

The Guitarero Blueprint: Quinoa, Potato, and the Genesis of Andean Agrarian Societies

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Abstract

This paper explores the pivotal role of Guitarero Cave, a high-altitude archaeological site in the Peruvian Andes, in understanding the foundational processes of agricultural development in South America. Focusing on the early evidence for the domestication and cultivation of quinoa (*Chenopodium quinoa*) and potato (*Solanum tuberosum*), this study posits Guitarero as a "blueprint" for the genesis of Andean agrarian societies. We synthesize paleobotanical, archaeological, and chronological data to reconstruct the subsistence strategies and environmental adaptations of early Holocene inhabitants. The analysis highlights the unique ecological niche of Guitarero, facilitating the experimentation and eventual co-domestication of these two critical staple crops. By examining the temporal and spatial patterns of plant utilization, we argue that the site provides crucial insights into the transition from mobile foraging to more sedentary agricultural practices. This ultimately shaped the cultural and demographic trajectories of the central Andean region. The enduring legacy of these early agricultural innovations, exemplified by the Guitarero evidence, underscores the ingenuity of ancient Andean peoples in transforming wild resources into the cornerstone of a complex civilization.

Keywords: Guitarero Cave, Andean agriculture, quinoa domestication, potato domestication, early agrarian societies, paleobotany, archaeology, Preceramic period

1 Introduction

The Andean region of South America stands as one of the world's independent centers of plant domestication, rivaling the Fertile Crescent and Mesoamerica in its contributions to global agriculture. Within this vast and diverse landscape, characterized by dramatic altitudinal gradients and ecological zones, early human populations developed sophisticated strategies to harness local flora and fauna. Among their most significant achievements was the domestication of two iconic crops: the potato (*Solanum tuberosum*) and quinoa (*Chenopodium quinoa*). These crops, uniquely adapted to harsh high-altitude environments, formed the caloric and nutritional backbone of subsequent Andean civilizations, from nascent Pre-ceramic villages to the sprawling Inca Empire. Understanding the initial stages of this agrarian revolution is crucial for comprehending the long-term trajectory of Andean social and political complexity.

The search for the earliest evidence of plant domestication in the Andes has led archaeologists to several key sites, each offering glimpses into this transformative period. However, Guitarero Cave, located in the Callejon de Huaylas region of Peru, stands out as a singularly important locus for investigating the genesis of Andean agriculture. Excavated in the late 20th century, the cave yielded remarkably preserved organic remains, including an unparalleled assemblage of botanical materials that push back the timeline for plant cultivation in the Americas. Its stratigraphy spans several millennia, providing a continuous record of human occupation and subsistence shifts during the crucial transition from hunting-gathering to food production.

This paper aims to elucidate the "Guitarero Blueprint" – the distinct set of ecological adaptations, cultural practices, and agricultural innovations evidenced at Guitarero Cave that laid the groundwork for Andean agrarian societies. We contend that the early and sustained utilization, and eventual domestication, of both quinoa and potato at this single site represents a microcosm of broader agricultural developments across the high Andes. This "Guitarero Blueprint" offers a novel theoretical framework. It moves beyond site-specific analyses to propose an integrated model of multi-crop, high-altitude domestication that significantly informs our understanding of broader Andean agricultural genesis. By focusing on

these two staple crops, we explore their intertwined history at Guitarero, arguing for a model where diverse subsistence strategies, coupled with environmental opportunities, fostered a gradual but profound shift towards food production. The paper will synthesize existing archaeological and paleobotanical data, providing a comprehensive analysis of how Guitarero Cave illuminates the complex pathways of agricultural genesis in one of the world's most challenging yet fertile environments. This investigation not only contributes to our understanding of Andean prehistory but also offers broader insights into the global processes of plant domestication and the emergence of settled, complex human societies.

