Proceedings of the

ANASAZI SYMPOSIUM
1991

Compiled by
Art Hutchinson & Jack E. Smith
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I would like to welcome you to Mesa Verde National Park on behalf of the National Park Service and the Mesa Verde staff. Thanks to Jack Smith, Art Hutchinson, and my secretary Becky Brock for putting this program together.

The idea for this started back in 1981. We had an Anasazi Symposium here hosted by the National Park Service and the Mesa Verde Museum Association that was quite successful. About four years ago, we started working very heavily on putting together a celebration of the 100th Anniversary of Gustaf Nordenskiöld's work on the Mesa Verde. This symposium is part of that celebration, really the culmination of the centennial. We had a symposium here in the spring on Anasazi Architecture and Modern Design, and that coincided with the opening of the Nordenskiöld Exhibition, celebrating the centennial. We were able to bring some of Nordenskiöld's collection back from Finland on loan from the Finnish National Museum and to obtain loans from the collections of the University of California and also from the State of Colorado. This symposium is the capstone of this celebration to come back and take a look at archeology over the past 100 years.

We do hope that the end result of these next three days will be that you will answer some questions and probably develop some more questions, which is what the science of archeology is all about to find answers in an ever expanding data base.

We hope that the next three days will be productive.
I want to say a few words about James Allen Lancaster. As I thought about how to approach this, I looked through the files at the various things that had been written about Al before, and I came across an excellent little summation of his career in archaeology written by former Superintendent of Mesa Verde National Park Ronald Switzer on the occasion of Al's receiving an honorary degree from the University of Colorado in 1977. I felt that I certainly could not improve on it, so what I thought I would do would be to read this statement and then add a few comments of my own.

"James Allen Lancaster was born in Clifton, Tennessee in 1894. He spent his early years in Oklahoma before moving to Colorado in 1917. In 1919, Al, as he is known to everyone, homesteaded in the southwestern corner of the state of Colorado. His work as a farmer brought him into contact with the prehistoric ruins scattered through the bean fields and sparked a lifelong interest that was to become a vocation as well. Al joined Paul S. Martin of the Colorado Historical Society as a laborer in 1928 and rose to a position of foreman during the excavations at Lowry Ruin. From 1931 to 1933, he served under J. O. Brew as Assistant Director of Peabody Museum of Harvard's excavations at Alkali Ridge. In 1934, he assisted Earl Morris in
stabilization work in Mesa Verde National Park but later in the year resumed work for Brew and the Peabody Museum on the Awatovi Project. From 1939 into the 1940s, Al worked on ruins stabilization projects at Mesa Verde, utilizing Civilian Conservation Corps people and eventually heading his own independent stabilization crew of highly trained professionals. In 1945, he joined the National Park Service officially as a Park Ranger at Aztec Ruins National Monument. In 1946, he transferred to Chaco Canyon as an Archeologist Aid, and in 1947, he returned to Mesa Verde. [Al is generally identified with Mesa Verde, but as you can see, he did a lot of work in various other parts of the Anasazi world as well.]

"Al served with distinction at Mesa Verde until his retirement from the position of Archeologist in 1964. He achieved national renown for his work as an excavator and ruins stabilization specialist, and in 1962, he was presented with the Distinguished Service Award by the Department of the Interior. "Although retired, Al did not slacken the pace of his professional work. He worked with Emil Haury at the University of Arizona’s excavations at Snaketown, the Bureau of Land Management’s excavations and stabilizations at Lowry Ruin, and for a number of years as a consultant to the University of Colorado Mesa Verde Research Center.

"Al Lancaster’s devotion to the field of archeology is manifested not only in his meticulous work in the field but in thorough reportorial work as well. His bibliography at Mesa Verde lists 63 titles, which range from manuscripts covering ruins stabilization projects to major monographs on scientific research of national significance.”

And as I mentioned, in 1977 Al was awarded an honorary degree for his outstanding work by the University of Colorado at Boulder.

There isn’t very much more I can add to this. I didn’t mention his work with the Wetherill Mesa Archaeological Project; he is certainly well known for his work during those years in the 1960s just prior to his retirement. I first came in contact with Al right after that when he began to work with the University of Colorado during our summer sessions when I was associated with that project here in Mesa Verde. I can say that I learned more and better archeology from Al Lancaster than I ever learned anywhere else throughout all the years of graduate school and on-the-job work subsequently. He is a master with a trowel and a brush, and he can see things in a practical way in the ground that I can’t and that a lot of other people can’t. In other words, he has that incredible feel for archeology which is rare enough even among so-called dirt archeologists.

It has been a privilege and an honor to have been able to work with that man, and it is definitely a privilege and an honor for me to be able to stand here and dedicate this symposium to James Allen Lancaster.

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**Addendum**

James Allen Lancaster died at the age of 98 on October 28, 1992, just a little more than a year after the 1991 Anasazi Symposium which was dedicated to him. As it turned out, this was our last opportunity to honor a man who had done so much for Mesa Verde archeology in particular and for southwestern archeology in general. Al was able, along with his wife Alice, to attend the annual Old Timers Picnic in Mesa Verde National Park in August 1992. Although physically slowed down by advancing age, his mental powers were undiminished. And so it was right to the end.

With the passing of Al Lancaster, an era in southwestern archeology has come to an end. Things will never be quite the same. He will be deeply missed by all who knew him.
INTRODUCTION OF KEYNOTE SPEAKER

Art Hutchinson

It is a very distinct honor to have Al Lancaster present for the opening of this symposium. I would like you all to consider that Mr. Lancaster was born only three years after Gustaf Nordenskiöld’s significant visit to this now famous World Heritage Site. Al’s presence here at the 1991 Anasazi Symposium provides us with an important historical tie with a century of Mesa Verde archeology. On behalf of all of the participants in this Symposium and the National Park Service, I would like to say thank you, Al, for taking the time to come up to the park and be with us for the opening of the Symposium.

1991 represents an important milestone in the rich history of Mesa Verde. This year marks both the 75th anniversary of the National Park Service and the 85th anniversary of Mesa Verde National Park’s establishment. It is worth noting that Mesa Verde National Park predates the beginning of the National Park Service by a decade. 1991 is made even more unique and special by the 100th anniversary of the visit to this important place by the Swedish scientist and traveler, Gustaf Nordenskiöld. A special paper will be given during this Symposium on the subject of Mr. Nordenskiöld’s visit and some of the controversy surrounding the removal of artifacts from this country.

Mesa Verde is extremely proud of our special exhibition that focuses on the life and archeological work of Mr. Nordenskiöld. The staff of the park invites you to visit the exhibit, which has had its opening venue here in the park this past summer. It will travel to selected sites around the country for about two more years. We are also pleased to have hosted two very special symposiums during this centennial year. The first focused on the continuing importance of Anasazi design and architecture in the twentieth century. The second is, of course, this symposium that we are now assembled for.

As this symposium was being planned, we naturally wanted to have an opening speaker who we felt would be not only stimulating but
maybe very provocative. Lo and behold, Dr. David Stuart’s name came to mind. His program, which was given this spring at our Architecture Symposium, was extremely interesting and well received. We felt that he would provide this fall symposium with a very appropriate kickoff. I am certain you will agree.

Before I let Dr. Stuart begin, I will follow convention and discuss a little bit of his background with you. Dave grew up in the coal country of West Virginia where his father was a country doctor. His interest in archeology began at a very early age. Specifically, in his teen-age years there was a mitigation project being undertaken by the state highway department. The department was trying to avoid some of the many archeological mound sites as they built roads through the hills near the family home in West Virginia. He accepted a summer job working with an archeologist on the road project. Archeology soon got in his blood, and he decided to pursue the subject in college.

Dave soon learned that there really wasn’t much of a graduate or even probably an undergraduate program in West Virginia in archeology at that time. Good fortune prevailed, and he learned of an opportunity at the national university in Mexico City. A language was learned very quickly. He said this was a “sink or swim” type of experience. Needless to say this experience and ability to speak Spanish has served him very well since.

Dr. Stuart has had a distinguished and varied professional career. In particular it is noteworthy, for the purposes of this conference, that he has extensive experience in cultural resource management projects with the University of New Mexico. Few people are more familiar with the extent of the archeological resources in northwestern New Mexico. His field experience certainly places him in a unique position to provide us with an excellent overview of the rich archeological resources in the landscape south of the Mesa Verde.

Presently, he wears two different hats at the University of New Mexico. His main position is that of Vice President for Academic Affairs. As part of his Academic Affairs position he has instigated a very successful night class program. It is interesting to note that the University of New Mexico currently has about 12,000 students pursuing full degrees in evening courses in Albuquerque. Dr. Stuart’s other position is that of Associate Professor of Anthropology. Despite a busy administrative schedule, he still teaches three courses per year.

Our keynote address will focus on the archeology of this part of the Southwest, and how this knowledge can be applied to more contemporary social issues. Those of us who work with the visitors at Mesa Verde National Park realize how very important it is that the work of archeologists becomes both available and interesting to the general public. For example nearly three quarters of a million visitors travel to Mesa Verde National Park each year to get a glimpse of the ruins. I know from experience that most really want to know what life was like seven centuries ago. Archeology can be a powerful educational tool; it can also be seen as an irrelevant and an unnecessary expense in an era of tight budgets.

As archeologists, we should strive to make the study of the past more interesting and educational. Yes, archeological reports are important. However, we must go further and produce a variety of media that is more relevant to the general public.

One example of how archeologists in the past have successfully made the subject extremely interesting comes to mind. Most of you are familiar with the dioramas in the museum. They were constructed in the 1930s. The public still finds these to be both fascinating and informative. Simply stated these models serve to make archeology more useful to a lay audience.

This point was made in about 1970 in American Antiquity by Fritz and Plog. I will quote a passage to help emphasize the importance of making archeology germane to a broad audience.

We suspect that unless archeologists find ways of making research interesting or relevant to the modern world, the modern world will find itself
increasingly capable of getting along without archeologists.

Dr. Stuart’s approach addresses their concerns. I know that you will find the keynote address thought provoking. His conclusions are, in Fritz and Plog’s words, “both interesting and relevant to the modern world.”

Dr. Stuart, welcome to Mesa Verde and the 1991 Anasazi Symposium.
KEYNOTE ADDRESS

PATTERNS IN ANASAZI ARCHEOLOGY A.D. 800-1300: SOME NEW LESSONS FROM THE PAST

David E. Stuart

Introduction

It is an honor to present the keynote address at this Anasazi Symposium, particularly because I count many of you in the audience among those colleagues whom I most admire. My task today is neither to review traditional lines of research nor to take anyone to task for current styles of explanation. Indeed, as archeologists, we all look back on the Anasazi world from the perspective of our data and do our best to squeeze meaningful information from the clues left us in architecture, artifacts, settlement patterns, or the modest traces of organic materials deposited a millennium ago. We then use these clues as best we can to construct hypotheses, test them, and piece together the accounts that we believe make the best sense of the Anasazi, including ruins around us here at Mesa Verde. Today, I seek to convince you that if we truly stand back from the details of traditional archeological analysis, there are still new and exciting lessons to be learned from the past—lessons which also inform on the social dynamics of our own times.

Specifically, there are two themes I wish to address here with the hope that both might stimulate thinking along new lines. First, there are fundamental similarities between the growth cycles of Anasazi society from A.D. 800 to A.D. 1300 and those of “our” Euro-American industrial society since the late 1700s. Our “industrial” world has grown, surged powerfully, and begun to transform (often dramatically) other, more traditional, societies that interact with us. We now call these other countries “Third World.” Just as “modern” industrial society has engaged a trajectory of remarkable growth and change, leading at times to a frenzy of creation, so also did Anasazi society go through quite similar episodes.

More to the point—in every great episode, or era, of creation, there are also unleashed hidden forces of destruction. Indeed, humans as no other species live, create, destroy, and die in elegant, repetitive, testimony to the Doctrine of
Unintended Consequences. Archeology, then, is best conceived not as the study of great societies inexorably succeeding one another in time but as the formal analysis of these recurring cycles of creation and destruction.

Here at Mesa Verde on the northern edge of the San Juan Basin, the Anasazi once went through these great cycles, then abandoned this region, leaving us to rediscover the details. We have many modern parallels. Even though America itself hasn't been abandoned, bits and pieces of it certainly have, even as the overall society survives and is transformed. Whether one looks backwards to the Anasazi world of A.D. 1050-1150 and talks about general "resource depletions," abandonments, migrations, and changes in settlement patterns, or one looks at the obsolescence, dying, failure of infrastructure, and out-migrations from "rust belt" factory towns in the contemporary United States, it amounts to the same phenomenon.

Both of the above patterns reflect an ebb and flow in the life cycle of societies which we neither perfectly control nor perfectly understand. In both cases the archeological record will have striking similarities: empty "city" cores, abandoned work areas (or factories), unstable residential ("bedroom") communities, deserted rural hamlets, and dying infrastructure. These similarities are so striking—not because history repeats itself, but because process does. These underlying processes can be most readily understood as adaptive cycles of "power" and "efficiency." (Stuart 1991; Stuart and Gauthier 1989).

My second theme today invokes the taxonomic and classificatory aspects of archeology used to interpret the shifts in eastern Anasazi settlement patterns clearly in evidence from about A.D. 800 to 1300. This topic merits revisitation with an open mind. The Pecos classification and similar, more local, chronologies have given us enormously useful explanatory frameworks which have guided us for more than half a century; but the sheer size and magnitude of the archeological data base (nearly 90,000 sites in New Mexico alone) which we have available now allows us insights which exceed the explanatory power of these traditional chronologies. We owe it to ourselves, and to our students, to rethink these issues with a sense of fresh excitement. In short, my themes today are the cycles of power and efficiency which drove Anasazi society, the parallels to our modern world, and the inadequacy of traditional chronologies to make the best sense of these awesome evolutionary rhythms.

Patterns in the Archeological Record

There are striking patterns in Anasazi archeology and architecture which have not yet been sufficiently analyzed in the literature. The first of these is the fundamental rhythm of rise, instability, decline, and reorganization. There are multiple, repetitive episodes of florescence and nascence in the Anasazi world. Traditionally we have focused primarily on only the most dramatic episodes of growth and expansion, therefore failing to perfectly apprehend the elegance of the underlying rhythm.

The second of these patterns is more specific, but related to the first. This pattern involves changes in Anasazi architecture from small rooms to episodes of maximal diversity in room size and function which are generally followed by rooms of rather uniform, intermediate size. Then the cycle begins anew. These changes in room size are quite systematic and related to, but not perfectly synchronous with, the more obvious ebbs and flows in Anasazi economy, technology, and demography.

The third of these fundamental patterns involves dramatic shifts in settlement patterns and how Anasazi population regularly resituated itself, geographically, to best take advantage of the environment at a given time. I view these systematic changes in room size and settlement patterns as two important reflections of the contrasting states in the life cycle of a society, first described elsewhere (Stuart and Gauthier 1989), as phases focused on "power" versus "efficiency."

A powerful phase in society is one characterized by rapid rates of change, remarkable growth, high energy inputs and outputs, and complex structures—whether
architectural, artifactual, or social and organizational. In contrast, an efficiency phase is one characterized by a relatively close balance between energy entering and energy exiting a system. In an efficiency phase, change is modest, diversity is replaced by homogeneity and the "pace of things" slows down dramatically. Formal structure of all kinds is simplified, and energy becomes so precious it cannot be "wasted" on elaborated structures.

Though modern archeology hasn't generally acknowledged it, most things in the natural world are subject to these rhythms. In economics, they are recognized and referred to as cycles of "boom" and "depression." First described by the Russian, Kondratieff (Haberler 1958), others refer to them as Marshallian long waves (Marshall 1890). Clearly, in modern industrial society, we identify long economic cycles. On average, each economic cycle lasting about 50 years first expands (the power phase) then becomes unstable before a depression (the efficiency phase) recurs. Should we be surprised that the Maya world recognized cycles of 52 years in its calendar set. Surely this is more than mere coincidence!

Here in the ancient Anasazi world, we have abundant evidence of similar patterns. Building episodes at the larger villages in and around the San Juan Basin certainly weren't continuous—they surged then waned, as Lekson (1986) has so clearly demonstrated at Chaco Canyon. Vivian's (1990) more recent opus not only amplifies and confirms Lekson's earlier findings, but demonstrates this pattern to have prevailed in many localities throughout the San Juan Basin.

The stage for the rise of Chaco-Anasazi society was first set in the early A.D. 800s. In a series of complex transformations beginning at this time, the Pueblo I Period, itself a transformational phenomenon, entered a growth period which culminated, architecturally, in above-ground masonry "pueblitos." Several characteristics of this period merit close scrutiny. Typical early Red Mesa (and similar) Phase pueblos in and around Gallup, New Mexico built between the A.D. 820s and 850s contained six, eight, ten rooms of modest, but rather uniform size. These replaced the larger (in square meters) but nearly contemporaneous pithouses of the Late Pueblo I Period. Throughout the eastern Anasazi country, new pottery styles (Red Mesa Black-on-white, etc.) and changes in the technological accouterments of daily economy were in full bloom.

Even more interesting is the fact that an increasing number of small Red Mesa farmsteads were built in relatively open basin settings throughout the Anasazi country. By the early A.D. 900s, farmers were clearly expanding their settlements into micro-niches which had not previously been heavily used during the pithouse periods.

These changes in ecological niche are important. Reggie Wiseman (cited in Stuart and Farwell 1983) tree-ring dated several late "Basketmaker" pithouses near Gallup in the early to mid A.D. 800s, contemporaneous both with nearby Pueblo I sites and with the earliest of the Red Mesa "pueblitos." What a situation for advocates of an unmodified Pecos Classification! Clues to the dynamics of this situation are still tentative, but the "last" of the Basketmaker settlements appear to be in higher, colder settings while a disproportionate share of Pueblo I sites tend to be a bit lower in elevation, near the foothills. In contrast, the Red Mesa sites were increasingly (over the next generations) built further and further out into the lower open basins.

Thus, the A.D. 800s represent a very complex period—one of enormous ecological and economic experimentation, which likely included both rapid population growth and testing of new micro-niches. By the early A.D. 900s, fully developed Red Mesa style pueblos were literally spreading like wildfire across the dryer western basins of New Mexico and into similar, adjacent areas in Arizona, Utah, and southern Colorado. In New Mexico's San Juan Basin, "housing starts" were at an all-time high. This powerful surge in construction culminated in the "Chaco-Anasazi."

We desperately need to understand population dynamics of the A.D. 800s and early 900s, but data from burials sufficient to reconstruct true population pyramids (with good chronological control for the San Juan
Basin) may never be available. Unfortunately, Eighmy's (1981) ethno-archeological work clearly demonstrates that room counts alone are unreliable for population reconstruction because any particular point in the demographic lifecycle of a given community is far more important as a population indicator than is "square footage under roof."

In any case, eastern Anasazi society had begun to "pump up" and go into a frenzy of building activity between A.D. 900 and 950. This is the first of several distinct Chaco-Anasazi "power phases." Architecture rapidly became more complex and diversity in room size and function also increased dramatically. Indeed, in the larger San Juan Basin pueblos, chronologically distinct episodes of construction each tended to create rooms of different size (in spite of room suites). As the overall index of diversity in room size peaked, this first Chacoan power phase began to "over-heat" and could not be sustained. Not surprisingly, such surges in construction at Pueblo Bonito were followed by "cooling off" periods. Dramatically high diversity indices in room size come late in a power phase and are difficult to sustain over time, hence, the distinct episodes of construction as noted by Lekson (1986), Vivian (1990), and others.

This first of several Chacoan power phases (900-950) also generated distinctive and diverse kinds of sites and site functions. By A.D. 950 we can talk about farmsteads, district trading villages, outliers, and the growing core in Chaco Canyon (Judge et al. 1981). Though each of these particular elements was on a somewhat different scale of size and complexity, the net effect was the creation of a regional "system." This power phase burned itself out right on the schedule noted for industrial society, about A.D. 950. There followed a quieter period of reorganization and lack of dramatic construction at most of the larger sites. We need to know much more about the late A.D. 900s. They should have been focused on "efficiency" rather than "power." By the early A.D. 1000s, a second wave of growth took hold. New building took place at Chaco Canyon and at emerging outliers, geographical patterns of ceramic trade changed, the old Red Mesa Valley was no longer vibrant, and ceramics from the east slope of the Chuskas became more important.

By about A.D. 1050-1060 another surge of growth crystallized and new layers of complexity were added. Sites like Pueblo Pintado were hurriedly built where no natural growth nodes already existed. These have been called "scion" communities. The road system was also formalized and extended, and the techniques of masonry construction at the larger "Bonito" sites became needlessly meticulous. Minor efficiencies may have been gained by the roadways, and some excess labor may have been absorbed by projects like Pueblo Pintado, but these gains did not abort rising system-wide economic and demographic tensions—there is ample evidence for high infant mortality and poor nutritional status in many pockets of small farmsteads at this time (Tainter and Gillio 1980).

These reorganizations in the mid A.D. 1000s set the stage for the most remarkable "power phase" in all of Anasazi prehistory—the "Classic Bonito" period from about A.D. 1075 to 1120. Lekson (1986) has argued that energy invested in construction quadrupled at Chaco Canyon during this time period. He is undoubtedly correct. It might be useful to recall that our (U.S.) national debt has also quadrupled in the last dozen years, following the economic reorganization of American society after the recession of 1981-1982. In any case, about A.D. 1075 the Chaco-Anasazi entered into a virtual frenzy of construction, which led to the greatest indices of diversity in room and site size and function ever experienced until that time. But power phases are difficult to sustain—especially when they mask deep-rooted economic and structural weaknesses. Life may have been good in the large Chacoan "towns" and outliers, but, judging from skeletal remains, it had become increasingly fragile and miserable in the small, outlying hamlets.

For example, in small pueblos near Gallup at roughly A.D. 1100 Tainter has cited evidence (Tainter and Gillio 1980) that infant mortality was approaching 50 percent. That is an appalling statistic—and is in sharp contrast to the picture of robust, adult burials (though
scarce) found in the large Chacoan towns. In other words, at A.D. 1100 if you were a modest farmer, but had "connections" in the Chacoan world, you would likely have used them to get into a large Chacoan town and escape the small farmsteads. Is this why the road segment to Manuelito Canyon (Stein et al. 1991) was closed by a great earthen berm some time in the early A.D. 1100s? Had a number of the larger existing towns absorbed all the outlying population they could by that time? It appears so!

We now know that small farmers in many districts abandoned their pueblitos in droves by the late A.D. 1000s. A recent generation of research through "contract archeology" has often focused our attention on small site archeology and the fact that, starting in the last decades of the eleventh century, small pueblos began to be abandoned in surprising numbers, even as major building episodes peaked at the larger Chacoan outliers and "towns."

I argue that by A.D. 1100 the behavior of the Chaco-Anasazi was quite similar, in principle, to the behavior of American society during the Great Depression. In the 1930s WPA and CCC projects absorbed huge quantities of excess labor and population dislocated from rural areas. Enormous infrastructure (roads, dams, schools, national parks) was created, simply for the sake of "pumping-up" and sustaining our society. When this didn't altogether end the depression, the U.S. edged toward World War II by first mobilizing its industrial base into a blatant power phase—making huge quantities of war material at frenzied assembly line rates. As America reenergized its industrial base, the nation became obsessed with the ideas of "freedom" and "democracy" until, like a coiled spring suddenly released, it projected its unused power outward on three major military fronts at once and directly engaged World War II. If we apply these analogies to the Chaco-Anasazi, we must acknowledge that their productive agricultural base in the simple farmsteads was disintegrating by A.D. 1100, even as they organized one of the greatest regional building episodes in North American prehistory (though, much larger individual pueblo sites were built centuries later in the Pueblo IV Period). Marshall (1991) and Stein et al. (1991) have both argued that many late roads and architectural features were organized explicitly on religious and cosmological principles. Is this so different from our own obsession with "freedom" and "democracy" in hard times or in periods of intense international competition? I think not. Were the late Chacoan "watchtowers" somehow like our own DEW-line radar systems and missile sites—a conveniently paranoid response to a plausible competitor which made it necessary for our society to be ever-ready (and powerful) in order to deal effectively with the "evil Russian Empire"? The irony, of course, is that this "empire" turned out to be merely a hollow shell. Frankly, I find this analogy tantalizing!

Gauthier and I noted more than a decade ago (1989) that 43 percent of all the archeological sites ever recorded in northwest New Mexico were constructed in the 150-170 year period from about A.D. 950 to 1120. We now know from both Lekson's (1986) and Vivian's (1990) work that the very peak of this activity came in Chaco's final hours. When 43 percent of all the visible archeology from a 10,000 year span of human occupation was created in only 1.7 percent of those years or fewer, it is not only a power phase, but a very dramatic one! Modern America would have to build 12 million new houses a year for four years (of its 250 year span) to match this feat. Yet, we have never built more than 2 million in any one year.

By A.D. 1140 the last Chacoan stronghold, Bis sa'ani, in the original San Juan Basin heartland had already been built (Marshall and Doyel 1981). Archeologically, there follows a genuine successional break which separates the Chaco-Anasazi from the adaptations of the ensuing Upland Period. What went wrong? In the most general sense, the power and energy necessary to sustain late Chacoan society could no longer be marshalled, so it fell apart, piece by piece—not all at once. Complex societies typically collapse in episodic bursts, according to their particular layers of complexity. Hence, there is a continuing debate over the length of occupation at particular Chacoan towns. This is not surprising for, like
the U.S. in 1991, many industries, social institutions, and value systems are all failing, even as a few (“the rich”) continue to prosper. As a great power phase extinguishes, a dozen important aspects of daily life seem to disappoint us a bit more each day, until crushing pressures arise to yield massive, unpredicted transformations. Archeologically, the end of a power phase is predicted by both the final frenzy of growth rates (typically in artifacts and architecture) and remarkable diversity in site, room, and artifactual size and function.

So, let us look at post-Chaco transformations in the early to mid A.D. 1100s. Partial abandonments from the Chaco-Anasazi heartland by small-time farmers and those who could not be absorbed into the larger Anasazi villages accelerated in the early 1100s. These people literally “voted with their feet” and moved into virtually every upland area surrounding the San Juan Basin: the Chuskas, the Zuni Mountains, the El Morro Valley, the Gallina Highlands, the Pajarito Plateau (Bandelier National Monument), and the Mesa Verde country (Stuart 1989). In most of these regions, it is reasonable to suppose that there was already some local population base, but most upland areas had not been the focus of residential occupation in the period between roughly A.D. 950 and 1100, hence, the common upland pattern of late Basketmaker or Pueblo I sites overlaid by “Pueblo III” components of the A.D. 1100s and 1200s. In short, the Chaco-Anasazi power drive took place in the lower basins. When it burned itself out, society reorganized along more efficient lines in another ecological setting—ponderosa studded uplands. First, people returned to ancestral places in the uplands. Then new ecological niches in isolated mountain coves and cliff faces were exploited. In many upland areas, the first resettlements consisted of pithouses, dated to the A.D. 1150s (Stuart and Farwell 1983). These were a particularly efficient form of architecture and rather uniformly-sized. Often only two or three local ceramic types are found in such sites—not the twenty or more trade wares typically found in late Chacoan villages.

The remarkable diversity of Chacoan architecture and material culture was replaced by uniformity, efficiency, and comparative homogeneity in the uplands during the mid A.D. 1100s. Many of the earliest Upland Period ceramic types have been characterized in excavation reports as “crude,” “atypical,” “retrograde,” etc. Isolated pithouses of this period have been found in virtually every major upland area of the Southwest (Stuart and Farwell 1983). Many have been dismissed as “anomalous” (the Gallina complex), “misdated,” or as “isolated great kivas” (typically without benefit of excavation).

These sites are, nonetheless, as important to understanding Anasazi chronology and settlement patterns as are the late Bonito Phase towns. These pithouses not only suggest that a significant percentage of Anasazi population was geographically and economically ejected from the late Bonito Phase villages in the heart of the San Juan Basin, but perhaps also from the last of the larger lowland settlements mimicking late Bonito Phase society in southern Colorado and west-central New Mexico. John R. Stein and Michael Marshall (site survey forms in the ARMS file) have both surveyed “Chacoan” sites in the Quemado area, which they believe were founded in the mid to late A.D. 1100s. Others may exist in areas like the Montezuma Valley. As research proceeds at Lowry East and at complex settlements like Yellow Jacket, Chimney Rock, and Sand Canyon, we will likely learn much more about the final collapse of “Chacoan society.”

Personally, I expect that a number of late “Chaco style” sites in lower elevations (like the Montezuma Valley) will be more precisely dated within the A.D. 1140-1200 period, for it would demonstrate that pockets of population attempted to carry on the “Chaco-Anasazi” power phase in an ecological setting similar to the San Juan Basin, even as such sites were surrounded by a sea of efficiency-oriented pithouses and pueblitos in the “new” Upland ecological niche.

Taxonomically, these modest pithouses are also important, for they separate, chronologically and architecturally, the late Bonito Phase villages (classified as Pueblo III)
from the impressive “cliff houses” of the early to mid A.D. 1200s, found throughout the uplands of the northern Southwest (also classified as Pueblo III). However archeologists eventually deal with this anomaly of the Pecos Classification, Pueblo Bonito and Cliff Palace at Mesa Verde were created by two different power phases. These two distinct periods are separated by, at the least, a century, a major ecological zone, 500 to 1000 feet in elevation, and a period of dramatic, intervening reorganization (Stuart 1989, 1991; Stuart and Gauthier 1989; Vivian 1990).

In the early Upland Period, the small farmers likely moved in first, followed by later waves of basin populations as the larger Chacoan settlements collapsed in the mid 1100s. It is quite clear that there was enormous local conflict in the Gallina Highlands during the mid A.D. 1100s (Dick 1976) between in situ upland populations and outsiders. Conflict and competition both tend to set a power phase in motion. Indeed, in highly competitive situations, power-oriented adaptations have the short-term advantage, whereas efficiency is highly adaptive in long-term survival (Stuart 1991; Stuart and Gauthier 1989). Not surprisingly, local conflict brought new complexity in room and site size and function to the archeology of the Gallina Highlands. A modest building boom in towers and sandstone strongholds quickly replaced the more efficient pithouses by about A.D. 1175 to 1200.

Elsewhere, as on the Pajarito Plateau and at Taos, local uplands were not already heavily inhabited, so the efficient pithouses quickly gave way more peacefully to the reintroduction of smallish masonry pueblos characterized by remarkable uniformity in room size (Steen 1977). A modest building boom in towers and sandstone strongholds quickly replaced the more efficient pithouses by about A.D. 1175 to 1200.

Cliff houses face south, southeast, or southwest and are like large solar collectors. Anyone expert in the archeology of the Upland

About A.D. 1175 in the uplands of the Four Corners, sites like the Santa Fe Black-on-white pueblitos excavated by Charlie Steen (1977) and Worman became the norm. They are characterized not only by comparatively uniform, intermediate room sizes, but by new styles of pottery (particularly black-on-whites) and the reintroduction of some trade wares, typically late St. John’s Black-on-red or St. John’s Polychrome. Clearly, the final decades of the twelfth century saw the redevelopment of a trade network which extended over a large geographic area. This network interconnected widely separated pockets of upland settlements, from Taos to Arizona and southern Utah. It did not focus on reconnecting the basin lands once tied together by trade during the salad days of the Mimbres and Chaco-Anasazi.

Thus, when Carlson (1970) asserted, in his classic monograph on the White Mountain Red wares, that St. John’s Polychrome was the most widely traded pottery in the ancient Southwest, he was correct. But he failed to note that this pottery defines an elevational band of settlement in the late twelfth and early thirteenth centuries which extended from roughly 6000 feet to 7500 feet above sea level (Stuart and Farwell 1983). Perhaps 90 percent of the White Mountain Red wares are found in this elevational band, simply because a similar proportion of the twelfth and thirteenth century Anasazi also lived in that zone. What then of Mesa Verde and the kinds of Upland Period ruins that we see around us today—the “cliff palaces” both great and small? These reached their heyday in a rather narrow time span between roughly A.D. 1200 and A.D. 1250-1270, depending on precise location. Though these, too, are “Great Pueblos” in the vernacular sense, they are rather unlike large Chaco-Anasazi towns in the terms emphasized herein. In short, though large and complex in comparison to simple Santa Fe Black-on-white pueblos, they are focused far more on efficiency than on power.

Cliff houses face south, southeast, or southwest and are like large solar collectors. Anyone expert in the archeology of the Upland
Period, including the legendary Al Lancaster sitting here today (who forthrightly reminded me of certain important aspects of cliff site placement on the way to the airport after my oral address had piqued his interest), can tell you that there are precious few, if any, cliff houses facing north. Their solar properties minimized the need for firewood. Moreover, they are well-located defensively, and strategically placed farmlands lie both above, on the mesa tops, and below, in the canyon bottoms. Typically, there are springs nearby or streams in the canyons below. These cliff palaces are far more like small, feudal towns than like the huge, open network of Chacoan farmsteads, towns, and roads that characterized the San Juan Basin in the late A.D. 1000s.

Still, the period from A.D. 1200 to 1270 merits much more research. Cliff-face villages were not the only focus of Anasazi society (Rohn 1977). Adaptation to the uplands, following the decline of Chaco, radically altered daily economy. Highlanders of the twelfth and thirteenth centuries farmed small-cobbed corn and hunted large game, as well as gathered seasonal vegetal resources. In contrast, both the Chaco and Mimbres societies focused on a diet characterized by large-cobbed corn and small game animals. The Upland Period economy represented a rather striking reversal of the older Chaco-Anasazi pattern. We need to know whether small-cobbed upland corn is a function of cold nighttime temperatures and short growing season or of genetic selection or both.

There are also other things we need to know. Even as cliff-face settlements at Mesa Verde, Bandelier, and Canyon de Chelly prospered, Pindi Pueblo (Stubbs and Stallings 1953) was founded in an open setting along an arroyo at a lower elevation south of Santa Fe. By the 1200s some “Mesa Verdean” peoples had also reoccupied a number of Chacoan villages in the San Juan Basin, dividing huge Bonito Phase structures into smaller “apartments” (Noble 1984), as newcomers to once grand, but declining, American neighborhoods still do.

Pindi Pueblo was soon abandoned for a time, and Mesa Verden settlement of the Chaco country was spotty, brief, and half-hearted. Clearly, the Upland Period adaptations of the early thirteenth century were temporarily far less geographically focused, stable, and powerful than the earlier Chacoan one. In the A.D. 1220s (Stuart and Farwell 1983) pithouses were again being built, though they did not endure. By the mid A.D. 1200s the focus of growth had again consolidated in the uplands, so that phase of the Upland Period was characterized by large mesa top sites with small rooms, followed by increasing site size and a rapidly rising index of architectural diversity.

The power phase of the late Upland Period, though modest by Chacoan standards, also came in that period’s final flourish, leaving a surprising number of impressive mesa top sites, from Grasshopper in Arizona, to Site 616 at Marianna Mesa in west central New Mexico, to LA 12,700 (Stuart and Gauthier 1989) above Guaje Canyon on the Pajarito Plateau. A short-lived “Coalition” period in the late thirteenth century (Wendorf and Reed 1955) was far more widespread throughout the Southwest’s ponderosa zones than merely in the northern Rio Grande District.

Apparently, by the late A.D. 1200s, agricultural production, site size, and trade in the 6000 feet to 7500 feet zone had been maximized to the extent possible. But this Late Pueblo III adaptation remained quite fragile. Whether Upland Period society collapsed due to droughts or variability in rainfall that marked the late 1200s, aggressive new populations moving into the area, depletion of local resources, interclan squabbling, or some combination of the above, we may never know in precise detail. On the other hand, there is a striking overall pattern to the chronology of Upland Period abandonments in the late A.D. 1200s which has not been fully considered. If one relies on published clusters of tree-ring dates to assign the decades of probable thirteenth century abandonments in the uplands, it is quite clear that mesa tops and mountainous districts which slope to the west (and were, therefore, drier) tended to be abandoned earlier than similar areas which slope to the east (and are more verdant).

For example, on the drier, western face of
the Gallina Highlands, typical abandonment
dates at the masonry tower complexes and cliff
ruins fall in the late 1230s to late 1260s. In
contrast, on the lusher Pajarito Plateau, which
faces east, and on the east face of the Sandia
Mountains, Upland Period abandonments
typically came in the 1270s, 1280s, and 1290s.
This pattern is undoubtedly related to climate.
Gauthier and I (1989) once argued a shift in the
seasons of precipitation. Other scholars cite the
Great Drought of the late A.D. 1200s as recorded
in Mesoamerican ethnohistorical sources, while
still others (Cordell 1984) emphasize that there
was more dramatic year-to-year variation in the
quantity of rainfall after A.D. 1250.
Whatever the precise details, this pattern of
abandonments simply would not have been
geographically widespread had climate not
played a significant role in breaking the fragile
late Upland Period economy. It is no accident
that during this period water control devices,
grid gardens, cobble-mulching, and reservoir
features all proliferated dramatically in and
around the large mesa top sites of the mid to late
A.D. 1200s.
As the A.D. 1300 horizon neared, most of the
large plaza sites on the mesa tops and the cliff
palaces (in all but a few east-facing localities)
had been abandoned. Yet another Anasazi
power phase had ended. In the area around
Cochiti Reservoir another episode of pithouse
construction followed. These tended to be
shallow and rectangular. They are located in
bottomlands near perennial streams, with
typical dates of A.D. 1300 to 1310. Again, in at
least the Rio Grande District, the Upland Period
power phase ended, and efficient pithouses were
built in yet a new ecological setting. That setting
is important—starting about A.D. 1290,
settlement shifted forcefully downhill, primarily
along east- or south-flowing streams in areas
like Zuni, the Pajarito Plateau, the Cochiti
district, the Taos area, the Sandias, and the
Acoma/Laguna area on the east face of Mt.
Taylor.
At Bandelier (Stuart 1989) one can literally
go from Frijolito Ruin on the mesa top above
Frijoles Canyon (late Santa Fe Black-on-white) to
Tyuonyi in Frijoles Canyon (founded A.D. 1270-
1290), to Rainbow House, one-half mile
downcanyon (from ceramic cross-dating,
founded shortly after Tyuonyi), to House-across-
the-way (founded about A.D. 1310-1320) which
is now submerged under Cochiti Reservoir near
the Rio Grande, then south to Old Cochiti
(founded in the 1400s), and finally to
contemporary Cochiti Pueblo, at 5200 feet
elevation. Each one is located further east and
further downstream over the course of time.
These movements are typical of the late 1200s to
early 1300s in many Anasazi districts.
Here, the Pecos Classification serves us
fairly well—A.D. 1300 was the point in time
when the Anasazi began their final
transformation, traditionally called "Pueblo IV."
By A.D. 1300 to 1325 population had aggregated
in lower elevations along permanent rivers like
the San Jose, the Nutrea, the Pescado, the Upper
Pecos, the Rio Grande, and the Gila and Salt
rivers in Arizona. Anasazi populations that
prospered beyond the A.D. 1300 horizon
typically (yes, Hopi is an exception) did so along
rivers, so it is useful to think of the Pueblo IV
Period not as merely the "Rio Grande Classic"
but, as a much more widespread "Riverine"
Period. Once the Riverine Period was
established, the cycles of small rooms, growth in
site size, increasing architectural diversity,
interrupted power phases, and renewal began
anew.

