PUSHING THE LIMITS AND TORMENTING CORN SEEDS: CULTURAL ADAPTATIONS AND CLIMATIC CHANGE IN THE UPPER SAN JUAN DURING THE BASKETMAKER II PERIOD AND BEYOND

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ABSTRACT

Following the initial introduction of maize farming to the northern Southwest, farming techniques and corn varieties diversified in many areas of the region during the Basketmaker II period, but appear to have remained relatively unchanged in the Upper San Juan and Durango areas until much later. Throughout the area occupied by Eastern Basketmaker groups, populations appear to have shared a similar suite of agricultural land use practices focusing primarily on utilization of alluvial fan ecological niches. Patterns of periodic demographic shifts by farmers in the area appear to have been spurred in part by climatic fluctuation that changed the ecology of these alluvial fan settings at various times in prehistory. I present new data from analyses of ancient agricultural systems used by early farming peoples throughout the Durango and Upper San Juan areas, and experimentation with the limitations of these systems. These data provide new insights into prehistoric cultural variability and new methods to better test archaeological interpretations of the relationships between climate change and human subsistence through time.

INTRODUCTION

This paper discusses recent research of Eastern Basketmaker II agricultural strategies in use from roughly 800–400 B.C. to A.D. 550 by peoples in the Durango and Upper San Juan River areas of southwestern Colorado and northwestern New Mexico. Several researchers have noted the association between early farming sites and floodwater and runoff agricultural settings throughout the Southwest (Adams 1974, 1979; Bellorado 2009; Kohler et al. 2008; Matson 1991, 2006; Robins 1997, 2002; Vierra 2008). While maize and maize farming appear to have been initially introduced to the northern Southwest by migrant farmers from the south as early as 1400 B.C. (Kohler et al. 2008; LeBlanc 2008; LeBlanc et al. 2007; Sesler and Hovezak 2006; Vierra 2008), the adoption of maize agricultural lifeways took a different form in the Upper San Juan region among Eastern Basketmaker II groups than to the west among other Basketmaker II groups (Bellorado and Anderson 2009; Charles and Cole 2006; Hovezak and Sesler 2006; Matson 1991, 2006). Indeed, Charles and Cole (2006) and Matson (2006) have documented broad differences in material culture between Eastern Basketmaker II groups (centered in the Durango, Navajo Reservoir, La Sal Mountains, and Chuska/Lukachukai areas) and Western Basketmaker II groups (centered in the Cedar Mesa, Black Mesa, Glen Canyon, and Kanab areas) (Charles and Cole 2006:168) (Figure 1). However, Coltrain et al.'s (2006, 2007) analysis of human remains demon-

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strated that populations were largely dependent on maize in both the east and west by the Basketmaker II era, with maize providing between 60 and 80 percent of the diet annually. In this paper, I discuss some of the actual parameters of the agricultural systems that Eastern Basketmaker peoples had to deal with in the Durango and Navajo Reservoir site clusters in the Upper San Juan area over time (Figure 1).

THE SETTING OF EARLY FARMING SITES IN THE UPPER SAN JUAN

Looking at the earliest farming in the larger northern Southwest in Late Archaic or Early Basketmaker II times, farming strategies are largely confined to floodwater and well-watered micro-niche setting conditions, sometimes on alluvial fans (Matson 1991, 2006; Kohler et al. 2008; Vierra 2008). It strikes me that overall, most of the early agricultural strategies in the Upper San Juan region and downstream in the lowland valleys of the Middle San Juan region (Figure 1) were suited for runoff agriculture confined largely to alluvial fan settings. Indeed early ancestral Pueblo agricultural sites in the Upper San Juan drainage generally, and Durango area specifically, are found primarily in association with alluvial fans until well after the Basketmaker II era, through the Basketmaker III period, and until the Early Pueblo I period around A.D. 775 (Bellorado 2009; Bellorado and Anderson 2009; Charles et al. 2006; Kohler et al. 2008; Matson 1991, 2006; Reed 1978; Sesler and Hovezak 2002; Smiley and Robins 1997; Vierra 2008).

Alluvial fans are the primary types of runoff agricultural settings throughout the Upper San Juan area. Thus, when people either moved into the Upper San Juan drainage and/or adopted maize farming systems in this area, they were looking for runoff and alluvial fan settings specifically as the primary places to plant maize and squash and promote select wild edibles. Understanding the qualities of these agricultural settings can tell us a great deal about what farmers would have had to deal with in terms of the ecological conditions early maize varieties and farming strategies were adapted to, how both crops and farming peoples responded to climatic variability, and the cultural energy involved in the establishment and maintenance of new fields and crops.

THE ECOLOGY OF ALLUVIAL FAN FARMING SYSTEMS IN THE UPPER SAN JUAN

The alluvial fans in the Upper San Juan offered subsistence farmers a suite of positive and negative attributes that affected agricultural strategies. Alluvial fans offer access to secure sources of subsurface moisture. While many alluvial fan farming situations can be prone to cold-air drainage problems and short growing seasons (Adams 1979; Anderson and Bellorado 2009; Bellorado 2007, 2009; Fuller 1988), the small, relatively dispersed Basketmaker II populations would have only needed the best portions of alluvial fan agricultural settings above cold-air drainages and cold-air pools that are common in the upland basins and valleys associated with alluvial fan agricultural zones. That said, since there was nearly always enough moisture available for maize farm-