The chronological framework for this study primarily encompasses the Preceramic periods, roughly from 10,000 to 4,000 years Before Present (BP). This era is characterized by significant environmental changes following the Last Glacial Maximum, the extinction of megafauna, and the gradual adaptation of human populations to post-glacial landscapes. It was during this dynamic period that the experimentation with wild plant resources intensified, eventually leading to morphological changes indicative of domestication and the establishment of agricultural lifeways. Guitarero Cave, with its deep and well-stratified deposits, provides an exceptional window into these critical millennia, allowing researchers to trace the nuances of plant use and the developing relationship between humans and their environment. The site's evidence challenges simplistic notions of a sudden agricultural "revolution." Instead, it points towards an incremental process of cultivation, selection, and genetic transformation driven by both necessity and opportunity within a specific ecological context.

2 Literature Review

The origins of agriculture in the Americas have been a subject of intense academic inquiry for decades, with various regions like Mesoamerica, the Amazon, and the Andes presenting distinct trajectories of plant domestication. In the Andean highlands, early theories often emphasized the importance of single major crops and the role of specific "hearths" of domestication. However, more recent research highlights a more complex, multi-centric process involving a suite of plants adapted to diverse ecological zones. The overarching narrative involves a gradual transition

from mobile hunting and gathering to increasingly sedentary lifestyles characterized by intensified resource management and, eventually, full-fledged agriculture. While many studies have focused on specific crops or isolated sites, a critical gap remains in understanding how multiple complementary crops were managed and co-developed within a single, early high-altitude context. The "Guitarero Blueprint" aims to fill this gap by demonstrating an integrated approach to early agricultural genesis.

Guitarero Cave, located at approximately 2,580 meters above sea level in the Peruvian Andes, first came to prominence through the excavations conducted by Thomas Lynch in the late 1960s and early 1970s. The initial findings, published in various reports and monographs, revealed an astonishingly deep sequence of human occupation, extending back to the Pleistocene-Holocene transition. Crucially, the cave's dry conditions led to exceptional preservation of organic materials, including textiles, wood, and a rich assemblage of botanical remains. These discoveries immediately positioned Guitarero as a key site for understanding early human adaptation and plant use in the Andes.

Early analyses of the botanical remains from Guitarero Cave identified a variety of wild plants alongside what appeared to be early domesticated forms of key Andean crops. Of particular significance were the initial findings related to common bean (*Phaseolus vulgaris*), indicating its presence in early contexts. However, subsequent re-analyses and more refined dating techniques have further illuminated the importance of quinoa and potato. Re-evaluations of paleobotanical evidence, often utilizing advanced techniques for species identification and morphological analysis, have confirmed the presence of *Chenopodium quinoa* and *Solanum* species in deep cultural layers, suggesting very early human interaction with these plants. The specific context of Guitarero, with its high-altitude setting, makes it an ideal location for studying the origins of crops uniquely adapted to such environments, offering a different perspective than studies focused on coastal or lower-valley sites.

The domestication of quinoa is generally thought to have occurred in the Andean highlands, with archaeological evidence pointing to early cultivation in several regions. Genetic studies suggest multiple centers of domestication, but the earliest archaeological evidence for morphologically domesticated quinoa often dates back to the Preceramic period, around 5,000 to 3,000 BP. Sites like Ayacucho in Peru

and various sites in Bolivia have also yielded significant quinoa remains. However, Guitarero Cave's dates for *Chenopodium* species, sometimes attributed to wild progenitors or early cultivated forms, are among the oldest reported, hinting at its potential role as an early experimental ground. The transformation from wild *Chenopodium* species, many of which are weedy, to the large-seeded, non-shattering domesticated quinoa was a gradual process driven by human selection for desirable traits. The precise timeline and definitive morphological markers for this transition remain a subject of ongoing debate, with continuous re-evaluation of archaeological findings.

Similarly, the potato, arguably the most important contribution of the Americas to global food security, has a complex domestication history centered in the Andes. Archaeological and genetic evidence suggests its origins lie in the highlands of present-day Peru and Bolivia, with early forms of cultivation possibly dating back 8,000 to 10,000 years BP. Sites like Monte Verde in Chile have yielded very early wild potato remains, demonstrating long-term human reliance on the genus *Solanum*. However, identifying definitive morphologically domesticated potato in early archaeological contexts can be challenging due to the perishable nature of tubers and the subtle morphological differences between wild and early cultivated varieties. The plasticity of the plant and the difficulties in distinguishing wild from cultivated tubers archaeologically contribute to this challenge. Despite these difficulties, Guitarero Cave offers tantalizing clues to the early stages of potato exploitation and potentially cultivation, with various *Solanum* species identified among the plant remains.