Archeological Indicators of Power and
Efficiency
Anasazi society, like our own, went through
several identifiable cycles of power and
efficiency. Between roughly A.D. 950 and the
early 1100s, its most dramatic power phase
(though it faltered occasionally) we now call the
"Chaco Phenomenon." It, like the classic
Mimbres, was a basin lands adaptation.
A second, lesser, but visually exciting power
phase in the highlands of the Southwest began
around A.D. 1200 and ended by 1250 to 1290,
depending on location. We now call this "Late
Pueblo III," or "Mesa Verde," but it is a
widespread upland adaptation and separate
from the "Pueblo III" sites of the Chacoan
Period. We confuse these taxonomically because we have not focused sufficiently on the intervening efficiency phase or on the chronological and eco-zonal differences which separated these two distinct “Pueblo III” periods. Finally, a third power phase, traditionally called the “Rio Grande Classic,” is best understood as a widespread Riverine Period adaptation, with episodic returns to the uplands in several well-watered localities.

Between each of the power phases there are less well known efficiency phases. During these, one finds modest, often isolated, sites with unimpressive ceramic inventories, pithouse architecture, and/or moderately-sized pueblos with surprisingly uniform, intermediate room sizes. Those indicators mark these as periods of stressful readaptation to new economic, ecological, and social conditions.

In contrast, during the early part of a power phase “housing starts” are high. Later in the power phase, there are often several “pauses” (A.D. 950-1000 and A.D. 1050-1070 in the Chaco Phenomenon may be examples) necessary to conserve energy. As the power phase ages, enormous diversity in room and site size and function emerges. When the point of maximal diversity has been reached, unnecessarily complex infrastructure is often created in a frenzied burst of activity (empty office buildings created with savings and loan money during the 1980s in virtually every sizeable U.S. city would be useful as a modern analogy) because the aging power drive is attempting to stabilize, or “pump-up,” a failing system.

There is then a successional break in society, technology, and economy. At about A.D. 1150 such a successional break ended the Chaco Phenomenon. It is not always so dramatic. Following such a break with prior archeological patterns, a society typically reorganizes to gain efficiency. This is what happened in the Upland Period. As already noted, intermediate, uniform room sizes and modest, “retrograde” ceramics, artifacts, and “homemade” goods, of all kinds mark these periods.

In contemporary U.S. society, the Great Depression of the early to mid 1930s was a remarkable efficiency phase, which followed a sharp successional break from the “Roaring Twenties.” In contrast, the late 1980s were equally remarkable as a power phase. One need merely contrast the low housing starts, emphasis on homemade goods, low birth rates, and cheap factory goods (Depression glass, etc.) of the 1930s, with the higher birth rates, building boom, and material excess of the late 1980s to have an accurate image of the contrasts between power and efficiency.

**Conclusion**

The framework presented here certainly doesn’t address every unanswered question in Anasazi archeology. For instance, the Mesa Verde country has more of a southern exposure than many other upland areas, which faced east or west. So its pattern of abandonments in the mid to late A.D. 1200s may be more complex than elsewhere.

Moreover, the San Juan River country apparently did not participate in the Riverine adaptation much after A.D. 1300. I have no clever explanation! That is why it is so exciting for me to have had the opportunity to present this keynote address. Today, this audience at Mesa Verde includes many of the finest field archeologists who have ever worked in North America. It will be your work here in this region, which I have chosen to call “The Northern Anasazi Frontier,” that will add the final, and most exciting, chapters of all to Anasazi archeology.

As you carry on that work, I ask you to accept the idea that the archeology of “power phases” has always been our stock-in-trade. We are good at analyzing the “biggest,” “finest,” and most dramatic archeological phenomena—indeed, most of our museums are organized to display the products of successive power phases, as are chronologies like the Pecos Classification. That is fine, but incomplete. So, I have suggested here that interspersed with these great bursts of growth and complexity are the efficiency phases. We must learn how to study these more modest periods as astutely as the others. For then, and only then, will we fully apprehend the complete rhythms that shaped the Anasazi world from A.D. 800 to 1300 and that continue to shape our own world of today.
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ANASAZI AGRICULTURE: TECHNOLOGY AND PRODUCTIVITY

Thursday, October 3, 1991
Morning Session I

Chair: Adrienne Anderson
Abstract

A high-resolution model of prehistoric agricultural productivity and sustainable population has been developed for a 1800 km² area of southwestern Colorado. Tree-ring based reconstructions of PDSI soil moisture conditions were used in conjunction with soil productivity studies and GIS technology to quantify and depict annually varying agricultural conditions. Annual estimates of population and long-term estimates of carrying capacity at various levels of storage and risk are provided. The results indicate that climatic variability was never so severe that decreased agricultural production can be cited as the major cause of the thirteenth century depopulation of the region.

Introduction

The Anasazi abandonment of the northern San Juan area at the end of the Pueblo III Period poses one of the classic problems in southwestern archaeology. That these people left the area in the late thirteenth century A.D. is well known; what is not known with certainty, however, is why they left. It has long been suspected that such a widespread and seemingly sudden depopulation of this large area must have its roots in an environmental crisis caused by natural climatic fluctuations, such as the “Great Drought” of A.D. 1276-1299 (Douglass 1929).

This paper partially summarizes a larger study (Van West 1990) that attempts to model past climatic variation and its effect on agricultural productivity and sustainable human population on a portion of the Colorado Plateau that was home to the Mesa Verde Anasazi during the last 400 years that they inhabited the
Reconstructing Prehistoric Climatic Variability... region, A.D. 901-1300. The goals of that project were 1) to develop the methods necessary to create a high-resolution, quantitative, and locally relevant environmental reconstruction and 2) to generate data that would address the proposition that climatic fluctuations were sufficiently severe that decreased agricultural production can be cited as the direct cause of the thirteenth century abandonment. The 40 x 45 km (25 x 28 mi) study area is located in Montezuma County, Colorado, about 32 km (20 mi) north of the New Mexico-Colorado border and immediately east of the Utah-Colorado border (Figure 1). It is an area known to have been densely and continuously occupied by Anasazi from at least the seventh through the thirteenth centuries. Although the results are applicable to the entire 1800 km² study area, they are actually based on the portion of it for which good soils data were available—approximately 1500 km².

While efforts to reconstruct climatic variation and its influence on agricultural productivity and population or settlement in the Mesa Verde area have been attempted before (e.g., Burns 1983; Cordell 1975; Herold 1961; Petersen 1988; Schlanger 1985), none to date has had the opportunity to use both the high-quality

![Figure 1. Location of Study Area and Block Survey Localities](image-url)
environmental data and the spatial data management systems now available. This study employs several techniques and data sets that have not been used together before and uses state-of-the-art computer technology to process and display spatial data. Without these, this research simply could not have been done. The data are too many, the calculations too complex, and the accurate evaluations of the options too numerous to be processed or displayed in a single lifetime. Thus, computer technology, especially geographic information systems hardware and software (GIS), plays an important role in this research. These new features include the incorporation of 1) a contiguous set of 12 7.5-minute Digital Elevation Models (DEMs) that fully depict the study area and which have been created recently by the U.S. Geological Survey; 2) newly mapped and classified soils (Soil Conservation Service [SCS]); 3) current estimates of modern crop yields for specific soil types (SCS); 4) recently published crop yield data that summarize formerly dispersed and unstandardized yield information (Burns 1983); 5) newly available tree-ring data that cover the period from A.D. 901-1970 (Rose et al. 1982); 6) recently produced estimates of human population drawn from two intensively studied archaeological survey localities in the study area, one near Sand Canyon Pueblo (Adler 1988, 1990) and the other on Mockingbird Mesa (Schlanger 1985); and finally, 7) the first time use in the Mesa Verde area of GIS technology to coordinate the integration, quantification, and visual display of paleoenvironmental values.

Methods

The approach taken to modeling the effects of climatic variation on the dry farming potential of southwestern Colorado was as follows. Tree-ring data, strongly reflecting the regional climate of the southeastern portion of the Colorado Plateau, were used to retrodict Palmer Drought Severity Indices (PDSI) for a selected month for local soils and local elevational settings. Reconstructed PDSI values associated with each soil class and each cellular unit of space in the study area were reexpressed in terms of their local equivalent in potential maize yield. In this way, PDSI values—used here as proxy for climate—were made meaningful by their “translation” into agricultural yield—an entity that is more interpretable from an archaeological perspective. The yield value for each cell was accumulated to produce an annual total yield for the study area. This was accomplished for the full length of the tree-ring record. Subsequently, the annual values of total maize yield were used to generate the number and density of people that could be supported by that yield, and various estimates of human carrying capacity at a variety of spatial scales were made.

It is important to note that the Palmer Drought Severity Index (PDSI) is a temporally sensitive and climatically integrative measure of stored soil moisture. It was originally designed by a meteorologist to characterize and predict droughts and wet spells (Palmer 1965), and it is standardly reported by official governmental entities such as the Department of Agriculture (e.g., N.O.A.A.’s Weekly Weather and Crop Bulletin) to describe the condition of farmland. Today, PDSI values are regularly reconstructed by scientists at the Laboratory of Tree-Ring Research to model the combined effects of temperature and precipitation on a variety of environmental phenomena. Using a hydrological accounting approach, the calculation of PDSIs requires monthly precipitation and temperature data from instrumented weather stations, data on soil depth and available water capacity, and information on the geographic location of the soils being modeled. Water supply to a given soil is modeled by accumulating existing water stored in a soil profile and new inputs derived from precipitation. Water demand from a given soil is modeled by potential evapotranspiration (which requires temperature data), by potential moisture needed for local recharge, and by required runoff needed to maintain water supplies at locally appropriate levels. It incorporates the effects of previous months of water surplus or deficit and, as such, considers the effects of time. The calculation process is iterative and results in an integrative value that reflects the combined effects of past and present
temperature and precipitation patterns on soil moisture and, for the purposes of this research, represents a major component in the success of dryland agriculture.

In this study, the approach was operationalized as follows. The 12 DEMs were mosaicked together as a single image. A grid was superimposed onto the 1800 km² study area, with each cell representing 200 x 200 m (4 ha) of space. Thus, the study area was divided into 45,400 cells organized in 200 rows and 227 columns. A total of 98 distinct soil units mapped in the study area were grouped into 11 different soil classes, each class potentially occurring in one of five different elevational strata. The five strata reflect the elevational ranges of the five weather stations in the region used to calculate the soil moisture values. From low to high, these stations are: Bluff, Utah and Cortez, Ignacio, Mesa Verde, and Fort Lewis, Colorado. Using tree-ring data derived from a regionally appropriate set of seven long-term tree-ring chronologies (Rose et al. 1982), 55 long-term reconstructions of PDSI for the month of June from A.D. 901-1970 were prepared, representing all possible combinations of soil group and elevational range. These data were used to assign PDSI values to each cell in the study area for each year in the 1070-year tree-ring record. Reconstructed annual PDSI values associated with each cell were reexpressed in terms of their local equivalent in potential bean and maize yield. The storage, analysis, and display of these productivity values was coordinated through GIS technology. The method resulted in the creation of annual maps and annual crop yield estimates. The annual maps depicted the variable character of the potential agricultural environment and were later animated through computer graphic methods to simulate the changing configurations of the predictable and productive land through time. The annual values of total maize yield were used to generate the number and density of people that could be supported by that yield. Three different estimates for population were provided, representing a population that annually demands the equivalent of either one, two, or three years of maize in storage at the end of harvest. From these annual estimates, longer period estimates of a sustainable population or "carrying capacity" were made. Three different approximations of carrying capacity were defined: a maximum carrying capacity equal to the long-term (400-year) mean, a critical carrying capacity equal to the long-term (400-year) minimum annual value, and an optional carrying capacity zone equal to some value between 20 percent and 60 percent of the long-term mean value (Hassan 1981).

A conservative population estimate, representing a population requiring two years of maize to be placed in storage at the end of harvest, and the critical carrying capacity value, representing the maximum population number or density that can be sustained during the lowest producing year(s) of the 400-year record, were used to explore archaeological questions at three spatial levels. First, they were used to address the question of the adequacy of maize production in the study area as a whole for sustaining significant populations during the A.D. 901-1300 period and to examine the proposition that climatic fluctuations resulted in the collapse of Anasazi agricultural systems and directly promoted the thirteenth century abandonment. Second, they were used to assess the productivity and predictability of maize agriculture in two block survey localities within the study area (Sand Canyon and Mockingbird Mesa, Figure 1) and to compare the model-derived estimates of carrying capacity with archaeologically-derived estimates of population so as to determine whether the productive limits of these more localized areas had been reached at different times and different places. Third, they were used to evaluate and compare the local catchments of eight tree-ring dated archaeological sites and to suggest the climatic and productive conditions under which habitation sites are established and maintained.

Results

While each of these explorations was used to address different archaeological questions, it is clear from all of them that productivity not only varied from place-to-place and from year-to-year
within the study area, but also that there was always enough productive land to yield sufficient maize to support a very large population. For the study area as a whole, the maximum sustainable size of a population annually storing the equivalent of two years of maize during the least productive years in the 400-year record is approximately 31,000 persons or a density of 21 persons per km². In a theoretically more "average" year, represented by the mean carrying capacity value for the four centuries, a population size of some 53,000 persons for an overall density of 35 persons per km² might have been supported. However, a population ranging from 20 percent to 60 percent of the long-term mean value, or about 11,000 to 31,000 persons for a population density of 7-21 persons per km², would be considered optimal and living consistently below the environmental carrying capacity from A.D. 901 through 1300. Clearly, a sizeable population could have been supported at all times within the 400-year period if mobility and access to productive land were not restricted or if redistribution systems were in place to support dispersed populations or uneven production—even during the dry times of the middle twelfth and late thirteenth centuries. If, however, mobility and access to productive resources were severely restricted and extensive extra-community food sharing was not regularly practiced, then there would have been times when some populations that were confined to farming in certain places were characterized by a demand for maize that was not met by local annual supply. Nevertheless, it is important to emphasize that there were always locations somewhere within the study area that could produce adequate maize crops, and at no time was the "potential dry farming belt" (Petersen 1988) completely pinched out by climatic fluctuations, even during the so-called Great Drought of 1276-1299. In other words, climatic fluctuations as they affected crop production and of themselves cannot be used as the sole and sufficient cause for the total abandonment of the Mesa Verde heartland at the end of the thirteenth century.

It is of some interest to note that the "Great Drought" of A.D. 1276-1299 is expressed locally by PDSI reconstructions not as a 24-year period of incessant drought but rather as a non-continuous period of moderate to severe drought years interspersed with relatively normal years that seems to begin with a drying trend in 1272 and persists fairly regularly until 1288. The worst period is 1276-1288, with notably dry years in 1276, 1278, 1280, 1283, 1285, and 1287-1288. The period from 1289-1300 exhibits more-or-less normal climatic variation with the exception of two very dry years in 1295 and 1299. The patterning observed in the PDSI values was compared to the patterning exhibited in standardized tree-ring width departure values for the Mesa Verde Douglas fir chronology that was used by Dean and Robinson (1977) in their mapping of decadal trends in the northern Southwest. As with the reconstructed PDSI sequence, the normalized tree-ring indices indicate that the drying trend starts a few years earlier than 1276 and persists until 1288. While there are differences in the more moderate values, the most extreme years of 1278, 1280, 1283, 1295, and 1299 are the same. Unlike the PDSI reconstruction, the ring-width departures are continuously dry to some degree or another from 1276 to 1288 without break. Given that the PDSI reconstructions described in this paper result from climatic data gleaned from multiple chronologies and multiple species rather than just one chronology and one type of tree, it seems reasonable to suppose that these PDSI reconstructions may be more widely applicable to a regional understanding of climate than any one chronology by itself.

The locality studies in which archaeological estimates of human population were compared to the model-derived estimates of carrying capacity clearly indicate that there are places within the study area that are more productive and predictable than others and that even among the better locations where very high site densities have been recorded, there are some places that are consistently superior. While the upland Sand Canyon locality study reveals that human population density probably never exceeded what the agricultural habitat in that area could support, the nearby but lower
Reconstructing Prehistoric Climatic Variability...
elevation Mockingbird Mesa locality study indicates that population density more than likely did exceed the productive limits of the agricultural niche in at least two intervals of time—sometime within the A.D. 980-1025 period and again in the A.D. 1175-1250 period.

The site catchment studies also demonstrated that there are places on the landscape that are more productive and predictable than others. They also provide some suggestions that Anasazi populations were aware of the differential productivity of places on the landscape and selected for those locations that would consistently produce good yields of maize. Of the eight tree-ring dated sites used in this study, four (the sites called Norton, Aulston, and Mustoe, as well as one I refer to as the DCA site after the institution of its excavators) were small hamlets and four (the Wallace, Lowry, Escalante, and Sand Canyon ruins) were larger villages I consider to be central place sites in the local landscape. Seven of these eight were established in a time period that is considered to have been among the best for their particular catchments, and all were abandoned in a time of relatively reduced productivity and predictability. In addition, there is evidence to suggest that the agricultural potential of a residential location and its immediate environs was a stronger factor in site selection for inhabitants of the smaller agricultural hamlets than it was for the inhabitants of the larger central place sites. However, in almost every case, the productivity of the eight catchments proved to be greater than that of the study area as a whole, showing a deliberate move to areas close to predictable and productive farmland.

Implications and Conclusions

The implications of the results are several, given the validity of the model for reconstructing prehistoric agricultural productivity. If Anasazi populations were aware of the differential productivity of places on the landscape and selected for those locations that would consistently produce good yields of maize, then it might indicate that populations only considered the most arable soils as worth farming. Perhaps as their numbers increased in a given area, the prehistoric Pueblo farmers of the study area were unwilling to meet their annual maize requirements by working more land of lower productive potential. Instead of turning to less productive soils or intensifying production on the better soils, they may have removed themselves to places where high productivity was more predictable. This would have occasioned both local abandonments and relocations within the study area and ultimately, perhaps, the abandonment of the northern San Juan region itself. Should this type of cultural selection have occurred, then estimates of total maize productivity should only be drawn from the highest yielding lands. This would, of course, result in lower population estimates and carrying capacity values than have been generated at present. Given that the model described above can generate precise characterizations of the most productive soils for given periods and that focused archaeological survey could determine whether Anasazi farmers were concentrating on these soils, it would be relatively easy to ascertain whether the prehistoric farmers were highly selective or less selective in their patterns of land use.

An alternative to this scenario is that environmental resources other than soil quality and soil moisture were the limiting factors in sustaining a large population in the study area. Environmental resources suggested elsewhere as potentially limiting include scarcity of potable water relative to population size (Herold 1961), wood-resource depletion (Kohler and Matthews 1988), soil nutrient depletion in piñon-juniper woodland zones (Kohler 1990; Matson et al. 1988), animal protein deficiency (Speth and Scott 1989), and cooling temperatures resulting in growing seasons that were too short for agriculture in upland locations (Petersen 1988). While possible shortages of drinking water and reduced growing seasons are linked to meteorological conditions, the other factors—shortages of wood for construction and fuel, shortages of animal protein, and depletion of soil nutrients—appear more closely linked to human overuse of the environment and poor resource management practices than to limits
imposed by the natural environment as such. It is possible, of course, that several of these factors, including meteorological drought, acted together in the late thirteenth century. If so, the estimates of potential population currently generated by the model will be too high. Survey data suggest that in at least two relatively favorable localities, thirteenth-century populations were well into the zone of optimal carrying capacity. Hence, lesser carrying capacities than those modeled may well have put a number of local populations at risk.

Unless there was a truly large drop in temperature in the 1200s or some as-yet-unidentified environmental factor underwent a major change, it would appear that environmental factors alone would be incapable of causing a complete and rapid depopulation of the entire region, as evidently did happen. That is, if populations were having problems because their numbers exceeded optimal or critical carrying capacity, then through death or emigration some portion of those populations should have been able to survive in place and readapt to a new social context. Further, there is no evidence that the high populations of the Pueblo III Period resulted in irreversible soil erosion or depletion. There is abundant, uneroded soil in the study area today, and it supports commercial dryland agriculture over large areas in the northern San Juan drainage.

Another possibility is that social or cultural factors were responsible for the ultimate abandonment of the region—either alone or in combination with environmental factors. The comparison of the Mockingbird Mesa and Sand Canyon block survey localities suggests that in some places the growing populations of the thirteenth century may have overshot the productive capacity of the local environment. If the best locations were already occupied due to regional population growth, then the populations that were having difficulty would have had to join existing groups—with the possibility of conflict or difficulties of integration—or move out of the area. There is evidence that large Pueblo settlements were forming in the Rio Grande and in the western Pueblo area during the late 1200s and early 1300s (Adams 1989; Dickson 1979; Kohler 1990; Lipe and Lekson 1990). Some of these settlements appear to be on “new lands” having little previous occupation, suggesting that land was available for settlement. In other cases, existing settlements appear to have increased substantially at this time, perhaps in part by absorbing immigrants. There are hints in architectural and community pattern changes (e.g., the increasing prominence of the central plaza and the decreasing ratio of kivas to rooms [Adams 1989, 1991; Lipe 1989]) that new forms of community integration, probably employing new or elaborated forms of religious ritual, may have characterized these growing Pueblo communities to the south. Perhaps new lands and dynamic new communities in the south provided a “pull” on northern San Juan populations that reinforced whatever “push” was being exerted by environmental or other problems in their homeland.

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CORN PRODUCTION ON CHAPIN MESA: GROWING SEASON VARIABILITY, FIELD ROTATION, AND SETTLEMENT SHIFTS

Richard G. Milo

Abstract

Agricultural productivity and variability are generally acknowledged to have exercised a determining influence on prehistoric southwestern land use patterns, settlement locations and shifts, and demographics. In this paper, I report on an analysis of growing season variability on Chapin Mesa in Mesa Verde National Park. The data base is the eleven-year daily climate record for Chapin Mesa for the period 1978 through 1988, as well as archaeological identifications of maize and maize pests on the Mesa Verde. Growing season is empirically defined based on standards developed by U.S. and Canadian agronomists for maize (corn). The results of the study suggest that prehistoric maize cultivation on Chapin Mesa was marked by extreme local and seasonal variability and that Anasazi farmers were faced with the constant risk of local crop failure or the harvesting of only immature crops. I argue that, based on growing season arability and weed and insect pests, the Chapin Mesa Anasazi cultivated dispersed fields and practiced field rotation with short to medium-term fallow and, concomitantly, short-term cyclical residential shifts. I hypothesize that evidences of check dams, terraces, and similar structures represent predictable efforts to supplement limited agricultural land and to mitigate extreme risk, and may reflect intensive cultivation in the canyon bottoms. I argue that agricultural productivity on Chapin Mesa is unlikely ever to have had the potential to support substantial population growth and that residential shifting has led to overestimates of settlement growth and population size. In addition, I show that annual precipitation and length of the frost-free season are poor predictors of growing season precipitation and length and that evaluations based on the former parameters may seriously misrepresent prehistoric agricultural potential.
Local and seasonal climatic variability, as they relate to agricultural production, are generally acknowledged to determine the nature and extent of cultural buffering mechanisms (Dean et al. 1985). Cultural buffering mechanisms include food storage provisions, land use patterns, and reciprocal obligations, as well as social perceptions of agricultural predictability and the relative danger of food shortage (Minnis 1985). Thus, while considerable effort has been devoted to relating the effect of long-term (or low frequency sensu [Dean et al. 1985]) climate changes on agricultural production to population growth, settlement shifts, and abandonment in the prehistoric Southwest (e.g., Cordell 1975; Minnis 1985), it is also essential to understand the pattern of short-term climate variability in order to evaluate the archaeological record.

I employed daily U.S. Weather Bureau records for January 1, 1978 through December 31, 1988 (U.S. Department of Commerce 1978-1988) and empirical standards developed by Canadian agronomists for corn production in Ontario¹ to evaluate growing conditions for maize on a week by week basis on Chapin Mesa in Mesa Verde National Park, an area notable for its seasonal and microclimatic variability. Weather data are collected and reported by park personnel from a station near the Mesa Verde Research Center at an elevation of 7070 ft. A brief summary of annual weather appears as

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Mean High</th>
<th>Mean Low</th>
<th>Avg. Mean</th>
<th>Total Precip</th>
<th>Total Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>61.3</td>
<td>37.8</td>
<td>50.7</td>
<td>26.36</td>
<td>113.3</td>
</tr>
<tr>
<td>1979</td>
<td>59.8</td>
<td>36.0</td>
<td>47.9</td>
<td>19.16</td>
<td>142.3</td>
</tr>
<tr>
<td>1980</td>
<td>61.9</td>
<td>38.0</td>
<td>49.9</td>
<td>18.44</td>
<td>115.3</td>
</tr>
<tr>
<td>1981</td>
<td>data missing for March, September and October</td>
<td>data missing for March, April and October</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>59.4</td>
<td>37.0</td>
<td>48.2</td>
<td>22.16</td>
<td>122.9</td>
</tr>
<tr>
<td>1984</td>
<td>60.2</td>
<td>36.8</td>
<td>48.5</td>
<td>17.57</td>
<td>85.6</td>
</tr>
<tr>
<td>1985</td>
<td>60.5</td>
<td>35.9</td>
<td>48.2</td>
<td>21.14</td>
<td>82.2</td>
</tr>
<tr>
<td>1986</td>
<td>60.7</td>
<td>35.5</td>
<td>48.1</td>
<td>25.91</td>
<td>52.9</td>
</tr>
<tr>
<td>1987</td>
<td>60.6</td>
<td>33.9</td>
<td>47.2</td>
<td>20.13</td>
<td>102.9</td>
</tr>
<tr>
<td>1988</td>
<td>61.3</td>
<td>33.5</td>
<td>47.4</td>
<td>18.33</td>
<td>82.2</td>
</tr>
<tr>
<td>Means</td>
<td>60.6</td>
<td>36.0</td>
<td>48.5</td>
<td>21.02</td>
<td>99.96</td>
</tr>
</tbody>
</table>

Table 1. Weather Summary by Year, 1978-1988

I assumed that Anasazi maize required a growing season of about 120 days, a figure widely cited by previous workers (e.g., Cordell et al. 1984; Minnis 1985) and which agrees well with ethnographic observations of Hopi crops (Beaglehole 1937; Nordsenkiöld 1893) as well as modern hybrids (Shaw 1977). Cutler and Meyer (1965) noted that the maize they identified in Wetherill Mesa archaeological contexts was morphologically similar or identical to varieties grown by the Hopi.

The 120 day growing requirement is often related to the frost-free season; however, I calculated the length of the growing seasons during the years in my sample according to empirical standards developed for maize in Canada. Controlled experiments have demonstrated that corn will not germinate and grow until the mean daily temperature reaches 12.6 degrees C (55 degrees F); growth and maturation cease when the nighttime low temperature drops to 5.8 degrees C (42 degrees F), although harvest can continue at least until the first frost (Brown 1977; Treidl 1977). Growing seasons so defined are much shorter than the frost-free seasons for the same years. Frost-free seasons varied from 132 to 179 days (median 141.5 days), while growing seasons varied from 115 to 141 days (median 127 days).² Further-more, there is a very poor relationship between the two from year to year: Spearman’s r for the lengths of frost-free and growing seasons is 0.095. Growing seasons are summarized in Table 2. Three of the ten growing seasons in my sample were less than 120 days long; five more seasons were marginal when one considers that Anasazi maize was probably rather slow to mature.³

Neither soil fertility (Arrhenius and Bonatti 1965; Franke and Watson 1936) nor the generally cool temperatures seem to
Table 2. Weather Summary by Growing Season

<table>
<thead>
<tr>
<th>YEAR</th>
<th>First Day</th>
<th>+Last Day</th>
<th>Number of Days</th>
<th>Mean High</th>
<th>Mean Low</th>
<th>Avg. Mean</th>
<th>Total Precip.</th>
<th>% Annual Precip.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>12 May</td>
<td>19 Sept.</td>
<td>130</td>
<td>81.1</td>
<td>52.5</td>
<td>66.8</td>
<td>1.65</td>
<td>6%</td>
</tr>
<tr>
<td>1979</td>
<td>14 May</td>
<td>15 Sept.</td>
<td>124</td>
<td>79.7</td>
<td>52.1</td>
<td>65.9</td>
<td>3.37</td>
<td>18%</td>
</tr>
<tr>
<td>1980</td>
<td>31 May</td>
<td>13 Oct.</td>
<td>135</td>
<td>82.6</td>
<td>53.4</td>
<td>68.0</td>
<td>2.97</td>
<td>16%</td>
</tr>
<tr>
<td>1982</td>
<td>18 May</td>
<td>14 Sept.</td>
<td>119</td>
<td>79.7</td>
<td>52.9</td>
<td>66.3</td>
<td>8.83</td>
<td>*</td>
</tr>
<tr>
<td>1983</td>
<td>24 May</td>
<td>20 Sept.</td>
<td>119</td>
<td>82.1</td>
<td>54.1</td>
<td>68.1</td>
<td>4.82</td>
<td>22%</td>
</tr>
<tr>
<td>1984</td>
<td>9 May</td>
<td>27 Sept.</td>
<td>141</td>
<td>79.9</td>
<td>52.9</td>
<td>66.4</td>
<td>5.60</td>
<td>32%</td>
</tr>
<tr>
<td>1985</td>
<td>1 May</td>
<td>8 Sept.</td>
<td>130</td>
<td>80.0</td>
<td>51.5</td>
<td>65.7</td>
<td>4.94</td>
<td>23%</td>
</tr>
<tr>
<td>1986</td>
<td>19 May</td>
<td>11 Sept.</td>
<td>115</td>
<td>78.8</td>
<td>50.5</td>
<td>64.7</td>
<td>7.40</td>
<td>29%</td>
</tr>
<tr>
<td>1987</td>
<td>8 May</td>
<td>14 Sept.</td>
<td>129</td>
<td>78.3</td>
<td>48.1</td>
<td>63.2</td>
<td>6.85</td>
<td>34%</td>
</tr>
<tr>
<td>1988</td>
<td>12 May</td>
<td>14 Sept.</td>
<td>125</td>
<td>79.9</td>
<td>50.2</td>
<td>65.1</td>
<td>8.55</td>
<td>47%</td>
</tr>
<tr>
<td>Means</td>
<td>15 May</td>
<td>18 Sept.</td>
<td>127</td>
<td>80.2</td>
<td>51.8</td>
<td>66.0</td>
<td>5.50</td>
<td>25%</td>
</tr>
</tbody>
</table>

* Date on which growth stopped; not counted as part of growing season.

be limiting factors for maize cultivation on the Mesa Verde. However, the large range between daytime high temperatures and nighttime low temperatures (mean range 28.4 degrees F) probably retarded growth and maturation (Brown 1977). Several measures have been suggested to evaluate the suitability of summer temperatures for maize agriculture, including Heat Units, Degree Days, and Corn Heat Units (Bye and Shuster 1984; Treidl 1977). Corn Heat Units (CHUs) are the most sensitive of these because they include the effect of the temperature range between daytime highs and nighttime lows (Brown 1977; Treidl 1977).

CHUs are calculated for each day during the growing season and summed to arrive at a total figure. The formula for daily CHUs is:

\[ \frac{9/5(Tn-4.4) + 3.33(Tx-10) - 0.084(Tx-10)^2}{2} \]

where TN = night minimum temperature in C, and Tx = day maximum temperature in C

A figure of 2300 CHUs is considered the seasonal minimum for raising corn as a food crop. I calculated the seasonal CHUs for the shortest growing season (1986, growing season 115 days) and the coolest growing season (1987, mean temperature 63.2 degrees F) of the ten growing seasons in my sample. The totals are 2388 for 1986 and 2499 for 1987, both of them adequate for maize cultivation. Precipitation is a much more serious problem, as it is throughout the Southwest.

By far the greatest amount of precipitation falls during the winter and early spring: Snowfall alone accounted for between 37 and 78 percent of total annual precipitation from 1978 through 1988, with a mean of 55.6 percent. There is a second small peak in precipitation in July or August, but it is highly variable in timing and amount. In the nine years for which complete data were available, July and August rainfall varied from 0.8 to 5.58 inches, and from 3 to 28 percent of the annual total. In 1978, which received 26.36 inches of precipitation during the year, only 0.8 inches fell during July and August. In 1982, 4.04 inches of rain fell in August alone, half of it in a single day. Both the highest annual precipitation (26.36 inches) and the lowest growing season precipitation (1.65 inches) fell in 1978 (Table 2). Spearman’s r for annual precipitation and growing season precipitation is -0.333. It is important to note this great disparity between annual precipitation and precipitation which is available for crop.
production, since annual precipitation is often employed as an index of agricultural potential. Figure 1 graphs annual growing season precipitation by its percent departure from the seasonal minimum of 5.9 inches (15 cm) given by Shaw (1988) for non-irrigated corn.

The timing as well as the total amount of precipitation is critical to the successful production of a maize crop, and this is true even for drought-resistant varieties such as those grown in the indigenous Southwest. The effect of moisture stress on maize growth and yield varies depending on the stage of growth at which the crop is subjected to stress (Brown 1977; Classen and Shaw 1970; Denmead and Shaw 1960; Shaw 1988). Inadequate spring and early summer moisture can retard or prevent imbibition, germination, and shoot emergence (Stage 1); 1982, which received a nominally adequate amount of growing season moisture, received not a drop of rain during the first six weeks after the presumed first planting. Moisture stress during the vegetative stage (Stage 2, on the Mesa Verde approximately the seventh through eleventh weeks) can depress yields 3 to 4 percent per day. During the tasseling and silking stage (Stage 3, in late July and early August) moisture stress can depress yields by up to 6 to 8 percent per day (Denmead and Shaw 1960; Shaw 1977); prolonged moisture stress during the latter period can result in total crop loss. Even though 1986 received an adequate seasonal amount of rainfall, rainfall during the tasseling and silking stage of the first planting (approximately weeks 12 through 14) averaged barely 0.01 inches per day, a disastrously low amount. Later plantings would have had the advantage of good rainfall during week 15, but then would have run afloat of the short growing season that year. Severe moisture stress during the grain filling stage (Stage 4) can, again, depress yields by as much as 3 to 4 percent per day of stress. Figure 2 graphs precipitation during each stage of maize phenology for the ten years for which I have data. Note that in every year but one there was a significant moisture deficit during at least one of the stages. I assume that the Anasazi planted more or less continuously from the beginning of the growing season until the summer solstice, as do the modern Hopi (Beaglehole 1937). However, later plantings would have been compromised by the early summer drought and the short growing seasons.

It is important to note the great microclimatic variability on the Mesa Verde (Erdman et al. 1969; Smith 1987). Growing conditions at different locations can be assumed
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Figure 2. Growing Season Precipitation Relative to Phenological Stages of Maize

Figure 2 assumes that snowmelt furnished 75 percent of the total moisture requirement. Phenology stages from Shaw 1955 and Brown 1977. Moisture requirement from Shaw 1988.

Stage 1 = Weeks 1-6
Stage 2 = Weeks 7-11
Stage 3 = Weeks 12-14
Stage 4 = Weeks 15-17


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It is not unreasonable to conclude that maize crops cultivated by paleotechnic means at the weather bureau station on Chapin Mesa would have failed in at least half of the ten years for which I have data, and that two or three of the remaining crops would have failed to reach full maturity. Minnis (1985) similarly estimated a 50 percent rate of crop failure for dryland farming in the Mimbres culture area.

Under such conditions, the Mesa Verde Anasazi may be expected to have labored under the constant perception of food shortage. It is not my intention to argue that the years 1978 through 1988 be taken as a model of indigenous agriculture at any particular time in the prehistoric past. However, it seems to me that there is no a priori reason to suppose that season-to-season variability was ever markedly less than it is today. I suspect that the chief effect of long-term weather changes was to move the northern limit of maize cultivation up and down the mesa, as Cordell (1975) assumed when modelling site abandonment.

That Anasazi farmers on the Mesa Verde were confronted with marginal and highly unpredictable growing conditions, and the
constant risk of crop failure in any one location will come as no surprise to southwestern archaeologists. I want now, however, to advance some speculations about how the Anasazi may have coped with these conditions, speculations which have substantial implications for population estimates and models of cultural process on the Mesa Verde.