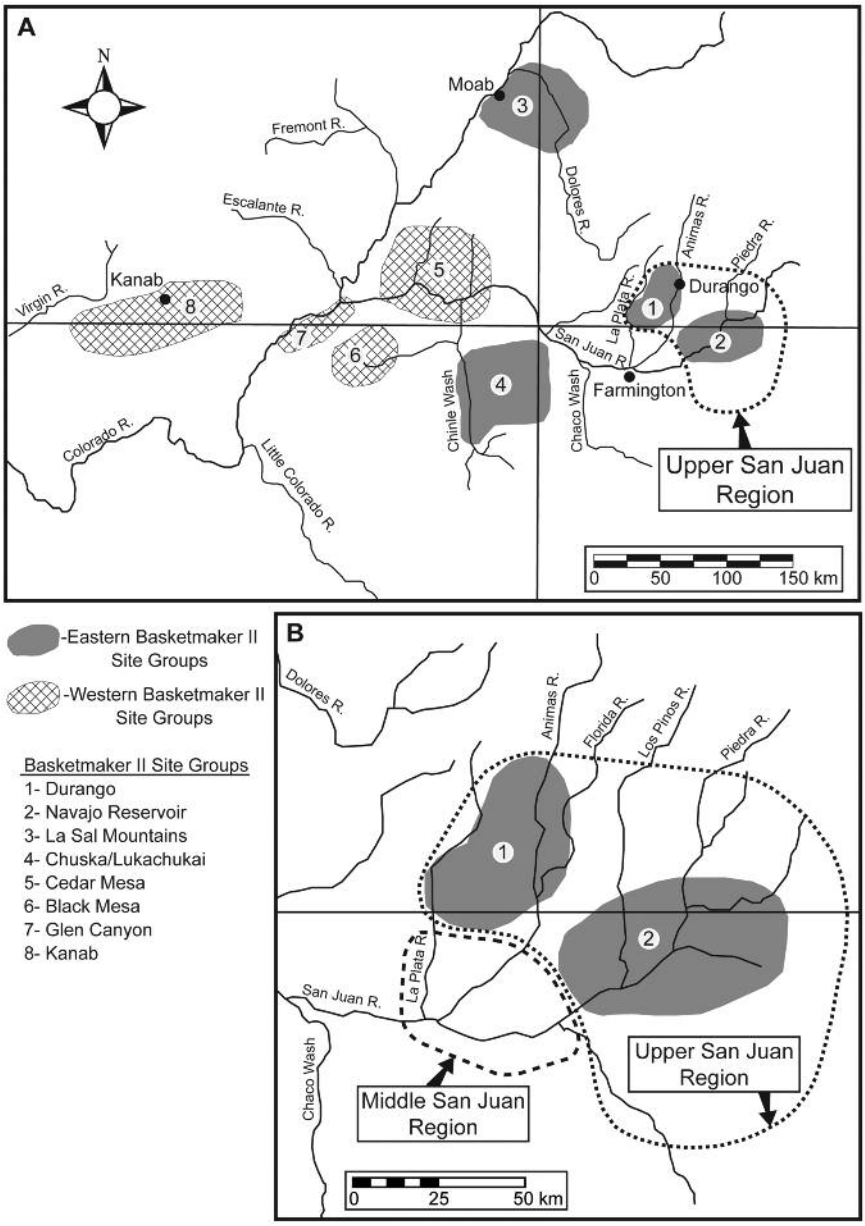

FIGURE 1. Geographic areas of the northern Southwest mentioned in text: A: Overview map of Eastern and Western Basketmaker II site group distributions (redrawn and modified from Charles and Cole 2006:Figure 1) in relation to the Upper San Juan region mentioned in text. B: Close-up map of Upper San Juan region in relation to the Durango and Navajo Reservoir Eastern Basketmaker II site groups and the Middle San Juan region mentioned in text.

ing in these uplands environments, it was the ability of fluctuating annual temperatures to provide sufficient heat to grow maize that determined whether agricultural subsistence was successful in the Upper San Juan from year to year (Anderson 2008; Bellorado 2009; Bellorado and Anderson 2009). To supplement diets or buffer against crop losses, many of the Basketmaker II sites in the Upper San Juan were also situated to take advantage of not only agricultural settings but also the large diversity of wild plants and game found in and around the upland valleys and basins of the area (Bellorado 2009; Bellorado and Anderson 2009; Potter and Edwards 2009; Charles et al. 2006; Vierra 2008). In many ways, these situations are similar to those found in the upper reaches of the canyons draining the Abajo and La Sal Mountains in southeast Utah and the Chuska/Lukachukai Mountains in northeastern Arizona and northwestern New Mexico (Figure 1). It is interesting that Charles and Cole (2006) have pointed out similarities between Basketmaker II material culture in these areas and that of the Durango area.

Overall, we know that the Upper San Juan River region could have supported a large number of people on alluvial-fan-based subsistence systems. Several centuries later in the Durango area, during the Early Pueblo I Period (A.D. 760–820), similar maize farming technologies on many of these same alluvial fan settings may have supported as many as 1,400 people during peak Pueblo I period population levels between A.D. 780 and 810, in fairly confined agricultural zones (Bellorado 2007, 2009). Experimental farming research on alluvial fan agricultural zones in the Durango area demonstrate that traditional Puebloan maize varieties and farming techniques could produce enough corn to feed six to eight people annually on each hectare of primary alluvial fan agricultural land, given a general estimate requirement of 160 kg of maize per person per year (Bellorado 2007, 2009). So, Basketmaker peoples should have had plenty of farmland to support a maize-rich diet during years with amiable climatic conditions.