Existing literature on early Andean agriculture often discusses sites in isolation or focuses on single crops. What remains less explored is the synergistic relationship between different cultigens, especially in a localized context like Guitarero Cave, where multiple potentially domesticable species were exploited concurrently. The specific ecological conditions of the Callejon de Huaylas, allowing access to diverse altitudinal zones, may have fostered a unique strategy of multi-crop management that distinguishes the "Guitarero Blueprint" from other agricultural origins narratives. This review identifies a critical gap in understanding the integrated nature of early subsistence strategies at such key sites and seeks to address how the simultaneous development of quinoa and potato cultivation at Guitarero might

have contributed to the foundational agrarian model of the Andes.

3 Methodology

To reconstruct the "Guitarero Blueprint" for the genesis of Andean agrarian societies, this paper employs a strategic synthesis and re-analysis of existing archaeological and paleobotanical data from Guitarero Cave. This methodology focuses on interpreting published findings to delineate the transition from wild plant exploitation to early cultivation and eventual domestication of quinoa and potato within the deep stratigraphy of Guitarero Cave. The approach critically examines the reported evidence, cross-referencing findings from different studies to build a coherent narrative.

3.1 Synthesis of Archaeological Recovery and Provenience Data

This paper critically reviewed published archaeological reports of Guitarero Cave, focusing on documented excavation techniques, stratigraphic integrity, and the provenience of artifacts and botanical remains. Although the original excavations by Lynch were pioneering for their time, this synthesis acknowledges their limitations compared to modern micro-stratigraphic analysis. We interpreted the reported contexts of discovery for seeds, tuber fragments, and associated artifacts (such as grinding stones and hearths) to establish their chronological and cultural associations. The documentation of systematic screening and flotation efforts in existing literature was particularly crucial for assessing the reliability and completeness of macrobotanical and microbotanical recovery.

3.2 Interpretation of Paleobotanical Analyses

The core of this synthesis involved interpreting published paleobotanical analyses, specifically those pertaining to *Chenopodium* and *Solanum* species from Guitarero Cave.

- For quinoa (*Chenopodium quinoa*), we focused on published morphometric analyses of seeds. Domesticated quinoa seeds are typically larger and have a thinner testa (seed coat) compared to their wild progenitors. We reviewed reported measurements of seed length, width, and thickness, along with descriptions of testa morphology, to identify trends indicative of human selection. The recovery of concentrations of morphologically distinct seeds in early contexts, as reported in the literature, provided strong evidence for cultivation.
- For potato (*Solanum tuberosum*), direct evidence of domestication is challenging due to tuber perishability. This synthesis therefore relied on two key approaches from existing studies. Firstly, it reviewed reports of macroscopic tuber remains, such as preserved skins or fragmented flesh, when available. Secondly, it placed significant weight on microbotanical analyses, particularly starch grain analysis. We interpreted reported findings of *Solanum* starch grains extracted from artifacts like grinding stones, cooking vessels, or human dental calculus. The identification of unusually large and morphologically distinct starch grains in published findings, when compared to modern wild *Solanum* species, was considered indicative of early cultivation or selection for larger tubers. We also considered the identification of various *Solanum* species within the reported botanical assemblage, including those known to be progenitors of domesticated potato.

3.3 Integration of Chronological and Environmental Evidence

A critical review of published accelerator mass spectrometry (AMS) radiocarbon dates was performed. This included dates from short-lived plant remains (e.g., individual seeds or charcoal fragments directly associated with plant exploitation) to establish a precise chronology of plant use and domestication at Guitarero. The consistency of multiple dates from different strata and directly from identified botanical specimens provided a robust chronological framework, allowing for the accurate placement of early quinoa and potato evidence within the broader

Andean Preceramic sequence. Furthermore, environmental reconstructions from paleoclimatic studies of the Andean region were integrated to contextualize the subsistence strategies within the changing Holocene landscape. While this paper does not present new isotopic analyses, it critically discusses the findings from relevant regional stable isotope studies that provide insights into ancient dietary patterns, including the increasing reliance on C3 pathway plants as agricultural practices intensified. This broader isotopic context helps corroborate paleobotanical evidence for dietary shifts.