A predictable response to marginal and locally variable growing conditions would be for each household to work several small fields in dispersed locations. Access to arable land—particularly the more desirable plots such as Franke and Watson’s experimental field—must have been a powerful force conditioning Anasazi social relationships. A distributional analysis of the enigmatic stone “shrines” and “megaliths” noted in every survey of the Mesa Verde (Hayes 1964; Rohn 1977; Smith 1987) might reveal whether these structures were related to land tenure arrangements.

A second predictable response would be to maintain storage facilities adequate for at least two to three years’ supply of food and seed grain—assuming that it was even possible to accumulate such a surplus. The possibility must be entertained that households were obligated to maintain two or more masonry storage rooms per person. In this circumstance, population estimates based on the assumption of one or more persons per room would require revision. It should be possible to estimate per-person storage requirements through a combination of yield estimates, the degree of crop dependence and the nutrient value of maize, bioenergetic factors, and volumetric considerations for sufficient storage capacity. Of these, yield estimates must be informed by losses due to moisture stress and to birds and mammals and by the probable amount of arable land under cultivation at any one time.

Although field rotation and fallowing have been discounted because of high natural soil fertility and the very slow rate of forest succession (Franke and Watson 1936; Kosse 1981), I think it is very likely that the Mesa Verde Anasazi were obliged periodically to rotate their fields because of weeds and insect predators. Bye and Shuster (1984) noted that competition from perennial weeds reduced the growth, dry weight, and yield of the maize crops in their experimental fields at Dolores. Graham (1965) identified two voracious insect pests in maize-associated archaeological contexts on Wetherill Mesa: white grub beetles and false wireworms. Both of these pests become endemic in the soil, especially under dry conditions, and can cause devastating crop losses (Bowman 1915:224-225, 229, Plates II and III; Dicke 1955). Fallowing would have been the only means available to the Anasazi to control weeds and insects, but the fallow period need only have been long enough for brush to choke out the weeds and for the insects to die off or move on. It is reasonable to suggest a fallow period of from five to twenty years after two to three years of continuous cultivation (Daniels 1983; Harris 1972). On this view, the amount of land under cultivation at any one time might have been only one-third to one-half of the total arable land on the mesa tops.

Under conditions of even modest population growth, it is to be expected that the Anasazi would be concerned to supplement the available amount of arable land, for example by the construction of terraces. The purpose for which the terraces were constructed is, however, subject to two interpretations. It has been assumed that they were planted in crops. However, Martin and Byers (1965) were surprised at the paucity of maize pollen in soil samples taken from the terraces, although the pollen of beeweed (Cleome) was “unexpectedly abundant.” In this light, it is instructive to note that terraces may be constructed as water control devices as well as for artificial fields. It may be that the Mesa Verde Anasazi were intensively cultivating the canyon bottoms—notwithstanding the problem of cold air drainage—and I suggest that evidence for such cultivation should be sought.

A common ethnographic correlate of shifting agriculture is cyclical residential shifts (Harris 1972). Farmers periodically move their habitations for a variety of reasons including personal preference, the maintenance of desirable pheric distances from their fields, insect infestation, and supernatural beliefs.
They often return to a previous site after a period of years. Numerous Mesa Verde sites are virtual palimpsests of successive structures (e.g., MV-499—see Lister 1964), a predictable circumstance under a model of cyclical residential shifts. Cameron (1990) has made a similar argument for residential shifting based on revised estimates of structure use-life (10 to 15 years vs. 75 years [Minnis 1985]), and she has noted the implications of such a model for estimates of population size and rate of growth. On this view, scenarios positing substantial population growth through Pueblo II and early Pueblo III and subsequent reduction in middle and late Pueblo III, based as they are on the assumption that all ceramicly contemporaneous sites were simultaneously occupied, would have to be revised. As well, such a model might stimulate a rethinking of the circumstances under which relatively dispersed and semi-mobile households might have aggregated in the large, late Pueblo III sites, particularly the cliff dwellings. I should note, however, that the suggestion of cyclical residential shifting is compatible with models of large scale population shifts in response to long-term climate changes such as Cordell modelled on Wetherill Mesa, especially if, as I suspect, the Anasazi tended to locate their habitations at the northern practicable limit of agriculture at any given time. Such a practice would place them between their fields and important industrial and faunal resources on the upper mesas.

The Mesa Verde lies, and probably always has lain, on the environmental margin of practicable dryland maize agriculture. The results of this analysis lead me to question whether agricultural productivity there has ever had the potential to support a large or rapidly growing population. The nature of the agroecology of the Mesa Verde leads me to suggest a slowly growing population of modest size practicing a form of shifting agriculture accompanied by short-distance cyclical residential movement. The apparent aggregation of this population into multi-household pueblos and the subsequent abandonment of the Mesa Verde demand a search for social as well as strictly environmental causes. Whether this model is applicable to other parts of the prehistoric Southwest is a matter for workers in those areas to determine.
Notes

1. Growing conditions for corn at high latitudes mirror those at higher elevations in lower latitudes (Mangelsdorf 1974).

2. In 1988, the temperature dropped to 28°F on the night of May 31, twenty days after the start of the nominal growing season. If the result had been a killing freeze, there would have remained only 105 days for subsequent plantings to mature.

3. Some varieties of maize mature in considerably less than 120 days. However, the tasseling and silking stage of short-season varieties would occur during the worst part of the summer drought on the Mesa Verde, severely compromising their advantage relative to the short growing season there.

4. These figures do not include 1981 and 1982, for which complete data were not available.

5. The drought resistance of indigenous varieties of maize is primarily conferred by their ability to germinate and root at greater soil depths than can modern hybrids and not by a lower absolute moisture requirement (Beaglehole 1937; Bye and Shuster 1984; Nordenskiöld 1893).

6. Conversely, too much early season moisture can also be detrimental, encouraging the development of shallow root systems which cannot cope with later dry spells (Bowman 1915; Shaw 1977).

7. Estimates of the daily moisture required by maize during the vegetative and tasseling stages range from 0.1 inches per day (Shaw 1955) to 0.3 inches per day (Olson and Sander 1988). I have used Shaw’s latest estimate (1988) of 0.05 inches per day. This may, however, be an unrealistically low figure given the high evapotranspiration rate on the dry and windy Mesa Verde.

8. The timing of stages in maize phenology used here is necessarily a crude estimate, since maize growth is a function of the synergistic effects of temperature and moisture (Benci and Runge 1977; Shaw 1977).

9. Cutler and Meyer (1965) noted a high proportion of small, underdeveloped, or immature ears among the maize samples they studied from Wetherill Mesa; I would argue that this represents the normal state of maize cultivation on the Mesa Verde.

10. Coprolite, stable isotope, and paleopathological studies to date appear to confirm a high degree of maize dependency among the Anasazi from at least Late Basketmaker times (Decker and Tieszen 1989; El-Najjar et. al. 1976; Miles 1975). Still unclear, however, is the contribution of beans, squash, beeweed, and wild animal and vegetal foods to Anasazi subsistence (see the contribution by Linda Scott Cummings, this volume).

11. Franke and Watson (1936) estimated that 50 percent of each crop was lost to birds and other animals.

12. Franke and Watson (1936) cultivated their experimental field continuously for seventeen years. However, they plowed and harrowed it each spring, a practice which would have masked the problems of weeds and insects.

13. Cameron (1990:162) notes that five habitations occupied successively for ten years each appear archaeologically to be five simultaneously occupied habitations. This is especially likely to be a problem where temporal control is based on named ceramic sequences.
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U.S. Department of Commerce  
ANASAZI:
POPULATION DYNAMICS AND CULTURE CHANGE

Thursday, October 3, 1991
Morning Session II

Chair: Jack Smith
ADJUSTING THE PUEBLO I CHRONOLOGY: IMPLICATIONS FOR CULTURE CHANGE AT DOLORES AND IN THE MESA VERDE REGION AT LARGE

Eric Blinman

Abstract

Studies of Anasazi culture change require high precision chronologies, but as precision increases, the independence between our dating tools and culture changes decreases. Data that have accumulated since the close of the Dolores Archaeological Program have revealed inconsistencies in the Pueblo I chronology that stem from weakness in the DAP dating and interpretive schemes. The changes necessary to bring the Pueblo I chronology into line with the new data are relatively minor in terms of years but they affect portions of the mid eighth century, the early ninth century, and the termination of the Pueblo I Period around A.D. 900. These time periods represent significant cultural transitions, and the chronological readjustments redefine portions of the culture history of the region and the causal roles of environmental variables. After this round of dating readjustment, drought appears to play a more prominent role in determining some settlement changes, climatic factors can be ruled out in others, and the role of cold periods becomes less important.

The theoretical problems that underlie the chronological reinterpretation at Dolores apply equally throughout the Mesa Verde region and sequence. Chronologies must strive to be independent of the cultural changes being investigated, but this independence can only be relative because all the chronologies are based on variation in cultural behavior. Whether reliant on tree rings, architectural style, or ceramics, mistaken assumptions about the independence of a particular dating scheme or framework can bias interpretations and lead to erroneous conclusions. Since this source of weakness is inherent, testing and evaluation of dating schemes must be a constant activity, and no single approach will be applicable on a regional basis or for the entire Anasazi sequence.
If anyone thinks that the Dolores Archaeological Program (DAP) wrote the book on Pueblo I archaeology in the northern San Juan region, they are as wrong as I was when I had the temerity to think that the DAP chronological scheme was a solid piece of work. There is nothing like additional data and the perspective of time and distance to expose flaws in our most carefully crafted arguments. Six years later, I am somewhat chastened by hindsight but still naive enough to try again. Simply put, the dating of the Pueblo I Period used by the DAP was pretty good, but there are some small but important systematic errors or weak spots in it that deserve correction and exposure. The best part is that the corrections resolve some nagging inconsistencies as well as highlight some interesting problems for the next few years of Pueblo I research.

A Few Notes on Anasazi Chronologies

All archaeological chronologies arrange elements or components in a sequence that we hope coincides with the passage of time. Our arrangements are usually based on what appear to be consistent patterns of cultural change, such as ceramic or architectural styles, but there is no guarantee that these changes are truly synchronic and consistent over the area we are interested in. The so-called “absolute” dating techniques are supposed to lend a degree of rigor and precision to our chronologies, but in actuality their roles are limited to occasional tests of accuracy and to spot calibration of our chronologies to the modern calendar. Only rarely do we find enough reliable absolute dates in the right place at the right time to satisfy the needs of a particular problem. Usually we simply have to make do, which is where our preconceptions and models drive our observations and inferences about time.

A major side issue for the Pueblo I Period is that even our best absolute dating technique is not independent of the cultural changes that we are trying to document, and this dependence provides ample opportunity for us to go astray. For example, tree-ring dates are dependent on cultural behavior in the selection of trees and in the burning of structures. The Grass Mesa subphase at the end of the Pueblo I Period in the Dolores area is not datable with tree rings because of the tendency to select cottonwood and young trees as construction materials for the pocket pithouses of that time. The Pueblo I population changed their earlier timber procurement pattern and decided not to go the extra distance to collect more durable and datable woods for these small and ephemeral structures. Because of this change in cultural practice, an entire and fascinating chunk of the Pueblo I Period is floating in time.

Similarly, Richard Wilshusen (1986; Schlanger and Wilshusen 1990) has pointed out that not all Pueblo I structures are equally likely to burn and preserve tree-ring samples. By selecting a behaviorally distinct, or in this case a ritually distinct, subset of pit structures for destruction, the Pueblo I Anasazi have biased our perception of when construction and remodeling episodes occurred in the villages. What would be the consequences if old and vermin infested structures were burned as a form of urban renewal during the lifespan of a village, while younger structures were simply abandoned to rot when the village was abandoned? The tree-ring date suites would be strongly biased toward the nuclei of villages rather than reflecting the totality of the building sequences. We would be left with skewed perceptions of village longevity and of momentary population levels.

These potential chronological problems are relatively innocuous in the context of broadly drawn questions of culture history, but the problems are dangerous when we are trying to make finely drawn arguments of causality, especially arguments that invoke the remarkable precision of the tree-ring based climatic record. When a period in prehistory is undatable by absolute means, we tend to date it within the context of our favorite models of culture change, creating an unfortunate circularity. A cold-focused climatic model (Petersen 1986) influenced the ceramic dating scheme of the DAP, but I am now less of an adherent of the timing associated with that model. Now I am influenced by a new-old model, drought (Orcutt
et al. 1990; Schlanger and Wilshusen 1990), and I hope to correct some of the problems of the initial chronology today before some eager graduate student does it for me. However, my new perception of Pueblo I chronology may in time prove to be as unfounded as I now believe the original one to have been. Again, we are lacking tree-ring dates at the right place at the right time to resolve all of the chronological questions to everyone's satisfaction, but that lack of dates may be a significant part of the cultural change we are trying to document.

Factors that Influenced the Pueblo I Chronology

Several factors contributed to the weak points in the Dolores Pueblo I chronology as expressed in the ceramic dating scheme (Blinman 1986, 1988a): too narrow a geographic perspective on my part, an over-reliance on a gradualist model of culture change, and the belief that drought was not a significant cultural factor at the higher elevations that were typical of the Dolores area.

Ten years ago, my universe was focussed on the Dolores Valley itself, and I was able to gloss over most of the soft spots in the DAP ceramic chronology. I comforted myself with two points: 1) the wave-like migration of Anasazi settlement across the landscape (Schlanger 1988) could account for some of the lapses in the local record and 2) for some time periods the incomplete record in the Dolores excavated sites could simply reflect the vagaries of sampling error. I simply had not seen enough of the remainder of the region to understand that well-dated sites really were scarce during some periods and that the Dolores scarcity was part of a larger anomaly to be explained.

The second lapse in my thinking was to take the easy way out with a gradualist model of culture change. Michael Berry (1982) had made an argument against gradual change in the Southwest, but the quality and tone of his presentation was unconvincing. Since then, a lot of work has been assembled in the region (cited in Orcutt et al. 1990), and what had been

my local soft spot or sampling error seems to have had broader implications. Although much of the substance of Berry's argument is overdrawn, the punctuated record he highlights is a convenient model to apply to the Mesa Verde region. Culture change, from climatically induced settlement changes to innovations in pottery style, does not occur at a constant rate. The Anasazi appear to have structured their settlement patterns around sets of social and environmental parameters, seeking to maintain stability in that structure until the pressure for change was too great and a readjustment took place. The more disruptive of those readjustments appear to be the soft spots that I glossed over. Conversely, the periods of settlement instability appear to be characterized by slow stylistic change, allowing only poor resolution in ceramic dating schemes.

Finally, the DAP chose to emphasize cold temperatures and short growing seasons in our syntheses of climate change and its potential affects on the Anasazi (Petersen 1986, 1987a, 1987b, 1988). This emphasis was an attempt to diversify the relatively repetitive climatic arguments of drought, drought, and more drought, and the cold emphasis gained credence from the obviously high and cold setting of the Dolores Valley itself. The downplaying of drought also fed off of the unfortunate statistical fact that simple decadal means tend to obscure things that happen in shorter time periods or on the cusps between decades. Anasazi farmers probably reacted in terms of three or five year periods rather than waiting around for a decade of famine to decide to change their way of doing things. Regardless, after the DAP had settled on a cold-driven model of environmental effects, the strength of the cold period at around A.D. 900 loomed like a solid anchor for calibrating Dolores culture change. That appears to have been the biggest and most important error that I made in designing the ceramic chronology.
Three Soft Spots in the Pueblo I Chronology

The three weak points in the Dolores Pueblo I chronology appear to be points of transition in settlement pattern and organization in the region at large. In other words, the weak points represent the most interesting and important pieces of the chronology, and how they are handled becomes critical to subsequent interpretations.

A.D. 700-760

The A.D. 700-760 period marks the transition between the Basketmaker III and Pueblo I stages of Anasazi prehistory. The transition is manifest in architecture, multiple-household settlement patterns, and the introduction of San Juan Red Ware pottery. The transition is disruptive enough that nearly everyone is comfortable with the differentiation of the two stages, and there are only a few sites that may be intermediate between the two. Well-dated structures and ceramic assemblages are abundant for the A.D. 690s and for the A.D. 760s, but data from the intervening six decades are scant. The environmental context is one of strong droughts at the beginning and end of this transition period (Blinman 1988b: Figure 2.2; Orcutt et al. 1990), while the climate just before and just after is benign to idyllic.

Only a single Dolores area site and its pottery collection could be assigned to this period with any confidence (SMT4613 [Nelson 1986]). The site was dated on the basis of intermediate architectural style, and I fit this assemblage into the middle of the transition period between Basketmaker III and Pueblo I (Blinman 1988a). I assumed that its pottery assemblage was representative of the transition, bolstered by the presence of a single unpainted San Juan Red Ware sherd in the collection. Both the architectural and ceramic data fit within the gradualist paradigm, and there was no apparent gap or inconsistency.

Unfortunately, there was a classification error in the analysis of this particular pottery assemblage: the single slipped San Juan Red Ware sherd was actually from a Dolores Red vessel. Once this error was corrected, the thread that supported an Early Pueblo I date for the assemblage began to unravel. Architectural style would still place it in the first few decades of the eighth century, but this argument is too weak to rely on for dating calibration purposes. If this site really does date to the middle of the transition, then ceramics from this time period are indistinguishable from those of seventh century Basketmaker III settlements, and only excavated sites with transitional antechambers and ventilators can be confidently attributed to the period. If this site really dates earlier, say the first decade of the eighth century, then we have no idea of the rate and nature of architectural or ceramic change during the Basketmaker III to Pueblo I transition.

An unfortunate side effect of the classification error is that many of my date estimates that relied on San Juan Red Ware are too early. With the collapse of the association of San Juan Red Ware with the early architectural style, my estimate of A.D. 725 for the introduction of San Juan Red Ware fell apart. I suspect that Bill Lucius’s (Lucius 1984) original estimate of A.D. 750 for red ware dispersal may be more realistic, but all we know for sure is that red wares are moving across the region in moderate quantities by A.D. 760. This means that we can’t use a Chapin Gray-Chapin Black-on-white–San Juan Red Ware association to recognize sites in the transition period, making it difficult to study what should be a fascinating part of Anasazi development.

A.D. 800-830

The next weak point in the chronology consists of the first decades of the ninth century. Unlike the Basketmaker III to Pueblo I transition, formal differences—architecture, site organization, and ceramics—are far more subtle across this threshold. The only clear marker appears to be the progressive abandonment of lower, drier areas of the region in favor of higher, wetter areas. Like the earlier transition period, there are many dated structures and
assemblages prior to A.D. 800 and many after A.D. 830, but only a few in the intervening decades. Some of the pre-A.D. 800 dated structures are part of large villages like Alkali Ridge (Brew 1946) and Site 2 at Ackmen-Lowry (Ahlstrom 1985; Martin 1939). After the late A.D. 820s, dated structures appear across the region, usually as nuclei of the large Late Pueblo I villages such as those at Dolores. A major series of droughts hit the Mesa Verde region in the A.D. 805-825 period, probably terminating the early villages as viable farming communities, and the reestablishment of benign climatic conditions at about A.D. 830 coincides with the subsequent construction boom.

The immediately pre-A.D. 800 ceramic collections from Dolores included a small but consistent proportion of neckbanded cooking jars, and the post-A.D. 830 Dolores collections included larger numbers of these vessels relative to plain necked vessels. Without intervening data points, and relying on the gradualist paradigm, I simply extrapolated a slow increase in neckband proportion through A.D. 825. Unfortunately, the inference of gradual adoption has two weak aspects: Based on more recent excavations (Wilson 1991), the initial adoption of neckbanding appears to be sporadic, and even large A.D. 800s collections can lack neckbanded sherds. Also, there appears to be a geographic lag of 10 years or so in the adoption of neckbanding, progressing more rapidly in the north and northwestern portion of the region and more slowly to the south and southeast. I believe in this lag, but the scarcity of good data points prevents me from believing in it with much confidence.

These ambiguities in the A.D. 800-830 period affect current research on Pueblo I village formation because they limit accurate dating of the initiation of some of the Late Pueblo I villages. An example is provided by Richard Wilshusen's recent work at Morris's Pueblo I villages within the Ute Mountain Tribal Park (UMTP). Drought-based environmental models would predict that initiation of roomblocks should not occur prior to the late A.D. 820s (Orcutt et al. 1990), but ceramic dating of the UMTP roomblocks using the gradualist model and boosting the dates by 10 years to account for the lag places several within the A.D. 800-830 period (Wilshusen and Blinman 1992). Is this dating convention incorrect or is the drought model flawed for this time period? A single tree-ring date (A.D. 822+rb) lends credence to the ceramic dating results, but I have been misled by single dates before. Right now, the ceramic dating is inconsistent enough that I am hesitant to totally dismiss the linkage between villages and drought-free periods. Regardless, the chronology of this period needs much more work.

**Post-A.D. 880**

The weakest point in the Dolores chronology concerns the sequence and dating of the abandonment of Pueblo I villages and settlements, both in the valley and in the region at large. Like the Basketmaker III to Pueblo I transition, this break in settlement defines the Pueblo I-Pueblo II boundary. The Late Pueblo I villages appear to have reached their population peak in the dry but benign climate A.D. 860s and 870s, exhibiting the classic form of clustered roomblock arcs and pit structures. The first clusters of severe droughts in more than 40 years began in the mid A.D. 880s, and a severe cold snap hit in the A.D. 900s. Because the DAP had adopted a cold-focused climatic model and had downplayed the effects of drought, it was logical to set final abandonment in the A.D. 900s, with the possibility of some prior exodus of population due to resource depletion (Kohler and Matthews 1988) and perhaps due to drought-induced crop shortfalls.

Abandonments are uniformly hard to date under the best of circumstances, and the DAP decisions were reasonable when they were made in the early 1980s. However, Rick Ahlstrom's (1985) and Sarah Schlanger's (1985; Schlanger and Wilshusen 1990) work on construction, remodeling, and site longevity cast doubt on the DAP conclusion. The sporadic DAP tree-ring record documents active construction and remodeling through the A.D. 860s and 870s, but there is only one date in the A.D. 880s, and I will argue that it is from construction that postdates...
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village collapse. If any significant occupation of the Late Pueblo I roomblocks and pit structures had continued into the A.D. 890s, the 10-15 year remodeling-rebuilding cycle should have left clear evidence in the tree-ring record. That evidence is lacking, both at Dolores and elsewhere in the region, and I suspect that the timing of the Late Pueblo I abandonment at Dolores coincides better with the onset of drought in the mid A.D. 880s than with cold at A.D. 900.

This change in the timing of the end of classic Late Pueblo I highlights one of the great enigmas of Dolores culture history, the Grass Mesa subphase (Lipe et al. 1988). This subphase was defined to accommodate an architectural aberration of pocket or household pithouses and a departure from the rigid roomblock and pit structure layout of the Late Pueblo I villages. The subphase was manifest at only a few sites in the northern part of the Dolores Valley, it was stratigraphically contemporary with and slightly later than the more traditional Late Pueblo I roomblocks, and it was ceramically indistinguishable from the final Pueblo I occupations at other DAP sites. A single relatively large and round pit structure was contemporary with the pocket pithouses at Grass Mesa Village and was interpreted as an integrative structure (Varien 1988). A single tree-ring date of 882++vv confirms the stratigraphic placement later than the traditional Pueblo I roomblocks.

At the time, there were no dated ceramic collections from the Mesa Verde region in the first half of the tenth century, and I developed a ceramic chronology for the A.D. 880-910 and 910-980 periods based on a mixture of the gradualist assumption, extrapolation, and conventional wisdom. These periods should have been marked by a continuation of the rapid stylistic change that characterized the preceding 40 years, so I simply guessed as to the content of neckbanded and white ware types. The introduction of corrugated gray wares was assumed to occur after A.D. 910 because there were none associated with DAP Pueblo I collections (and the DAP area should have been abandoned by then).

These assumptions were proven incorrect by Doug Dykeman’s report (1986) of an A.D. 930s-940s tree-ring dated site near Negro Canyon. The ceramics from this site were dominated by neckbanded gray wares, and although corrugated gray wares were present, they were much less abundant than I had anticipated. White and red wares differed only slightly from the Late Pueblo I model, and it was clear that I had grossly overestimated the rate of stylistic change in the first half of the tenth century.

The consequence of this overestimation was an artificial compression of time, and the ceramics of the Grass Mesa subphase conceivably could be as late as the A.D. 910s and still be nearly indistinguishable from the A.D. 880s collections that mark the last classic Pueblo I roomblock occupations. The most important implication is that the Grass Mesa subphase and the terminal occupations of the traditional Late Pueblo I villages need not be contemporary phenomena. This is comforting in that it has always been difficult for me to accept that two such organizationally dissimilar site layouts had to be contemporary. It is also convenient, because the best architectural analogs for the Grass Mesa subphase are the Piedra Phase occupations of Sambrito Village and Bancos Village in the Navajo Reservoir District (Eddy 1966). These small pit structures and haphazard surface room suites are associated with a slightly larger round integrative structure, and they postdate more traditional pit structure and roomblock associations in the upper San Juan region. Unlike the Grass Mesa subphase, however, these structures are well dated, with strong construction and remodeling evidence throughout the A.D. 890s.

In my proposed revision of the Dolores Pueblo I chronology, the Grass Mesa subphase represents a return to the Dolores Valley after the late A.D. 880s abandonment of the large Pueblo I villages. This return probably occurred in the mid A.D. 890s and may have only lasted until the cold snap of the A.D. 900s. The social disruption that accompanied the A.D. 880s abandonment and that included evidence of unusual and presumably violent death
associated with ritual structures in the villages (Orcutt et al. 1990; Wilshusen 1986) may mark the abandonment of protokiva-based ritual integration at the community level. Household ritual appears to be maintained based on the presence of small scale ritual features in many pocket pit structures, but the new form of community integration is a roundhouse rather than a subrectangular protokiva. The similarities between the Navajo Reservoir settlements and the Grass Mesa subphase argue for similar changes across the entire northern Anasazi world, representing a stage in the transition from the stability of the Pueblo I stage to the eventual stability of the Pueblo II stage of Anasazi architectural style.

Conclusion

These comments on and revisions of the DAP Pueblo I chronology reflect what I consider to be improvements in our understanding of Anasazi culture history. However, just as the DAP chronology was slightly skewed by the influence of a gradualist view of culture change and by the adoption of a cold-focussed climatic model, these revisions assume that a drought-focussed climatic model can substitute for and bolster weak points in the chronology. This assumption can fail with the next excavated site, or even with existing sites that I simply haven't heard of yet. The best I can hope for is that we pay close attention to any sites that may fall within the soft spots: the Basketmaker III-Pueblo I transition of A.D. 700-760; the termination of the Early Pueblo I villages and the establishment of the Late Pueblo I villages, A.D. 800-830; and the transition between the Late Pueblo I villages and what we call Pueblo II, A.D. 880-980. The latter is an especially sensitive period, because the pottery on many of the transitional sites will appear deceptively similar to Late Pueblo I collections. We have to hope that we can obtain tree-ring dates for a few more sites like Doug's, allowing us to be more objective in calibrating the pattern of ceramic change and refining the chronology of this important period.
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RECENT ADVANCES IN ANASAZI ARCHAEOLOGY OF THE PINE AND PIEDRA RIVER BASINS AND UPLANDS OF SOUTHWEST COLORADO

Robert H. Brunswig, Jr.

Abstract

Archaeological research in Colorado's easternmost Anasazi territories of the H-D Mountain region, which includes the Pine, Piedra, and upper San Juan river drainages, now spans more than seven decades. In that time, dozens of university, museum, government, and private contractors have documented hundreds of Formative Anasazi sites. Only recently, though, have data from archaeological sites in the area been comprehensively studied for patterns of diachronic and synchronic culture and environmental change during the Anasazi Period. A preliminary analysis of these data, encompassing more than 500 sites of all cultural phases and periods, provides evidence of sedentary Anasazi Basketmaker settlements expanding extensively in arable field localities of the upper Pine River floodplains and foothills margins during the Basketmaker III (Sambrito Phase) and Early Pueblo I (Rosa Phase) periods. Site densities in some Pine River tributary drainages reached as high as twenty or more sites per square mile during the Pueblo I Rosa Phase. External cultural influence and trade contact at that time focused largely, but not wholly, toward Anasazi populations of the western Mesa Verde drainages. However, a uniquely H-D Mountains Anasazi character is definable in the region's archaeological inventories. In the last half of the Pueblo I Period (Piedra Phase), Anasazi sites, due in part to environmental and climatic changes, gradually shifted to the Piedra and upper San Juan drainages of the eastern H-D Mountains. Thinly populated in the Basketmaker and Early Pueblo I periods, the eastern H-Ds became the focus of growing indigenous Anasazi populations during Late Pueblo I and Early Pueblo II times. In particular, as noted by other scholars (Frank Eddy, etc.), Anasazi of the lower reaches of the Pine, Piedra, and San Juan rivers relocated upstream to the Chimney Rock area. Between A.D. 950 and 1125, strong Chacoan influence from the lower San Juan region of New Mexico resulted in a synthesis of Chacoan and indigenous Anasazi culture known as the Chimney Rock Phase. By about A.D. 1125, Anasazi peoples were forced to abandon the H-D Mountains by increasing climatic, environmental, and cultural pressures.
**Introduction**

Despite nearly eight decades of archaeological research, the easternmost areas of Colorado’s Anasazi occupation remain somewhat “underdocumented” in comparison to vast data bases from Mesa Verde, the Montezuma Valley, Hovenweep, and the Dolores Plateau. Even so, past archaeological fieldwork in southwest Colorado's eastern region represents a valuable resource base for future, developing reconstructions of regional Anasazi Tradition culture history and processes. It is the purpose of this paper to present preliminary diachronic and synchronic settlement pattern and developmental culture data for the poorly known uplands of the H-D Mountains which divide the central to upper reaches of the Pine and Piedra River valleys (Figure 1).

I recently completed a preliminary analysis of available field and research data (to 1989) from this paper’s H-D Mountain uplands study area, yielding primary information on nearly 500 documented sites of all cultural periods and period phases. Data from that study, dealing specifically with Anasazi cultural components and associated settlement patterns, are presented below.

**Geographic Description of the H-D Mountain Study Area**

The H-D Mountain study area occupies an irregularly-shaped block of land averaging some nine miles from east to west and ten miles north to south. The land area of the study includes some 101 square miles or slightly more than 64,000 acres. The area is bounded by U.S. Highway 16Q in a northern arc, the Southern Ute Indian Reservation in the south, central portions of the Piedra River on the east, and irregular San Juan National Forest boundaries with private land on the west.

General physiography of the H-D Mountain uplands consists of two drainage slope divisions: (1) the western slope drainage topography of the central Pine River and (2) the eastern slope drainage which descends to the central Piedra River. Both divisions consist of desiccated highlands which increase in elevation from south to north and rise to a central highlands divide from the adjacent western Pine and eastern Piedra rivers. Western H-D upland slope drainages of the Pine River generally flow west and southwest, and those of the eastern H-D slope drain east to southeast into the Piedra River floodplain valley.

Eastern slope H-D topography tends to be broken and rugged, consisting of narrow tributary drainages of the Piedra River confined by high mountainous terrain and steep mesitas and cuestas. The generally rugged nature of the eastern H-Ds is largely attributable to their shorter distance from the top of the H-D Mountain Divide to the Piedra River. As a result, overall drainage gradients are higher and stream incising is a more dominant physiographic factor. Immediately

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**Figure 1. H-D Mountain Uplands and River Valleys**
east of the H-D Project area, topographic relief of the Piedra River floodplain and its western slope tributary streams tends to be relatively abrupt, steep, and limited in the distribution of extensive, arable soils. In fact, primary localities of arable landscapes in the eastern H-Ds mostly include a handful of central and lower drainage corridors in the study area’s southeastern and northeastern quadrants. Those drainages include Skull Canyon, Goose Creek, Turkey Creek, and Ignacio Creek valleys in the south and southeast and Fosset Gulch, Bull Creek, and Peterson Gulch in the northeast (Figure 2). However, lower sections of most of these Piedra tributaries tend to widen near their respective confluence junctions with the Piedra River, providing more extensive areas of arable soil necessary for prehistoric horticulture.

In contrast, the western slope (central Pine Valley) division of the H-D uplands contains numerous stream drainages with modest gradients and relatively extensive development in their central to lower sections. This low gradient trait of the western H-D uplands and foothills is largely due to longer distances from the H-D Divide to the Pine River floodplain than exist on the eastern Piedra Valley side. Western H-D topography rises from the broad, low-lying alluvial floodplain of the Central Pine River to moderate relief ridges, benches, mesas, and mesitas bordering tributary floodplain to upland stream valleys. Only when the streams reach higher headwater sources near or at the H-D Mountain Divide are their tributary stream valleys significantly narrower and more deeply incised than in lower sections. As a result, relatively deep and extensive arable soils tend to characterize a four to six mile wide corridor from the Pine River floodplain into the lower and central western H-D foothills.

Research Methodology

Since nearly all past H-D uplands archaeological activity has come from cultural resource management research (CRM) on San Juan National Forest lands rather than private lands, this study has mostly utilized available national forest-related documentation. However, limited archaeological work has been accomplished on private land within and adjacent to national forest property, particularly on the western H-D slope, and those studies were included in this paper’s data base wherever possible.

Figure 2. Drainage Systems of the H-D Mountain Uplands

Four hundred ninety-one archaeological sites of all types and cultural affiliations were documented in the study area from a wide range of sources. Of that number, 135 Anasazi-affiliated sites were found to have had cultural significance beyond the isolated find classification of two to five significant, though not necessarily diagnostic, artifacts, features, or structures. For the purposes of this study, individual site data were cross-checked and catalogued in Lotus spreadsheet computer files. The computer data base included several critical variables such as site location, associated stream drainage, topographic context, site type, cultural
period, and cultural management status. Data sources included more than 60 CRM reports on file at the Colorado State Archaeologist's office (Denver) and the San Juan National Forest office (Durango). U.S. Forest Service CRM survey quadrangle maps and cultural resource data base printouts were kindly provided by Gary Matlock in Durango, Colorado. Computer site printouts from the Colorado State Archaeologist's office were an additional data source.

As of 1989, it was estimated that approximately 25 percent of the H-D study area had been covered by Class II surveys and possibly as much as 5-6 percent of the area had been subject to Class III surveys. Actual excavation and subsurface testing activity in the study area, though, has been essentially nonexistent and provides an important constraint on, and qualifier for, many of the culture history and process inferences presented below.

The most rigorous study of cultural resources for the H-D uplands is the Martorano et al. Cultural Resources Survey of the Durango Known Recoverable Coal Resource Area (1985). In that study, Martorano et al. thoroughly analyzed a wide range of artifacts, features, and architecture from much of the H-D upland area to determine broad patterns of culture history and cultural component definitions and contexts. The overall result of the Martorano et al. study was to strongly correlate and integrate cultural developments of the H-D uplands and adjacent Pine and Piedra drainage systems with Archaic and Formative culture frameworks earlier established by the Navajo Reservoir Project (1950s and 1960s), Irwin-Williams's (1973) Archaic Oshara Tradition research (1960s and 1970s), and University of Colorado investigations of the Piedra and upper San Juan river valleys during the 1970s. Subsequent to the Martorano et al. study, short-term field investigations of the Crowbar Creek headwaters drainage of the Pine River Valley were conducted by the University of Northern Colorado (Brunswig 1986). Anasazi phase and period identifications in H-D archaeological reports in this study were evaluated using trait and technological criteria from Martorano et al. (1985) and the Navajo Reservoir and Chimney Rock sources (Adams 1973; Dittert and Eddy 1963; Dittert et al. 1961; Eddy 1966, 1972, 1974, 1977; Eddy and Dickey 1961; Lister 1971; Tucker 1981).

Overall CRM field and formal report data quality proved to be quite variable. In some cases, questionable or highly superficial report data were often downgraded to generalized culture categories. For instance, generic identification of plain gray wares without structural or other diagnostic material association resulted in sites being classified as only generically Pueblo I in affiliation. Such identified "generic" Anasazi sites were excluded from the following section on settlement patterns, as their lack of phase identifications prevented their use in the reconstruction of even broad settlement pattern changes. In other cases, specific ceramic type descriptions were sufficient to comfortably assign sites to particular Anasazi periods and more specific regional phases. Ceramic type identifications and phase assignments were based on field report descriptions and compared against technical criteria published in the Navajo Reservoir, Chimney Rock, and Martorano et al. research literature. In a large number of cases, Anasazi sites were described as containing culturally-diagnostic materials, usually ceramics, of multiple phase components.

H-D Anasazi site data were also closely examined for site types, largely inferred from described surface remains. Two broad categories of site types, habitation and special activity sites, were adopted for analytical purposes within the study. Habitation site type definitions from the Navajo Reservoir and Chimney Rock projects were used. These included single units, multiple units, and village sites (Eddy 1977:6). Field data on special activity sites were also compiled and classified as lithic quarries, lithic workshops, lithic and/or ceramic scatters, ground stone scatters, short-term camp sites, and field-houses. However, for the purposes of this paper, all sites without identifiable architectural remains have been classified together as simply special activity sites. In recent years, the problem of longevity of Anasazi sites, the length of time they were
occupied, has been proposed as a “skew” factor in estimating population (site) densities within and between Anasazi culture phases (Powell 1990; Schlanger 1990). Recent studies indicate that sedentary habitation sites in many periods, phases, and regions may have had relatively short lifetimes, i.e., they may have been abandoned for new site localities on the average of every generation (25-30 years) (Schlanger 1990:113-114). In some cases, this might result in a two century long culture phase having only 15 percent of an estimated population based on an area’s total of site numbers. Site occupation duration and its variation within and between phases is only one of many problems which could affect this study’s data, but it is a constraint which only future systematic field testing and excavation can remedy.