CLIMATIC FACTORS THAT AFFECTED EARLY AGRICULTURE IN THE UPPER SAN JUAN

Along the hogback uplift of Cliff house Sandstone, Kirtland, and Fruitland formations that structure the setting of the alluvial fan farming zones of the Durango and the Upper San Juan, maize-farming-dominated subsistence strategies were viable only when climatic conditions in the region were warm enough to provide the needed frost-free growing season periods and heat accumulation in corn plants over the growing season. When climatic conditions were warm and wet enough, early farmers in this region used varieties of flint and pop corn (Adams and Paterson 2011; Adams et al. 1999; Jones and Fonner 1954; Peterson 1988; Wicker 1997) that could produce yields even under short growing season conditions on alluvial fans in perched valleys and basins and on shelves above the major rivers in the region. During years when the effective growing seasons were too short to produce ripe maize yields, Basketmaker II peoples in the Upper San Juan appear to have used slab-lined adobe collared storage features as roasting pits for processing green (unripe) corn yields prior

to storage (Bellorado 2004) and likely maximized wild food resources use in the area.

THE NATURE OF CLIMATIC DATA FOR THE REGION AND ITS EFFECT ON INTERPRETATION OF ARCHAEOLOGICAL DATA

Many archaeologists have the perception that the Durango area uplands are relatively marginal for maize production compared to many other areas in the northern Southwest. This perception is likely based on the often cited Adams and Peterson (1999) calculation that 90 percent of the time in the Durango area there will be a frost-free season of 114 days (1999:Table 27). These calculations were based on historic climate data reported by the Western Regional Climate Center (WRCC) in the Colorado climate summaries, available on the Internet (http://www.wrcc.dri.edu/summary/climsmco.html). This 114-day frost-free growing season is just short of the 120 days that many archaeologists have cited as the precise number of frost-free days needed by corn farmers to produce good harvests (Adams and Petersen 1999; Charles and Cole 2006). However, my research has demonstrated that these historic data from WRCC's Durango weather station are misleading and should be used cautiously for several reasons.

First, the weather monitor that recorded these data is located on the lower eastern side of the Riverview Mesa subdivision on the west side of Durango, directly in the path of a cold-air drainage that does not represent even the average farming setting used by people at different times in the area's prehistory. In my research with eight temperature monitors over three to four years, in and out of cold-air drainages in the Durango area, I found that the frost-free seasons on actual farmlands used prehistorically by Basketmaker II, Basketmaker III, and Pueblo I subsistence farmers provided maize with between 130 and 190 day effective frost-free seasons (Bellorado 2007, 2009). Thus, the base data used for correlating much of the paleoclimatic data with modern/historic climate data from the WRCC station may be misleading, making the Durango area appear more marginal for maize farming than it actually was during the Basketmaker II, Basketmaker III, and Pueblo I period occupations of the area.

Second, most traditionally used varieties of Southwestern maize do not even require 120 frost-free days to produce mature yields. Indeed, several Hopi varieties that I have been studying, or "tormenting" as some put it, require almost one-third fewer frost-free days to mature than the hybrid varieties familiar to most members of Western society that regularly require the magic 120 frost-free days (Anderson and Bellorado 2009; Bellorado 2007, 2009). Many of these varieties can also withstand several frosts up to 28 degrees as opposed to 32 degrees increasing the length of the effective growing season further. Thus, the Upper San Juan and Durango areas actually have the potential to be one of the best, if not the best place for agriculturalists in the northern Southwest, at many times in prehistory. Similar potential farming situations extend far to the east along the extent of the Sandstone hogback that runs from west of Durango to north and east of Chimney Rock to the continental divide

between the San Juan and Rio Grande River drainages, opening up large areas of the Upper San Juan region as areas where archaeologists should look for early farming sites.

INTERPRETATIONS OF ANCIENT MAIZE VARIETIES AND THEIR ADAPTATIONS

Jones and Fonner (1954) originally identified the maize remains from the Falls Creek Rockshelters and classified the maize into many different types based on morphological traits. Based on these analyses, the assumption became that Eastern Basketmaker II peoples had quite a few distinct varieties or land races of corn which they used to plant in an array of field settings to buffer against crop loss (Adams 1994; Wicker 1997). My feeling is that this is not entirely the case. New research on many of the materials recovered by Zeke Flora and Earl Morris from the Durango Falls Creek Rockshelters (Morris, and Burgh 1954), partly on the corn (some of which is unburned), is underway and the archaeological community is quasi-patiently anticipating what Sally Cole, Karen Adams, and Laurie Webster, to name a few, will uncover in this research of Falls Creek Rockshelters material remains. These data will certainly shed greater light on the question of Basketmaker II maize origins and varietal characteristics.

In the meantime, recent studies looking at modern Hopi and other Native American maize varieties grown using strict dryland farming techniques on alluvial fan farm plots in the Durango area (Adams et al. 2008; Anderson and Bellorado 2009; Bellorado 2007, 2009) and at Crow Canyon Archaeological Center, near Cortez, Colorado, have the ability to enhance understandings of early maize varieties. These studies documented that several Colorado plateau maize variety grow-outs exhibited a similar amount or greater morphological and developmental variability as Jones and Fonner (1954) observed in the Falls Creek Rockshelter maize remains, but within single varieties. It appears that maize varieties with the most variability in developmental growth responses were the types that far out preformed other varieties with more homogeneous growth responses and morphological traits in upland farming locations (Bellorado 2007, 2009). Thus the jury should still be out as to how many varieties of corn the Eastern Basketmaker II peoples had and where these types came from. Researchers should also keep in mind that maintaining morphological variability in maize varieties may have been a conscious component of the larger agricultural strategy because plasticity in maize morphology allows plants to adapt to variations in field ecology and produce higher yields in fluctuating climatic and ecological conditions (Anderson and Bellorado 2009; Bellorado 2007; Adams et al. 1999; Muenchrath and Sandor 1995; Wicker 1997).