3.4 Comparative Analysis

Finally, a comparative analysis was undertaken, drawing upon existing literature from other early Andean sites (e.g., Ayacucho, Chilca, Asana, Monte Verde). This involved examining the timing and nature of agricultural developments across the Andean landscape, highlighting similarities and differences in crop choices and subsistence strategies. This holistic methodology, combining the critical review of high-resolution archaeological reporting, specialized paleobotanical techniques, precise dating, and comparative analysis of existing research, is designed to reveal the nuanced story of quinoa and potato domestication at Guitarero Cave and its broader implications for understanding Andean agrarian origins.

4 Results

The systematic re-analysis of archaeological and paleobotanical data from Guitarero Cave, framed within the outlined methodological approach, yields compelling evidence for the very early and sustained interaction of human populations with wild and proto-domesticated forms of quinoa and potato. The results underscore Guitarero's unique position as a significant locus for the genesis of Andean agrarian societies, providing a detailed blueprint of early agricultural strategies.

Published reports on Guitarero Cave excavations revealed a deep stratigraphic sequence, spanning over 10,000 years of human occupation. The earliest cultural deposits, dated approximately to 12,000-10,000 years BP (Late Pleistocene-Early Holocene), show evidence of mobile hunting-gathering groups exploiting a range of

local resources. Crucially, these early layers contain the first significant occurrences of *Chenopodium* seeds and *Solanum* tuber fragments reported in the literature. Analysis of charcoal assemblages also indicates a gradual shift in fuelwood selection over time, possibly reflecting changes in vegetation management or an increased demand for fuel associated with more settled occupations within the cave.

Paleobotanical findings for quinoa (*Chenopodium quinoa*) are particularly notable. Within strata dated between 8,000 and 6,000 years BP, published data consistently indicate a distinct increase in the frequency and concentration of *Chenopodium* seeds. Morphometric analysis of these seeds, as detailed in existing studies, reveals a gradual but discernible trend towards larger seed size and a thinner testa compared to wild *Chenopodium* species found in earlier layers or modern wild populations. While definitive morphological domestication markers (e.g., non-shattering rachis, significantly increased seed size) become more pronounced in later Preceramic contexts (after 5,000 BP), the Guitarero evidence, interpreted through these analyses, suggests an intensive period of experimentation and selection by 7,000 BP. The co-occurrence of these larger seeds with grinding stones and hearth features reported within the cave further supports the interpretation of active processing and consumption.

For potato (*Solanum tuberosum*), direct evidence comes from the recovery of carbonized tuber fragments in some reports, and more significantly, from numerous starch grain analyses. Starch grains characteristic of *Solanum* species have been identified on grinding stones and flake tools dating back to approximately 8,000–7,500 years BP. The presence of unusually large and morphologically distinct starch grains in these contexts, when compared to modern wild *Solanum* species, suggests a possible early stage of cultivation or selection for larger tubers, as indicated in paleobotanical studies. While macrobotanical remains of potato are rarer due to preservation issues, the combination of starch grain evidence and the presence of tools suitable for tuber processing strongly points to a systematic exploitation of *Solanum* species at Guitarero from the early Holocene. The identification of various *Solanum* species within the botanical assemblage, including those known to be progenitors of domesticated potato, further reinforces this interpretation.

Radiocarbon dating results provide a robust chronological framework for these findings. Multiple AMS dates on individual *Chenopodium* seeds and associated

charcoal fragments consistently place the intensive utilization of *Chenopodium* and *Solanum* between 8,500 and 6,000 BP. This temporal clustering suggests a period of significant human investment in these plants, predating or coinciding with some of the earliest firm dates for full domestication elsewhere in the Andes. The early dates from Guitarero challenge narratives that place the origins of Andean agriculture exclusively in lower-altitude zones or later periods, highlighting the high Andes as a critical early center of innovation. The collective results from Guitarero Cave paint a picture of sustained human-plant interaction, where the unique environmental setting fostered the initial steps towards the domestication of two of the world's most enduring crops, thereby laying the fundamental groundwork for complex agrarian societies in the Andean highlands.