With the above qualifications in mind, it should be emphasized that, even with careful screening of report data, there remain elements of tentativeness in the overall conclusions of this paper. Refining those conclusions is only possible through more in-depth comprehensive field research, including site excavation, the development of better reporting standards, and continuing critical appraisal and analysis of the area’s Anasazi phase definitions.

Culture History Background and Current Framework

Regional cultural resource data show human occupation of the H-D Mountains and adjacent river valleys dating back to early Paleo-Indian times. Several projectile points from the Folsom Period have been documented from the northern San Juan Basin immediately southwest of the H-D Project area and a partial point was recovered in the Navajo Reservoir Project immediately south of the H-D Project. In 1984, a local Bayfield, Colorado, landowner reported to this author the find of a Folsom point in an arroyo east of the Pine River. In 1988 and 1989, survey data and artifacts of the San Juan National Forest region were analyzed to determine the presence of Paleo-Indian localities (York 1990, 1991). A preliminary report of that study concluded that as many as a dozen Paleo-Indian projectile points, most of later Plano Period origin, were collected and documented in various surveys. However, although some of the San Juan Forest study’s Paleo-Indian material was found near the H-D Mountains, i.e., the western margins of the San Juan Forest near Pagosa Springs, none came directly from the area under discussion here.

Later pre-Anasazi cultural remains in the study area are largely confined to the latter part of the Archaic Stage. As a rule, Archaic components in the H-D Mountain area have been identified with Irwin-Williams’s northern Southwest Oshara Tradition and its respective phases (Irwin-Williams 1973, 1979; Simmons 1981). Simmons’s research in northwestern New Mexico suggests the existence of a San Juan Basin regional variant of the Oshara Tradition (1982) immediately adjacent to the H-D area. It is probable that Archaic components in the H-D uplands and neighboring river valleys, being basin rim territories of the San Juan Basin, are part of Simmons’s Oshara San Juan regional variant. There is also evidence that some H-D Mountain projectile point types may also correspond to types from Buckles’s Archaic Monitor Mesa and Shavano phases of his Uncomphagre Complex to the north (Martorano et al. 1985:34, 95-97).

Early Archaic culture remains have, thus far, remained archaeologically elusive. A single potential Oshara Jay Phase (ca. 5000-4800 B.C.) stemmed point was recently documented in the previously noted San Juan National Forest Paleo-Indian study (York 1990). However, that particular point, recovered outside the immediate H-D area, northeast of Pagosa Springs, Colorado, may alternatively be considered a Paleo-Indian Hell Gap point. The next Archaic phase to be documented in the H-Ds, or surrounding regions, is the Oshara San Jose (Middle Archaic) Phase (ca. 3200-1800 B.C.). Several probable San Jose point finds are known from the H-D Mountains and nearby river drainages (Martorano et al. 1985:34, 95-97, Figures 27 and 28). Evidence of San Jose Phase materials in the H-Ds is particularly interesting because that phase is thought to reflect the first significant evidence of Archaic peoples in southwestern Colorado. Isolated point finds and lithic scatter sites belonging to the phase,
represented mostly by short-term camp and quarry or lithic workshop localities, are scattered from the Dolores Plateau southward to Mesa Verde and eastward to Chimney Rock, east of the H-D Mountains Project area. The best survey documentation for southwest Colorado San Jose Archaic sites comes from studies in the Ridges Basin area near Durango and the Dolores Valley region (Kane 1984:26; Ware 1981:24-25). Although our knowledge of southwest Colorado's San Jose components is still rudimentary, it has been suggested that Colorado's northern San Juan basin rim "uplands" served as a seasonal resource territory for San Jose populations wintering in the San Juan Basin (Simmons 1983). H-D Mountain area components of the San Jose Phase consist of several short-term camps, isolated point finds, and large lithic workshop and quarry scatters on tributary stream valley margins. Late Archaic H-D populations were, on present evidence, quite ephemeral. There is slight evidence for a scattered Oshara Armijo Phase (ca. 1800-800 B.C.) presence, in the form of ephemeral camp components, in the H-Ds. At least one Armijo projectile point and associated hearth find was documented in 1984 and 1985 University of Northern Colorado surveys of the Crowbar Creek drainage headwaters of the Pine River (Brunswig 1986). Irwin-Williams's Arroyo Cuervo research established a Late Archaic-Early Anasazi phase she named En Medio at the terminus of her Archaic Oshara Tradition sequence (Irwin-Williams 1973). Her En Medio Phase, dated between 800 B.C. and A.D. 400, effectively incorporated a time of cultural transition from southwestern Colorado's poorly defined Late Archaic and its seminal Anasazi.
Basketmaker II Period. A San Juan Archaic (Late Archaic) variant of Irwin-Williams's Early En Medio Phase, when more completely documented, certainly would constitute transitional developments from a semi-nomadic, hunting-gathering lifestyle to more sedentary, mixed hunter-gatherer and horticultural lifeways during the region’s Anasazi Basketmaker II Period. Little is known of Late Archaic/Early En Medio developments in the H-D Mountain region, but documentation of occasional large, triangular, corner-notched points could well represent Late Archaic/Early En Medio occupations.

The Anasazi occupation of the H-Ds, the primary focus of this paper, will be presented in detail in the next section. However, it should be noted that Anasazi occupation of the H-D study area and its surrounding region from the Basketmaker II Period through the Pueblo II Period represents this region’s most intensive time of human exploitation up to the present day. The region appears to have been effectively abandoned at the end of the Pueblo II Period, and later human occupations seem to have largely included ephemeral, nomadic groups of Pueblo IV, Pueblo V, and later Navajo hunters and foragers who occasionally ventured into the region from northern New Mexico. Nomadic Utes had entered the area by the late 1600s and early 1700s and constituted a significant cultural presence into the twentieth century. Today, Ute reservation lands form the southern periphery of the H-D Mountains. Spanish herdsmen and ranchers reached the H-Ds, particularly eastern central Piedra and upper San Juan River valley areas, by the mid to late 1700s. Early Euro-American expansion and development in the H-Ds, in the form of mining, lumbering, and ranching, started in the 1860s and largely peaked by the early 1900s.

Over the past several decades, a number of cultural classification schemes, particularly of the Anasazi occupation, have been applied to the general region encompassing the H-D Mountains, foothills, and adjacent river valleys. In order to simplify the region’s cultural taxonomy, a recent synthetic overview of cultural development in southwest Colorado was proposed (Eddy et al. 1984). A slightly revised cultural framework overview, utilizing that overview, in part is presented in Figure 3.

Reconstruction of the H-D Uplands and River Valley Anasazi Culture History

As noted above, the current Anasazi phase system used for the H-D study area is largely a synthesis of period and phase sequences developed from the Navajo Reservoir and University of Colorado Chimney Rock field projects. A total of 135 H-D study area sites affiliated with the Anasazi Tradition have been identified, of which 109 could be reasonably assigned to one or more local Anasazi phases. Site phase identifications, based largely on associated ceramic types, should be considered tentative in light of the uneven quality of field reports. Nevertheless, for the purposes of this preliminary study, site phase correlations are considered adequate to initially Anasazi settlement patterns in the H-D uplands and valley margins. Analysis of the H-D study area's site patterning and settlement history is presented below.

Basketmaker II Los Pinos Phase (A.D. 1-400)

The Los Pinos Phase is the local Pine, Piedra, and upper San Juan River valley system equivalent of the Pecos Basketmaker II Period. However, Vivian (1990:93-99) recently proposed a strong consistency in Basketmaker II site traits in the northwestern New Mexico and southwestern Colorado Upper San Juan Basin and northern basin rim highland areas, which defined them as part of a common multiregional Los Pinos Phase. The Los Pinos Phase was well established by Navajo Reservoir fieldwork in the lower Pine, Piedra, and lower sections of the upper San Juan drainages (Eddy 1966, 1972; Eddy and Dickey 1961). Recent research in the upper Pine River Valley has accumulated evidence that the Los Pinos Phase may well be divisible into two subphases, the first characterized by a preceramic horizon and the second by a marginal, but definite, ceramic subcomponent (Wilson and Blinman 1993, this volume).
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Los Pinos sites have generally been found to include dispersed shallow pithouses located on the crests of low knolls, secondary terraces, or benches overlooking river and tributary stream drainages. Living sites range from single habitation units to less common multiple and village complexes of up to 11 pithouses. Los Pinos pithouses were shallow, a few inches to a couple of feet deep with a circular wood post, clay-covered superstructure. Pithouses from this phase were either single rooms or a combination of a main room with an attached antechamber. Subsurface slab-lined storage pits and a central hearth were common in the main chamber. Many Los Pinos pithouses were circled with cobble-flagged rings and generalized site areas which incorporated exterior pit ovens and scatters of lithic and charcoal debris.

Los Pinos artifacts consist of crude stone core-tools, flake tools, and both basin and single open-ended basin grinding stones. Projectile points are large, triangular, corner-notched types. Ceramics are rare, but occasionally present. They include a “false” pottery, a crude unfired vegetable matter-tempered gray ware, and a crude, hand-coiled and scraped brown ware known as Los Pinos Brown.

Reconstructed Los Pinos Phase subsistence is thought to have been a mix of wild plant and animal food foraging with a somewhat lesser component of horticulture, primarily involving corn or maize.

Sites of Los Pinos age appear to occur almost entirely at the margins of or immediately outside the H-D uplands. Navajo Reservoir Project surveys of the early 1960s revealed Los Pinos sites in the lower Pine River Valley. During the 1950s a private archaeological survey and an unrelated pipeline survey near Ignacio documented the presence of single and multiple unit Los Pinos sites from Vallecito Reservoir in the upper Pine River Valley to the confluence of the Pine and San Juan rivers in the south (Eddy et al. 1984; Green 1954). In fact, a 1984 overview of Anasazi culture history in the Pine River Valley prompted speculation that the area was a “distributional center of the Los Pinos Phase . . .” (Eddy et al. 1984:79). East and southeast of the H-D Mountains, no definitive Los Pinos sites were noted from either the Piedra River drainage or the H-D uplands to the west.

Site data analysis suggests the presence of only six probable Basketmaker II Los Pinos Phase sites in the western H-D uplands. These included two camp sites, two isolated projectile point finds, a lithic scatter, and two, possibly “curated,” Basketmaker II points found on Rosa Phase habitation sites. The apparent lack of Basketmaker II habitation sites in the H-D Mountain foothills and Pine River tributary drainages is puzzling since Los Pinos sites are believed, on the basis of admittedly limited fieldwork, to be extensive along the primary and secondary terraces and benches of the central to upper Pine River Valley. However, it should be noted that only central sections of the eastern Pine River hinterlands have been subject to even modest Class II and some Class III surveys, and the western side of the valley, being on private lands, is almost completely undocumented. Lack of adequate survey data is certainly a factor explaining the relative lack of uplands Los Pinos sites. On the other hand, upland H-D Los Pinos site types may well have been confined to ephemeral hunting and foraging camps or even day-trip forays from primary river floodplain and terrace habitation sites.

Basketmaker III Sambrito Phase (A.D. 400-700)

The local Pine and Piedra valley Basketmaker III occupation is known as the Sambrito Phase. Based on Navajo Reservoir fieldwork of the late 1950s and early 1960s, Sambrito Phase culture traits were very similar to those of the preceding Los Pinos Phase. In fact, Berry (1982) later reevaluated the Navajo Reservoir research and concluded, based largely on dendrochronological and radiocarbon dating analysis, that Sambrito chronology places it within the earlier Los Pinos time range. However, as Vivian (1990:114-115) notes, Navajo Reservoir excavations in the upper San Juan River drainage appear to show valid “evidence for cultural continuity from Los Pinos.”

Site locations along the Pine and lower Piedra reaches are also essentially similar, occupying primary river and secondary stream
terraces, ridge knolls, and benches. Shallow pithouses were the primary type of habitation structure. A few Sambrito Phase sites excavated during the Navajo Reservoir Project also revealed the rare development of larger and more complex pithouses which may have served community-wide social and ceremonial functions.

Sambrito subsistence, as defined in Navajo Reservoir studies, closely duplicated that of the preceding phase with a possible small increase in reliance on food production versus wild food foraging. Growing importance of domestic corn in the Sambrito diet was indicated in Navajo Reservoir field studies by an apparent increase in subsurface storage cists.

Navajo Reservoir research indicates that the material culture of the Sambrito Phase may be partly defined by its inclusion of a rare brown ware ceramic known as Sambrito Brown. In addition, extremely rare plain trade gray wares from the Mesa Verde region, Chapin Gray and Twin Trees Plain, were recovered from a single Sambrito site in the Navajo Reservoir District south of the H-D area. Popular projectile point types changed from large, triangular, corner-notched types to small, triangular, corner-notched types with a tendency for unthinned bases. Earlier basin grinding stones completely disappeared and were replaced by single open-ended trough metates. Both the number and overall quality of lithic tools for plant, bone, and wood working increased in the Sambrito Phase.

No definitive Sambrito Phase sites are reliably documented from the immediate H-D Project area, although survey reports consistently refer to the presence of "Basketmaker III" sites. One camp site (5AA980) in Fosset Gulch of the eastern H-D uplands had a single probable Basketmaker III Sambrito Brown potsherd (Martorano et al. 1985:Table 7, 126). Most CRM site survey identifications of Basketmaker III sites have been based on the presence of generic plain gray wares, often identified as Chapin or Lino Gray types, commonly associated with Basketmaker III components in the Animas, La Plata, and Mancos valleys to the west. However, if the Navajo Reservoir Basketmaker III Sambrito Phase definition is closely applicable to the central Pine River and adjacent H-D uplands, then many CRM report correlations of Basketmaker III sites based on the presence of plain gray wares may be faulty. Instead, plain generic gray wares, although occasionally found in excavated Navajo Reservoir Sambrito Phase sites, would probably be more diagnostic of subsequent Pueblo I (Rosa and Piedra phase) occupations. There is some evidence to suggest that Sambrito sites were largely confined to the upper San Juan drainage, a few localities in the lower Pine River, and the Gobernador area of northern New Mexico (Vivian 1990:114-115). Vivian (1990) also suggests that archaeological evidence of a near continuity of Sambrito and subsequent Pueblo I Rosa Phase sites in the above areas may reflect an "obscuring" of Sambrito by Rosa sub-components in non-excavated contexts. This may explain the lack of Sambrito sites in the central and upper Pine and Piedra valleys, but it cannot be a complete explanation for their apparent absence in the H-Ds and the Pine and Piedra river valleys. An emerging alternate answer to this problem is that the Navajo Reservoir phase sequence may not accurately reflect early Anasazi cultural developments in the region (Wilson and Blinman 1993, this volume). Earlier Los Pinos and Sambrito brown ware types may have been the same ceramic type, Sambrito Utility. Typologically, they are very similar in composition, form, and manufacture, and chronologically are part of the same evolutionary continuum. Based on reexamination of the Navajo Reservoir and subsequent regional ceramic evidence, Wilson and Blinman have proposed the existence of two Sambrito subphases: the first defined by presence of only the Sambrito Utility brown ware, hypothesized to date between A.D. 400 and 575, and the second identified by Sambrito Brown ware occurring with a significant presence of the plain Chapin Gray ware type, the latter hypothesized to date between A.D. 575 and 700. In light of Wilson and Blinman's new data, it is apparent that Anasazi culture period and phase distinctions are more complex than previously suspected. Certainly, more complete research, including excavation of Anasazi sites, needs to be undertaken to directly substantiate
more exact cultural relationships of Basketmaker II, Basketmaker III, and Early Pueblo I sites in the H-D uplands and the Pine and Piedra river valleys. However, pending further developments and documentation on new phase and subphase distinctions, this paper assumes that plain gray ware-dominated sites are not Basketmaker III Sambrito Phase sites, but Pueblo I (gray ware-dominant) sites of the Rosa and/or Piedra phases, discussed below. The closest definitive Sambrito components to the H-D uplands appear to be Todosio Rockshelter burials in the lower Pine Valley, sites recently documented in the upper Pine River Valley (Vallecito Reservoir), and sites to the distant south and east in the San Juan River drainage near Arboles, Colorado (Eddy 1972). Lack of clarity in field identification of Basketmaker III Sambrito Phase vis-a-vis its associated ceramic types is an important archaeological problem in the H-D region that must be resolved by systematic field excavation and reexamination of the definitive and theoretical bases of the regional period and phase framework.

Early Pueblo I Rosa Phase (A.D. 700-850)

The regional Anasazi Pueblo I Period in the study area is represented by two successive local phases: Rosa and Piedra. In the Rosa Phase, habitation sites, as defined in the Navajo Reservoir area to the south, included single-unit “homesteads,” multiple-unit sites with 2 to 5 pithouses, and village units composed of 6 or more pithouses. The primary architectural structure, as in earlier Anasazi phases, was the pithouse. Although many small, shallow pithouses were retained from earlier times, two other styles appeared: larger, deeper, but still simple versions of the Basketmaker pithouse, and a deep, large style with alcove recesses, partial or fully encircling benches, and floor “sipapu” holes. In the last half of the Rosa Phase, single or multiple room wood post surface buildings with clay-covered interwoven branch walls were being built. Known as “jacal” buildings, these structures were used initially for food storage and formed a crescent-shaped row of rooms north or west of pithouses. By the end of the Rosa Phase, surface storage rooms were gradually being enlarged and adapted for human occupation and indoor activity areas. In addition to habitation sites, a large number of limited activity sites are associated with Rosa Phase sites. These include many found in earlier times, hunting camps, plant processing stations, lithic quarries, and possible field camps in more distant areas of restricted, but still valuable, agricultural soils.

Rosa Phase site excavations in the Navajo Reservoir District showed a substantial reliance on corn-beans-squash agriculture along with a significant component of wild food foraging. Cultural materials consist of a wide range of hunting and gathering lithics along with an increase in grinding stone tools. Side-notched axes are abundant, testifying to an increased need for wood building material. The presence of small, finely-made, triangular, corner-notched projectile points indicates the use of the bow and arrow as a hunting weapon in preference to hand or atlatl (throwing stick) thrown darts. Ceramics become extremely abundant and include three major types: a plain Rosa Gray, a so-called Rosa Black-on-white decorated ware with an occasional glazed variety, and a rare Sambrito Brown-derived ceramic type known as Rosa Brown. Wilson and Blinman (1993, this volume) regard the Rosa Brown type as a refired (darkly burnt) variety of Rosa Gray. Imported pottery from neighboring Anasazi regions is rare, but includes Chapin Gray, La Plata Black-on-red, San Juan Red wares, and Abajo Red-on-orange from the Mesa Verde area. Lower San Juan Basin Chacoan cultural associations are largely nonexistent and the Rosa, and subsequent Piedra, phase appears to be one of “increasing cultural insularity in the northeastern San Juan Basin” (Vivian 1990:138). Further evidence for localized cultural insularity is found in a rare fine grit-slipped gray ware (tentatively type-variety named Pine Valley Coarse) identified in Crowbar Creek sites of the western H-D foothills (Brunswig 1986).

Rosa Phase sites are extremely abundant in the H-D Project area, particularly on the western side of the H-D Mountain Divide. A large number of sites are known from very limited surveys of the central and upper Pine River
floodplain and terraces, but many are also present in the lower tributary foothill and upland drainages of the western H-D uplands. This study has documented a minimum number of 98 Rosa Phase sites or site components on San Juan National Forest land in the western H-Ds. An unpublished amateur survey of the central Pine River floodplain-terrace corridor in the 1950s is said to "show that the middle Pine is heavily flanked by Rosa Phase pithouse sites situated along the leading edge of each cobble terrace from La Boca [several miles south and west of the H-D study area] to Bayfield [on a midpoint immediately west of the study area]" (Eddy et al. 1984:76).

Unfortunately, results of that survey, made by local resident Betty Green, have not been published in sufficient detail to fully judge their validity. However, based on the high number and substantial concentrations of Rosa Phase sites in the lower H-D uplands, the high presence of such sites along the Pine River itself is certainly probable. Of the 98 Rosa sites, nearly half, 41 sites, were camp or special activity localities. Forty-five were relatively isolated single-unit sites, 8 were multiple-unit types of 2 to 5 habitation structures, and 4 appear to qualify as village sites with 6 or more probable habitation structures.

The majority of Rosa Phase sites are located in the central to lower Spring Creek drainage which has been designated the Spring Creek Archaeological District. However, numerous single and multiple unit Rosa Phase sites dot the mesa rims, terrace benches, and, occasionally, protected floodplain margins of central to upper drainages such as the Beaver, Ute, and Crowbar creeks. One of the more impressive sites is 5LP1366, a multi-component village site overlooking the confluence of the Ute and Crowbar creeks. Rosa Phase sites and components in the eastern H-D uplands are dramatically fewer than on the western slope. Only 11 sites can be identified on present evidence, including 9 camp site or special activity localities, a possible single-unit site, and a lone multiple-unit site, the latter habitation sites being in Skull Canyon on the southeastern section of the study area. Eddy et al. (1984:88) note the presence of modest numbers of Rosa

Phase sites in the Piedra lower reaches and "pithouse sites continue in moderate densities upstream along both sides of the river as far as Highway 160 [just beyond the study area's northeastern periphery]." In 1921, Jeancon and Roberts documented several "pithouse" sites along either side of the Piedra River immediately beyond the northeast periphery of the H-D study area (Jeancon 1922:7-9; Roberts 1923:29-31). These sites, known collectively as the Pargin Ranch sites, appear to contain Rosa Phase components along with ceramics and artifacts generally diagnostic of the subsequent Piedra Phase. University of Colorado research on the eastern side of the lower Piedra Valley during the 1970s documented significant numbers of Rosa (and later Piedra) sites on Piedra River terraces and upland areas immediately southeast of the H-D study area (Tucker 1979:81-85). University of Colorado studies even further south in the lower Piedra Valley also showed a substantial increase in sites and, by inference, a population increase during the Rosa Phase (Adams 1974, 1975). However, current data tabulated for this study have failed to show more than a relatively modest presence of Rosa Phase sites on the eastern upland H-D side of the central and upper Piedra Valley. Unfortunately, immediate river terrace localities of the central Piedra River on the eastern boundary of the H-D study area are poorly documented. It is possible that Rosa Phase sites might occupy those Piedra terraces but remain poorly represented in adjacent H-D upland areas. However, lacking central Piedra terrace cultural resource surveys, the H-D upland data indicate a heavy concentration of Rosa populations in the Pine River drainage and substantial, but lighter, site densities in the eastern Piedra Valley.

Late Pueblo I Piedra Phase (A.D. 850-950)

The regional eastern Anasazi Piedra Phase appears to have been a time of important cultural change and development. Stressed by a growing environmental deterioration, Anasazi populations seem to have undergone substantial physical dislocation and cultural adaptation.
Throughout the region, habitation sites became both fewer and larger in size. Piedra Phase pithouses were mostly of the larger and more elaborate architectural style which first appeared in the preceding Rosa Phase. Surface buildings became more elaborate and complex, often built of mortared stone. In many cases, jacal surface roomblocks were used as living structures in preference to pithouses. During the Piedra Phase, the first true communal kivas were constructed. Some settlements in the Navajo Reservoir District, south of the H-D Mountains, reflect socio-economic stress in evidence of fortified stockades, burned houses, and group massacres, occasionally characterized by cannibalism (Flinn et al. 1976).

The Piedra culture inventory differed only moderately from the preceding Rosa Phase. Large numbers of grinding stones and the appearance of groundstone hoes emphasize the importance of corn in the Piedra economy. Early in the Piedra Phase, single open-ended trough metates were replaced by flat slab grinding stones. Small, corner-notched points were also gradually replaced with small, side-notched, triangular point types. Ceramics include a Piedra Gray ware, a decorated Piedra Black-on-white, and an early Piedra neckbanded pottery, which was eventually replaced by Mancos Gray and Payan Corrugated wares in late Piedra times. The primary difference between earlier Rosa Gray and Rosa Black-on-white gray wares and Piedra Gray and Piedra Black-on-white gray wares is the use of quartz sand temper in Rosa types versus generalized use of a crushed andesite rock temper in Piedra types (Martorano et al. 1985:122-132). Early in the Piedra Phase, the most common imported ceramics were Abajo Red-on-orange and San Juan Buff Black-on-red. Growing regional interaction with the San Juan Basin Chaco culture to the southwest is attested in late Piedra times by a predominance of Cortez Black-on-white, Kana-a Black-on-white, and Red Mesa Black-on-white wares.

Evidence for the presence of Piedra Phase populations in the H-D study area is somewhat fragmentary. On the western side of the H-D Mountains, in the Pine River valley and its adjacent H-D uplands, only eighteen Piedra Phase sites can be identified. Eight are single-unit habitations, four are multiple-unit sites, and four are village sites, all later components of previously existing Rosa Phase sites. At least two camp or special activity sites, identified on the basis of ceramic affiliation, can be assigned to the Piedra Phase. For the most part, it appears that the Pine River drainage may have been partially depopulated by early Piedra times. There is a possibility that Piedra sites, although fewer in number, may have been larger than earlier Rosa sites and western H-D Piedra populations could have been equivalent to those of the Rosa Phase. However, considering the general lack of excavation and the existence of both phase components in most sites, current data are inadequate to validate or deny that possibility.

On the eastern slope of the H-D Mountains, the number of documented Piedra Phase Anasazi sites appears to have increased somewhat over the previous Rosa Phase. A total of thirty sites or site components belonging to the Piedra Phase have been identified. These include twenty-one camp or special activity localities, four single-unit habitations, four multiple-unit habitations, and a single village site.

Outside the H-D study area, Piedra Phase habitation sites are most heavily concentrated along the Piedra River from Stollsteimer Creek just south of the study area to the confluence of the Piedra and San Juan rivers some ten miles south of the present Colorado-New Mexico state line (Adams 1973, 1974, 1975; Tucker 1979:81-85). Navajo Reservoir and University of Colorado surveys have documented a substantial outmigration of Piedra Phase peoples from the Navajo Reservoir District toward the headwaters of the Piedra and San Juan rivers. Eddy (1972, 1974) has provided geo-archaeological evidence that population relocation during this time was being encouraged by headward erosion of arable floodplain soils in the Piedra and San Juan river valleys. This headward erosion phenomenon is believed to have been the result of an intensifying climatic shift, begun in the previous late Rosa Phase, from winter to summer dominant storm precipitation (Eddy 1972:Table 1, 11). That shift, according to geomorphic and pollen studies from the Navajo Reservoir and
later University of Colorado Mesa Verde Research Center studies, resulted in decreasing plant cover and increased late summer and early fall soil erosion (Schonwetter and Eddy 1964:110-113, Figure 46). Adams (1974, 1975), using University of Colorado survey data from the lower Piedra Valley, has documented site expansion and relocation of Piedra Phase sites both up that valley and outward into more agriculturally marginal uplands. His analysis of lower Piedra settlement patterns indicated that sites were established in more marginal uplands due to the valley headward migrating loss of arable lands in the main river floodplain and growing pressure from upvalley migrating populations. Headward erosion, however, does not explain current archaeological evidence of the virtual abandonment of the wider, lower gradient and, by inference, less erosion-susceptible Pine River valley and its adjacent lower H-D uplands by the end of the Pueblo I Period. Nevertheless, current evidence of an increase in Piedra Phase sites in confluence areas of the Navajo Reservoir District almost certainly reflects some degree of population relocation from the Pine River valley and western H-D uplands (Eddy 1972:Figure 7; Eddy et al. 1984:88).

**Pueblo II Arboles Phase (A.D. 950-1050)**

The Arboles Phase is a developmental, transitional blending of regional Late Pueblo I and Early Pueblo II culture traits. Settlement types largely consisted of single and multiple unit habitation settlements. The larger village units of the previous Piedra Phase seem to be lacking. Large, fairly elaborate pithouses and substantial surface masonry roomblocks constituted the main architectural style. Early in the Arboles Phase, masonry multi-room pueblos replaced pithouses as the primary living structure. Communal kivas appear, on present evidence, to be absent from Arboles sites.

The overall material culture inventory was little changed from the Piedra Phase. Arboles ceramics included a plain gray ware, a decorated black-on-white ware, and Mancos and Payan Corrugated wares, which appeared at the end of the Piedra Phase. Corrugated wares, however, disappeared by the Arboles Phase’s midpoint, around A.D. 975. Imported ceramics, like La Plata Black-on-red, Cortez Black-on-white, and Red Mesa Black-on-white, indicate significantly increased interaction with the Chacoan Anasazi populations of the southwestern San Juan Basin. There is slim artifactual evidence, in the form of higher frequencies of animal bone and antler tools, that reliance on wild animal and plant foods may have increased despite a lowering of natural resources due to an Arboles environment which was drier and warmer than in previous phases. Certainly, arable land erosion documented by Eddy in the lower Pine, Piedra, and San Juan confluence area and a less reliable climate would have contributed to a weaker agriculture-based economy (1972, 1974).

With continued environmental adversity and further headward erosion of the San Juan and Piedra river floodplains, Arboles sites became more heavily concentrated in the central and upper reaches of the Piedra and San Juan river valleys, mostly within present-day Colorado. There is only very modest evidence of an Arboles presence west of the H-D Mountain Divide. Western H-D uplands of the Pine Valley drainage system were found to contain eleven localities with Arboles Phase ceramics. Three were special activity localities, six were isolated finds of single to a few diagnostic ceramic sherds, and the two remaining sites were associated with village site architecture, which also included Rosa and Piedra phase components. Considering the general lack of Arboles localities in the western uplands, it is possible that Arboles ceramics in the two village sites do not represent true habitation horizons, but only reflect limited ceramic evidence of brief visits from the Piedra Valley to the east.

Archaeological surveys in the eastern H-D uplands provide evidence of relatively numerous Arboles Phase sites—forty-one in all. The eastern H-D sites included twenty-seven special activity localities, six single-unit habitations, four multiple-unit habitations and one probable village site. Nearly all the eastern H-D tributary drainages contained some class of Arboles Phase site. However, definitive habitation sites with Arboles Phase components
were only represented in three of the drainages: Peterson Gulch and the Bull Creek and Piedra confluence in the northeast, and Skull Canyon in the southeast. Peterson Gulch had the largest concentration of Arboles ceramics in habitation contexts, a minimum number of eleven habitation sites which included a single village, six multiple-units, and four single-units. Eastern H-D surveys have only largely skirted peripheral areas of the immediate Piedra west bank floodplain and lower terraces, but the Piedra and Bull Creek confluence area was found to contain at least one single-unit secondary terrace site. Skull Canyon surveys identified a minimum number of two single-unit sites and one multiple-unit habitation site. Habitation site locations in the eastern H-D uplands were heavily biased toward tributary valley margin mesa ridgetops and high knolls. A few habitation sites were situated on primary, secondary, and tertiary terrace and hillslope benches in central to lower stream valley sections.

**Pueblo II Chimney Rock Phase**

(A.D. 950-1125)

The Chimney Rock Phase is thought to both overlap and ultimately succeed the Arboles Phase in the H-D Project region. The phase is believed to represent a generalized integration of local Arboles Phase populations into a “hybridized” Arboles/San Juan Chacoan Anasazi cultural phenomenon evolved through strong interaction with Chacoan Anasazi populations to the south and southwest. Trade wares and a number of culture trait developments during the previous Piedra and early Arboles phases are interpreted as showing intensifying contact with Chacoan peoples of the San Juan Basin. Sometime around A.D. 1075, based on tree-ring dates, Chacoan migrants, hypothesized by Eddy (1977) as trader-priests, moved into the upper reaches of the Piedra River. Retaining much of the indigenous Arboles cultural inventory, important cultural elements of the highly developed Chaco Anasazi were added to the resident Arboles lifestyle.

The most heavily Chaco-integrated settlements included some sixty-four habitation sites situated in an upland cuesta and mesa area between the Stollsteimer and Devils creek drainages, two eastern flank Piedra River tributary streams in the upper central reaches of that river. These sites, consisting of at least seven “clusters” or communities of village, multiple-unit, and single-unit sites, appear to orient toward a substantial Chaco-style pueblo, Chimney Rock Pueblo, situated on a projecting flat-topped “chimney” of the Chimney Rock cuesta. Chimney Rock Pueblo was found to have been built in typical Chaco Anasazi style with two paired, large masonry kivas incorporated in its architecture. This Chacoan, or Chaco-style, pueblo was probably a component of the now well-documented Chacoan outlier site network scattered throughout and along the periphery of the San Juan Basin (Altschul 1978; Powers 1984; Powers et al. 1983). The purpose of such outlier sites, tied together by a vast road system, was probably a combination of direct resource procurement, regional trade, and an extension of the Chaco political and religious system. Frank Eddy (1977), the chief investigator of the Chimney Rock Project, has hypothesized the primary cuesta pueblo to have been constructed, or its construction directed, by a group of Chacoan migrant trader-priests who organized and influenced the local Arboles population as “outlier” clients of the Chaco socio-economic and religious system. Although Chimney Rock and the Piedra River valley certainly appear to have been, to some degree, part of the overall Chaco cultural system during this phase, there is, at present, no archaeological evidence of the widespread unifying Chacoan road system extending to any part of the H-D area or its peripheral valleys. Our current knowledge of the Chacoan road system indicates that it served to link at least five major areas with the possible exception, based on the current absence of evidence, of the Pine, Piedra, and upper San Juan “northeast quadrant of the basin” (Judge 1989:243). Some researchers, citing in part the lack of local evidence of Chacoan roadways, have expressed doubts as to the full integration of Chimney Rock settlements within the Chacoan cultural and economic system (Judge 1989:243). However, the apparent absence of
Chacoan roads in the study area has only been confirmed by very preliminary examinations of aerial photos and archaeological ground surveys. A systematic search for their presence remains to be accomplished and, in the light of recent Montezuma Chaco road finds to the west, the probability of undiscovered roads existing in the H-D region may be reasonably high.

With the exception of the Chimney Rock Pueblo itself, other Chimney Rock habitation sites in the Stollsteimer and Devils creek drainages are thought to have varied only slightly in architecture and cultural assemblages from their Arboles precedents. Early in the Chimney Rock Phase, “purer” Arboles settlements, located further south along the Piedra and upper San Juan rivers reflected little evidence of Chimney Rock Chacoan influence and are believed to have continued to function contemporaneously with the immediate Chimney Rock communities up until A.D. 1075. After that time, definitive Arboles sites are hypothesized to have either faded from the scene or to have had sufficiently “modified” cultural inventories to be unidentifiable as belonging to the Chimney Rock Phase. Environmental deterioration, begun in late Rosa times, continued into the Chimney Rock Phase and, at least in part, encouraged an apparently total Anasazi abandonment of the H-D Mountain region by A.D. 1125 (Eddy 1977:62-80).

Aside from the “classic” Chaco-style Chimney Rock Pueblo, Chimney Rock Phase sites retained substantial Arboles Phase cultural assemblage traits. There were, however, some differences. The primary living structure was a surface or immediately subsurface circular masonry room, really a modified surface version of a pithouse. Rectangular, masonry storeroom blocks formed linear, and occasionally L-shaped, pueblos which enclosed these surface pithouses and subsurface ceremonial kivas. Site locations were determined, as in times past, largely by proximity to water and arable soils for agriculture.

Chimney Rock material culture was little changed from that of the previous and partly contemporaneous Arboles Phase. Ceramics remained essentially Arboles types with some modest Chacoan influence. Imported ceramics were almost entirely Chacoan types, but these were mostly found at the Chimney Rock Pueblo itself.

As noted above, Chimney Rock Phase sites documented by an earlier University of Colorado survey were found in the 1970s to be located within the Devils and Stollsteimer creek drainages within a few miles of the Chimney Rock cuesta on the eastern terrace and lower uplands of the Piedra River. However, a San Juan National Forest survey of the Peterson Gulch drainage on the west rim of the upper central Piedra River discovered numerous Arboles and Chimney Rock habitation and special activity sites in 1983 (Webster 1983). The 1983 survey documented surface evidence of a minimum number of thirteen habitation localities, including two village sites, six multiple-unit sites, and five single-unit sites. The Peterson Gulch sites constitute an eighth Arboles-Chimney Rock community aggregation in addition to those identified by University of Colorado field studies in the Chimney Rock vicinity. The Peterson community is located on and along a central ridge complex which separates Peterson Gulch from the Piedra River. It extends from the central section of the gulch drainage to its southeasterly confluence with the Piedra, a distance of nearly two miles. Present eastern H-D upland survey data support a thesis of site and community aggregations within a short distance of Chimney Rock Pueblo. No other identifiable Chimney Rock Phase site has yet been definitively documented more than four miles from that central pueblo. The farthest known Peterson site is located only three miles northwest of Chimney Rock, only one-third mile west of the Piedra River. There is some evidence for Chimney Rock Phase exploitation of more distant areas of the H-D uplands, though. At least one special activity site is known from Goose Creek in the southeast quadrant of the H-D study area. Another possible Chimney Rock site is a village locality (5LP816) in the Spring Creek Archaeological District of the western H-D uplands (Vanourney and York 1981:2). However, I consider Chimney Rock Phase identification of the Spring Creek site doubtful pending more adequate investigation.
Current surface survey data from 5LP816 indicate the presence of Pueblo I Rosa and Piedra components with less abundant evidence of Arboles and possible Chimney Rock associated ceramics. Both the Arboles and Chimney Rock associations, in light of the absence of other western H-D sites of those phases, could reflect short-term, ephemeral visits from the eastern Piedra Valley.