Variability in corn variety adaptations is beneficial as a buffer against changing and variable environmental factors. So, rather than maintaining a large number of different maize varieties, it is more likely that the Basketmaker II groups intentionally selected for a wide range of morphological variation in maize adaptations of a few varieties. In other words, they kept their corn "wilder" rather than selectively creating more homogeneous strains. This being

said, Eastern Basketmaker II people appear to have found broadly similar environmental niches to utilize (alluvial fans) and focused on these areas rigorously, which would have lead to an increasingly narrower window of potential adaptations in maize over time. This process would have made Eastern Basketmaker II maize varieties increasingly less adaptable to changing climatic and environmental conditions and resulted in a decreased ability for Basketmaker farmers to move outside of the alluvial fan farming parameters in the Upper San Juan region, potentially fostering regional isolation. While maize adaptations can be very plastic, it would take quite a while to adapt varieties of corn from alluvial fan to dryland settings (Sprague 1977) that are more widespread in the areas occupied by Western Basketmaker II groups. Additionally, settlement patterns indicate that dryland farming likely didn't develop in the Upper San Juan until the late Basketmaker III or early Pueblo I periods (Bellorado 2009; Bellorado and Anderson 2009), whereas dryland farming had been in use by Western groups since the late Basketmaker II and Basketmaker III periods (Matson 1991, 2006; Varien 2008).

DEMOGRAPHIC SHIFTS AND CLIMATIC CHANGE IN THE UPPER SAN JUAN

Now, understanding some of the nuances of prehistoric agricultural systems more clearly, I turn to a brief assessment of some of the demographic shifts that appear to be climate related in the Upper San Juan region. My discussion is limited to the first half of the first millennium A.D. as the data available for precise climatic reconstructions are limited by the time depth of available tree-ring chronologies and reconstructed Palmer Drought Severity Indices (PDSI) for the Durango and Upper San Juan River drainages. These data are available from the Southwest Paleoclimate Project of the Laboratory of Tree-Ring Research at the University of Arizona (Laboratory of Tree-Ring Research 2008), and extend back to A.D. 35 for the Durango area and only to A.D. 624 for the Gobernador (Navajo Reservoir area) presently. Regional Colorado Plateau temperature proxies are available from Salzer and Kipfmuller (2005) and have been converted to z-scores for my analysis. These data extend back to 250 B.C. and are specific only to the region generally.

The temporal limits of the tree-ring chronology based climatic data for the area make analysis most reliable for comparison to the Los Pinos phase (A.D. 200–550) Basketmaker II occupations of the Durango and Upper San Juan areas (Figure 2). While radiocarbon chronologies have demonstrated early farming occupation in the Durango and Upper San Juan areas as far back as 800–400 B.C., Charles et al. (2006) noted that the "most obvious Durango Basketmaker II occupation, occurred sometime between A.D. 190 and A.D. 375" (Charles et al. 2006:228) during the Talus Village subphase of the larger Los Pinos phase.

The initial Talus Village phase occupation of the Durango area began around A.D. 190 and began during a slightly wetter and colder period. This data is intriguing because the uplands of the Durango area appear to be better suited for agriculturalists during warmer periods. However, from the last two