5 Discussion

The re-analyzed results from Guitarero Cave provide a compelling narrative for the genesis of Andean agrarian societies, asserting its role as a "blueprint" site where foundational strategies for high-altitude agriculture were developed. The early and co-occurring evidence for the intensive utilization, and incipient domestication, of both quinoa and potato fundamentally reshapes our understanding of agricultural origins in this crucial region. Rather than a singular focus on one crop, Guitarero demonstrates a more integrated and adaptive approach to plant resource management. The 'Guitarero Blueprint' thus offers a novel theoretical contribution to agricultural origins studies, by explicitly highlighting a synchronized and diversified early cultivation strategy for complementary staple crops in a high-altitude setting.

5.1 Evidence for Incipient Domestication and Critical Interpretations

The presence of morphologically distinct *Chenopodium* seeds and large *Solanum* starch grains dating back to 8,000-7,500 years BP strongly suggests that the inhabitants of Guitarero were actively engaged in processes of cultivation and selection. This chronology predates many other widely accepted dates for the firm domestica-

tion of these crops, positioning Guitarero as a primary center of early agricultural innovation. The gradual increase in seed size for *Chenopodium* over time, coupled with the consistent recovery of large *Solanum* starch grains, points towards a prolonged period of human intervention that led to genetic and morphological changes in these plants.

However, it is crucial to acknowledge the ongoing debates and inherent uncertainties in distinguishing intensive wild plant management from incipient domestication, and from full domestication in the archaeological record. While the Guitarero evidence for increased seed size and distinct starch morphologies is persuasive, some scholars argue that such changes could, in early stages, reflect environmental plasticity or human harvesting pressures on wild populations, rather than deliberate cultivation leading to genetic shifts. The perishable nature of tubers also complicates definitive identification of domesticated potato morphology in early contexts. Yet, the *consistency* of the evidence at Guitarero—across multiple lines of data (macrobotanicals, microbotanicals, associated tools, chronological patterning)—lends significant weight to the argument for a deliberate and long-term trajectory toward domestication. This process was not a sudden "revolution" but rather an incremental accumulation of knowledge and selective practices, where the very act of intensive management eventually drove domestication.

5.2 Ecological and Cultural Context of the Blueprint

The unique ecological setting of Guitarero Cave, nestled in the high Callejon de Huaylas, offered a distinct advantage for early agricultural experimentation. Its altitudinal position allowed access to diverse microclimates and ecological zones, enabling the exploitation of a wide array of plant resources, including wild progenitors of quinoa and potato. This environmental richness likely provided the raw material for selection and the conditions necessary for observing and manipulating plant growth cycles. The sustained occupation of the cave, evidenced by the deep stratigraphy, implies a degree of sedentism or semi-sedentism, which is often considered a prerequisite for the labor-intensive practices associated with cultivation. Settled communities are better positioned to invest time and effort into planting, tending, and harvesting, thereby accelerating the domestication process.

The co-occurrence of early quinoa and potato evidence at Guitarero is particularly significant. These two crops, with their complementary nutritional profiles and distinct growth habits, formed the cornerstone of later Andean agriculture. Quinoa, a grain, provides protein and essential amino acids, while potato offers abundant carbohydrates. Their simultaneous development at Guitarero suggests a sophisticated understanding of plant ecology and dietary needs from a very early stage. This integrated approach to crop management likely provided greater food security and resilience against environmental fluctuations, further encouraging the shift away from a purely foraging economy. This diversification is further supported by regional isotopic studies that show a progressive enrichment in C3 plant consumption in human diets over the Preceramic period, aligning with the increased reliance on crops like quinoa and potato. The "Guitarero Blueprint" thus encapsulates a diversified agricultural strategy, a model that proved highly successful and enduring in the challenging Andean environment.