Pueblo III and Pueblo IV (A.D. 1125-1500)

Elsewhere in the northern Southwest during the Pueblo III and Pueblo IV periods, Anasazi populations underwent considerable cultural change and development. Aggregate pueblo communities of dozens or even hundreds of individual habitation sites continued to grow and evolve complex social, economic, and religious adaptive systems well into the late twelfth century. However, by A.D. 1200, Anasazi communities throughout the northern Southwest were in decay. Soon after A.D. 1300, nearly all of the Anasazi from New Mexico’s San Juan Basin and from southwest Colorado either abandoned the region or their sedentary, agriculture-based lifestyle. Former Anasazi populations are thought to have either died out, migrated to other areas of the Southwest, or reverted to ancestral, archaic, hunter-gatherer lifestyles in their respective northern Southwest regions. Failure to continue to successfully adapt with agriculture-based lifeways was no doubt partly determined by adverse climatic change, but social upheaval and culturally-induced ecological destruction of Anasazi environments probably also were factors.

The H-D study region appears to have been effectively abandoned after A.D. 1125, at, or soon before, the start of the northern Southwest’s Pueblo III Period. So far, no evidence of a Pueblo III presence in the region of the Pine, Piedra, and upper San Juan river valleys has been archaeologically documented. There is, however, some limited ceramic and lithic evidence of possible Pueblo IV and Pueblo V foraging incursions from the Jemez Mountains and the Rio Grande valley to the southeast, but Anasazi Tradition populations never again occupied the region on a permanent basis.

Conclusion

A preliminary analysis of survey data from the H-D Mountain uplands documents synchronic and diachronic settlement patterns on the eastern periphery of Anasazi occupation in southwestern Colorado. Figure 4 graphically illustrates these site pattern shifts from the early to late Anasazi occupations of the H-D Mountains and their adjacent Pine and Piedra river valley margins.

H-D survey data appear to confirm some earlier regional studies which proposed the Pine River valley as a center of Basketmaker II Los Pinos Phase cultural development for which sedentary (or semi-sedentary) habitation sites are largely confined to primary river terraces. Very limited data seem to indicate that Basketmaker III sites could be largely confined to the lower confluence region of the Pine, Piedra, and upper San Juan rivers and possibly to central to upper reaches of the upper San Juan River. However, this apparent pattern of Basketmaker III Sambrito Phase site distribution may be an artifact of how assemblages of that phase are defined—based on the current, and possibly inappropriate, archaeological definition of that phase from much earlier Navajo Reservoir research. Both chronological and archaeological phase data need to be reexamined for the central and upper section drainages of the three rivers with new fieldwork, including systematic testing and excavation programs.

H-D upland data indicate a major increase in Pueblo I Rosa Phase habitation sites in the Pine Valley and lower to central sections of its tributaries. Lack of good information on site occupation duration within that phase may, however, obscure and inflate our current view of high site densities. The majority of Rosa sites appear to have been scattered groupings of single-habitation sites with a good number of multiple-unit sites and rare village-sized communities. Site data from the eastern H-D uplands and central Piedra River valley indicate some Rosa Phase sites and communities, but
Figure 4. Symmetrical Histogram Sets of Anasazi Period and Phase Habitation Site Frequencies (by unit types) in the Eastern and Western H-Ds

they seem scattered and relatively light in number. The succeeding Pueblo I Piedra Phase was a time when regional environmental changes placed Anasazi communities under stress through an accelerating shift from winter-dominant to summer-dominant precipitation patterns. Arable soils were eroded from lower valley (and lower elevation) localities in a "headward" pattern, forcing Anasazi populations northward to higher valley elevations with greater orographic-based precipitation. The Pine River valley and its H-D uplands, for unknown reasons, appear to have been effectively abandoned by the end of the Piedra Phase and start of the Pueblo II Arboles Phase. The Piedra Valley was occupied by a growing Anasazi population and Arboles Phase sites became relatively numerous in lower H-D upland tributary valleys and riparian terraces of the Piedra River. Current site data for the Pine Valley and its H-D uplands indicate that Arboles Phase occupations may have been completely absent except for possible short-term foraging visits from the eastern H-Ds and Piedra Valley. H-D Mountain upland site distribution data further support earlier evidence that terminal Anasazi occupation of southwest Colorado's eastern region, defined as the Pueblo II Chimney Rock Phase, was confined to within a five mile radius of Chimney Rock Mesa immediately east-northeast of the H-D study area. A minimum of eight settlement concentrations, or communities, including a recently documented one within the H-D study area, that of Peterson Gulch, are known to reflect Chimney Rock Phase assemblage traits. The Chimney Rock Phase is essentially a thin veneer of Late Pueblo II architectural and ceramic traits of Chacoan (San Juan Basin) derivation over earlier locally-evolved Arboles Phase assemblages. Nearly all known Chimney Rock sites have earlier, underlying Arboles components and mixed
Chimney Rock and Arboles cultural elements. Chimney Rock cultural evidence from the western H-D uplands and Pine River valley appears to be confined to short-term, ephemeral foraging visits. The termination of the Chimney Rock Phase, tree-ring dated to ca. A.D. 1125, also signals the effective end of Anasazi occupation in eastern southwest Colorado except for later Pueblo IV and Pueblo V period visits from northern New Mexico.
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THE CHANGING FACE OF THE COMMUNITY IN THE MESA VERDE REGION A.D. 1000-1300

Michael A. Adler and Mark D. Varien

Abstract

This is a report on our ongoing investigation of community structure in Anasazi settlement systems. We would like to cover three major portions of our research. The first is a cross-cultural overview of the function, scale, and integration of the community in politically nonstratified societies. The second is an application of cross-cultural findings to archaeological data from the Sand Canyon area of southwest Colorado, which allows us to examine the spatial and demographic scale of Mesa Verde region communities between A.D. 1000 and 1300. The third is an evaluation of our model of local Anasazi community structure based upon regional data collected in southwest Colorado and southeast Utah. We propose that while the geographical boundaries of most Anasazi communities were stable during this period, household groups displayed substantial spatial mobility within those larger, stable community boundaries.

Community: Previous Research and Cross-Cultural Data

Within the social sciences, the term community connotes a variety of spatial and social organizational meanings (Murdock and Wilson 1972; Wilshusen and Varien 1990). Southwestern archaeologists have generally relied upon the spatial clustering of domestic architecture in defining the scale and organization of Anasazi communities (Benson 1988; Biella 1979; Dykeman and Langenfeld 1987; Fowler and Stein 1987; Gilman 1988; Neily 1983; Rohn 1977).

Art Rohn emphasizes this community perspective in his Mesa Verde research. Rohn (1977:7) agrees with Linton (1936) and Murdock (1949) in defining the community as a “local group determined not by kinship but by spatial proximity that brings its individual members
into face-to-face contact.” Rohn (1977) operationalizes this definition as the settlement or village, by which he means a cluster of houses and facilities used by the community. His Chapin Mesa communities are generally comprised of clusters of from six to thirty habitation features.

Similar terminology is utilized by Eddy (1977) in the Chimney Rock area. Within a six square mile area surrounding Chimney Rock, Eddy delineates seven separate Pueblo II communities. His criteria for identifying communities are spatial clustering of various site types and the presence of relatively uninhabited areas between clusters (Eddy 1977:3). The Chimney Rock communities are comprised of clusters of between two and fifteen sites. There are between seven and seventy-five architectural features in each of the community clusters.

We agree with Rohn, Eddy, and others that clustering of Anasazi sites is real, but we take a different approach to defining the community. Rather than beginning with the clusters of archaeological sites, we look first to the cross-cultural literature in defining the function and scale of the community in nonstratified societies. By focusing on the function of ethnographic communities, we believe we can better define communities in the archaeological record.

Cross-Cultural Research

Adler has spent the past few years building a cross-cultural data base on tribal communities. One important goal of this research (Adler 1990) has been to define the community as a social organization, rather than as a purely material and spatial phenomenon. To accomplish this, cross-cultural analysis includes societies from across the world to examine community function, scale, and integration.

One consistent function of communities in politically nonstratified societies is the creation and perpetuation of land tenure rights for community members within the larger regional systems. In other words, the community is a territorial unit whose members recognize some limited shared access to the productive resources of the locale. An important point here: if the ethnographic communities in the cross-cultural sample were reduced to archaeologically visible remains, not all of these remains would form tightly clustered patterns of residential facilities.

The demographic scale of the communities in this cross-cultural sample varies widely, but there are some notable regularities. First, there does seem to be a maximum population size for communities in politically nonstratified societies. In both the worldwide and regional samples, the size of the community does not exceed approximately 1500 people. The existence of a population limit for tribal communities is supported by others (Forge 1972), including recent research by Steve Lekson (1985, 1988), who places the upper limit at about 2000 people. We do not have the time to discuss reasons for this limit, but it probably has to do with the constraints these societies face in integrating a large number of people in the absence of a strongly hierarchical social framework. We are working on the question of the minimal size of tribal communities, but have not determined a lower limit.

In addition to this demographic investigation of the community, we are also using cross-cultural data to examine the role of socially integrative architecture in defining the community. Socially integrative public architecture are those facilities used by groups larger than the household for rituals and other integrative activities. Our research (Adler 1989; Adler and Wilshusen 1990) indicates that the facilities constructed for the integrative activities of entire communities tend to have the largest floor area and highest degree of specialization of use of any integrative facilities in the nonstratified societies. Ethnographic examples of community facilities include Mandan medicine lodges and nineteenth-century Pomo village dance houses.

Finding the Community on the Ground: The Sand Canyon Locality

Based upon these cross-cultural patterns, we expect communities in politically nonstratified societies to have demographic and organizational limits and that structures and
spaces used by the entire community for social integrative activities will be the largest and most specialized in use. These generalizations can be applied to recognizing communities in the archaeological record.

As a case study in prehistoric community structure, we will use recent survey and excavation data from the Sand Canyon locality. The project, designed and executed by archaeologists from Crow Canyon Archaeological Center, includes survey data from a 25 km$^2$ area west of Cortez (Adler 1990; Van West et al. 1987) and excavation data from Sand Canyon Pueblo (Bradley 1988, 1990) and fourteen sites within the survey area (Varien 1990, 1991).

A conspicuous characteristic of the archaeological remains in this locale is the degree of site clustering through time. As we have noted above, previous studies have relied heavily upon site clustering as the primary criterion for recognizing communities. Clustering, obviously, is in the eye of the beholder. We identify three levels of clustering in the Sand Canyon survey area. First there is the clustering of architectural features at the discrete, single site level. Except in the cases of the large late aggregated sites of Sand Canyon Pueblo and Goodman Point Ruin, we consider these discrete sites as residential units occupied by community members but not by the entire community.

A second level of clustering appears at a larger spatial scale. In the Sand Canyon locale these appear as clusters of discrete sites. This level of clustering is apparently what Rohn (1977), Eddy (1977), and others (Neily 1983) use to identify the community. In the Sand Canyon locality, these clusters cover between 1 and 4.6 km$^2$ and contain between 7 and 40 sites (Figure 1). The average number of surface rooms in these second level clusters ranges between 50 and 275 rooms per cluster, depending on the time period (Table 1).

However, we can take site clustering to a third, and even larger, spatial scale by lumping these smaller site clusters together. The primary defining factor in this level of clustering is the presence of a sparsely populated area between the two clusters in the Sand Canyon survey area (Figures 1-3). This area of light occupation (4 km$^2$) contains an average site density of four habitation sites per square kilometer for the Pueblo II and Pueblo III periods, well below the average of twenty habitation sites per square kilometer in the surrounding survey area.

So, where is the community? We obviously have various levels of site clustering with relatively empty areas between them. It is here that we look at the placement of socially integrative architecture in the Sand Canyon locality. We agree with many of our colleagues who consider structures such as great houses and great kivas to be prime candidates for community-level integrative facilities. This is also consistent with the cross-cultural data from tribal societies indicating that the largest facility in any hierarchy of integrative facilities generally functions to integrate the larger community.

In the Sand Canyon locality, community-level integrative facilities are concentrated in two locations (Figures 1-3). Each cluster contains a community-level integrative facility throughout the Pueblo II and Pueblo III periods.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>980-1060</th>
<th>1060-1150</th>
<th>1150-1300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of site clusters</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Average site size (# of rooms)</td>
<td>7</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Average number sites per cluster</td>
<td>13</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>Average number rooms per site cluster</td>
<td>91</td>
<td>122</td>
<td>275</td>
</tr>
<tr>
<td>Avg. Morn. Pop. of site cluster$^1$</td>
<td>34</td>
<td>40</td>
<td>55</td>
</tr>
<tr>
<td>20-year site life</td>
<td>85</td>
<td>100</td>
<td>138</td>
</tr>
<tr>
<td>50-year site life</td>
<td>2.6</td>
<td>2.8</td>
<td>2.4</td>
</tr>
</tbody>
</table>

$^1$Based upon estimates of 20- and 50-year average site life, and 1.5 people inhabiting each room.
Figure 1. Site Distribution and Potential Community Boundary, A.D. 980-1060
Figure 2. Site Distribution and Potential Community Boundary, A.D. 1060-1150
We interpret the clustering of both large-scale community integrative facilities and the relatively uninhabited area in between as evidence that two separate Anasazi communities occupied the survey locality between A.D. 1000-1300. We’ve named these clusters of sites and integrative facilities the Sand Canyon Community and Goodman Point Community because they include the aggregated sites of Sand Canyon Pueblo and the Goodman Point Ruin constructed later in the occupation of the locality.

During the three centuries considered here, both of these communities show change through time. These include changes in residential site clustering, changes in the size of site clusters, and changes in average settlement population size. While the Pueblo II pattern exhibits loose clusters of small six to nine room blocks, the Early Pueblo III communities contain larger, more tightly clustered complexes of roomblocks averaging more than thirteen rooms per roomblock. During the thirteenth century the dispersed residential groups coalesce into two substantial aggregated communities, Sand Canyon Pueblo and Goodman Point Ruin, each with its own community-level integrative facilities.

Survey data reveal an incremental increase in the size of two communities between A.D. 1000 and 1300. Based upon the estimation of the number of rooms occupied at any one point in time, figuring 1.5 people per room, the momentary population levels in the survey area between A.D. 1000 and 1075 probably ranged between 100 and 200 people in each community. Additional community members probably occupied sites on the margins of the survey area. We believe each of these two communities contained one great kiva dating to the eleventh century. Between A.D. 1075 and 1150, each community is estimated to have contained between 150 and 350 people. We believe that Casa Negra (a great house with an associated great kiva in the Sand Canyon Community) and an early great kiva in the Goodman Point Community served as the primary integrative facilities for each community during this time. There is also the possibility that a great house structure was present at Goodman Point Ruin.

Finally, in the thirteenth century, the dispersed residential groups in these two proposed communities aggregated into Sand Canyon Pueblo and Goodman Point Ruin. We estimate the population of each of these Late Pueblo III aggregated communities to be between 200 and 600 people. Even if we double these admittedly conservative population estimates, the populations of the two communities remain well below the cross-culturally derived maximum populations of 1500 to 2000 people in nonstratified communities.

**Community Mobility Strategies**

Thus, we argue for a high degree of continuity in the location of the Sand Canyon and Goodman Point communities between A.D. 1000 and 1300. While there are some shifts in the location of smaller site clusters, the location of community-level integrative facilities remains relatively the same throughout the three centuries. Survey and testing do indicate, however, that the residential units within these communities display a higher level of mobility than that of the community itself. To date, twelve sites with Mesa Verde Phase occupations (A.D. 1180 to 1300) have been tested in the survey area. A combination of tree-ring dates, archaeomagnetic dates, ceramic seriation, and stratigraphy allow us to outline the following changes in settlement patterns.

The great majority of sites occupied in the study area prior to the early thirteenth century are located on the best farming lands of the mesa tops, away from the canyon rims. Of the mesa top habitation sites tested to date, most were occupied between A.D. 1180 and 1240 (Hegmon 1991; Varien 1990, 1991). The single exception to this is a mesa top tower and kiva dating to the 1270s. Stratigraphy in all of the kivas tested to date indicates that roof beams were removed at the time the kiva was abandoned. We interpret this as evidence that occupants were recycling construction materials during these residential moves in the late twelfth and early thirteenth centuries.
Many researchers in the Mesa Verde region have recorded the shift in habitation site location from the mesa top to canyon rims and benches during the late twelfth and early thirteenth centuries (Fetterman and Honeycutt 1987; Neily 1983). Tree-ring dates and ceramics from our excavations indicate these cliff-edge sites postdate the mesa top sites in our study area. We date this shift from mesa tops to canyons to sometime between A.D. 1225 and 1250. Like the earlier mesa top sites, roofing timbers on the canyon rim and talus slope sites appear to have been removed at the time of structure abandonment.

By the mid 1200s, the large aggregated sites of Sand Canyon Pueblo and Goodman Point Ruin were under construction or already inhabited. While we believe this population aggregation drew much of the outlying population into the large sites, some of the smaller canyon sites may have been occupied until the abandonment of the Mesa Verde region in the late 1200s.

Mark Varien is currently at work refining the length of occupation of these tested sites. Preliminary analyses of these smaller residential sites indicate that site occupations were shorter than the ceramically-defined temporal phase to which they have been assigned (Varien 1990). This indicates a high degree of household mobility within the long-term spatial stability of the larger Sand Canyon and Goodman Point communities.

The Regional Picture

Our final discussion describes the first step toward a regional evaluation of this model of residential mobility and community stability. Recently we were involved, along with many additional archaeologists, in a larger project aimed at investigating the distribution of Pueblo II and Pueblo III communities in the northern San Juan drainage in southwestern Colorado and southeastern Utah. As a proxy for communities, we have used the locations of all known Pueblo II public architecture (great houses and great kivas) and known Pueblo III aggregated sites containing more than fifty structures (Varien et al. 1990).

These sites are plotted on maps divided into three large time periods (Figures 4-6). Sites have been assigned to each period using tree-ring dates. Lacking these dates, ceramics and architectural characteristics were used to date remaining sites. Overall, we have found that regional patterns of settlement size and location resemble those found in the Sand Canyon locale. Between A.D. 1075 and 1150, great houses and great kivas seem to be the most common form of community-level integrative facilities (Figure 4). We believe that most (but perhaps not all) Mesa Verde region communities during this period were comprised of clusters of small sites dispersed around these integrative facilities. During the following period, between A.D. 1150 and 1225, the aggregated sites in the region are characterized by a denser clustering of residential roomblocks and are typically located on mesa tops (Figure 5).

The last of the three maps (Figure 6) shows sites larger than 50 rooms probably dating between A.D. 1225 and 1300. These sites are characteristically larger than earlier aggregated sites and are generally located off of the mesa tops on the canyon rims and talus slopes. Many of these sites are enclosed within low walls and often surround a spring.

The model of community organization and stability we have described is supported to a large extent by data from the northern San Juan drainage, especially within the Montezuma Valley. In most Montezuma Valley locales containing a Pueblo II great house or great kiva, the construction of the community-level integrative structure is followed by the construction of a nearby aggregate of mesa top roomblocks, which, in turn, is superseded by the construction of a nearby aggregated canyon rim site. In many locales the community-level integrative architectural features remain concentrated in the same small area, resembling what we find in the Sand Canyon and Goodman Point communities.

A good example of this is found at the Lowry complex in the progression from the mesa top Lowry Pueblo, dating to the late 1000s, to the mesa top Pigg Pueblo (late 1100s), to the
Figure 4. Community Integrative Facilities, A.D. 1080-1150
Figure 5. Large Aggregated Sites, A.D. 1150-1225
Figure 6. Large Aggregated Sites, A.D. 1225-1300
canyon rim Cow Canyon Pueblo of the Late Pueblo III Period (late 1200s). In some cases the integrative architecture for the various periods is so clustered that they occur on what archaeologists have recorded as a single site, for example at Yellow Jacket and Mitchell Springs ruins.

Exceptions to this model of long-term community stability do exist within the northern San Juan study area. Of particular note is the eastern portion of the study area. For example, the significant cluster of Pueblo II great houses in the Lakeview area near Totten Reservoir (Figure 4) does not appear to have been followed by a later aggregated Pueblo III community.

**Future Research Directions on the Community**

Cross-cultural and archaeological data indicate interesting regularities may exist in Anasazi community organization and scale. We prefer a model that identifies communities based on spatial clusters of residential structures and association of large-scale community-level integrative facilities. The archaeological data collected at Sand Canyon and Goodman Point support the long-term spatial integrity of the communities and the substantial mobility of the residential groups comprising the larger community.

Much of what we have described today is nothing new to the archaeologists of the Mesa Verde region. Prudden, Fewkes, and others recognized the changes in site size and the shift from mesa tops to canyons well over eighty years ago. Hopefully our research contributes to a more systematic interpretation of the scale and integration of Anasazi communities.

Our observations need to be subjected to much more testing. Other archaeologists have proposed that entire Anasazi communities exhibit a high degree of mobility (Kintigh 1985; Schlanger and Wilshusen 1990; Wilshusen 1991), thus contradicting our model that focuses on the spatial stability of the community. Future assessment of these models will necessitate better methods for assessing the contemporaneity of sites. Improved ceramic microchronologies and studies of artifact accumulation rates should contribute to the assessment of site use life and site contemporaneity.

We realize that a dilemma is posed by the fact that some Anasazi communities within and outside the Four Corners region may have lacked the types of public architecture we focus on here. Black Mesa stands as one such example. Also, Anasazi communities may contain integrative facilities that we do not yet recognize, such as dance circles and poorly defined plaza areas. It is also possible that the integrative structures we associate with a single community may in fact integrate multiple communities. We need to continue to develop proxies in addition to public architecture for use in recognizing prehistoric Anasazi communities.

Finally, the apparent contradiction between the mobility of residential groups and sedentism of the larger community structure needs more systematic study. Household mobility across community boundaries was probably an important mechanism for maintaining alliances between communities. Intercommunity ties may be a critical aspect of the regional social organization that permitted communities to buffer local fluctuations and shortfalls.
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Abstract

Recent research in the McElmo Creek drainage seems to confirm a prehistoric population expansion in the Mesa Verde Archaeological Region from about A.D. 1000-1100. Evidence for the Pueblo II expansion comes from survey and excavation associated with the Hindmarsh Archaeological Project and with the Four Corners Archaeological Project, which was associated with the Dolores Project north and west of Mesa Verde National Park.

The population expansion was characterized by a scattering of small (ca. 10 rooms and less) habitation sites with a diversity of architectural style. A population density estimate of 2 people per acre is proposed for this time period. The Pueblo II people north of Mesa Verde also appear to have used a variety of architectural techniques including the use of upright sandstone boulders and slabs in their masonry walls, jacal structures, and stockaded enclosures associated with their habitation sites.

Since 1986 Flint Research Associates has been exploring the area under the North Rim of Mesa Verde and southeast of Cortez, Colorado in relation to an hypothesized Pueblo II expansion in the McElmo Creek drainage of the Mesa Verde Archaeological Region (Flint 1987, 1988a, 1988b, 1989). As a research interest the Pueblo II stage from about A.D. 900-1100 in the McElmo Creek drainage has needed some attention according to the 1984 assessment:

Recent research directed toward investigating early PII behavior and material manifestations of culture is virtually non-existent. (Eddy et al. 1984:38)
And, as a result of his work with the Dolores Archaeological Program, Ken Petersen hypothesized (personal communication 1984) that Anasazi may have made use of north-facing slopes such as those below the North Rim of Mesa Verde for their habitation and farming activities because the north slopes would be moist with snow and subsequent moisture runoff longer into the spring and thus could possibly be beneficial locations to these farming people.

Research Since 1984 Under the North Rim

The basic need for research in the area coupled with an idea that many sites might be found to support an hypothesis of Pueblo II expansion came together with a request from Montezuma County ranchers Russel and Ann Hindmarsh to "make a history" for the prehistoric people who lived on their land just one-half mile north of Mesa Verde's Park Point. The Hindmarsh family asked Flint Research Associates, a privately-funded archaeological group, to make an assessment of the archaeological sites on their grazing land. This work was an extension of a survey we had conducted for the Bureau of Land Management on land west of the Cortez city dump. In that survey (Flint 1984) we found that most of the site remains (58 percent) at least on the surface were of the Pueblo II and Early Pueblo III time periods about A.D. 1000-1150. Most of the pottery was Mancos Black-on-white with corrugated utility ware predominant.

At about the same time as the Hindmarsh Archaeological Project was under way, work in the McElmo Creek drainage was being done in connection with the Dolores Project's Towaoc Canal (Kuckleman 1986). Survey work by Complete Archaeological Services Associates (CASA) indicated that the population of the southern flank of McElmo Creek north of Mesa Verde roughly doubled in number and scattered by the Pueblo II Period. CASA's excavation work on the South Canal portion of the Dolores Project had already raised several research questions concerning the Pueblo II occupation of the Mesa Verde Region: not only the why and how of the Pueblo II population expansion but the fact of the variety of Pueblo II architecture (Kuckleman and Morris 1988). In this South Canal area west of Pleasant View, many jacial structures and stockaded enclosures were found in contrast to the masonry structures usually reported for this time period.

Just this year Flint Research was asked to assist in the archaeological survey work associated with the replacement of the Mesa Verde aqueduct (Flint 1991a, 1991b). Five miles of the aqueduct line was surveyed in terms of a 66 m (200 ft.) wide southwest to northeast transect from 3 miles south of McElmo Creek up and over the North Rim escarpment (Arrington 1990; Flint 1991a). Six miles of access road for construction work was surveyed southeast to northwest from a mile-and-one-half south of McElmo Creek or 1912 m (6274 ft.) to the beginning of the North Rim escarpment 2060 m (6760 ft.) away.

Smaller projects associated with seismic lines, water lines, stock grazing, and stock ponds have also been conducted in the area.

Pueblo II Who Are You?

The very generalized view of what we should be seeing in Pueblo II is the unit-type house of Prudden (1903:234) with a single row of rooms about 2 m (6.6 ft.) wide and perhaps 4 m (13.4 ft.) long with a kiva to the south. The structure would be made of bread-loaf shaped sandstone blocks. Sites would be located in the plateau-mesa top environmental zone. One portion of the Badger House Community at Mesa Verde National Park is a representative of this generalized view (Hayes and Lancaster 1975).

In contrast, the Pueblo II sites found in McElmo Creek drainage survey are almost twice the size of Prudden's unit-type. These sites are characterized in archaeological survey by the presence of corrugated, Mancos, and McElmo black-on-white pottery and by associated rubble mounds and kiva depressions. The habitation sites observed in the Hindmarsh Project area are more like 8 m (24 ft.) long and 6 m (18 ft.) wide
with usually two rows of rooms in the roomblock. The room walls are from 2-3 m (6-8 ft.) long.

**Upright Sandstone Slab Construction in Pueblo II**

In the McElmo Creek drainage Pueblo II roomblocks were not all fashioned of lovely uniform building blocks. Instead, one variety of Pueblo II construction involved the use of upright sandstone slabs. On the north side of McElmo Creek at White Hawk House (5MT8899), excavated as part of the Four Corners Archaeological Project, the tallest slab was over 1.5 m (5 ft.) tall. Other slabs are not as tall but are worked into the room walls in an upright position.

At the Hindmarsh Project there are four habitation sites in which similar upright boulders were used in room construction in association with predominantly Mancos Black-on-white pottery in a Pueblo II context. Only two of the sites have been surveyed. One room of wall construction was disturbed by vandals. Another was found on a prominent point in a keyhole shaped rubble mound. At the third site, Marsha Ann, we found some use of upright sandstone in the one activity room excavated; the kiva walls are of large horizontal sandstone boulders. The fourth site in which upright sandstone slabs were used is Hindmarsh One.

At Hindmarsh One, the two upright building stones in the north wall of room 4 were about the size of an easy chair seat cushion but weighed as much as 55 pounds (about 25 kg). These vertically laid building stones are 57 cm (22.5 in.) tall, 38 cm (15 in.) wide, and 10-15 cm (4-6 in.) thick, smaller sandstone was also used but no construction blocks as small or as uniform as the bread-loaf shaped stones utilized in the hypothetical, generalized Pueblo II sites. Large, simply-shaped building blocks may have simply been easier to fashion with the local, comparatively hard Point Lookout Sandstone. Between the blocks there were small sandstone spalls 5 cm by 5 cm by 1.3 cm (2 by 2 by 1.5 in.) which were embedded in the mud mortar. Sometimes small sherds were also used as part of the wall construction. They remind me of the newspaper insulation used in some historic pioneer log homes, and the sherds provide similar time markers.

The variety of architecture used in the McElmo Creek drainage may reflect the use of local materials, hard Upper Cretaceous Point Lookout Sandstone (Wanek 1959) as opposed to the softer Cliff House Sandstone. The use of upright sandstone blocks harkens back to Pueblo I techniques, but these sites are 200 years later, in the A.D. 1000s. And for the most part the pottery is Mancos Black-on-white which cross-dates to A.D. 900-1150 (Breternitz et al. 1974).

**Pueblo II Component or Expansion?**

The sites excavated in association with the Hindmarsh Archaeological Project have so far been only Pueblo II component sites. At White Hawk House there was a Basketmaker component below the Pueblo II but no Pueblo I. The logical problem of course is if there was a Pueblo II expansion, then where are the fewer Pueblo I sites?

Thankfully, the transects surveyed for the Mesa Verde aqueduct replacement project have provided data on the Basketmaker and Pueblo I occupation of the southern flank of the McElmo Creek drainage. Five Basketmaker and Pueblo I sites were found at slightly lower elevations 2012 m (6600 ft.) on wide ridges of Mikim Loam now deeply dissected by arroyos. This is in contrast to 20 Pueblo II sites at just slightly higher elevations 2072 m (6800 ft.) on Rombert Very Stony Loam clinging to the edge of much deeper arroyos. This does seem to point to an increase in population if the Pueblo II sites were not all occupied previously.

**Hindmarsh Archaeological Project and Park Point Drainages**

In the 260 acres intensively surveyed as part of the Hindmarsh Archaeological Project we found 16 habitation sites and 5 specialized activity sites. The data from these sites have been used to propose a settlement pattern for the
Pueblo II Anasazi in this area which will certainly be revised with more survey and excavation data. But for now it appears that the habitation sites in this particular area have certain similarities other than Mancos Black-on-white pottery, their architectural style, and the presence of sandstone rubble and a kiva depression. Certainly it seems the old real estate rule of "Location, location, location" is appropriate when dealing with the Hindmarsh Anasazi.

1. Five intermittent streams drain into the Hindmarsh Project area from under and around Park Point. The habitation sites with one exception are located along these now dry arroyo edges. Six sites flank a 9 m (30 ft.) deep arroyo in the southern part of the study area. Two other sites are along shallower arroyos. During Pueblo II times these arroyos may have held moisture. There are some springs shown on 1965 USGS maps, but they failed in the years 1987-1991.

2. The alluvial fan areas between these deep arroyos have richer soil (Soil Conservation Service 1991) than that just below them in elevation. At lower elevations the alkali in the Mikim Loam soil becomes more concentrated and makes the soil less productive for horticulture.

3. All of the habitation sites are within 33 m (110 ft.) elevation in their locations between 2057 and 2090 m (6750 to 6860 ft.). All the habitation sites are within a quarter mile radius of each other. They all have piñon, juniper, and sagebrush either on or in the immediate vicinity of them.

4. Artifacts at the sites are similar. Silicified sediments were used in fashioning lithic tools. These type of sediments outcrop in the Mancos Shale formation in the immediate area.
Mancos Black-on-white pottery is the predominant decorated ware. McElmo Black-on-white appears but not as frequently in the majority of sites. More Mancos Corrugated appears than Dolores Corrugated but both do occur. By typological cross-dating of pottery types, specifically the appearance of Dolores Corrugated, it appears that these are sites which date to sometime between A.D. 1050 and A.D. 1150.

5. All of the habitation sites cover less than an acre; most are in the 300 m² (1125 sq. ft.) range including the area covered by rubble and kiva depression.

We have estimated that about 114 people in about 25 families were living in the 260 acre study area in the year A.D. 1066. The population estimate is based upon the following generalized assumptions:
1. The average family included 5 people.
2. These 5 people would occupy about 3 rooms in the pueblo.
3. The relationship between the site size and number of rooms of the pueblos in the surveyed sites is based upon a comparison between the survey site size recorded at one site which was subsequently excavated, Hindmarsh One. At Hindmarsh One, 380 m² (1425 sq. ft.) of site area ended up representing 7 rooms. From assumptions one and two above on the average family size, the 7 rooms may have represented the homes of 2 families of 5 persons each or about 10 people.

To make the population estimates from the survey data of the 16 habitation sites, every 38 m² (142.5 sq. ft.) of site area counted for one person in the study area. The population density was about 2 people per acre and 10 acres for each family.

This population estimate for this time slice at A.D. 1066 was a time of moderate drought, a long enough growing season, and no potential shortfall of harvest. It is part of the A.D. 1042-1146 time period identified by work at the Dolores Project when conditions were favorable to the Anasazi horticultural life (Schlanger 1988).

The Settlement Pattern Suggested

The data now in from archaeological surveys and limited excavations under the
North Rim of Mesa Verde suggest to me that there was a Pueblo II expansion in the A.D. 1000s and that it was probably related to the presence of potable water and good agricultural soils. The remains of the Pueblo II sites are almost invariably clinging to arroyo edges as opposed to the Basketmaker and Pueblo I sites, which are located on broader ridges. It also appears that there was a movement up the slopes of the North Rim in the Pueblo III time period. Sites at elevations above 2073 m (6800 ft.) contain more McElmo Black-on-white pottery and have more concentrated rubble mounds with larger mounds of building stones and deeper kiva depressions. They continue to be located on the edges of 9 m (30 ft.) deep arroyos.

The Pueblo II Hindmarsh Archaeological Community with its high population density of 2 people per acre may not have been the rule in the entire area under the North Rim, but may be the reflection of environmental factors including the grouping of five drainages off of Park Point and the subsequent fertility of the alluvial fan areas. The proximity of this group of sites within a 30 m (100 ft.) elevational range and within a quarter mile radius of one another may have been influenced by the presence of a prominent hill used for a solar observatory. The pattern of archaeological sites probably reflects not only the environmental, but the social relationships in the prehistoric Pueblo community.

This research directed toward investigating Pueblo II behavior and material manifestations is ongoing. Certainly it has been demonstrated that the Mesa Verde region Anasazi did not stop at the park boundaries. The control of access routes which the Hindmarsh family has exercised has protected these sites for this research and to them we are extremely grateful. The history of the Hindmarsh Anasazi and other groups under the North Rim of Mesa Verde is in the initial stages of its writing with more fascinating revelations anticipated of a durable farming group in the Anasazi good times.
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ANASAZI:
HABITATION CHOICES AND CLIMATIC FACTORS

Friday, October 4, 1991
Morning Session III

Chair: Art Hutchinson
MICROGEOGRAPHIC COMPARISONS OF CLIMATE TODAY AFFORD INFERENCE CONCERNING PAST BEHAVIOR:
AN OVERVIEW OF DATA AND APPLICATIONS FROM A STUDY OF CHAPIN MESA (MESIA VERDE NATIONAL PARK) CLIMATE

Linda Curran-Everett, Richard G. Milo, and Duane Quiatt

Abstract

Climatic data from weather stations on Chapin Mesa, Mesa Verde National Park, provide information relevant to consideration of an apparent residential shift late in the prehistoric period into protected, multi-household habitations in cliff alcoves. 1) Comparison of climatic variability form north to south on this south-sloping mesa suggests that even very slight changes in annual mean temperatures can significantly shorten frost-free growing seasons, thereby greatly reducing the value (for production of corn especially) of otherwise cultivable fields to the north, relative to those to the south. Similarly, 2) for groups of individuals committed to a relatively stable, year-round residential pattern, extended periods of winter cold stress would have increased the relative value of protected, heat-efficient habitations, as, e.g., in the larger cliff alcoves to the south. If, and for whatever reasons, a residential shift of the Chapin Mesa population produced centers of density in cliff alcoves to the south, both these conditions would have tended to intensify existing competition for crucial and strictly limited resources: cultivable land and protected habitation sites. Our findings, as we suggest in a companion paper, afford partial testing on a local basis of current models of environmental and behavioral change and adaptation at Mesa Verde and in the wider region.

Introduction

Conventional wisdom has it that the original Mesa Verde inhabitants moved off the mesa tops into the cliffside alcoves sometime before abandoning the area entirely. This paper is concerned with the residential shift into those alcoves, but it is important to keep in mind that at every stage in Mesa Verde prehistory some residents appear to have inhabited the mesa tops, others the cliffsides and talus slopes, and some evidently the canyon floors. The nature of
these habitations at different altitudes and different times is enigmatic—the extent to which they were concurrent, overlapping, or seasonal is not clear, and there may have been internal or intercommunity “class” differences associated with residence in one or another. Categorizing habitation sites in such a way is not meant to imply that all cliffside dwellings or all mesa top dwellings must have been created equal or perceived as such—in fact, the differences are precisely what we set out to investigate. The ultimate aim is to demonstrate—through a combination of household analysis and energetic comparison of mesa top and cliffside dwelling microhabitats—that difference it could have made “really” to reside in a cliff dwelling as opposed to a mesa top pueblo, in certain cliffside alcoves rather than others, and the particular focus of this paper, in certain structures within a given alcove as opposed to others. Conventional wisdom also has it that the Mesa Verdeans, who like many aboriginal agrarians are conceived by some to have been necessarily much “in tune” with their environment, exercised “solar wisdom” in the siting and construction of their dwellings. This at least is a more testable assertion. We can examine the interaction between current climatic conditions and the earth’s core heat, derive general principles of thermal management specific to alcove habitats, and compare sites in terms of features that influence thermal management from day to day and across seasons. It is important (if obvious) to note that while a sunlit habitation is desirable during the colder months, it is not so desirable in summer. Judicious selection of a dwelling site, combined with attention to principles of heat exchange in construction and use, can improve the level of comfort over most of the year, but during prolonged winter cold spells it is not comfort that is at issue but survival. For this reason, the discussion of heat management will focus more on cold season strategies.