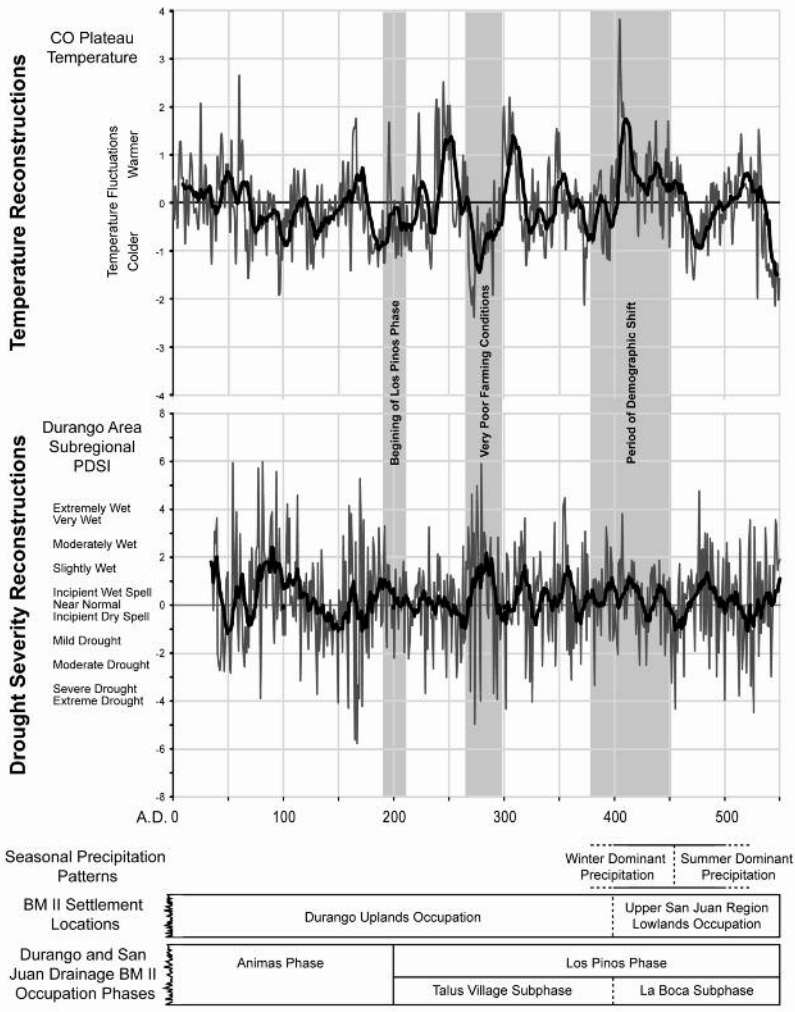

FIGURE 2. Paleoclimatic reconstructions available for the Durango area and Colorado Plateau compared to Basketmaker II occupation phases, settlement locations, and key periods of climatic and demographic shifts in the Durango and Upper San Juan drainage areas. Colorado Plateau regional temperature reconstruction data (Salzer and Kipfmuller 2005) converted to z-scores and Palmer Drought Severity Index (PDSI) reconstructions for the Durango area (Laboratory of Tree-Ring Research 2008) shown annually (gray line) and in 10-year moving averages (black line). Note the last 25 years of the A.D. 300s and first 50 years of the A.D. 400s in relation to climate and demographic shifts in the Durango and Upper San Juan drainage areas.

decades of the A.D. 100s to around A.D. 225 regional temperatures warmed and PDSI levels averaged at near normal until around A.D. 265.

Assuming that the Los Pinos phase occupation was relatively continuous (if populations stayed in the uplands of the Durango area full-time and year-round), its people survived through two significantly warmer periods bracketing a significantly colder period that began in the last quarter of the A.D. 200s.

This significantly colder period coincides with the wettest 25-year period (A.D. 265–290) experienced during the Los Pinos phase (Figure 2) and would have been a very difficult episode for farmers to produce mature maize and squash yields. Interestingly, this cold and wet period coincides with a period when construction at the Falls Creek Rockshelters ceased (Charles et al. 2006; Dean 1975; Potter 2008, 2010). However the occupation of other sites in the Durango area appear to have persisted through this difficult climatic period indicating that some level of subsistence was still possible. When the climate finally ameliorated at about A.D. 300, construction episodes were seen at Talus Village, the Darkmold Site (Charles et al. 2006), and in Ridges Basin (Potter 2010), but not again at the Falls Creek Rockshelters (Charles et al. 2006).

The Los Pinos phase of the Basketmaker II occupations of the Durango area persisted throughout the fourth century A.D. until roughly A.D. 375 (Charles et al. 2006) during which time both regional temperatures fluctuated just below average and PDSI levels fluctuated just above average after a brief warmer period between A.D. 299 and 314 (Figure 2). Apart from a brief single year of very cold temperatures in A.D. 373 (z-score of -2.12) and two short strings of slightly cooler years (A.D. 372–381 and A.D. 389–396) there is little if any indication of a climate-change-based reason for the decline of Basketmaker II farming settlements in the Durango area at the end of the A.D. 300s. During the Los Pinos phase, inhabitants of the Durango uplands maintained a persistent presence through several extreme fluctuations in both temperatures and precipitation. The last few decades of the Talus Village subphase then, were well within the normal range of climatic variability that marked this occupation of the area, but this picture was about to change.

Around A.D. 400 or just after, there were a series of distinct and abrupt shifts in the climate of the Upper San Juan drainage, and Durango area specifically, that coincided with dramatic demographic shifts of Basketmaker II peoples in the area (Figure 2). Regional Colorado Plateau temperature proxies indicate a dramatic warming period from around A.D. 400–465 after a period of just below-average regional temperatures at the end of the A.D. 300s (Salzer and Kipfmuller 2005) (Figure 2). This change in regional temperatures occurred concurrently with a change in Durango area moisture regimes, which had remained near-average in the last several decades of the A.D. 300s (as indicated by PDSI levels). At the beginning of the A.D. 400s, moisture patterns shifted slightly to an above-average trend in the Durango area PDSI levels. Additionally, a shift to a more summer-dominated precipitation pattern occurred around A.D. 450 in the Upper San Juan area (Hogan et al. 1991; Hovezak and Sesler 2006) (Figure 2).

Interestingly, it is precisely at the beginning of the A.D. 400s when it appears that Basketmaker II peoples in the Durango area simply picked up and left and moved to lower areas of the Upper San Juan region near the Fruitland Project area, Cedar Hill, and Navajo Reservoir, in New Mexico, to alluvial fan and runoff agricultural settings (Hovezak and Sessler 2006). This demographic shift also marks the transition from the Talus Village subphase to the La Boca subphase of the larger Los Pinos Phase occupation of the Upper San Juan

region (Charles et al. 2006; Hovezak and Sesler 2006). The drastic climatic changes at the beginning of the A.D. 400s correspond too precisely with the Basketmaker II abandonment of the Durango area (and projected population movements into the southern and eastern portions of the Upper San Juan region) at around A.D. 400 (Charles et al. 2006; Sesler and Hovezak 2006) to be coincidental and deserve further attention. Unfortunately, to date, no comparable tree-ring based climatic reconstructions are available for the Gobernador (Navajo Reservoir) area prior to A.D. 624, but these data would surely aid in our interpretations of the archaeological record.

