The samples come from post-temple occupations in the East Atrium sector and the La Banda sector (c.1000- 600 BCE). The data below illustrate how remains from the East Atrium sector (Figure 2) differ in terms of differ in terms of quantities and diversities of species represented from the La Banda data (Figure 3).

A number of salient points are discernable from Figures 2 and 3. First, the samples from the Atrium have a greater diversity of preserved remains. This is to be expected as they date to a more recent time and as such have been less exposed to the natural elements and sediment diagenesis. The parenchyma, or remains from tubers, are large components of both sectors' remains and are part of larger diet patterns. The continued importance of tubers across time can be taken as

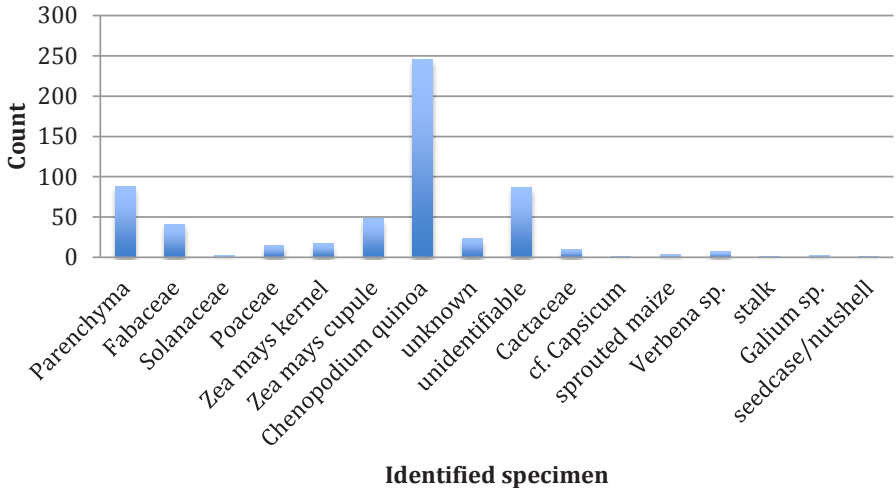

Figure 2. East Atrium macrobotanical plant remains without wood, N=57.

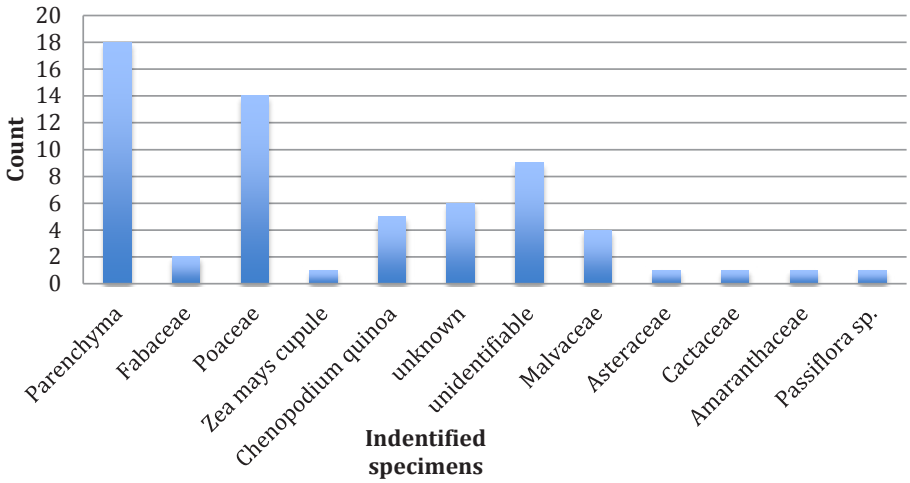

Figure 3. La Banda macrobotanical plant remains without wood, N=106 .

evidence that inhabitants of the site of Chavín did not have to radically shift their planting practices over time due to either changing climate or increased availability of plants, such as maize (*Zea mays*), that thrive on valley bottoms. This relative stability in ancient practices can be broadly contrasted to some more recent data.

The survey of the Potato Park revealed key points demonstrable from aerial images. The valley sides and bottoms have clear terraces that date back to Inka times, if not earlier (Figure 4). There are no clear examples of these ancient agricultural terraces on the upslope areas. In these upper regions llamas and other grazing animals were traditionally kept. In modern times rising temperatures

Figure 4. Potato Park with close-up of Lake Kinsaqocha showing ancient terraced fields below the high slopes with recent informal fields planted around the lake.

Figure 5. Lake Kinsaqocha with recently planted potato fields visible on the opposite shore of the lake. Photo by author.

have prompted local farmers to begin planting cold tolerant varieties of potato in the northern upslope area (Figure 4). If these varieties of potatoes are not planted in these highland areas they may not thrive and could disappear from the local pool of diversity.