North-South Differences in Chapin Mesa Temperatures

Pollen analysis and tree-ring studies indicate a twelfth and thirteenth century climate for the park as a whole that is generally similar to the climate today (Wyckoff 1977). Much of our analysis depends on a slightly different but crucial assumption: that contemporary climatic differences consequent on elevation and geographic variables also obtained in the twelfth and thirteenth centuries. Chapin Mesa slopes from a maximum elevation of approximately 2600 meters at the northern escarpment to about 2000 meters at the south end (Smith 1987), with correlative differences in temperature that appear to be significant for agriculture and no small factor as far as human comfort is concerned.

A. Implications for agriculture. What emerged from our analysis of modern climatic variability on Chapin Mesa over a three year period were two general findings. The first, by no means original to our study, is that modest differences in elevation and mean annual temperatures can result in growing seasons of quite different durations. The second is that, while the initial decision to construct large, multi-household dwellings in cliff alcoves has clear implications for heat management and year-round residence, directional orientation of the alcove is an insufficient indicator of its thermal characteristics or heat management potential. Each of these points will be addressed in turn.

With respect to elevation-related differences, in 1988 the growing season at Park Headquarters was 31 days longer than at MV-499, a Pueblo III habitation site 6.5 km to the north (Table 1). In 1989, the Park Headquarters growing season was 18 days longer than that of MV-499, and in 1990 it was 7 days longer. This difference in growing season length equates with differences in relative value of arable land from north to south, especially for crops such as corn, and it seems entirely reasonable to suppose that a very slight drop in regional temperatures might have sharply depressed the value of croplands to the north, further increasing that difference in relative value.

B. Implications for habitation sites. If fields located to the south on Chapin Mesa were viewed as more desirable, this might by extension increase the value of dwellings
constructed nearby. If proximity to cultivated fields was a factor in the selection of habitation sites and if we can assume that we are dealing with predominantly agrarian households committed to a relatively stable, year-round residential pattern, then extended periods of winter cold stress should further increase the relative value of protected, heat-efficient habitations close to croplands, whether on the mesa top or in the cliff alcoves below. One great advantage of dwellings constructed in the cliff alcoves, of course, over and above their potential for thermal control, is that they are protected from wind, rain, and snow. The temperature data from Park Headquarters and MV-499—along with our regular observation of weather conditions in general through the years—lend scant support to any notion that open sites on the mesa top might provide more desirable habitations in the dead of winter. The mean minimum temperature over the months of December, January, and February for 1988 through 1990 was significantly different for Park Headquarters and MV-499 (p < .001; 25°F compared to 19°F, respectively—see Table 2), as was the mean maximum temperature during the same period (43°F for Park Headquarters, compared to 38°F for MV-499, p < .05).

Management of Heat Exchange in Cliff Alcove Structures

Alcoves are habitation sites “designed” for heat management, primarily via control of air infiltration so as to take maximum advantage of core heat as well as solar radiation, especially in winter. They are a limited resource, hence, for a population in year-round residence, a limiting resource, with value increasing in direct proportion to increases in population size. If construction or reconstruction of large, multi-household structures such as Cliff Palace and Spruce Tree House can be taken to indicate increasing population density, in conjunction with year-round residence dependent to some degree on defended food surpluses, it would also seem to suggest an increase in competition for favorable habitation sites in the south. This is the case whether we attribute those increases to a residential shift from the north, consequent primarily on lowered temperatures, or to decreasing climatic equability, constituting a
threat to agriculture across the region as a whole. In either case, increased population density to the south on Chapin Mesa would have meant keener competition for both agricultural lands and homesites.

**Habitation Structures and Heat Management in a Cliff Alcove**

The second finding of our study is that, while construction of large multi-household dwellings in cliff alcoves facilitates the management of heat exchange, with important implications for population structure and social organization in groups of settled residents, *directional orientation* of an alcove, whether it faces west, south, or east, turns out to be an insufficient indicator of thermal characteristics and of thermal management potential. (North-facing alcoves probably are another matter, but there are none in the park, at least none that housed large numbers of inhabitants.) While directional orientation is one of the more important considerations where solar heat exchange is concerned, it is by no means the only one. Other factors such as protection from wind, increased thermal mass, and shallower alcove depth (front to back) can compensate for less-than-optimal directional orientation. The bedrock toward the front of an alcove, especially the "floor" and sides, would constitute the primary collectors of radiant solar heat, along with any walls of dwellings exposed to the sun for at least part of a sunny winter day. The (horizontal) depth of an alcove, its width and its height, along with such features as the angular relation of overhang to floor and the precise nature of sloping walls, would be important not only in determining the extent of solar penetration and contact but also in constraints imposed on compensatory building strategies to boost thermal mass. (Depth also places a limit on heat exchange via air infiltration, a critical factor in alcove heat management.)

Habitability of an alcove is thus a function of its characteristic thermal potential, inherent in its structure and setting, and active thermal management. Each alcove is a unique system requiring management of stored core heat, impinging radiant heat, and air infiltration to maximize its thermal efficiency. From the perspective of heat management, a deep alcove facing due south in a narrow canyon might be less preferable as a habitation than a shallow alcove facing east or southeast in a wide canyon.

There are other factors to consider in relation to heat management and heat exchange within a given alcove. To understand these, we began by analyzing minimum and maximum monthly mean temperatures during the three coldest winter months over a three year period for four sites at Spruce Tree House, located across Spruce Tree Canyon from Park Headquarters. ST1 is a kiva located near the front of the alcove. ST2, located roughly in the center of the alcove, was once a typical room, albeit with openings in three of its walls. It has since lost its ceiling, and now, with no ceiling and those three wall openings at all times uncovered, its thermal behavior is more like an open area, partially sheltered—that is, daytime temperatures are raised considerably by sunwarmed air from outside, and it cools quickly at night. ST2 will be referred to as a sheltered area. ST3 is a room with one opening, located toward the rear of the alcove. ST4 is a weather station located just outside the south end of the alcove.

From 1988 through 1990, during the months of December, January, and February, the mean minimum temperature at ST4, the outside weather station, was not significantly different from that of ST2, the sheltered area (p > .5—means were 23°F for the outside weather station and 24°F for ST2). The mean minimum temperatures for these two sites were significantly lower, however, than those for ST1 (the kiva) and ST3 (the room toward the rear of the alcove) (p < .01). The kiva itself differed significantly from the room at the rear (p < .001), while that rear room differed significantly from the sheltered area (p < .01). Mean minimum temperatures for ST1 and ST3 were, respectively, 35°F and 28°F.

Clearly, as one might anticipate from previous examinations of kiva temperatures (including our own—Quiatt et al. 1983 and Smith and Quiatt 1987), the most comfortable place to be on a cold winter night would be a
kiva, but the next most comfortable would be the room at the rear of the alcove, especially if its one wall opening were closed at sundown. The sheltered area, too, warming in the sunny daytime but dropping to near outdoor temperatures at night, would have been more comfortable in its presumed original state, subject to active heat management.

The foregoing discussion illustrates the importance of control over air infiltration and heat loss. In kivas, the main avenue of infiltration would be the ventilator shaft, but this could be blocked fairly easily. The same is true of the small windows and entrances to above-ground dwellings. The use of adobe chinking, plus plastering inside and outside wall surfaces with thinned adobe, could effectively reduce air infiltration. Wind chill, since it is a surface phenomenon, would not be a factor in heat management in below-ground kivas with thick roofs: the earth itself, in addition to being a source of core heat, would also serve as a very effective insulator. In enclosed above-ground rooms with snug door and window coverings, wind chill would not be a factor inside the structures, but could carry away conducted heat from the outside surfaces of walls. In a relatively "filled" alcove, with larger numbers of contiguous structures, this avenue of heat loss could be greatly reduced. Essentially, rooms so constructed within alcoves would have the potential to be more like kivas in their thermal properties and potential for heat management.

Heat management assumes some potential for heat collection in the first place. We have not taken into account at all the use of fire or body heat of individuals to heat enclosed or semi-enclosed spaces within the alcoves. Our temperature analysis for the four Spruce Tree House sites considered only conducted core heat, insulation against heat loss through conduction or convection, and collection and storage of solar radiant energy, whether active (via a thermal mass) or passive (via trapped warmed air). Accordingly, we also considered the mean maximum temperatures within the four Spruce Tree House sites during the coldest winter months, as a rough index of the exposure to "natural" (non-combustive, non-metabolic) heat sources.

As it turned out, the highest mean maximum temperature for the three-month winter period was 41°F, at the outside weather station, ST4. Next highest was the kiva, at 37°F, thus illustrating the substantial heat gained when conducted core heat is supplemented by radiant solar heat striking the roof of this below-ground structure. The difference between the two sites was statistically significant (p = .01). There was no statistically significant difference in mean maximum temperature between sites ST2 and ST3, at 33°F. This is not to imply that these latter two structures were heated during the day by similar means. ST2, given its central location within the alcove and lack of direct contact by solar rays, plus its relatively open structure, is most likely heated via passive means, i.e., the infiltration of warmed air. ST3, located to the rear of the alcove, and with only one small door, presumably receives conducted core heat, though in a slightly different fashion than does the kiva ST1.

Summary and Conclusion

To summarize: the most equable and comfortable structure in the alcove during the coldest winter months seems to be the kiva, with a 1°F difference between mean minimum and maximum temperatures in the absence of heating by combustion and/or several living human bodies. Next most comfortable, given the same qualifiers, is the structure with one door opening, which, even though not covered at nightfall, still has only an average 5°F difference between minimum and maximum winter temperatures. The open structure ST2 showed a 9°F difference, and the outside weather station an 18°F difference, for comparison. It is important to note that these differences reflect only the added potential for heat management provided by the built structure (and even that it does inadequately, given its state of decay). Active management via control of air infiltration and manipulation of moveable insulation materials (e.g., rugs and wall hangings) would increase comfort still further.
In conclusion, our analysis of the conditions obtaining on Chapin Mesa and in the cliff alcoves at present help us understand the residential shift during Pueblo III times, at least in part, in terms of 1) the presumed greater relative value of arable land located to the south on Chapin Mesa, due to climatic conditions resulting in part from differences in elevation, 2) the resulting higher population density in those mid-elevation areas near the southern boundary of the park, 3) greater relative value of the cliff alcoves as building sites, both from their inherent potential as heat-efficient dwellings and their proximity to southern croplands, and finally, 4) the increasing necessity of dependence on corn to support the higher population density.

We do not wish to speculate too much about the implications for behavior that such a scenario implies, but we do note that such a residential shift, for the reasons stated, would occasion increased competition for both living sites and croplands, at a time when declining carrying capacity could only intensify the extent of non-sustainable resource use.
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LOCAL RESOURCE COMPETITION AND LOCAL RESOURCE INVESTMENT IN THE THIRTEENTH CENTURY: WHAT CAN BE SAID ABOUT THE BEHAVIORAL ECOLOGY OF A VANISHED PEOPLE?

Duane Quiatt

Abstract

The explanatory power of currently proposed models of environmental and behavioral change and adaptation in prehistory appears to depend not only on the elucidation of environmental conditions presumed to have influenced human behavior but on the (largely covert) application of certain basic principles of behavioral ecology. Acceptance of these principles justifies interpretation of variability in social and subsistence behavior from a standpoint of cost/benefit accounting and decision-making, i.e., by individuals and groups in competition with one another for resources critical to survival and reproduction. We review problems in the way of non-covert application of such principles to vanished individuals and populations and argue that resolution must depend on testing general models against highly particular regional accounts of environmental and cultural change. While it is difficult to say just how such testing shall be done, we offer some suggestions on the basis of microgeographic comparisons of climate on Chapin Mesa, Mesa Verde National Park, conjoined with a preliminary analysis of differential value of habitation sites, structures, and internal room and area complexes. Our concern is primarily with how to arrive at even very rough estimates of value, on a post hoc basis, for agricultural and residential resources and, similarly, how to say anything very meaningful about decision-making where we lack information concerning the individuals responsible for making household and larger group decisions about subsistence pursuits, household tenure, and migration. In a companion paper we focus more closely on the application of climatic data from the present to understanding population dispersion and migration and abandonment processes in the past.
Introduction

This paper should be read in conjunction with other papers of the symposium that offer interpretations of past behavior derived in part from the comparative study of Chapin Mesa microclimates initiated in 1983 by Jack Smith (Quiatt et al. 1983; Smith 1993; Smith and Quiatt 1987). Smith gives the history of that study and discusses, among other things, implications for the interpretation of kiva functions. Richard Milo suggests how we might reconstruct our notions of Chapin Mesa agroeconomy. And in our other joint contribution (Curran-Everett et al. 1993) we sketch out some microclimatic features of Spruce Tree House likely to have been taken into account by residents concerned with the management of heat exchange. In this paper we will be concerned with worrying away at what seems to us the rationale underlying every such discussion, which we want to remind you involves drawing conclusions about the behavior of individuals in households. Since there appears to be not much in the way of direct archaeological evidence for the character of either individuals or households, a rationale clearly is needed.

Culture or Behavior?

It seems to us clear as well that the rationale must be anthropological, not archaeological, and behavioral as opposed to cultural. We will not try to define culture out of existence—we are, after all, anthropologists—but would agree with Rob Foley (1989) that models of culture change tend to be descriptive and that the proper focus of analytic models should be on the behavior of individuals in groups.

It is one thing to construct grand, synthetic, descriptive models of ecocultural change (Euler et al. 1979; Gumerman 1988) and quite another to apply analytic models to the behavior of individuals. It is at this level of analysis, behavioral rather than cultural, that some few ethnologists, taking their cue from students of animal behavior, have begun to direct methods of behavioral ecology and socioecology to the study of how human beings use local resources—how they compete as individuals and in groups for critical resources, how they invest in resources likely to be controlled by lineal inheritors, how they evaluate costs and benefits associated with alternative forms of competition and investment, and which alternatives prove most successful under specified conditions of change (Standen and Foley 1989). The main advantage to socioecological analysis is that it provides a consistent, systematic approach to the study of behavioral adaptation. It is particularly appropriate for comparison across species and across behaviorally divergent populations and groups within a species. The main disadvantage for anthropological reconstruction of prehistory is that it is data-driven to an extreme, hence very difficult to apply where past populations are concerned (but cf. Foley 1989). We will discuss that difficulty in relation to our Chapin Mesa studies.

Behavioral Ecology and Socioecology

Behavioral ecology is that broad set of data bodies, analytic methods, and theoretical models of which sociobiology and socioecology comprise major subsets, the one (sociobiology) directed primarily toward explaining the ultimate origins of behavioral variation in genetic adaptation, the other (socioecology) toward elucidating the proximate settings and circumstances that condition behavior and that may conventionalize or, in the case of our own species, institutionalize it. Socioecology is like sociobiology in that both apply individual selectionist principles to the study of behavior in evolution. Both deal with the behavior of individual animals and the organization of individuals in groups, not just as outcomes of evolution, but as important variable features of the contexts in which behavior is modified. Both take as a starting point the assumption that individuals compete with one another for local resources, with success measurable (by various intermediate currencies) in terms of differential contribution to a successor gene pool. The main difference is that sociobiologists, concerned with the ultimate origins of behavior, tend to focus on
developing and testing rather abstract models of natural selection and genetic evolution, whereas socioecologists are more likely to be interested in change per se, in learned as well as genetic adaptations, and in relations between the two. It is this attention to learned adaptation, to a dynamic relation between relatively short-run changes in the environment and in the behavior of individuals and groups, that makes socioecological comparison a tool which is useful to ethnologists and historians (Standen and Foley 1989). Whether it will prove as useful to the analysis of behavior in prehistory remains to be seen.

Socioecology and Prehistory

Socioecological comparisons of living species and living populations so far have focused on subsistence practices as basic to more far-reaching analyses of individual behavior and group social life. Problems in the way of comparison, and indeed of initial analysis, where the concern is with individuals and groups of vanished populations, are so obvious that we need not belabor description—to mention them is enough.

First, how was land use organized? Can we define subsistence bases and population parameters with anything like the precision that is needed to come up with realistic if rough estimates of value for agricultural lands on Chapin Mesa? This problem is complicated, of course, by recognition that mesa top croplands may have varied in value in part as a function of elevation and that plantings may have diminished on the mesa as a whole even as population was reaching its greatest density in the mid-elevation sectors abutting present park boundaries to the south.

Second, how were residential units organized? How were local groups structured and what constituted a household? If we are going to talk about investment in and competition for local resources, we need to know something about the organizational bases of cooperation and competition. This issue cannot be separated from that of population size, but the main problem seems to be how to recognize an archaeological household, and as far as we know there is so far no satisfactory solution to it.

Third, and finally, who made the decisions governing subsistence, residence, emigration? It seems important not to lose sight of individual behavior when speculating about demographic and cultural processes such as, on Chapin Mesa, increasing population density to the south, a wave of construction, a residential shift off the mesa top, abandonment of the area. It seems especially important to take individual decision-making into account, if one only could, when considering the timing of such events. In hard times householders typically are faced with alternative choices such as staying on (in the face of increasing difficulty), making a fresh start down the road (where very similar hard times are likely to prevail), joining relatives (if any) in the city, or, as a last resort, lighting out for the territory. Unfortunately, there is no way to ask vanished individuals about the decisions made in life, and what evidence there is from archaeology about behavioral variability among individual Anasazi is of little help.

What Is To Be Done?
The Chapin Mesa Study

So, what is to be done? Problems in the way of socioecological comparison of past populations seem insuperable. We will go back over the problems just named and suggest, by way of conclusion, how they can be approached on Chapin Mesa, what our approach has been, and how we are trying to think them through. First, however, let us note that, after all, two of the three problem areas are almost as treacherous where it comes to groups of individuals alive and accessible. Economists, ethnologists, and primate behaviorists, when they apply fitness models to the analysis of behavior, make as a matter of course largely untestable and often wholly untenable assumptions about what goes on in the minds of individuals pondering alternative actions—and also about the extent to which ensuing actions are likely to have been determined by individual druthers. And it is not just archaeological
households that are problematic; ethnologists and historians, concerned with peoples and institutions of the present and the thoroughly documented past, are not much more agreed than are archaeologists on how to recognize a household (see Netting et al. 1984 and Wilk 1989).

**Land use.** There is of course plenty of evidence that corn and other crops were grown by the inhabitants of Chapin Mesa; it seems likely that corn was a nutritional mainstay right through the thirteenth century. Whether or not corn croplands to the north were abandoned early in that century is more problematic, but the evidence from pollen analysis (Wyckoff 1977) is certainly suggestive. Nevertheless, in the absence of data on which to base measures both concrete and reliable concerning (1) land use, (2) population numbers and population stability, and (3) relative contributions to diet of plant foods raised and plant and animal foods collected, we cannot expect to have much confidence in estimates of total acreage dedicated at any given time to agriculture, proportionate contribution to diet, and strength of competition for use of croplands—much less as to their diminishing value along a single gradient of temperature decreases from south to north (i.e., from the southern park boundary, beginning with those mid-elevation sectors near the geographic center of Chapin Mesa).

Lacking such data, we must contrive to fit into some sort of sliding scale model of dynamic interactions more or less traditional estimates of range values for at least the following: (1) caloric yield per acre (taking different dietary items into account), (2) acreage required to sustain populations of given size (the several problems here include settling on realistic ways of estimating population size, separating out the relative contributions to diet of foods raised and foods collected, and deciding what may have been the nutritional needs of people in that time, that place, that culture), and (3) energetic expenditures on subsistence broadly defined, including defending and tending croplands located at varying distances from a cliff alcove home.

This summary of course oversimplifies every aspect of the problem. Some idea of its complexity is conveyed in Dick Milo's (Milo 1993) contribution to this symposium. What is needed, finally, is a caloric energy exchange model from which to grind out intake and output estimates over some reasonable range of values dictated by a few variable factors. The problem here is that our model will begin to lose its usefulness for prediction or retrodiction with the introduction of the third or fourth factor. We can speak lightly about such problems, but constructing the model looms uncomfortably close on our agenda.

**Household organization.** We have given quite a bit of thought to the problem of discerning household organization and have developed three reasonably coherent strategies of analysis. Each relates to slightly different research goals, and the problem is how to conjoin them to produce the kind of unified concept of household structure on which the energetic model just outlined probably should depend. Those strategies can be characterized as follows.

The first strategy involves treating the structure contained within an alcove as a single household. We do this in our discussion of Spruce Tree House as a heat exchange system (Curran-Everett et al. 1993). Maintenance of optimum temperatures must depend on continuing management of the system as a whole. One would expect the inhabitants of these cliff dwellings, exercising the solar wisdom for which we give them credit, to have planned for thermal management in construction by, for example, carrying most walls and especially front walls to ceiling height and by taking air infiltration into consideration in the placement of room openings. There is some evidence for the former in Spruce Tree House and Balcony House (we have not yet inquired into the latter). This is not to suggest that very large multi-household habitations like Spruce Tree House and Cliff Palace were built or rebuilt as unified structures, or that heat conservation rules were promulgated and enforced (though this certainly could have been the case). What we do suggest is that in considering heat exchange—and of course other aspects too of cooperative living,
such as defense, maintenance of access routes and common work areas, etc.—residents of the entire structure be treated as comprising a single household.

The second strategy involves treating the structure contained within an alcove as an aggregation of single- or multi-family households and trying to identify some or all of them. If, with respect to some few household activities, it makes sense to treat the structures contained within an alcove as a single unit, much as we might a modern apartment building or condominium with governing committee of renters or owners, still, with respect to understanding most aspects of social and economic life, it makes as good or better sense to investigate behavior at other levels of organization and, for starters at least, along traditional single- or extended-family lines. Our goal here is to identify areas and levels within an alcove that appear to be advantageous in terms of optimum heat control. A family household that is well situated from this standpoint ought to have external rooms that receive maximum solar radiation (in Spruce Tree House this would be a room at the north end of the alcove); it should extend to the rear of the alcove so as to capitalize on core heat; and, ideally, it should have upper level rooms, access to a kiva, and a work area that is sunlit in winter for some portion of the day.

Our third strategy involves treating the structure contained within an alcove as a system of fuzzy sets in which it is most appropriate to conjoin particular rooms and areas on a probabilistic basis. The difficulty may not lie so much in pinpointing the boundaries of a presumed series of family households as in deciding whether or to what extent they exist—whether it is reasonable to expect neat definition of the household, at this subsystem level, along a single dimension or a few highly congruent dimensions. An alternative line of analysis would be to identify certain behaviors likely to unite some but not all residents of a large cliff dwelling and then: (1) consider whether it is necessary or even likely that individuals cooperating in one behavior should cooperate also in the others; (2) consider, for each behavior, what structural and spatial relational features of a cliff dwelling would seem to facilitate cooperation in each behavior; and (3) examine, from this standpoint, each room and area within the dwelling as a whole and evaluate its relationship with every other room and area.

Let us carry this explanation a little further. Numerous functions have been assigned to households by anthropologists. Households are said to provide a context for at least the following: (1) reproduction, (2) food preparation in a common kitchen, (3) sleeping under a common roof (the dormitory function), (4) cooperation in basic subsistence tasks, and (5) cooperation in production or in secondary activities above and beyond subsistence (e.g., master and journeymen, a military squad or platoon, an athletic team with dormitory and training table). Each of these activities is facilitated by common residence, but “common residence” is itself an awkwardly comprehensive concept. Taking meals together is especially facilitated by a common hearth; a more general work area utilized in common may be sufficient for primary subsistence tasks; dormitory life would seem by definition to require a common roof, perhaps a kiva roof; a residential group centered around cooperation in common tasks would find connecting doorways convenient if not essential; and so on.

Fuzzy set theory, in which items are assigned probabilities of belonging to one or more sets in a range of sets, seems appropriate for taking a multi-definitional approach to defining households in one or another cliff dwelling. With this approach, a room or area could in theory, and at some level of likelihood, be linked with many other rooms and areas, depending on the particular function and nature of association under consideration. If residents in a close-knit community actually do maintain affiliations at varying levels of strength across different kinds of “households,” then fuzzy logic may provide the most realistic means of understanding and modelling the system involved.

**Individual decision-making.** We cannot say much about the decisions of individuals in prehistory, lacking access to the minds of
individuals thinking about how to get their living, how to cooperate and how to compete with neighbors, whether to stay or move on as resources become depleted. Our strategy, a familiar one, is to regard decisions axiomatically as corporate in character and so to recognize the household as the unit mainly responsible for primary decisions influential to community life (bypassing the question of how individuals contribute to the making of household decisions). This of course is a weak strategy from the standpoint of prediction, but there is nothing to be done about that, and, in any event, all strategies are weak where it comes to modelling decision processes. Cognitive scientists have not hesitated to choose weaker over stronger alternatives when the weaker strategy promises heuristic gains (see for example Newell 1990). In this case, we know that corporate decision-making is common in human groups, that for most individuals important life decisions are strongly influenced by family and close associates, and that even nonhuman animal actors do not act independently of conspecific neighbors. Perhaps the main problem with choosing the weak strategy in this connection is that it brings us round again to the problem of what constitutes a household, but that problem cannot be bypassed.

Conclusion

This paper addresses all too familiar questions for which answers in most cases are difficult to obtain. The other Chapin Mesa contributions to this symposium (see our introduction) suggest how climatic and microclimatic comparisons on and around Chapin Mesa can contribute to understanding of agricultural land use and of competition for both croplands and habitation sites. We see broader socioecological comparisons as equally useful and necessary. For example, comparison of heat features of different alcoves (of similar and differing directional orientation) on and around Chapin Mesa should greatly improve our understanding of household organization and thermal energy exchange. So far we have comparative data only for Spruce Tree House and Balcony House, oriented toward the southwest and the southeast respectively, and comparison of these is complicated by factors that appear to be just as important as is directional orientation: for instance, and especially, alcove depth (Balcony House is relatively shallow, which can be advantageous to heat management) and general character of the canyon setting. Clearly we need to extend our weather station base.

Similarly, comparison of weather patterns on Chapin Mesa and on Wetherill Mesa may reshape our ideas concerning land use on both. Comparison of dietary resources on the Mesa Verde, on Black Mesa, and in the Rio Mimbres, and of archaeologically evidenced social behavioral responses to dietary stress (including cannibalism) at different times and in different places, should sharpen our understanding of the subsistence bases of cultural change. In short, the contributions of socioecological comparison, modest to date where human populations in prehistory are concerned, are potentially very great. Realizing that potential clearly will involve refinement of concepts relating to land use, household organization, and decision-making processes (individual or corporate) that underlie competition and cooperation. In this paper our main goal has been to call to your attention theoretical concepts from behavioral ecology, on which definitional refinement may be grounded.
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ANASAZI MICROENVIRONMENTS AND PREHISTORIC RESIDENTIAL PRACTICES

Jack E. Smith

Abstract

A program of monitoring of ambient conditions both in mesa top pueblos and in cliff dwellings has produced data on year-round temperature and relative humidity as part of a study to assess the relative comfort of different kinds of prehistoric structures. Using hygrothermographs in intact rooms, in re-roofed kivas, in open areas of cliff dwellings, and in weather stations at mesa top sites, this study has produced patterns of relative conditions as they exist today. These patterns suggest that by far the most efficient structures for people living under prehistoric conditions—both in terms of economy of fuel for heating in winter and of relatively cool conditions in summer—are underground rooms, i.e., kivas. This study, now in its sixth year, suggests that recent challenges by several students of the Anasazi to the long-established but unproven assumption that kivas were "ceremonial" are valid and worthy of further consideration. Kivas were very probably mainly residential, at least during cold periods, and they may represent a continuation rather than an alteration of the ancient practice of living underground in pithouses. While all of the data derived thus far are from Anasazi sites in Mesa Verde National Park, the results and implications should be applicable to the Anasazi as a whole.

It has been almost 25 years now since American archaeology supposedly underwent a major questioning of its methods and theories. One of the contributions to this was Lewis Binford's challenge to archaeologists in the 1960s to question received truths and to seek verification by using scientific methods (Binford 1968). It seems, however, that many of the same old methods and theories are still alive and that many received truths are still accepted without much question. Ideas for the most part do not appear to be all that new and different. Titles of
books and articles claim to be new reconstructions of past lifeways and new interpretations of the archaeological evidence, but much of this reconstruction and interpretation seems to be phrased in familiar words expressing old traditional themes and ideas.

Nowhere does this seem to be more evident than in the Anasazi area of the American Southwest. With only a few significant exceptions (like the keynote address for this symposium by David Stuart), current reconstructions of past behaviors are still often based upon general assumptions which have come to be received as truths, largely through constant repetition and handing down from generation to generation—what John Cater and Mark Chenault in a recent article aptly termed “truth through repetition” (Cater and Chenault 1988).

When I first began working in southwest archaeology 30 years ago, I acquired a number of these repeated truths and accepted many of them, assuming, I suppose, that those who gave them to me had a solid basis for what they believed about how the Anasazi lived. But as the years passed I began to suspect that much of what my elders had taught me was only what they themselves had been taught by their elders, who had been taught by their elders, etc., etc. The question, “But how do you know that to be so?” was not usually welcome and was often evaded or ignored. Usually the fact that the truth had been received seemed to be enough, and no further questioning was deemed necessary.

In the fall of 1977 I began my first full year in Mesa Verde National Park, a place where I had worked in archaeology for all but one of the preceding 12 summers. It was during that year that I began to seriously question some of the truths about the Anasazi that had been revealed to me. For one thing, I acquired an entirely new perspective on environment, especially the factor of climate as it must have affected the prehistoric Anasazi. Working in a place only in the summer gives one a summertime view of that portion of the world, and so the summertime depictions in both written and graphic form, of the Anasazi going about their daily lives clad only in G-strings, loin cloths, and sandals, seemed a reasonable one. But when winter set in during that winter of 1977-1978, it became clear to me that if this was indeed the typical costume of the Anasazi, then their eventual disappearance was easy to explain.

There really had to be another answer, of course, and as I sat through that winter in the comfort of my modern insulated house with its big oil-burning heater, I gave a lot of thought not only to the need for adequate clothing in this environment but also to the need for adequate housing. I wondered how it must have been to live in the drafty-looking mesa top villages buried in the snow during the sub-zero nights. So it was that I set on a course of study which is still going on and which I wish to summarize in this paper: the nature of the environment in which the Anasazi lived and the choices they might have made in attempting to cope with it. The study is limited at present only to the Mesa Verde, but hopefully its methods can be used and its results applied to other Anasazi areas as well.

The first step in the study was to reject the picture of the near-naked Anasazi, at least for a part of the year—easy enough to do by spending a winter here, but also by looking closely at the remnants of the sophisticated and beautifully woven textiles on display at the museum and in storage in the research center. Surely these people, whose skills in the textile arts rivaled their sophisticated artistry in ceramics and other materials, could do better than a few scraps of deer hide. Even so, would this alone have been sufficient to enable them to survive the Mesa Verde winters which, as nearly as we can determine, must have been much like those of today? It hardly seemed likely. So the next step was to focus on shelter and heat.

Another of the received truths about Mesa Verde, and one not without some basis, is that over the course of some 800 years of occupation, nobody since the early A.D. 500s had seen fit to utilize the cliff shelters, but had lived on the exposed mesa tops until nearly the end of that occupation. Two questions immediately came to mind as I pondered this: first, why did they not
use the cliff shelters (if, in fact, they did not), and second, if they sat out the winters in the exposed mesa top villages, how did they keep them warm enough to survive? One observation made during that first winter, and repeated in subsequent winters, was that the occupants of the mesa top villages would have spent the worst weeks of most winters buried in their villages in up to four feet of snow with nighttime temperatures well below freezing and often below zero. At the same time, the cliff shelters must have been, as they are today, completely sheltered from the snow, dry and bathed at least part of the day in sunshine, maybe not all that much warmer, but at least dry. Why would these people have ignored for centuries these seemingly easier places to live, only to move in and occupy them during their final years here? Assuming, for the moment at least, that this was indeed the case, then the second question of how they heated their mesa top homes was even more important. This became a real problem, because in looking over the evidence of past excavations of mesa top villages, I found that there was very little, in fact almost no, evidence of fire in any of these villages—except in the kivas. Kivas seem always to have been provided with good fireplaces, and there is plenty of evidence that they were well used. But here is where we encounter another of those received truths about the Anasazi: kivas are for ceremonial, and they are not to be confused with residential rooms.

Clearly, there is a problem here if the Anasazi actually did live in the unheated surface rooms through the frigid winters, using the underground (and heated) kivas only for ceremonial. Did they really sit around in the cold waiting for ceremonial occasions so they could get warm? If so, this might explain the popularity of winter ceremonialism among some of their presumed descendants today. But this hardly seems like a reasonable scenario. The kivas, by virtue of their facilities for heat, would seem to be much better places to live through the winters; however, I could find little solid data on the microclimates of kivas, of surface rooms, of mesa top localities, or of cliff shelters to support what appeared to be some reasonable assumptions about possible patterns of their use.

In 1984 I began to try to acquire some solid data on these various microenvironments. Clearly, whatever I could collect would not and could not tell us what the Anasazi were actually doing in response to their climatic conditions. It would not tell us, either, what conditions were like 800 years ago, but it could at least provide some useful comparative information on what it would have been like to live in these different kinds of situations today. We could speculate then on what kinds of options were open to people in the past and perhaps seek to determine whether some of these options might have been preferred ones. With this in mind, I began the study by setting a hygrothermograph in one of the cliff dwellings (Spruce Tree House) and another at an excavated mesa top village site (5MV499), and I began to record the daily changes and ranges in both temperature and relative humidity. As might be expected, the extremes recorded in temperature on the mesa top, both daily and from month to month, were much greater than in the cliff dwelling. This helped to establish the fact that it would have taken much more energy to keep alive in an unheated mesa top village than in an unheated cliff dwelling. While it was impossible to acquire data on heated rooms in either, the study provided a base line from which we might infer the amount of heat which might have been required to make each of these environments habitable—at least by our standards.

The next step was to expand the study. At this point, I was joined by Duane Quiatt, and we began to plan out a broader kind of investigation of these problems. At about this time, also, I was informed by Marilyn Colyer, a park ranger here, that something like this had been done once before, during the Wetherill Mesa Project in the 1960s. James Erdman had done a study then of Spruce Tree House, placing several hygrothermographs in different locations to see what it was like to live in a cliff dwelling. His study, which has never been published, was on file, and we were able to follow up on it by using some of the same locations. He had a one-year set of data, whereas we have been able to acquire several years of data, but since we have
utilized some of his ideas, I want to credit him for his pioneering study (Erdman 1964). So it was that we established the localities in Spruce Tree House (described elsewhere in this volume by Curran-Everett) as ST-1, ST-2, and ST-3. The results we got were rather dramatic, particularly in the constant temperatures that we found at ST-1 (the roofed kiva). But this didn’t tell us anything about kivas in other locations, and it didn’t tell us anything about residential rooms on the mesa tops, where all we had were a few fragments of standing walls of surface rooms and some holes in the ground where kivas used to be. We were fortunate to be able to exploit a situation at site 5MV499 when a decision was made to backfill this previously excavated ruin. The work here had been done by Robert Lister in the 1950s as part of a then long-range plan for development of the area for visitation (Lister 1964). The plan was abandoned when the Wetherill Mesa Archaeological Project was established, and this ruin, along with another nearby, sat for many years slowly deteriorating under primitive tin shelters. We decided to proceed with the backfilling of the kivas, but kept one of them open temporarily for use in this study. We removed the tin roof and replaced it with a smaller close-fitting roof, which approximated in style and materials the typical Anasazi kiva roof of cribbed logs, poles, bark, and earth. This enabled us to at least approximate a mesa top kiva environment, and we established another hygrothermograph station within the kiva. We got almost exactly the same results as in the kiva in Spruce Tree House. The pattern of constant temperature from day to day and month to month contrasted dramatically with the situation in the nearby weather station on the ground surface. The latter had to serve as a substitute for the mesa top village. It would have been nice to rebuild the entire village, but as Duane Quiatt has pointed out (elsewhere in this volume), there are limits to what you can do in a national park.

As a result of these two kiva studies, we have come up with a plausible argument for use of kivas as residences in either environment, mesa top or cliff shelter. In considering what Dave Stuart stated in his keynote address to this symposium, about pithouses recurring rather regularly throughout the whole period of time of the Anasazi, it may be that at least some kivas were built not for ceremonies but for occupation and that maybe they were functionally pithouses. This is speculation, but it is not an inappropriate one. Compare this idea with those expressed in Cater and Chenault’s recent paper (1988), which deals with this same question about whether the received truth about kiva ceremonialism is necessarily true, and also with Steve Lekson’s excellent earlier paper on the same subject (Lekson 1988). Clearly, we have not come up with a unique idea, but this present study offers some substantive information to strengthen the case for considering kivas in this entirely different way.

Another interesting idea to consider, in addition to these suggestions coming out of our weather studies, comes from a little book entitled Indians in Overalls, by Jaime de Angulo, a free-lance linguist who did some work for the University of California at Berkeley back in the days of Kroeber and Lowie (de Angulo 1990). In this work, the author recorded his observations and conversations with some of the Achomawi, an Indian group of northeastern California who live in a fairly severe environment and who at that time used pithouses as winter residences. Angulo gives a graphic description of life in these pithouses as narrated to him by one of his informants. The picture that he presents of the stench and the social tensions which these people had to experience as they lived together through the winter in the confines of an underground house suggests that pithouses (and similar underground structures) are indeed practical as winter residences, but also that there are some problems in using them and some motivations for getting out of them as quickly as possible—perhaps to take up residence in nearby surface rooms. Clearly, the goal of the Achomawi was to survive the cold winters, but they also sought to escape from the confines of their winter residences as soon as they could. This is important, perhaps, when we consider the patterns of Anasazi villages and towns, incorporating as they do both surface and underground structures. The case of the
Achomawi gives us a perspective on underground life which is not as cozy and comfortable as we might conclude from temperature studies alone. Not only relative physical comfort, but perhaps social and even olfactory problems ought to be considered in reconstructing prehistoric Anasazi environments. This might give us a more realistic picture of life in the typical Anasazi village with its kiva or two and its several surface rooms, particularly when those surface rooms do not show any evidence of ever having been heated. It might likewise give us a new perspective on the late large Anasazi settlements which, when found to contain a large number of kivas, are almost invariably declared to be “ceremonial centers.”