The demographic shifts at the start of the fifth century A.D. are an interesting turn of events because in both earlier and later times, during warm region-wide droughts, farming populations often moved into the uplands of the Upper San Juan and Durango areas to gain access to more consistent moisture regimes (Bellorado 2007; Bellorado and Anderson 2009; Charles et al. 2006; Eddy 1972; Fuller 1988; Hovezak and Sesler 2006; Petersen 1988; Schlanger and Wilshusen 1993). So the fact that people moved out of the Durango uplands around A.D. 400, during a very warm period with relatively good precipitation, is puzzling. Were conditions too hot to farm in that series of years? If so, why move to the lowlands as suggested where it was likely equally as hot or hotter?

One possibility is that warmer climates would have lowered the extent of cold-air drainages and cold-air pools in lowland floodwater farming settings to the point that crop damage due to cold-air drainage problems in river valleys and on floodplains may have been rendered negligible as the length of frost-free growing seasons was lengthened on larger portions of the landscape. This scenario would have opened up new areas for runoff agriculture (lower down on alluvial fans and alluvial valley bottoms usually affected by cold-air drainage and pooling) to be used in addition to the tried and true alluvial fan systems and drawn early farming populations to the lowlands. A second possibility to take into account is the role of agriculture in Basketmaker II society and that while maize appears to have played a major role in Basketmaker diets, wild harvested foods and hunted game continued to play a sizable role in the overall subsistence strategies (Vierra 2008). Higher temperatures may have also changed the dynamics of foraging and hunting ranges in the uplands of the Durango area as well, causing maize agriculture to take on an increasingly centralized role in Basketmaker society (Phillips 2009; Vierra 2008). Perhaps Eastern Basketmaker populations in the Upper San Juan region were not willing to accept maize in this role and sought out areas to the south that would allow for the continued compliment of agricultural and foraging strategies (and the cultural energy each required) at a similar level to what these newly relocated people were accustomed to.

After leaving the Durango area, Basketmaker II populations appear to have moved to the lower areas of the Upper San Juan drainage and Fruitland Project areas (Charles et al. 2006; Hovezak and Sesler 2006). In these areas people continued to farm mainly on alluvial fans and other runoff farming situations. Indeed, the focus remained on alluvial fans until the addition of dry-

land farming techniques in either the Basketmaker III or Pueblo I periods throughout the Upper San Juan region (Bellorado 2007, 2009; Bellorado and Anderson 2009; Charles et al. 2006).

CONCLUSION

Following the initial introduction of maize farming into the northern Southwest, farming techniques and corn varieties diversified in many areas of the northern Southwest during the Basketmaker II period. However, in the Upper San Juan and Durango areas farming technologies appear to have remained relatively unchanged in the until several centuries later during the late Basketmaker III or early Pueblo I period. Throughout the area populations appear to have shared a similar suite of agricultural land use practices focusing primarily on utilization of alluvial fan ecological niches. Overall, the agricultural strategies employed by Eastern Basketmaker II farming populations in the Upper San Juan region offer an interesting case study of the process of the adoption of maize agriculture, the development of farming techniques, and cultural selection processes in the development of early maize varieties on the larger Colorado Plateau.

In the future, archaeologists will likely find even earlier agriculture sites in the Upper San Juan area that can direct research into even more informed discussions of the adoption and development of early farming systems in the Southwest. Present data show the nature of early agricultural adoption shortly after its introduction into the Upper San Juan region, but after maize had already become a significant component of the subsistence systems and lifeways of early farmers as expressed by populations during the Basketmaker II era.

In this paper, I have discussed some of the actual parameters of the agricultural systems that the Eastern Basketmaker people dealt with in the Upper San Juan region over time. I also noted several avenues of research that could greatly increase our understanding of early farming societies, and suggested potential areas where additional early farming sites might be found as illuminated by a review of recent archaeological investigations in the region, including recent experimental agricultural research. These data provide new insights into Eastern Basketmaker II cultural variability and outline new methods to better test archaeological interpretations of the relationships between climate change and the limits of subsistence systems in the Upper San Juan region through time.

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REFERENCES CITED

Adams, E. Charles
1974 Location Strategy Employed By Prehistoric Inhabitants of the Piedra District, Colorado. *Southwestern Lore* 40(1):13–26.
1979 Cold Air Drainage and Length of Growing Season in the Hopi Mesas Area. *Kiva* 44(4)285–296.

Adams, Karen R.
1994 A Regional Synthesis of *Zea mays i*n the Prehistoric American Southwest. In *Corn and Culture in the Prehistoric New World*, edited by Sissel Johannessen and Christine A. Hastorf, pp. 273–302. Westview Press, Boulder.

Adams, Karen R., Deborah A. Muenchrath, and Dylan M. Schwindt
1999 Moisture Affects On the Morphology of Ears, Cobs, and Kernels of a North American Maize Cultivar, and Implications for the Interpretation of Archaeological Maize. *Journal of Archaeological Science* 26:483–496.

Adams, Karen R., Shawn S. Murray, and Benjamin A. Bellorado
2008 Chapter 8: Archaeobotanical Supportive Research Projects. In *Animas-La Plata Project: Volume X-Environmental Studies*, edited by James M. Potter, pp. 145–169. SWCA Anthropological Paper Number 10. SWCA Environmental Consultants, Phoenix.

Adams, Karen, and Judy Paterson
2011 Plant Materials Associated with Falls Creek Rockshelter Burials and Burial Crevice Fill. Manuscript on File, San Juan National Forest, San Juan Public Lands Center, Durango, Colorado.

Adams, Karen, and Kenneth L. Peterson
1999 Environment. In *Colorado Prehistory: A Context For the Southern Colorado River Basin*, edited by William D. Lipe, Mark D. Varien, and Richard H. Wilshusen, pp. 14–50. Colorado Council of Professional Archaeologists, Denver.