DISCUSSION

This initial research into past and present uses of potatoes revealed two distinct findings. First, potatoes were consumed at valley bottom sites in the pre-Conquest Andes for thousands of years. Chavín de Huántar's relatively low elevation, 3100 masl, likely demonstrates that in the past tubers were easily grown and moved from local fields down to the valley bottom. This was not solely a plant suitable for mountain top and *altiplano* cultivation. Rather, it was likely interspersed with maize and beans (*Phaseolus* sp.). The current conception that tubers are more suitable for higher elevations may have been an agricultural concept that developed over time as greater numbers of lowland plants were introduced to the valleys of the Andean mountains (Ugent et al. 1982). This evidence of slowly changing agricultural practices demonstrates that past farmers conservatively preserved traditions but at the same time they were able to change planting patterns over time.

This conclusion has a direct corollary to the second aspect of this project. The initial survey of planting practices at the Potato Park revealed that potatoes were grown primarily in the upslope areas of the park, not on the valley bottoms which were primarily planted with maize. The longstanding practice of planting on higher ground has occurred for at least six hundred years as is visible from the Inka terraces that surround the archaeological site of Pisac. Yet, the changing climate is forcing the farmers to plant further upslope, in areas that have not been cultivated previously. As Figure 5 illustrates there are no visible terraces in this highland region. Rather the vegetation is predominately composed of native bunch grasses, *ichu* (*Stipa* sp.), and there are no indications of past terracing in this area. The lack of terracing and the local accounts of changing practices due to climate change revealed that farmers are entering a new agricultural reality, one shared by farmers and ecologists across the world (Lenoir et al. 2008). If they hope to preserve their frost tolerant adaptive varieties they will have to continue to move their crops upslope. Yet, this is a limited space and there are no suitable soils in the true alpine zone; the continued desire to preserve native diversity may be running out of space. Continued survey in the region will be necessary to document how quickly these changes are occurring, and outreach efforts will need to be made to communities at higher elevations to see if they can become caretakers of this crop diversity of the Andes. As recent research has demonstrated, subsistence farmers with more stable finances were better able to adapt their farming practices to the changing planet (Kristjanson et al. 2012). Places like the Potato Park that seek to preserve cultural and ecological diversity are of tremendous importance to a world undergoing rapid change and homogenization.

ACKNOWLEDGEMENTS

Thanks- Centro International de la Papa, Global Heritage Fund- Conservation Fellow Program, the Parque de la Papa, and the South Dakota Academy of Science.

LITERATURE CITED

D'Altroy, T. 2002. The Incas. Blackwell Publishers. Malden, MA.

FAO (Food and Agricultural Organization of the United Nations). 2008. International Year of the Potato: New light on a hidden treasure. Rome, Italy.

Patti Kristjanson, H. Neufeldt, A. Gassner, J. Mango, F. B. Kyazze, S. Desta, G. Sayula, B. Thiede, W. Förch, P. K. Thornton, and R. Coe. 2012 Are food insecure smallholder households making changes in their farming practices? Evidence from East Africa. Food Security 4: 381-397.

Lenoir, J., J.C. Gegout, P.A. Marquet, P. de Ruffay, and H. Brisse. 2008. A Significant Upward shift in plant species optimum elevation during the 20th Century. Science 320: 1768-1771.

Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. da

Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853-858.

Piperno, D., and D. Pearsall. 1998. The Origins of Agriculture in the Neotropics. Academic Press. San Diego, CA.

Pearsall, D. 2010. Paleoethnobotany: A Handbook of Procedures, Second Edition. Left Coast Press. Walnut Creek, CA.

Rick, J., C. Mesai, D. Contreras, S. Kembel, R. Rick, M. Sayre, and J. Wolf. 2011. La Cronologia de Chavín de Huántar y sus Implicancias para el Periodo Formativo. PUCP (13): 87-132.

Sayre, M. 2010. Life across the river: Ecology, Ritual, and Agriculture at Chavín de Huántar, Peru. Thesis. University of California at Berkeley, Berkeley, CA.

Smith, B. 1998. The Emergence of Agriculture. Scientific American Library: New York, NY.

Spooner D M., K. McLean, G. Ramsay, R. Waugh, and G. J. Bryan. 2005. A single domestication for potato based on multilocus amplified fragment length polymorphism genotyping. PNAS 102 (41): 14694–14699.

Ugent, D., S. Pozorski, and T. Pozorski. 1982. Archaeological potato tuber remains from the Casma Valley of Peru. Economic Botany 38: 417-432.