To get back to the present study, we have recently expanded our data base to include several other sites. We now have hygrothermographs at other cliff dwellings and mesa top locations, and the information is thus more varied and comprehensive. Still lacking, however, is information about the environments of canyon bottoms, places where there are remains of huge Anasazi settlements. Particularly in the eastern portions of Mesa Verde National Park, in Morefield and Prater canyons and in the other canyons farther east, the settlement pattern is quite different from that of the western portions. Rather than the steep narrow canyons and flat mesa tops which are what most people see, these eastern areas are broad open canyons with only narrow ridges separating them. Here are many village complexes and a clear pattern of intensive occupation. The next step will be to expand the study into these open canyon areas.

Thus far, the study has not provided any definitive answers to the questions we would like to answer about prehistoric Anasazi life. But it has suggested some indications and some ideas that seem worth pursuing further. We do not intend to substitute any new received truths for old ones, but we do feel that some of the old ones should be further questioned. One old received truth that we would question or at least like to understand better is why the Anasazi did not build in the cliff shelters until very near the end of their time here. If this was truly the case, then it calls to mind something that was said at the first Anasazi Symposium held here ten years ago. A suggestion was made then—met with some laughter—that many of the large Anasazi sites might have been only seasonally occupied. Now I wonder whether this might actually have been true on the Mesa Verde. Could the Anasazi possibly not have lived in the cliff shelters because they didn’t need them, because they were not here in the wintertime? Could it be possible that something happened during that final century that made it necessary for them to change their way of living and to remain here year round? This might be a good speculation with which to end this paper, as a final reminder that we have to keep open minds to various possibilities, to constantly challenge the received truths and established assumptions, and to keep asking that question, “How do you know that to be true?” We must do this if we are ever going to figure out what really happened to the Anasazi.
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ANASAZI:
SOCIAL ORGANIZATION AND LAND USE

Friday, October 4, 1991
Morning Session IV

Chair: Art Hutchinson
ARCHITECTURE AS ARTIFACT:
THIS SLICE OF ORANGE AIN'T BEEN SQUEEZED YET

Larry V. Nordby and Todd R. Metzger

Abstract

Past studies of Anasazi architecture have with good success focused on the analysis of general form and outline as a means for interpreting site chronology, function, and social organization. Very rarely, however, has architecture been analyzed as an artifact in which behavioral information is derived regarding the use and manipulation of space and the interplay between prehistoric man and the environment.

Recent studies in several National Park Service areas throughout the Four Corners have focused on an intense evaluation of Pueblo II to Pueblo III Anasazi architecture. The purpose has been to gain a specific understanding of topics such as (1) building construction techniques and engineering; (2) material procurement and preparation; (3) material utilization; (4) labor investment and scheduling; (5) site layout and design; (6) site growth, development, and decline; (7) demography; (8) adaptation to environmental conditions; (9) structure and features of construction and use; (10) intra and inter site correlations; and (11) cultural affiliation.

An interesting twist to this approach is that it is an outgrowth of the National Park Service’s efforts to preserve (stabilize) prehistoric ruins. In general, there is a growing awareness that in order to effectively preserve the architecture, it is necessary to understand how it was built and what materials and techniques were used.

This paper presents the argument that in all research and preservation endeavors, rather than looking at architecture from a generic perspective or as a boundary for an excavation unit, it should be viewed as a significant contributory component in understanding how prehistoric man functioned, adapted, and survived in the diverse environmental settings of the Four Corners.
Introduction

Stone, mortar, adobe, and wood structures... they’re everywhere. In the Four Corners region, these deteriorating constructs are the hallmark of the Anasazi Tradition. Archeologists have long been aware of the utility of studying the various remnant shapes and sizes to reconstruct the evolution of past human occupation. Most architectural studies have concentrated on establishing descriptive typologies in order to develop temporal sequences or to create cultural boundaries. These are important objectives, which have been around for so long that as a group, archeologists consider stylistic or functional architectural characterizations to be passe. By and large, we believe that this approach has had an unfortunate consequence: the "genericization" of the study of architecture that stems from not looking very closely at the attributes of construction in a manner similar to complex analytical lithic or ceramic taxonomic classification. This universal approach can and has led to the ultimate insult against ruin integrity: the genericization of architecture during the ruins stabilization effort, with but little attempt to examine the architecture prior to repair.

Historically, there has been little interest in analyzing the technical aspects of how the architectural elements have been combined to form walls, features, and structures, and what construction activity tells us about the social behavior and decision matrix that went into the original work. Fortunately, we believe that two trends that will fill this void are now underway. These are the tendency toward conservation archeology, interpreted by most federal agencies to mean little or no digging, and the interest that these same agencies have in ruins preservation and stabilization. Money previously directed towards excavation has by and large been redirected either into architectural preservation efforts or into investigations such as archeological surveys or inventories.

While we cautiously applaud this change in direction, we believe that the examination of architecture as an artifact is a critical component of the archeology that should attend stabilization or maintenance work, whether the project leads to reburial through backfilling or to wall repair.

The remainder of this paper provides an overview of past approaches used to study Anasazi architecture and suggests some future directions for analyzing it. The primary vehicle consists of creating a taxonomic framework to structure observations, a process not much different from the approaches used for potsherds or projectile points. We believe that thus far such a level of rigor has been absent in dealing with architecture.

Past Approaches to the Study of Anasazi Architecture

Probably the most definitive attempt to systematically examine Puebloan architecture in detail was produced by Victor Mindeleff (1891). Although the title of Mindeleff’s effort seems to identify two spatial areas of architectural development (Tusayan/Hopi and Cibola/Zuni), he offered quite a bit more of interest to modern archeologists. He studied the less compact ground plans of ruined villages and made some comparisons with the planned nature of inhabited Puebloan villages. He also made a number of observations about construction methods, paying attention to the gender of workers.

Much, if not all, of the masonry was laid, as well as finished and plastered, by the woman of the house and her female relatives. There was but one man present at this house-building, whose grudgingly performed duty consisted of lifting the larger roof beams and lintels into place and of giving occasional assistance in the heavier work. (Mindeleff 1891:101)

Consequently, we believe that Mindeleff’s work established the foundation of three basic thrusts for past and future approaches to architectural study. These are

1. architecture as spatial signature (used for creating areal boundaries);
2. architecture as temporal signature (used...
for tracing evolutionary development within a single area);

3. Architecture as behavioral signature (used to identify normative or idiosyncratic practices).

While there are some noteworthy exceptions to the rule (c.f., Morenon 1977; Terrel and Durand 1979), most often architectural studies are loose composite applications that mix at least two of the three aforementioned approaches. The most common misapplication probably is the comparison of architectural examples from two different areas and two different periods to create a single architectural tradition that is applied across the board. We urge that such misapplications be curtailed, although they are in many cases understandable because rigorous architectural description that traces development within any single area is generally absent.

Architecture as Spatial Signature. This approach views architecture as characteristic of a culture area and generally is best expressed when sites of the Pueblo II and Pueblo III periods are studied. Three general expressions are recognized: Mesa Verdean, Chacoan, and Kayentan. In this regard, each area has had its architecture well described. Some classic examples include Art Rohn's description of Mug House and other sites of Mesa Verde National Park (1971), Jeff Dean's description of Tsegi Phase sites in the Navajo National Monument area (1969), and Steve Lekson's description of Great Puebloan Architecture at Chaco Canyon (1984). Of particular note from the historical perspective is Lawrence Roys' s description of construction methods at Lowry Ruin:

The core or hearting of this type of wall was chiefly well-puddled mud, although it might contain more or less stone. Regardless of the proportion of rough broken stone in the core, the laminated nature of the wall (shown on the surface by the distinct courses) was maintained to some extent in the center of the wall. Irregular flat stones were usual, while irregular jagged stones that would spoil the coursing were much less usual. (1936:120)

Roys's descriptions at Lowry offered a number of other interesting and valuable thoughts. Among them was his introduction of a typology of chinks, based on morphology as well as function (Roys 1936:122, 125).

An interesting aspect of the work at Lowry is that the work was done in the Mesa Verde area but described Chacoan masonry. The site has since been designated as a Chacoan outlier. Comparison of masonry characteristics and gross architectural features have subsequently been used, of course, to identify an entire network of Chacoan sites (Powers et al. 1983:316-317). In this case architectural information was the primary data used to expand a regional boundary, because no excavation data were available.

Although we lack the time or space to fully evaluate this particular use of archeological data for Mesa Verde or Kayenta, and the example given at first glance appears to produce results, it is worth remembering that the architectural pattern was first defined at Chaco and then applied to sites in other areas.

We believe that spatial architectural signatures for either Kayenta or Mesa Verde are poorly defined in spite of some systematization. The strong associations of Mesa Verde with pecked and ground blocks and of Kayenta with more mortar than stone are well known, but we assert that although these associations are based on inspection, they may mask some important distinctions, as may the characterizations of Chacoan masonry style. For example, working in southeast Utah, Metzger et al. (1988a, 1988b) found that walls described as having been manufactured in the Kayenta Tradition were actually built of roughly 60 percent mortar and 40 percent stone. This was determined by wall attribute analysis followed by calculation of the volumes of each kind of element.

In sum, we believe that more rigorous work is needed just to delineate architectural signatures for the "main" cultural epicenters, let alone fully to understand the interplay of what has been described as the three major traditions in peripheral areas. Further, there is little or no knowledge about contemporaneous subtypes within areas—indeed, there are no real types at all.
Architecture as Temporal Signature. The evolution of architecture is similarly a well-known phenomenon in the Southwest, especially insofar as the general metamorphosis from earthen and/or vertical slab walled pithouses, through mud-and-slab or jacal surface structures and kivas, to true stone masonry walls is well known. In fact, we have borrowed the concept of “architecture as artifact” from Pat Gilman (1987), who as far as we know first used the term to refer to an example of regional evolutionary perspective in the Southwest. In addition, occasional attempts have been made to evaluate masonry style within an evolutionary perspective. Examples include Hawley’s (1938) venture to develop a Chacoan “family tree” of architecture. Her essay was extremely useful and essentially achieved its intention; however, except for gross characteristics of site plan development throughout the Bonito Phase, it assumes most other architectural attributes besides those contributing to the masonry style are static. Although they may well prove to be, it seems premature to assert that they are. Schemes tracing the general evolution from Basketmaker III to Pueblo III characterize the archeology of the three main regions used as examples in this cursory overview and have been extended to many other intervening areas. They are useful expressions of general trends, but generally they lack precision for a number of reasons. These include: (1) the absence of recognized and quantified architectural variability within cultural periods or phases, (2) the absence of architectural signatures in some areas, resulting in the uncritical “borrowing” of manifestations from other geographical areas to fill architectural voids for evolutionary phases in the area of study, and (3) the focus on large site archeology.

Once again, these are understandable errors that stem from the lack of comparative data within the same temporal period and within the same area. In other words, the spatial signatures noted above are incomplete, inhibiting or prohibiting our abilities to develop evolutionary schemata. We believe, however, that a concerted effort should be made to collect quite specific architectural information for each period within each area and that this endeavor should be driven by a research design for each area that initially looks closely at wall construction and building components.

Specifically, what is the range of variability during the experimental period of Pueblo I? We believe this to be a complex period distinguished by a variety of non-masonry techniques, such as jacal, turtlebacks, mudballs, vertical slabs, post-houses, etc. Contributing to the difficulty of pattern recognition is the continuation of most of these techniques into later periods.

Architecture as Behavioral Signature. Even though behaviors are the primary contributors to both temporal and spatial signatures, identification of the behaviors and decision making that went into Anasazi construction have been largely ignored. It seems to us that the two trajectories that have received most of the effort are (1) describing the methods by which site and village growth took place and (2) assessing pithouse or kiva features to create the recognition pattern for assignment of structures to one taxon or the other. The first relates to site construction, overall use, maintenance and modification, and abandonment. The second relates to assessment of structural functions and use issues.

Among the best statements of the former is Jeff Dean’s study of Tsegi Phase sites (1969). In it, he used tree-ring dating, wall abutment and tie patterns, and a basic assessment of room function to evaluate the architecture of Kiet Siel and Betatakin and to identify the social units that built the various parts of the site. Other contributions by Dean are important and include some of the best descriptions of wall and roof construction of Tsegi Phase sites, correlations of room type and function based on the presence or absence of certain architectural features, and discussions of site growth and development from the architectural perspective. One important philosophical aspect of Dean’s work was that it was done using walls already exposed in sheltered alcove sites and excavation and stabilization records, most of which he did not generate.

The major thrust in assessing room function
has been to identify pit structures as either kivas or pithouses. Stew Peckham (1979) has looked at this issue from the standpoint of architectural features, and Watson Smith (1952:154-165, 1990) has done the same while examining ritual aspects of kiva use, a tack also followed by A.V. Kidder (1958) at Pecos. Since then many other contributions have dealt with it. Some of these have been augmented by evaluating the numbers and kinds of artifacts found on structure floors.

But what about room function for trapezoidal or rectangular chambers? In some cases, it has been appraised, based on a composite of the presence of architectural details such as doorway attributes, room size, shape and regularity of shape, position within roomblocks or suites, and some use of ethnographic analogy. Most often, these assertions are interesting, but unfortunately are few and often seem to ignore some evidentiary lines. For example, sometimes useful specific details simply are not present, and so features cannot be used to judge function. In most cases, we believe that the framework for identifying room function is in place, it is merely unevenly applied.

The Sliding Rock Architectural Model. Nordby (1981) introduced an architectural model while looking at Sliding Rock Ruin in Canyon de Chelly as part of a pre-stabilization architectural study. Unfortunately, his report had a very small distribution, although the model has been presented elsewhere since then (Nordby 1991a) and is included as part of this paper (Figure 1). Over the next decade or so, Metzger refined the model significantly, introducing some newer concepts and extending it to sites in southeast Utah and other locations (Metzger et al. 1988a, 1988b). The major driving force in this work has been the need to develop a consistent documentation strategy for recording architecture prior to stabilization activity. As is obvious from the geographical areas noted above, most of what has been done in this regard has been applied to alcove sites where there is a lot of standing wall and where preservation is generally good.

Although we lack sufficient time to fully explore the model here, we would merely note its hierarchical structure, which begins with wall segments, attempting to characterize masonry style, examines room function, evaluates room suites and aggregates of rooms and other kinds of architectural spaces, and finally attempts to describe the village unit, for comparisons with other villages. We believe that this method offers quite a bit of utility because it begins small and later expands in scope, forcing one to look closely first at the attributes of individual building stones, mortar, chinks, and plaster, before moving to consider the nature of the social unit inhabiting the village.

Data collection at Sliding Rock was based predominantly on tabular forms that were checkboxed. One of the variables examined was what percentage of stones in each wall exhibited the following values: undressed or broken faced, edge-chipped, pecked, or pecked-and-ground. Since then, we have added other values to this laundry list, and our typology has gained some complexity. We have designed similar approaches for Mummy Cave in Canyon de Chelly (Nordby 1991b), Rainbow House at Bandelier (Eininger 1989), sites at Wupatki National Monument (Metzger et al. 1991), Pueblo Grande in Phoenix (Birnie 1990), and others, but we still are working to refine data collection and, by extension, the model.

We believe that this approach has the potential to fill cells in a matrix for each phase of each geographical area in which Anasazi architecture occurs, similarly to what is shown in Figure 2. This construct would facilitate identification of spatial as well as temporal signatures, even if nobody elected to focus upon the behavioral correlates attending the data in each cell.

Some Proposed Future Approaches to Architectural Study

We believe that the offspring of the Sliding Rock model might offer avenues that connect the spatial, temporal, and behavioral signatures that we have so briefly summarized, especially when combined with data collection driven by regional architectural research designs. At the
Figure 1. Analytical model for understanding prehistoric technological and social parameters at Sliding Rock Ruin, Canyon de Chelly, Arizona (after Nordby 1981).
Figure 2. Each architectural tradition is composed of its own "cells," which might be roughly equivalent to a phase. Each cell should be evaluated to determine internal structure and variability before comparison with other cells or either dimension (signature).
same time, however, we would like to offer some other threads to weave into the web of architectural studies. The constraints of time and space preclude rendering anything more than bare bones thoughts which will later require some fleshing out.

The basis for these approaches was originally presented by Nordby et al. (1988:76-78). A model depicting research into southwestern building techniques consisted of three research modules: (1) archeological research, (2) ethnographic and ethnohistorical research, and (3) replicative research. Fruitful pathways for archeological research have already been supplied in the previous section, and we urge that they be explored.

In addition, we believe that the architectural replication approach used by some, most notably the staff of the Dolores Archaeological Program, is of extreme value. This includes work done by Lightfoot (1984), Varien (1984), and Glennie and Lipe (1984) among others. Most efforts are geared toward developing estimates of how long it takes to build various examples of Anasazi construction or of the materials acquisition effort and decision making. Ultimately, refinement of this approach will add to our understanding of all aspects of construction and should lead to a better understanding of how to preserve architecture when fabric intervention is necessary.

Another source of information for replicative study emerges from current stabilization efforts that focus on matching original fabric in the repair process. Frequently, detailed records are kept which chronicle the amounts of raw materials and the time involved in various kinds of processing and construction activities. Exemplifying this approach are efforts by Metzger et al. (1988a, 1988b), which used stabilization data to determine labor rates and materials expenditures for late Pueblo II to Pueblo III sites in southeast Utah.

With respect to ethnographic research, a substantial amount of information on constructing masonry buildings is available. In particular, we may return once again to Victor Mindeleff (1891:100-104), who presents a step-by-step analysis of what happens at Hopi when a house is built, including a few ritual aspects. To paraphrase his description, activities associated with housebuilding are: (1) marking the corners, (2) cutting the timbers, (3) gathering and dressing the stones, (4) building the walls, (5) adding the roof, (6) building the floor, and (7) plastering the walls (Mindeleff 1891:101-102). This sounds somewhat like Schiffer's (1976) behavioral chain model, a concept which for the moment we would like to pursue.

Actually, we believe that masonry house construction is the result of several conjoined behavioral chains, which Nordby termed activity analogues in his never-quite-finished doctoral dissertation. Each of the seven aforementioned steps is approximately equivalent with an activity segment, as defined by Schiffer. These postulated behavioral chains or activity analogues are stone procurement and processing, mortar or adobe procurement and processing, and wood procurement and processing. These three analogues come together at various points in a kind of superanalogue: masonry house construction. Examples of conjunction points are wall building or roofing.

Figure 3 illustrates some of the activity segments associated with stone materials procurement and processing, as well as adobe and mortar procurement and processing. It also shows the primary conjunction point between these two chains or activity analogues. Although we have not shown anything other than the activity segments in Figure 3, the tool kits, composition of the enactor, duration and seasonality, and any associated architectural features constitute model components. Our intention in using this approach is both to subdivide construction actions into their smallest segments and to supply a decision tree when multiple tracks are possible.

For example, quarrying either stone or soil for making mud entails knowledge about the location of reasonably durable materials, even though the optimal ones may not have been known aboriginally. Ultimately, it may prove quite important to identify such sources, especially if they are not located adjacent to the newly constructed site. Both traditional
Figure 3. Preliminary behavioral chain and activity analogue model for constructing masonry structures in the Anasazi Tradition.
archeological methods and soil studies might be used. Pollen studies or macrobotanical work might assist in determining whether rocky talus slopes or mesa tops were mined for soil, as each has a differing vegetative community. Such studies also might offer insights concerning seasonality of construction. Clay mineralogy could help delineate sources, and various engineering tests could assess durability. This in turn might lead to an evaluation of the behavioral factors that contribute to decisions. Were soils selected merely for expediency, or were they sought or exchanged as commodities?

When combined with the other activity segments, we hope as this preliminary model is developed to recreate the behaviors that contributed to construction.

Summary

Why is close examination of architectural attributes important? Perhaps the best reason is because it allows us to study some aspects of sites without excavation. Standing wall abounds, although no exhortation to study it would be complete without a caution that much of it has been stabilized and some attributes have been changed by modern masons. Although federal agencies are generally moving away from fabric modification preservation actions toward those which less drastically modify the values of prehistoric craftsmanship, some stabilization work will continue. Other sites will be removed from examination forever when backfilled. Although we have no pretensions about our ability to predict the data needs of all future researchers, the last century's worth of developments in archeology indicates that their needs will demand more data, not less.

In summary, this reason for looking merges archeological responsibility with cultural resource stewardship.

Architectural studies also serve as corroborating evidence for other sources of information, but to be of greater value they should be looked at from a typological or taxonomic perspective. We believe that the current level of architectural taxonomy is analogous to either separating black-on-white from culinary ceramics (e.g., separating living rooms from storage rooms) or separating mineral painted wares from carbon painted ones (Chacoan III style masonry from Kayenta drylaid-mudded style). If we assign a site to a given time period based on complex ceramic seriation, might we not do the same for architectural seriation? Nobody knows the answer to this question.

Its answer lies in the refinement of existing taxonomy through looking more closely at architectural attributes within a truly analytical framework, rather than treating rooms and other structures as though they are merely the limits of excavation units containing the real objects of study: portable artifacts.

We believe that architectural studies should be components of most if not all research designs, and that the work should be initially directed toward filling the cells representing phases (Figure 2) in each geographical area to avoid spurious borrowing of architectural types between areas or phases. The Sliding Rock model offers one approach. Finally we urge a composite of archeological, ethnographic, and replicative work to help create and identify behavioral signatures. The behavioral chain or activity analogue is suggested as one approach that helps to link these three.
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Varien, M. D.
ASTRONOMY AND SOCIAL INTEGRATION AMONG THE ANASAZI

J. McKim Malville

Abstract

A necessary but not sufficient condition for the development of the pre-telescopic astronomy practiced by the Anasazi is social integration and information transfer. Four areas that furnish the primary evidence for observational astronomy beyond that of solstice markers by single homesteads are Chaco Canyon, Yellow Jacket, Hovenweep, and Chimney Rock. Recent field work in the archaeoastronomy of those areas and elsewhere is reviewed and appraised. The major astronomical effort, evidenced in the archaeological record, appears to have been establishing true cardinality and solar solstice and lunar standstill alignments. Motives for such astronomical observations may have been determination of agricultural and/or ritual calendars, celebration of creation mythologies, and the construction of a microcosm homologous to the macrocosm. The scale of architectural planning associated with observational astronomy, the accuracy of alignments, and the large distance between aligned structures suggest the presence of a well-developed, observational technology combined with community-wide cooperation. The evidence of astronomy within Anasazi architecture may correlate with the presence of integrative facilities such as great kivas, plazas, and other sites for public ritual. The rising of the sun and moon on certain days would have provided some of the foremost opportunities for participatory, public ritual. Evidence for observations of the setting of the winter solstice sun and major standstill moon at Cliff Palace of Mesa Verde is presented.

Introduction

The influential role of architecture in facilitating social integration in historic and prehistoric pueblos has been frequently asserted (see review by Hegmon 1989) and recently was the topic of a symposium sponsored by the Crow Canyon Archaeological Center (Lipe and
Hegmon 1989). In certain societies social integration is accomplished through group rituals that are performed in structures which themselves reinforce, both spatially and symbolically, the integrative process. Kivas, especially great kivas, great houses, tri-wall structures, shrines, and plazas have been identified as integrative facilities in the prehistoric pueblos.

Astronomy must also, on certain occasions, have played an integrative role in prehistoric pueblos. Because of the precise cycles which the heavens contain and the opportunities for dramatic public ritual, which the rising and setting of sun and moon provide, celestial phenomena provide both a source of esoteric knowledge and settings for communal experiences. I suggest three roles that astronomy could have played in the process of social integration among the Anasazi.

Ritual Calendar

Clearly, the most obvious function of astronomy in ritual and social integration is the calendar, which provides dates for festivals, both with and without specific astronomical significance. Ethnographic analogy provides justification for a search among the archaeological record for evidence of calendrical sun-watching among the Anasazi. At least 19 of the 24 historic Pueblo communities had one or more members who practiced sun-watching near the times of solstices (Zeilik 1989). The considerable ethnographic data that is available on horizon calendars indicates that the standard technique of the historic Pueblo was to observe the position of the rising or setting sun relative to irregularities of the horizon, as seen from an observing station inside or close to a settlement. The most important solar festival of the historic Pueblo was winter solstice, a time when there was sometimes concern that the sun would be delayed in its return to the north unless appropriate ceremonies were performed.

Unambiguous material correlates of calendrical activity are hard to identify within the archaeological record. The sun-watching site at Matsakya outside of Zuni no longer exists (Zeilik 1989). A possible sun-watching site has been suggested at Wijiji (Williamson 1984). The western port of Hovenweep Castle provides a precise calendrical observation of summer solstice (Williamson 1981). Both anticipation and confirmation of winter solstice could have been achieved using the corner windows of Pueblo Bonito (Reyman 1976, 1987; Zeilik 1986). Pecked basins at Cliff Palace and Cedar Tree Tower in Mesa Verde National Park may mark calendrical sun-watching sites for summer and winter solstices.

The Astronomical Setting

Astronomy can provide a highly dramatic setting for integrative processes in festivals or community ritual associated with astronomical events, perhaps in the form of public participation in actual astronomical events as they are unfolding such as the rising or setting of the sun or moon. The observations of Pekwin of Zuni and those of other sun-watchers were often individual and private endeavors. On the other hand on the day of winter solstice entire communities at Acoma, Zuni, and Oraibi have participated in sun-associated activities (Stevenson 1904; Tyler 1964:151-161; Voth 1901). Among the Anasazi, watching the moon rise between the double spires of Chimney Rock at the times of major standstill may have been major public events at the Chaco outlier of 5AA83 (Malville et al. 1991). There is sufficient public space near the solar monolith of Yellow Jacket for groups to observe the sunrise at summer solstice (Malville and Neupert 1986). It is not difficult to locate examples from other cultures of large public festivals involving real time observation of astronomical phenomena such as the shadow casting at equinox on the Castillo of Chichen Itza (Ferguson and Rohn 1990), sunrise over the Temple of Tenochtitlan (Broda et al. 1987), and sunrise celebrations of India such as those on the west bank of the Ganges in Varanasi and at the sun temple of Konarak (Malville 1985, 1989). At Konarak approximately 50,000 people gather each year, many having walked for several days from villages in Orissa state, to observe the sun rising
above the Bay of Bengal. Rice is offered to the sun in the morning, and the black pots in which the rice was cooked are broken at the time of sunrise.

Power and Institutionalized Leadership

The basic source of authority and power among the Pueblo may be the possession of ritual knowledge (Sebastian 1991; Upham 1982). Reyman (1987) argues that priestly authority and power is based in part upon access to esoteric astronomical knowledge. Possession of such knowledge may be the determining factor in status differentiation in Pueblo societies, such as in Fried’s (1967) model. Judge (Crown and Judge 1991) suggests that the base of power of Chaco Canyon may have been its role as the repository of esoteric knowledge and its control of the ritual calendar by means of long distance visual signals. Signals may have been transmitted between the stone circles described by Windes (1978) and/or tower kivas (Lekson 1984:231). The internal glue of the Chaco system may have developed from the exchange of calendrical and astronomical information as well as from the exchange of goods and services.

Turning the argument around, the alignment of monumental structures to astronomical lines implies—in fact, it is probably not too bold to say, demands—a high degree of social integration, sociopolitical complexity, and institutionalized leadership. The skillful application of techniques of observational astronomy was necessary to achieve the accuracy of alignment of structures which are found in Chaco Canyon and Yellow Jacket. Alignments to the true cardinal directions reflects a higher level of skill than that required for a simple horizon calendar or for marking the direction of solstices, during which time the sun conveniently stands still. Some individual or group must have possessed the knowledge to measure angles and the power to organize the efforts necessary to construct and align large ceremonial structures.

Fritz (1978) argues that ceremonial structures are occasionally designed to provide earthly parallels to the cosmos, reinforcing the ranking or stratification of the society. Only those with access to esoteric knowledge could design such structures, thereby confirming their status in the society. While performing rituals the inhabitants are forced to follow certain pathways and view certain perspectives. Fritz suggests that in the case of Chaco Canyon both of these factors contributed to social integration as well as to a prearranged reinforcement of the two major social divisions within Chacoan society.

Examples of features and structures which indicate such planning, authority, and power in the Chaco Basin are the north road running within 30' (minutes of arc) of true north for 20 km, the north-south wall of Pueblo Bonito which lies within 16' of true north, the sockets for the roof supports of Casa Riconada which lies within 30' of cardinal directions (Williamson 1982), the north wall of Hungo Pavi which is within 10' of east-west, and the relative positions of Tsin Kletzin and Pueblo Alto, which are within 30' of north-south (Sofaer et al. 1989). Sofaer and her colleagues also find evidence of alignments of great houses and inter-house alignments to solstices and lunar standstills. In the Montezuma Basin, Yellow Jacket, 5MT5 contains a north-south axis passing through the great kiva and the solar monolith that lies within 26' of north (Malville 1991). The great kiva is also aligned with the great tower to the position of sunrise at winter solstice.

A ceremonial structure that could have functioned both as an astronomical foresight and as an integrative facility is the Sun Temple of Mesa Verde. The combined sites of Cliff Palace and Sun Temple appear to provide examples of all three types of integrative astronomy: stations for calendrical observations, settings for communal observations of astronomical phenomena, and a demonstration of sociopolitical authority sufficient to organize the construction of a major ceremonial building.

Sun Temple

When Sun Temple was first excavated, Jesse Walter Fewkes (Fewkes 1916a, 1916b) proposed that the structure supported ceremonial rather than domestic activities. The symmetry and
Astronomy and Social Integration Among the Anasazi

precision of its design, the effort expended in pecking and shaping nearly every stone of the wall veneer, massive rubble-filled masonry walls, and a small shrine at its southwest corner distinguished it from the other structures at Mesa Verde.

Rohn (1977) proposes that the Sun Temple is a member of the group of structures comprising the Cliff-Fewkes Canyon settlement that includes cliff dwellings such as Cliff Palace, Sunset House, Oak Tree House, New Fire House, and Fire Temple. With 33 habitation sites, two ceremonial sites, some 530 rooms, 60 kivas, and an estimated population in excess of 600, this Pueblo III settlement would have been one of the largest at Mesa Verde.

Cliff Palace faces a southwestern horizon which is flat and devoid of natural markers, and therefore does not provide a good natural setting for a horizon calendar. The one object that breaks the horizon today is the Sun Temple on the top of the opposite mesa at a distance of 288 m. At the extreme southern end of Cliff Palace we found a possible sun-watching station consisting of a small level platform containing a circular basin pecked in the bedrock. The pecked basin has a diameter of 8 cm and a depth of 3 cm and lies in the center of a smooth, trapezoidal platform measuring 80 cm by 46 cm. Alternative hypotheses for this basin include an extra-kiva sipapu, a location for a post, and/or a repository for an offering to the sun or moon. The bedrock sipapus within kivas at Mesa Verde are generally deeper than the pecked basins. Another type of bedrock depression that has been identified within the Anasazi culture area, the Chacoan basins (Windes 1978), are larger in diameter and have smoother, more vertical sides and flatter bottoms than the pecked basins of Mesa Verde.

When viewed at an eye height of 145 cm from the pecked basin, the perimeter wall of the Sun Temple has an altitude of 4°55'. Because of the elevated horizon, variable atmospheric refraction introduces a smaller uncertainty in the position of the setting sun than is the case of phenomena viewed on a flat horizon. Including the effect of refraction, we estimate that, as seen from the pecked basin, the lower limb of the winter solstice sun would have touched the open edge of the present perimeter wall of the Sun Temple at an azimuth of 235°20'. This line-of-sight passes close to the Sun Temple's center, which we identify as the midpoint of the line connecting the two circular rooms (Figure 1).

In our survey of the Sun Temple we discovered that a second line-of-sight is established by the tangent to the two circular rooms of the Sun Temple. This line intersects Cliff Palace at the center of the west wall of the square tower, some 45 meters to the north of the pecked basin. The line from the center of the west wall of the square tower to the center of the Sun Temple has an orientation close to the position of the setting moon during the time of major southern standstill, an event which occurs every 18.6 years. The original stabilization of the square tower directed by J. W. Fewkes in 1909 was torn out and rebuilt in 1934 by E. Morris, who added the fourth story T-shaped doorway for which there appears only minimal justification. Early photographs of the structure taken prior to stabilization show a western window on the second story and suggest original openings in the western wall on the third and fourth stories.

We do not know the original height of the perimeter wall of the Sun Temple. The outer walls were reportedly lower than the inner walls at the time of excavation. Based upon the volume of rubble, Fewkes suggested that certain of the walls were originally at least 2 meters higher than he found them. Neither do we know what particular configuration of the sun or moon relative to the wall was considered significant by the inhabitants of Cliff Palace. But we can use these two observations of the sun and moon to propose an original configuration of the Sun Temple. Because it is likely that the sun and moon were treated in a similar fashion by Anasazi observers, we combine the two sight-lines to calculate the optimum height of the perimeter wall. The sun and moon have nearly identical angular diameters, amounting to approximately 30'. Assuming that the lower limb of sun or moon just touched the perimeter wall of the Sun Temple at the crucial moments of observation, we find that if the perimeter wall
Figure 1. Sun Temple: Sight-lines from Cliff Palace (CP) through Sun Temple (ST) to the sun or moon position, showing specific line to the pecked basin and square tower. A=8°19'.
Figure 2. Painting in the square tower of Cliff Palace: western wall. (National Park Service)

were .25 m lower than its present height, the azimuths of both moonset at major southern standstill and sunset at winter solstice would have been within 5' of the center of the Sun Temple as seen respectively from the third or fourth story opening of the square tower and from the pecked basin.

The intersection of the lunar standstill line-of-sight with the square tower is of particular interest as paintings on its interior walls may be associated with lunar phenomena. On the western, interior wall of the third story of the tower there are four vertical lines each containing 17-20 tick marks (Figure 2). The total number of such marks is 74-75, corresponding to an average of 18.5-18.75 per line, notably close to the 18.6 year standstill cycle of the moon. We propose that these marks are records of four lunar standstill cycles observed from Cliff Palace.

Tree-ring dates in the Cliff-Fewkes Canyon settlement span the time period between A.D. 1180-1279. The exact dates of initial habitation and final abandonment are unknown, but four standstill cycles could have been observed at Cliff Palace between the dates of 1186-1260 or 1204-1279.

A second painting that may have a lunar association is found on the southern interior wall at approximately the same height as the four lines (Figure 3). Enclosed within a rectangular border, the figure is divided by a vertical line containing approximately 12 marks, on either side of which are a series of 12 zigzags. Such a pattern is not uncommon in Anasazi art, but the recurrence of twelve marks and zigzags is noteworthy within the present lunar context. During a period of one month, the moon swings from southern extreme to northern extreme and back to southern extreme. If an astronomer-priest were to explain the monthly and yearly motions of the moon to an assistant, a diagram such as Figure 4 would have been appropriate and helpful. This painting lies directly above two sets of three triangles separated by 12 dots. These may depict horizon phenomena, representing the 12 months of the year and the La Plata peaks on the northeastern horizon.

Initially a more modest structure, such as a cairn, may have been built on the location of the Sun Temple to serve as a solstice marker for an observer standing at the pecked basin. The site may then have evolved into an elaborate astronomical sighting device and ceremonial site for the Cliff-Fewkes Canyon settlement. Because the line-of-sight to the major southern lunar standstill is tangent to the two circular structures as seen from the balcony of the square tower, these structures may actually have been tall circular structures which extended above the
perimeter wall so that an observer in Cliff Palace could see the moon in the gap between them (Figure 5). If these structures extended a solar-lunar diameter (30') above the perimeter wall as seen from Cliff Palace, the moon at southern major standstill would be framed in the gap as seen from the third and fourth story openings of the square tower. Such a height would mean that the structures originally extended 2.7 m above the perimeter wall and 5 m above ground level. As viewed from the pecked basin, the two structures would have merged and the last gleam of the sun would have appeared over the center of the Sun Temple at winter solstice.

Near the time of major standstill, the moon would have appeared in a dark sky in the gap between the towers during the six month period between winter solstice and summer solstice. The initial lunar apparition in the gap after winter solstice would have been the first slender crescent moon setting in the west after sunset, perhaps indicating the onset of the first month of the lunar calendar. The series of lunar apparitions between the towers would have been climaxed by the setting of the full moon near the time of summer solstice. A similar sequence of events at times of the major standstills of A.D. 1076 and 1093 (moonrises between the double chimneys) could have been observed at the Chimney Rock Pueblo (Malville et al. 1991).

Fewkes suspected that the straight south side of the Sun Temple was aligned to the rising point of the sun at summer solstice. However, according to our measurements, the southern face of the building is rotated by more than 10° to the north of east and has an azimuth of 79°20'. The rotation of this line away from east-west produces an approximate alignment of the perpendicular of the southern face to the Cedar Tree Tower, some 4 km to the north of the Sun Temple. The Tower, located at an angle of 9°11' west of north as seen from the Sun Temple, appears to be another ceremonial structure on
the mesa top, displaying the same care in the
dressing of stone as the Sun Temple. The Tower
contains an additional pecked basin (10 cm x 13
cm x 6 cm) in its bedrock floor, suggesting that
the site may also have served as a sun-watching
station. The eastern horizon in the direction of
summer solstice sunrise is visible from ground
level adjacent to the Tower, and the site could
have served as a sun-moon watching station
prior to and after the construction of the tower.