Anderson, Kirk A.
2008 Chapter 3: The Early Pueblo I Climate of Ridges Basin–Inferences from Dendroclimatic Reconstructions. In *Animas-La Plata Project: Volume X-Environmental Studies*, edited by James M. Potter, pp. 235–248. SWCA Anthropological Paper Number 10. SWCA Environmental Consultants, Phoenix.

Anderson, Kirk A., and Benjamin A. Bellorado
2009 Chapter 7: Selected Data and Interpretations from Weather Stations in Ridges Basin. In *Animas-La Plata Project: Volume XIII-Special Studies*, edited by James M. Potter, pp. 235–248. SWCA Anthropological Paper Number 10. SWCA Environmental Consultants, Phoenix.

Bellorado, Benjamin A.
2004 Replication of Basketmaker II Roasting Pits From the Durango Area. In *Anasazi Archaeology at the Millennium: Proceedings of the Sixth Occasional Anasazi Symposium*, edited by Paul Reed, pp. 29–34. Center for Desert Archaeology, Tucson.
2007 *Breaking Down the models: Reconstructing Prehistoric Subsistence Agriculture in the Durango District of Southwestern Colorado*. Unpublished Master's thesis, Department of Anthropology, Northern Arizona University, Flagstaff.
2009 Chapter 6: A Reconstruction of Prehistoric Subsistence Agriculture in Ridges Basin. In *Animas-La Plata Project: Volume XIII-Special Studies*, edited by James M. Potter, pp. 215–233. SWCA Anthropological Paper Number 10. SWCA Environmental Consultants, Phoenix.

Bellorado, Benjamin A., and Kirk A. Anderson
2009 Roving Climatic Marginality and Population Movement: Farming Opportunities and Constraints in the Upper and Middle San Juan. Paper presented in the 74th Annual Meeting of the Society for American Archaeology, Atlanta.
Charles, Mona C., and Sally J. Cole
2006 Chronology and Cultural Variation in Basketmaker II. *Kiva* 72(2):167–216.
Charles, Mona C., Leslie M. Sesler, and Timothy D. Hovezak
2006 Understanding Eastern Basketmaker II Chronology and Migrations. *Kiva* 72(2):217–238.
Coltrain, Joan Brenner, Joel C. Janetski, and Shawn W. Carlyle
2006 The Stable- and Radio-Isotope Chemistry of Eastern Basketmaker and Pueblo Groups in the Four Corners Region of the American Southwest: Implications for Anasazi Diets, Origins, and Abandonments in Southwestern Colorado. In *Histories of Maize*, edited by John E. Staller, Robert H. Tykot, and Bruce F. Benz, pp. 275–287. Academic Press, New York
Coltrain, Joan Brenner, Joel C. Janetski, and Shawn W. Carlyle
2007 The Stable- and Radio-Isotope Chemistry of Western Basketmaker Burials: Implications for Early Puebloan Diets and Origins. *American Antiquity* 72:301–321.
Dean, Jeffrey S.
1975 *Tree-Ring Dates from Colorado W: Durango Area*. Laboratory of Tree-Ring Research. The University of Arizona, Tucson.
Eddy, Frank W.
1972 Culture Ecology and the Prehistory of the Navajo Reservoir District. *Southwestern Lore* 38(1 and 2):1–75.
Fuller, Steven L.
1988 *Archaeological Investigations In the Bodo Canyon Area La Plata County, Colorado*. UMATRA Archaeological Report 25. Complete Archaeological Service Associate, Cortez.
Hogan, Patrick, Janette M. Elyea, and Peter N. Eshman
1991 Overview and Research Design for the Fruitland Coal Gas Development Area. Office of Contract Archaeology. University of New Mexico, Albuquerque.
Hovezak, Timothy D., and Leslie Sesler
2006 New Data on Northwest New Mexico's Los Pinos Phase: A Classic Basketmaker II Occupation? *Kiva* 72(2):239–258.
Jones, Vonley H., and Robert L. Fonner
1954 Appendix C: Plant Materials Form Sites in the Durango and La Plata Areas, Colorado. In *Basketmaker II Sites Near Durango, Colorado*, edited by Morris, Earl H. and Robert F. Burgh, pp. 93–115. Carnegie Institution, Washington, D.C.
Kohler, Timothy A., Matt Pier Glaude, Jean-Pierre Bocquet-Appel, and Brian M. Kemp
2008 The Neolithic Demographic Transition in the U.S. Southwest. *American Antiquity* 72(4):645–669.
Laboratory of Tree-Ring Research
2008 Southwest Paleoclimate Project, Palmer Drought Severity Indices (PDSI) annual data for the Durango, Colorado area. Electronic documents on file, Laboratory of Tree-Ring Research at the University of Arizona, Tucson.
LeBlanc, Steven A.
2008 The Case of an Early Farmer Migration Into the Greater American Southwest. In *Archaeology Without Borders: Contact, Commerce, and Change in the U.S. Southwest and Northwestern Mexico*, edited by Laurie D. Webster and Maxine E. McBrinn, pp. 107–142. University Press of Colorado, Boulder.
LeBlanc, Steven A., Lori S. Cobb Kreisman, Brian M. Kemp, Francis E. Smiley, Shawn W. Carlyle, Anna N. Dhody, and Thomas Benjamin
2007 Quids and Aprons: Ancient DNA from Artifacts from the American Southwest. *Journal of Field Archaeology* 32(2):161–175.