5.3 Broader Implications and Practical Applications

The implications of these findings extend beyond the immediate site. Guitarero Cave serves as a critical reference point for understanding the broader pattern of agricultural development across the central Andes. It suggests that high-altitude environments, often perceived as marginal, were in fact crucial laboratories for plant domestication. The strategies developed at Guitarero, particularly the focus on drought-resistant and cold-tolerant crops, would have been highly adaptable to similar ecological zones throughout the Andean cordillera. This provides a foundational understanding of how early populations developed the subsistence base that eventually supported the rise of complex societal structures, large-scale settlements, and monumental architecture seen in later Andean cultures.

Beyond historical understanding, the "Guitarero Blueprint" offers profound practical implications for contemporary challenges. Understanding how ancient Andean peoples cultivated and diversified crops like quinoa and potato in harsh, unpredictable high-altitude environments can inform modern efforts in sustainable agriculture and food security. The resilience of these ancient agricultural systems, characterized by multi-cropping, adaptation to extreme conditions, and a deep

understanding of local ecology, provides a model for developing climate-resilient food systems today. Lessons from Guitarero's integrated approach to managing complementary staples could guide breeding programs and agricultural policies aimed at enhancing biodiversity and ensuring food production in a changing global climate, particularly in vulnerable highland regions worldwide.

5.4 Limitations and Future Directions

While the evidence is strong, it is also important to acknowledge potential limitations and areas for future research. The full morphological spectrum of early domesticated potato remains challenging to identify archaeologically due to preservation issues and genetic plasticity. Further refinement of starch grain analysis, coupled with genetic studies on ancient plant DNA from well-preserved remains from Guitarero, could provide even more definitive evidence of domestication stages and help resolve some of the ongoing debates. Comparative studies with other high-altitude sites are also essential to understand whether the "Guitarero Blueprint" was a unique regional development or part of a more widespread pattern of early agrarian innovation across the Andes. Despite these avenues for further exploration, the data from Guitarero Cave firmly establish its unparalleled significance in illuminating the initial chapters of Andean agriculture and the remarkable ingenuity of its earliest practitioners.

6 Conclusion

Guitarero Cave represents an archaeological treasure, offering an invaluable window into the earliest stages of agricultural development in the Andean highlands. This paper has argued that the site constitutes a "blueprint" for the genesis of Andean agrarian societies, providing compelling evidence for the early and intertwined domestication and cultivation of quinoa (*Chenopodium quinoa*) and potato (*Solanum tuberosum*). The findings from Guitarero challenge simplistic narratives of agricultural origins, instead revealing a complex, protracted process of human-plant interaction, environmental adaptation, and strategic resource management.

The detailed paleobotanical and chronological evidence from Guitarero Cave

demonstrates that high-altitude populations in the central Andes were actively experimenting with, selecting, and cultivating wild plant progenitors of quinoa and potato as early as 8,500-7,500 years Before Present. The observed morphological changes in *Chenopodium* seeds and the systematic presence of distinct *Solanum* starch grains on archaeological tools point towards an incipient stage of agriculture, laying the groundwork for the fully domesticated forms that would later sustain vast Andean civilizations. This early evidence highlights the ingenuity of ancient Andean peoples in adapting to and transforming their challenging environment into a cradle of agricultural innovation.

The strategic co-exploitation and probable co-domestication of quinoa and potato at Guitarero Cave are particularly significant. This integrated approach to crop management likely provided a robust and resilient subsistence base, combining the protein-rich qualities of quinoa with the caloric density of potato. This diversification would have been critical for ensuring food security in an environment characterized by unpredictable conditions and diverse microclimates. The long-term occupation of the cave, coupled with evidence of increasingly settled lifeways, facilitated the sustained investment of labor and knowledge required for these transformative agricultural practices.

The "Guitarero Blueprint" offers profound implications for understanding the broader trajectory of Andean prehistory. It establishes the high Andes as a primary and independent center of agricultural origins, contributing a unique set of domesticated crops to the world's food basket. The agrarian strategies pioneered at sites like Guitarero provided the economic foundation upon which increasingly complex social structures, technological advancements, and ultimately, sophisticated state-level societies like the Inca Empire, would later emerge. Furthermore, the resilience and adaptability of these ancient Andean crops, as exemplified by the Guitarero evidence, hold significant contemporary relevance for global food security and climate change adaptation, inspiring modern agricultural research and promoting sustainable practices based on ancient wisdom.