Matson, R. G.
1991 *The Origins of Southwestern Agriculture*. The University of Arizona Press, Tucson.
2006 What is Basketmaker II? *Kiva* 72(2):149–166.
Morris, Earl H. and Robert F. Burgh
1954 *Basket Maker II Sites Near Durango, Colorado*. Publication 604. Carnegie Institution of Washington, Washington, D.C.
Muenchrath, Deborah, and Ricardo J. Sandor
1995 Maize Productivity and Agroecology: Effects of Environmental and Agricultural Practices on the Biology of Maize. In *Soil, Water, Biology, and Belief in Prehistoric and Traditional Southwestern Agriculture*, edited by Wolcott H. Toll, pp. 303–333. New Mexico Archaeological Council, Special Studies Publication No. 2, Albuquerque.
Petersen, Kenneth Lee
1988 *Climate and the Dolores River Anasazi*. Anthropological Papers Number 113. University of Utah Press, Salt Lake City.
Phillips Jr., Davis A.
2009 Adoption and Intensification of Agriculture in the North American Southwest: Notes Toward a Quantative Approach. *American Antiquity* 74(4):691–708.
Potter, James M.
2008 Chapter 31: Summary. In *Animas-La Plata Project: Volume IX–Ridges Basin Excavations: Archaic, Basketmaker II, and Limited Activity Sites*, edited by James M. Potter, pp. 298–319. SWCA Anthropological Paper Number 10. SWCA Environmental Consultants, Phoenix.
2010 *Animas-La Plata Project: Volume XVI–Final Synthetic Report*. SWCA Anthropological Paper Number 10. SWCA Environmental Consultants, Phoenix.
Potter, James M., and Joshua S. Edwards
2008 Chapter 12: Vertebrate Faunal Studies. In *Animas-La Plata Project: Volume X-Environmental Studies*, edited by James M. Potter, pp. 243–285. SWCA Anthropological Paper Number 10. SWCA Environmental Consultants, Phoenix.
Reed, Alan D., and Ronald E. Kainer
1978 The Tamarron Site, 5LP326. *Southwestern Lore* 44(1 and 2):1–47.
Robins, Michael R.
1997 Modeling the San Juan Basketmaker Socio-Economic Organization: A Preliminary Study in Rock Art and Social Dynamics. In *Early Farmers in the Northern Southwest: Papers on Chronometry, Social Dynamics, and Ecology*, pp. 73–120. Animas-La Plata Archaeological Project Research Paper No. 7. Northern Arizona University, Flagstaff.
2002 Status and Social Power: Rock Art as Prestige Technology Among the San Juan Basketmakers of Southeast Utah. In *Traditions, Transitions, and Technologies: Themes in Southwestern Archaeology*, edited by Sarah H. Schlanger, pp. 386–400. University Press of Colorado, Boulder.
Salzer, Matthew W., and Kurt F. Kipfmuller
2005 Southern Colorado Plateau Temperature and Precipitation Reconstructions. IGBP PAGES/World Data Center for Paleoclimatology. Data NCDC Paleoclimatology Program, Boulder, Colorado.
Sesler, Leslie M., and Steven L. Hovezak
2002 Synthesis: Cultural and Adaptational Diversity In the Fruitland Study Area. In *Archaeological Investigations in the Fruitland Project Area: Late Archaic, Basketmaker, Pueblo I, and Navajo Sites in Northwestern New Mexico. Volume 1: Introductory Chapters and Synthesis*, edited by Timothy D. Hovezak, Leslie M. Sesler, and Steven L. Fuller, pp. 109–239. La Plata Archaeological Consultants Research Papers No. 4., La Plata Archaeological Consultants, Dolores.

Schlanger, Sarah H., and Richard Wilshusen
1993 Local Abandonments and Regional Conditions in the North American Southwest. In *Abandonment of Settlements and Regions: Ethnoarchaeological and Archaeological Approaches*, edited by Catherine M. Cameron and Steve A. Tonka, pp. 85–98. Cambridge University Press, Cambridge.

Sprague, G.F.
1977 *Corn and Corn Improvement*. American Society of Agronomy, Madison.

Smiley, Francis E., and Michael R. Robins (editors)
1997 *Early Farmers in the Northern Southwest: Papers on Chronometry, Social Dynamics, and Ecology*. Animas-La Plata Archaeological Project Research Paper No. 7. Northern Arizona University, Flagstaff.

Varien, Mark D.
2008 Early Agriculture in the Northern San Juan Region: The Basketmaker II–III Transition. Paper presented in the 73rd Annual Meeting of the Society for American Archaeology, Vancouver, BC, Canada.

Vierra, Bradley J.
2008 Early Agriculture On the Southwestern Periphery of the Colorado Plateau. In *Archaeology Without Borders: Contact, Commerce, and Change in the U.S. Southwest and Northwestern Mexico*, edited by Laurie D. Webster and Maxine E. McBrinn, pp. 71–88. University Press of Colorado, Boulder.

Western Regional Climate Center
2011 Colorado Climate Summary Information. Electronic document, http://www.wrcc.dri.edu/summary/climsmco.html, accessed March 20, 2011.

Wicker, Christy
1997 Morphological Variability of Maize from Selected Durango and Black Mesa Basketmaker II Rockshelters. In *Early Farmers in the Northern Southwest: Papers on Chronometry, Social Dynamics, and Ecology*, edited by Smiley, Francis E., and Michael R. Robins, pp. 121–163. Animas-La Plata Archaeological Project Research Paper No. 7. Northern Arizona University, Flagstaff.