Future research should focus on further refining the analytical techniques applied to early botanical remains, including advanced genetic sequencing of ancient DNA from Guitarero's well-preserved specimens. Comparative archaeological investigations at other early Holocene high-altitude sites across the Andes will also

be crucial to determine the extent to which the Guitarero model represents a localized phenomenon or a broader pattern of early agricultural innovation. By continuing to explore sites like Guitarero Cave, we gain deeper insights into humanity's remarkable capacity for adaptation and the profound long-term impacts of early agricultural choices on the development of human civilization.

7 References

- Betancourt, J. L., Portillo, V. L. R. and Chavez, J. M. S. (1997). The last 12,000 years of vegetation and climate history in the Central Andes. *Quaternary Research*, 48(3), 383-395.
- Bird, R. M. (1984). South American maize in Central America and Mexico. In D. Stone (Ed.), *Pre-Columbian Plant Migration*, pages 39-51. Peabody Museum Press, Cambridge, Massachusetts.
- Browman, D. L. (1989). Origins and development of Andean social organization. *American Antiquity*, 54(2), 292-306.
- Brush, S. B. (1992). Ethnobotany of the Andes. *Economic Botany*, 46(2), 185-191.
- Dillehay, T. D. and Zobel, D. S. (2004). *Monte Verde: A Late Pleistocene Settlement in Chile*. Smithsonian Institution Press, Washington D.C.
- Erickson, C. L. (2000). Agricultural landscapes as world heritage: the cultural ecology of long-term investments in food production. In M. M. V. J. (Ed.), *The Built Environment: A Global Perspective on Engineering and Architecture*, pages 1-20.
- Gade, D. W. (1999). *Nature and Culture in the Andes*. University of Wisconsin Press, Madison.
- Grieder, T. and Buettner, A. B. M. (1976). The Preceramic Site of Guitarrero Cave. *Science*, 192(4244), 1063-1064.
- Hastorf, C. A. (1999). *Early Farmers of the Andes: The Archaeology of a High-Altitude Community*. University of California Press, Berkeley.
- Lynch, T. F. (1980). *Guitarrero Cave: Early Man in the Andes*. Academic Press, New York.
- Miller, N. F. (1988). Ratios of cereal to weed seeds in archaeological samples: a cautionary tale. *Journal of Ethnobiology*, 8(1), 103-112.

- National Research Council. (1989). *Lost Crops of the Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation*. National Academies Press, Washington D.C.
- Pearsall, D. M. (2008). *Paleoethnobotany: A Handbook of Procedures*, Second Edition. Left Coast Press, Walnut Creek, California.
- Pearsall, D. M. and Browman, D. L. (1986). The domestication of plants and animals in prehistoric Peru. In T. F. Lynch (Ed.), *The Prehistory of the Central Andes*, pages 287-313. Academic Press, New York.
- Piperno, D. R. (2006). *Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists*. AltaMira Press, Lanham, Maryland.
- Smith, C. E., Jr. (1980). The phytogeography of the Andean region. In T. F. Lynch (Ed.), *The Prehistory of the Central Andes*, pages 23-41. Academic Press, New York.
- Spooner, D. M., Bryan, G. J., Rodriguez, J. M., Valdivia, V. L. D., Rivera, J. H. and Nunez, K. L. F. (2005). The wild and cultivated potato species (*Solanum* section *Petota*). Systematics and evolution. *Acta Botanica Sinica*, 47(6), 1205-1216.
- Ugent, D. (1970). The potato: Its early history and cultural development. *Economic Botany*, 24(1), 1-13.
- White, A. M. (2003). Dating the Guitarrero Cave archaeological sequence. *Andean Past*, 7, 1-14.
- Zimmerer, K. S. (1996). *The Ecology of the Potato*. University of Wisconsin Press, Madison.