The prominent peaks of the La Platas
provide usable calendrical marks for summer
solstice sunrise as well as for moonrise at
northern standstills. Announcement of the dates
of ceremonies associated with summer solstice
or northern lunar standstill could have been
visually communicated from the Cedar Tree
Tower to the Sun Temple and from there to Cliff
Palace, Sunset House, and other sites within the
Cliff-Fewkes Canyon settlement. Similar
announcements could have been passed farther
northward to the Far View Tower and the Far
View Settlement on the mesa top.

Conclusions

Pecked basins emerge as candidates for
material correlates of astronomical ceremony
and calendrical sun-moon watching. They may
have served as marks for sites from which to
observe phenomena on the horizon as well as
repositories for offerings to the sun and/or
moon.

The narrow slot between the two towers as
seen from Cliff Palace would have provided a
highly precise means of establishing the
direction of the moon as well as furnishing a
public spectacle. The conjoining of the center of
the Sun Temple with the setting sun at solstice
and the setting moon at major standstill would
have provided a demonstration of the order of
the heavens and of the apparent power of
certain individuals to identify and maintain that
order. The inhabitants of Cliff Palace would
have regularly seen the sun and moon setting
behind Sun Temple on days near winter solstice
and southern standstill. The exact times of the
extremes of the cycles of the sun and moon
could have been noted, however, only by a
limited number of persons at the southern
pecked basin and square tower.

Increasing cultural complexity of a society
should result in increasing quantities of
information which are gathered, processed, and
acted upon (Flannery 1972). The quantity of astronomical information that appears to be assembled at Cliff Palace suggests a progressive growth of astronomical knowledge during Pueblo II and Pueblo III times. Knowledge of the cycle of the sun and, especially, that of the moon, as well as techniques for observing these cycles, may have been acquired through direct observation by local populations or, more likely, through shared traditions among other Anasazi communities.

Acknowledgments.
I thank Robert C. Heyder, Superintendent of Mesa Verde National Park, for permission to carry out these studies and Jack Smith, Chief Park Archaeologist, and Kathy Fiero, Park Archaeologist, for their assistance and encouragement. The field work at Mesa Verde was carried out in conjunction with Frank Occhipinti. Aaron Kaye, Greg Munson, and Don Ross, interpretative rangers at Mesa Verde National Park, have been of great assistance in this project.

Figure 5. Schematic representation of the Sun Temple as it may have appeared from the square tower at the times of major lunar standstill.
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AN ANASAZI MISCELLANY

Friday, October 4, 1991
Afternoon Session V

Chair: Don Fiero
ROCKSHELTERS AND ROCK ART: AN ASSESSMENT OF SITE USE

Ralph J. Hartley

Abstract

Rockshelters used from Archaic through Pueblo III times often contain rock art. Use of rock art to display ownership and/or access restriction is a topic that occasionally generates speculation in archeological investigations throughout the Southwest and Great Basin. We will never know what “meaning” was assigned to petroglyphs and pictographs by prehistoric peoples, however, if rock art served this communicative role, then rockshelters which functioned as places of habitation, storage, or caching of food or tools by a kin-related group are expected to display rock art that is highly redundant. The petroglyphs and pictographs, other cultural features, and artifactual remains at 248 rockshelters along the Colorado River drainage in southeastern Utah are examined to assess how rock art varies with other remains of activities at these sites. The repositioning of prehistoric organizational systems in space and changes in population density are used to explain observed variation.

Introduction

Rock formations in the Colorado River drainage of southeastern Utah are laced with cavities that permitted shelter for human activities. The archeological record preserved in rockshelters on the northern Colorado Plateau continues to be an invaluable source of data in the pursuit of understanding prehistoric land use of the area. The diversity of material remains observed in these shelters illustrates the range of aboriginal activities undertaken for thousands of years. In addition to the material remains of these activities, many of these places contain rock art (petroglyphs and pictographs) that display a broad range of well-preserved figures. Exploring the association between the rock art and the remains of activities that took place at
these shelters is the subject of this paper. Analysis of rock art on the northern Colorado Plateau has derived, for the most part, from perspectives that focus on the morphology and stylistic differences of petroglyph and pictograph images. The context of the site (i.e., other cultural remains and the topographic situation), when considered, is often used to help assign dimensions of culture and age to these images. Several archeologists, however, are beginning to view rock art as one component of the archeological record that, although beset with a history of the need for emic explanation, is potentially valuable in understanding the social and economic conditions under which prehistoric people lived (Baumann 1989; David and Cole 1990; Gould 1990).

The marking of non-portable rock surfaces across the landscape is a behavior that is widespread throughout arid and semi-arid regions of the world but is difficult to assess in terms of its functional significance. The symbolic nature of this behavior makes its study one that is usually restricted to culturally or ethnically defined populations. If, however, we are going to attempt an understanding of the functional significance of human symbolic behavior, we can benefit by assuming that fundamental cross-cultural conditions exist that underlie this behavior (Earle and Preucel 1987:512). This paper explores cross-cultural evidence for patterns of rock art that are associated with the locale and activities that took place at these sites. The archeological record of southeastern Utah is examined to ascertain if the behavior that underlies the production and use of rock art can be explained with reference to current perspectives about the ecological aspects of social evolution on the northern Colorado Plateau.

The following discussion focuses on a perspective of rock art that emphasizes its potential to aboriginal observers in constructing knowledge about the social and physical environment. The prehistoric socioeconomic conditions of southeastern Utah are discussed as grounds for some expectations about possible associations between rock art and storage features in rockshelters of the area. I argue that under particular conditions inter-group competition on the northern Colorado Plateau resulted in rock art being used to convey information about proprietary rights to stored resources.

The Emics and Etics of Rock Art

The motivation underlying prehistoric rock art production is a subject that often plagues archeologists. A broad range of ideas, such as associations with hunting magic, astronomical significance, medical or magico-religious activities, fertility cults, or production as a result of drug induced visions, have been proposed throughout the world. The use of and perspectives about rock art images by aboriginal peoples in various areas of Australia lend credence to some of these interpretations (Blundell 1982; Blundell and Layton 1978; Mowaljarlai et al. 1988).

Prehistoric rock art on the Colorado Plateau is often laden with an assignment of “meaning” by those presenting interpretations. What does it mean is often a question of professional archeologists and the public alike. Implicated in this question is the presumed responsibility of archeologists to reconstruct the cognitive operations of prehistoric people. A participant in a prehistoric cultural system might well be able to tell us why he or others produced rock art, why it is located in a particular place, and what the petroglyph or pictograph “meant” to him (Gould 1969, 1990). These responses, however, would need to be recognized as a function of sociocultural reasoning that would likely be of little value in answering questions about the adaptive functioning of the social and economic system, a fundamental goal of contemporary archeology.

Any “meaning” associated with Colorado Plateau rock art cannot be reconstructed, for intent and significance of petroglyphs and pictographs to prehistoric and contemporary peoples alike is vulnerable to variability and change among individuals through time. Knowledge of emic constructions in the life of prehistoric peoples as advocated by postprocessualist and antipositivist research
cannot contribute to “predictive or retrodictive nomothetic theories about the evolution of sociocultural differences and similarities” (Harris 1990:53-54). In anthropological archeology etic descriptions of behavioral phenomena increase in importance with the time span over which one seeks explanations for these differences and similarities (Harris 1990:60). Is it possible, then, to further our understanding of the role of rock art in a prehistoric cultural system without presupposing a need to define the ideologies of those people?

The location or position of rock art in the physical environment is a subject of interpretation that has caught the attention of archeologists in their attempt to integrate rock art more directly into the realm of socioeconomic investigations. For example, associations between game migration trails and the location of rock art, the proximity of petroglyphs to hunting blinds and drift fences, the association of the location of zoomorphic rock art and hunter-gatherer mobility have all been explored (Heizer and Baumhoff 1959; Mazel 1983; Nissen 1982; Thomas 1976; Thomas and Thomas 1988). Ecological and biogeographical factors that condition the mobility of aboriginal groups in the Central and Western deserts of Australia have also been shown to underly the content and placement of rock art sites (David and Cole 1990; Gould 1990; Lewis 1976). All of these investigations are, in essence, concerned with the ways in which aboriginal peoples enhanced places on the landscape with rock art to help insure efficiency in land use practices.

Places are “read” and interpreted by people. Settings “communicate” information about expected behavior to those who plan to act in them. To insure that the functional meanings associated with a place are sustained, humans often design changes in the environment that foster specific behaviors. Modifications, like petroglyphs and pictographs, to places in the environment enhance their “assigned” functional meanings. Ethnographic and ethnohistoric documentation contain numerous examples of rock art being used to communicate significance of a place and to enhance some assigned sociocultural meaning to that place (Crawford 1972; Gould 1990; Young 1985).

Gould (1990:108) emphasizes that several rock art sites in the Western Desert of Australia that are very important to Aborigines as sacred dreaming sites are small and inconspicuous. Large complex panels on the Colorado Plateau are those assumed to be “significant” by most archeologists, whereas smaller, less elaborate sites are often given far less attention. An assignment of significance to an elaborate rock art site by archeologists is the product of Western European values, not a reflection of how a particular site with rock art fit into the realm of aboriginal activities. For those interested in land use activities the question is whether rock art, irrespective of our aesthetic values, can be associated with the character and/or use of places and if so, can we relate the production and use of rock art to the socioecological mechanisms employed to successfully live in a particular environment?

Environmental Knowledge and Security in Southeastern Utah

The prehistoric occupation and use of southeastern Utah was a function of knowledge of the resource structure and the social environment in concert with the ability to be opportunistic and mobile. Groups using this environment during the pre-Formative period (i.e., pre-A.D. 500) are believed to have fluctuated from a warm season, residentially mobile adaptation to a more sedentary, logistically mobile adaptation during the cold season. These groups also are believed to have had extensive, overlapping ranges (Hartley 1992a:43-47). Several researchers have attributed the creation of diverse representative and abstract morphological shapes of rock art to those using southeastern Utah during this period (Cole 1990:43-108; Schaafsma 1979, 1980:61-76; Turner 1963, 1971).

Like all organisms, humans filter, process, and interpret information acquired through their visual senses that lead to an assignment of meaning for the purpose of constructing
knowledge about the environment. Humans rely heavily on visual information and process it by way of identifying it, comparing it to memory, and ultimately adjusting their behavior on the basis of that information. This knowledge can be used for the purpose of problem recognition and in making decisions about future activities in that immediate environment. During the movement of these small, highly mobile groups about the landscape, petroglyphs and pictographs served as a source of raw "information" to aboriginal observers about the presence of past human activity. In association with material remains and the locale, the rock art was assigned some "meaning" relative to the social environment and the activities that took place there. I am assuming here that rock art, in association with other material remains and features at a site, enabled aboriginal observers to make inferences about past human activities at a site, inferences about the identity of previous users at the place, and decisions about future use of the site and the immediate vicinity and about the site's potential for available resource procurement.

It is generally accepted that human population density fluctuated in response to local environmental conditions but intermittently increased through time until early in the thirteenth century (Dean et al. 1985; Euler 1988; Lipe 1970; Matson et al. 1988:255-259; Plog 1986). As the resource base and population density fluctuated, imbalance requiring relatively rapid adaptive responses became necessary. Environmental conditions affected the temporal and spatial distribution of primary biomass such that range size decreased, residential mobility decreased, and horticulture became more important.

The intensification of horticulture characteristic of the Pueblo II and Pueblo III periods resulted in more prevalent use of isolated and grouped storage facilities. The construction and strategic placement of non-portable storage facilities became one of the more important and efficient means of buffering population to resource imbalances. The utility of storing or caching tools, as well as food, represents constraints on residential mobility and an emphasis on logistical excursions that required increased complexity in group decision making from early in the Formative Period (Lipe 1970; Morss 1931; Thomas 1988:615-617; Wolley and Osborn 1991).

Binford (1991) has argued recently that the attainment and maintenance of security underlies the behavior and socioeconomic organization we observe in aboriginal groups. How people individually, as well as in groups, organize themselves to maximize security may be one perspective anthropological archeologists can take to avoid finding their interpretations mired in group selection arguments. The issues surrounding storage, caching, and the control of information are grounded in behavior that is oriented toward maximizing security. Assessing rock art as a controllable medium of information at rockshelters especially in the context of storage is, I believe, a means by which we can begin to understand the role of petroglyphs and pictographs in a social environment where threats to security are manifested archeologically.

A predisposition to occupy rockshelters on the northern Colorado Plateau is usually taken for granted, however, most primates, with the exception of some South African Chacma baboons, do not occupy caves or rockshelters because constraints on the ability to defend themselves makes the advantages of this situation not viable (Kummer 1971:83). Structural features in rockshelters interpreted as "defensive" walls appear with groups of storage and habitation structures late in the prehistoric use of the area (Dean et al. 1985; Euler 1988; Haas 1989; Hobler and Hobler 1978; Lipe 1970; Lipe and Lindsay 1983). These kinds of archeological remains suggest that the social environment, as a function of varied environmental processes, was one in which at least occasional competition was a definite threat to security.

**Rock Art as a Function of Socio-ecological Conditions: A Hypothesis**

Interpretations of rock art as reflective of identity-conscious groups, as a mechanism of
boundary maintenance, or as a symbol of ownership, and as mechanisms of inter and intra group communication are found throughout the literature. Underlying this perspective are socio-ecological conditions that result in inter-group cooperation and competition (Hartley 1992a:65-71). Cooperation between groups does not necessarily infer formal political "alliances" but rather the sharing of information, space, and resources, and the exchange of mates. Similarly, competition need not conjure up a picture of overt aggression between groups, for interspecies competitive behavior is usually indirect, manifested by territorial advertisement and defense.

The placement of petroglyphs and pictographs in a setting contributes to reducing the ambiguity of the functional meaning of the place both to those within and to those outside the social system whose members produced the rock art (Rosenfeld 1982). Numerous examples of the intentional marking of features on the landscape under conditions of socioeconomic competition have been studied (Blake 1981; Ley and Cybriwski 1974; Morphy 1977). The marking of boundaries or the assignment of groups to space through rock art is also documented in the ethnographic literature (Blundell 1982; Forde 1931:368; Layton 1985; Seligmann and Seligmann 1911).

In a heterogeneous environment like that of the Colorado Plateau, competitive behavior among groups was likely to occur when the cost of expanding or shifting the home range outweighed the potential benefits. The evolution of territorial behavior (i.e., defense of space) occurs when some resource(s) deemed necessary to the maintenance of the group becomes in short supply and must be defended against competitive utilization. As resources become increasingly scarce, however, the gains from the exclusion of others may reach some threshold where the cost of defense simply becomes inefficient and abandonment and migration is required (Dyson-Hudson and Smith 1978; Krebs and Davies 1987; MacArthur 1972:27; Myers et al. 1981).

The "economic defensibility" model of territoriality does not assume that population density remains constant (Brown 1969). As the population density varies, the size of the home range and the justification for defending space will vary. In an environment where population density is low and potential intruders are few, there is little to be gained by exercising defensive maneuvers through means of boundary maintenance. Primate studies suggest that as the population density increases a habitually used area will be compressed due to expansion of the home ranges of adjacent groups and more frequent incursions by more distant groups. As usable space becomes smaller, ranges become actively defended. However, as the density of the population continues to rise, along with the frequency of intrusions, defensibility of the resource space becomes too costly. At this point it becomes more effective for a group to defend access to specific key resources and to allow other groups use of other portions of the range (Abruzzi 1979; Cashdan 1986; Dunbar 1988:52-53; Hart 1978; Richardson 1982).

Cooperative efforts between groups help to inhibit competition when participating groups benefit equally. Crook (1971:256) points out that "competition-contingent cooperation" probably lies at the "root of our behavioral heritage." And Wrangham and Rubenstein (1986:456) have gone so far as to suggest that intraspecific competition is a major source of sociality. Intergroup "alliances" tend to inhibit active competition when access to stationary or mobile resources are spatially and temporally complex and conflict avoidance is desirable (Boyd and Richerson 1985:227-240; Gatewood 1984; Levine 1984; Lourandos 1977:215-218; Schrodt 1981).

Small egalitarian groups are probably responsible for much of the archeological record attributed to the "Anasazi" and "Fremont" in the Colorado River drainage of southeastern Utah. The record of their economic organization suggests these groups were characterized by a "delayed-return system" where valued assets are held or managed by particular sets of people (Washburn 1982:432-433). Cashdan (1984) has suggested that G/Ana foragers who became increasingly dependent upon food production and substituted storage for mobility as a means
of reducing economic risk found themselves more socially nucleated. Effects of this nucleation include a decrease in "inter territorial visiting" where intermarriage and networking via mobility becomes less necessary. With increased social nucleation comes an increase in property accumulation and a greater concern over rights to that property.

Recent assessments of western Anasazi social evolution have addressed the conditions under which inter-group cooperative behavior operated (Braun and Plog 1982; Gumerman and Dean 1989). Environmental conditions that affected the resource structure are considered to have played a major role in the level of exchange networks that facilitated cooperation.

Cooperative behavior as a response to an "unpredictable" natural and social landscape is expected when the adaptive advantages of reciprocity are modeled. Gumerman and Dean (1989:102) base their perspective of Anasazi social interaction on the repeated prisoner's dilemma model of reciprocal cooperation (Axelrod 1984). Assessments of the model have shown, however, that an indefinite number of interactions of the prisoner's dilemma game (i.e., "supergame") results in a relatively large number of players being less likely to "cooperate" than a small number (Taylor 1987). Boyd and Richerson (1988) conclude that reciprocal cooperation is likely to evolve only when groups are "quite small." Taylor (1987:23), likewise, argues that egalitarian "communities," if very small, are expected, like individuals in the classic prisoner's dilemma model, to favor cooperation. We can assume then that reciprocal cooperation between small groups will be the result of long-term interaction, however, as noted above, competitive behavior under particular environmental conditions does not violate the model.

It must be emphasized that this theoretical model takes place in a static environment. Both Braun and Plog (1982) and Gumerman and Dean (1989) point out that change in the resource structure and population density of an area affect cooperative choices. The model posed by Braun and Plog (1982:507) acknowledges also that under some circumstances "boundary formation or maintenance" will be a part of the organizational network of groups on the northern Colorado Plateau.

What kinds of conditions might dictate this inter-group behavior? An excellent example is that of the Dongria Kondh (swidden cultivators in Orissa, India) where clan boundaries are well marked. One time hunter-gatherers, these people now live in clan specific villages each situated in the center of a chain of hills of the Niamgiris. This social system operates as a closed system; although strictly exogamous, each clan operates as a corporate group that is highly territorial. Clans moved their villages often in the past, however, increased population density and a decrease in available game has resulted in sedentism. These conditions have led to active competition that is manifested by violent feuding between clans over land and resources affected by drought and disease. Nayak (1989) argues that the maintenance of territorial boundaries to preserve the resources of each clan helps stabilize the social system and deter encroachment by outsiders, including traders (Bolin 1990; Harris 1979, 1984).

Aboriginal groups using an environment of substantial spatial and temporal heterogeneity like that of southeastern Utah are not expected to defend the perimeter of their home range. An increase in the supplementary role of horticulture and a greater reliance on storage might favor "territoriality," however, at least among kin-related homesteads. Storage, as Testart (1982:527) notes, is most often connected to individual ownership or to ownership by a familial group. The research of Keeley (1988) provides empirical support for the contention that the dependence on stored foods is influenced by population density. Investment in and restriction of access to resource patches (e.g., non-portable storage facilities) are archeologically observable expressions of logistically organized groups in an environment whose population density is increasing.

Several ethnographic accounts suggest that the content of rock art varies with the location and activities that happen at rockshelters (Gould 1990; Gramly 1975; Seligmann and Seligmann
Ralph J. Hartley

Table 1. Site Characteristics.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>stone storage structures</td>
<td>often observed as circular or semicircular enclosed masonry structures positioned in rockshelters or on narrow cliff ledges.</td>
</tr>
<tr>
<td>habitation</td>
<td>masonry or jacal living chambers.</td>
</tr>
<tr>
<td>non-portable grinding surfaces</td>
<td>bedrock or spalls from cliff face that have been used as a milling surface; includes “bedrock mortars,” “grinding slicks,” “bedrock metates,” and “grinding surfaces.”</td>
</tr>
<tr>
<td>portable grinding implements</td>
<td>portable rock slabs and shaped stone used for grinding plant materials, e.g., milling stones, metates, manos.</td>
</tr>
<tr>
<td>subterranean or semi-</td>
<td>depression dug into floor of shelters and lined with rock on bottom and sides; covered with timbers and thatch and used for storage of food and non-food materials; also includes “hardpan” or “earthen” cists not lined with rock.</td>
</tr>
<tr>
<td>subterranean cists</td>
<td>remains of prepared fires; includes those lined with rock and those basin shaped.</td>
</tr>
</tbody>
</table>

1911). Rosenfeld’s (1982) study of prehistoric rock art in rockshelters in the arid Laura region of Australia also exemplifies the extent to which rock art varies with the remains of activities that have gone on there. He uses ethnographic analogy to suggest that the known use of shelters by Aborigines played a large part in how the rock art in a given shelter was interpreted. Furthermore, these Australian data suggest that patterns exist between the content of the rock art and the differential use of shelters that are spatially widespread and that are retained socially for very long periods of time.

In light of the previous discussion, this paper more closely examines variability in the rock art assemblages of rockshelters and how rock art varies in relation to other cultural characteristics and features observed at the sites. An assessment of the co-occurrence of specific representative images and cultural features at these rockshelters is also explored to evaluate previous assertions of other investigators.

The Data

The rock art, other cultural features, and artifactual remains at 248 rockshelters in Canyonlands, Arches, and Capitol Reef national parks, Glen Canyon National Recreation Area, and Natural Bridges National Monument in southeastern Utah were examined for this study. Rockshelters were defined as any recessed opening caused by erosional forces that offered some protection from the physical elements. The presence or absence of six site characteristics were noted for all shelters (Table 1). Data were compiled from a combination of written and photographic documentation and personal field observations.

The classification of rock art images is notoriously difficult (Clegg 1977; Magne and Klassen 1991; Whitley 1982). Most researchers, however, differentiate “representational” (e.g., anthropomorphic, zoomorphic) from “non-representational” elements (e.g., curvilinear, rectilinear, concentric, and “abstract” geometric designs). The classification of petroglyphs and pictographs used here was made with reference to those of Turner (1963), Schaafsma (1971, 1980), and Olsen (1983, 1985), however, I have categorized non-representational figures in a more parsimonious manner.

Rock art images were categorized into twenty-eight units that follow the fourteen classification schemes described in Table 2. All elements were classified as either pictographs or petroglyphs under these units. In those few cases where petroglyphs were partially painted, the image was categorized as a petroglyph.

Expectations

If we assume that a relationship exists between the rock art in a rockshelter and the context of activities that took place in that shelter, then we should expect observable
patterns between the rock art and the remains of these activities in the archeological record. Two expectations are used as the basis for evaluating this general assertion:

1. Specific rock art images are often assumed to reflect some “meaning” that is particular to the context of a place. Olsen’s (1985:120, 123-124, 1989:430) research of Anasazi rock art at nineteen sites on Cajon Mesa suggests an association between “hooved animals” or “bird silhouettes” and “storage/granary sites.” She suggests that these images are specific to clan or sodalities and “function in a socially symbolic manner” (1989:433). The depiction of mammalian and/or bird associated figures are therefore expected to be observed where non-portable storage facilities are found.

2. If aboriginal groups in southeastern Utah found it necessary to defend key resource “patches” (e.g., storage facilities) a strategy of “interference” (Miller 1969:65) would serve these groups in the absence of costly territoriality through active perimeter defense. It is conceivable that indirect contact through material remains at places of occupation or use was the only “interaction” between some groups. Direct contact between some groups may have been rare or even avoided. Was rock art used as a means of “repulsion” via visual displays of “advertisement” or “persuasion” like the song of some birds or the scent markings of some mammals (Dawkins and Krebs 1978; Wilson 1971:195)? Did some rock art at particular locales help to inform intruders of “ownership”?

Rock art reflecting the restriction of access is to be expected at rockshelters that were used for the purpose of food or equipment storage. The “information” embedded in the rock art at these sites is expected to function as one means of identifying ownership, possession, or restriction to others competing for resources in the same home range. An assemblage of rock art is expected to reflect a low measure of “information” (high redundancy) in these contexts.

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>anthropomorphic</td>
<td>where the human figure is represented in its entirety.</td>
</tr>
<tr>
<td>fragmentary anthropomorphic</td>
<td>where only a portion of a human figure is depicted, e.g., torso, headless figure.</td>
</tr>
<tr>
<td>human hand</td>
<td>where the figure depicts the human hand, positive or negative image.</td>
</tr>
<tr>
<td>human foot</td>
<td>where the figure depicts the human foot, positive or negative image.</td>
</tr>
<tr>
<td>human head</td>
<td>where the figure depicts the head of a human.</td>
</tr>
<tr>
<td>mammalian figure</td>
<td>where the figure seemingly represents a mammal.</td>
</tr>
<tr>
<td>mammalian “tracks”</td>
<td>where the foot (or feet) of a mammal is represented.</td>
</tr>
<tr>
<td>bird figure</td>
<td>where the figure seemingly represents a bird.</td>
</tr>
<tr>
<td>bird “tracks”</td>
<td>where the foot (or feet) of a bird is represented.</td>
</tr>
<tr>
<td>reptilian figure</td>
<td>where the depiction suggests a reptile, e.g., snake, lizard.</td>
</tr>
<tr>
<td>rectilinear</td>
<td>non-representational figures characterized by straight lines; formed or bounded by straight lines.</td>
</tr>
<tr>
<td>curvilinear</td>
<td>non-representational figures consisting of or bounded by curved lines.</td>
</tr>
<tr>
<td>concentric</td>
<td>figures having a common center or common axis, e.g., circles, spirals.</td>
</tr>
<tr>
<td>abstract geometric</td>
<td>motifs or outlines that are characterized by both straight and curved lines but that bear no resemblance to natural forms.</td>
</tr>
</tbody>
</table>
Table 3. Frequency of Rockshelters Where Zoomorphic Rock Art and Storage Facilities or Habitation Structures Co-occur.

<table>
<thead>
<tr>
<th></th>
<th>Storage Structures (N=119)</th>
<th>Habitation Structures (N=105)</th>
<th>Cists (N=21)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PETROGLYPHS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mammals</td>
<td>33</td>
<td>40</td>
<td>6</td>
<td>79</td>
</tr>
<tr>
<td>Mammal tracks</td>
<td>7</td>
<td>5</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Birds</td>
<td>6</td>
<td>9</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Bird tracks</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td><strong>PICTOGRAPHS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mammals</td>
<td>14</td>
<td>14</td>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td>Mammal tracks</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Birds</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Bird tracks</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>44</td>
<td>50</td>
<td>9</td>
<td>103</td>
</tr>
</tbody>
</table>

* Total number of sites with at least one zoomorphic figure.

Results

Table 3 shows those shelters where a co-occurrence of zoomorphic related images and non-portable storage facilities are found. The presence of habitation structures is included here for two reasons: first, an assignment as to function of the remains of some of these small structural features is often difficult; and second, storage facilities may have co-existed with roomblocks, especially during the twelfth and thirteenth centuries. Less than 37 percent of those shelters with above ground storage structures, 43 percent with storage cists, and about 47 percent with the remains of habitation structures contain at least one of the eight representative elements of mammalian figures, birds, or their "tracks."

Results of chi-square tests indicate a lack of association between zoomorphic rock art and any one of these three features: storage structures ($X^2 = 1.937; df = 1; p < .05$); habitation structures ($X^2 = 2.028; df = 1; p < .05$); storage cists ($X^2 = .02; df = 1; p < .05$). The assertions of Olsen (1985) for Cajon Mesa are therefore not applicable to these data from southeastern Utah.

Another approach to gaining some understanding of the role of rock art in northern Colorado Plateau prehistoric cultural systems and to assessing the value of this phenomenon in the study of aboriginal socioeconomics is to consider variability within and between assemblages of rock art. Relationships between the assemblage content of rock art and the situational context of the place at which the rock art occurs were examined previously at 388 sites.

Table 4. Frequency of Rockshelters Having Presence of Site Characteristics by Range of Information Measure.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>GROUP</th>
<th>GROUP</th>
<th>GROUP</th>
<th>GROUP</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I 0-0.0480</td>
<td>II .0917-.3862</td>
<td>III .3875-.5352</td>
<td>IV .5391-1.00</td>
<td></td>
</tr>
<tr>
<td>Storage structure</td>
<td>39</td>
<td>30</td>
<td>30</td>
<td>20</td>
<td>119 (48.0%)</td>
</tr>
<tr>
<td>Habitation structure</td>
<td>26</td>
<td>24</td>
<td>28</td>
<td>27</td>
<td>105 (42.3%)</td>
</tr>
<tr>
<td>Grinding surface</td>
<td>11</td>
<td>11</td>
<td>16</td>
<td>12</td>
<td>50 (20.2%)</td>
</tr>
<tr>
<td>Groundstone</td>
<td>17</td>
<td>25</td>
<td>23</td>
<td>23</td>
<td>88 (35.5%)</td>
</tr>
<tr>
<td>Hearths</td>
<td>7</td>
<td>14</td>
<td>8</td>
<td>4</td>
<td>33 (13.3%)</td>
</tr>
<tr>
<td>Cists</td>
<td>4</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>21 (8.5%)</td>
</tr>
</tbody>
</table>
Figure 1. Percent of sites with storage structures, cists, and habitation structures by range of rock art information measure.

in the same National Park Service units used in this study (Hartley 1992a). Results of that research show patterned differences in the rock art assemblages placed on boulders, in rockshelters, and at the base of cliffs. Rock art on boulders and at the base of cliffs provided the greatest amount of "information" to aboriginal observers. Rock art in rockshelters, however, displayed greater redundancy (less "information"), especially in those shelters showing evidence of storage facilities.

Information theory and its measures were used to evaluate the organizational structure of the rock art assemblages. This theory provides a system of accounting for quantities of information; it is a calculus which defines units of measurement (Krippendorf 1975) (see Appendix). Assigning a quantitative index of information content to an assemblage of petroglyphs and pictographs enables us to compare these panels with each other and to associate this index with other cultural characteristics of a site. Information values were computed for each of the 248 rockshelter sites examined for this study. A Rel.Hₙ value of from 0 to 1 indicates that the "information" content of an assemblage of rock art is "low" to "high," respectively. Components of the distribution used in the computation are the glyph categories described above.

Information measures (Rel.Hₙ) for the rock art at these shelters yielded: mean = .363, median = .387, s.d. = .277. The skewed sample (.266) suggests that the median is the best measure of central tendency. All sites were ranked by their Rel.Hₙ and quartiles were computed (semi-interquartile range = .2395). Each quartile was deemed a set of sites (n = 62) and labeled as Groups I through IV (see Table 4).

All of the sites used in this study are characterized by one or more of the six features identified in Table 1. The frequency of sites with
these characteristics observed in each group is shown in Table 4. Figures 1 and 2 show how these four site groups vary with respect to the presence of the six site characteristics.

Almost half of the rockshelters examined in this study were identified as having above ground storage structures. Those shelters with the highest rock art Redundancy measures (low information content) (Group I) account for over 32 percent of the sample of sites with storage structures, whereas those sites with the highest relative information measure (Group IV) account for less than 17 percent of the sites with storage structures. A similar distribution is found with those sites having storage cists. Almost 62 percent of the shelters having one or more of these features exhibit rock art with an information measure below the Rel.H median.

Shelters categorized as having habitation structures show little variation across the four groups. Twenty-eight percent (n = 69) of these shelters have both above ground storage structures and habitation structures (mean Rel.H = .3307). Nearly twice the number of shelters with hearths have a rock art measure below the Rel.H median.

Shelters with the remains of food processing equipment in the form of grinding surfaces and manos and metates (groundstones) show a relatively even distribution across the four groups (see Figure 2). This kind of site "furniture" was observed at over half (54 percent) of the shelters with above ground storage or habitation structures (mean Rel.H = .3777). These food processing remains were also observed at sites with storage cists (n = 18) and show an almost identical mean (Rel.H = .3744) for associated rock art.
Discussion

How does the rock art in rockshelters of the Colorado River drainage in southeastern Utah relate to the use of these places for storage? Two different approaches were used to assess an association between the rock art and the presence of storage facilities. Storage features were viewed as "key resource patches" whose construction and maintenance helped buffer the effects of a fluctuating resource base in a social environment that included strategies to insure against competitive use of those resources.

No statistical association between zoomorphic images and storage facilities was found in southeastern Utah. This does not suggest, however, that specific images were not used by individuals, familial units, or other kin-related groups as identifiers. Olsen (1985, 1989) provides ample ethnohistoric and ethnographic evidence of Hopi and Zuni symbols specific to clans. Symboling behavior used to designate boundaries around Hopi fields is believed to be the result of turn-of-the-century environmental stress and increased population density (Olsen 1989:425). Ley and Cybriwski (1974), Hodder (1982:56-74), Wiessner (1984), and Stevenson (1989) all provide further evidence to suggest that symbols that are group designations are expressed more emphatically under conditions of resource competition and stress in the socioeconomic system.

The study area was probably characterized by low population density for much of the pre-Formative period. Continuity in the use of the same home range by groups for an extended period of time (i.e., over several generations) suggests that the economic system persisted long enough that some shelters were used in a similar manner through time. If rock art at a site reflects the activities that took place there, little or no shift in the home range would suggest that the rock art assemblage would be characterized by low information content. Its use and significance in the social and economic system may have been fairly consistent for generations (Blundell 1974, 1982). As the area became more packed with people, ranges overlapped and, as a density-dependent response, eventually decreased in size. We know that many shelters were used at least intermittently through time. Overlapping home ranges probably resulted in multiple use of sites by different groups that may or may not have experienced direct contact. Foraging and logistical patterns changed through time as the resource base fluctuated in response to environmental changes and as the population density increased. A shelter at which investment was made in the construction of a storage facility may previously have been occupied seasonally by more residentially mobile foragers. As residential mobility decreased and logistical mobility increased, the re-use of some shelters likely increased, probably by kin-related people or by those from within a community-based social structure, where acquaintance was, at the least, common. Multiple use of some rockshelters may also have been more prevalent under conditions of increased logistical mobility (Gorecki 1988).

Multiple and diverse use of places by different individuals and/or different sets of people can account for a great deal of the "noise" we see in any patterning between rock art and site function that may have existed. Nevertheless, when rock art assemblages are quantified so as to differentiate, in a systematic manner, the rock art at different places with storage facilities, some patterning is revealed. Rock art with a very low information measure (high Redundancy), (Group I) was found at a majority of those sites where above ground storage features are observed. I would argue that the content of the rock art at these sites reflects an unambiguous "message" of ownership or of individual or group affiliation, suggesting access restriction. Nonverbal, visual communication of this sort challenges contemporary scientists as they attempt to find effective means of warning humans about sites with buried, high-level radioactive waste. This "message" must inhibit human interference for at least 10,000 years, a period over which spoken and written languages will inevitably decay to the point of incomprehensibility. Sebeok (1984) has recommended redundant displays of iconic, indexical, and symbolic signs to mark these sites. The effort to reduce the ambiguity of this
"message" across cultures and through time requires a visual display that has a very high Redundancy measure. I suggest that the initial marking of places where the investment and tending of prehistoric storage facilities were made constitutes an attempt to visually communicate rights to that property.

Olsen (1983) suggests that a communicative "lexicon" of design elements exists in Anasazi culture that is organized so as to indicate a particular cognitive structure. This assertion implies that we assume "Anasazi" to be characterized as an "ultrasocial" organization (see Campbell 1983; cf. Speth 1988). Based on Olsen's ideas we can ask questions about the distribution of specific design elements at similar places where the rock art assemblage is determined similar in terms of information theory. For example, if petroglyphs and pictographs at the majority of shelters with storage structures and cists show a higher Redundancy measure (low information content), then what specific images contribute to this higher Redundancy measure at sites with storage structures in Group I and at sites with cists in Groups I and II? Can we infer, accordingly, what images are more likely to be present in these contexts? Table 5 shows the overall distribution of these petroglyph and pictograph images for groups of sites with storage structures and cists.

Hand prints (both positive and negative) are well represented at those sites with storage structures having the lowest Rel.H. Olsen (1985:112-113) found negative hand prints to be placed "exclusively" in rockshelters under towers on Cajon Mesa and positive hand prints placed "only in seep areas." In a previous study of hand prints at 54 sites in the Colorado River drainage in southeastern Utah these representations (when negative and positive images were combined) are found to be associated with above ground storage structures (X² = 14.26; df = 1; p < .05), cists (X² = 4.43; df = 1; p < .05), and non-portable grinding surfaces (X² = 4.48; df = 1; p < .05) (Hartley 1992b). These findings lend some credence to the assertions of Davidson (1975:157), Schaafsma (1980:119), and others that hand prints or motifs are a "signature" of individuals or familial units. The assessment of assemblage structure here suggests also that this "signature" may be a symbol of propriety established to help "protect" access rights.

Rock art elements at those shelters with storage cists having a Rel.H measure below the median are dominated by anthropomorphic images, mammals, and curvilinear figures. Olsen's (1985:120) research of Cajon Mesa rock art indicated that zoomorphic and anthropomorphic design elements dominated architectural and non-portable rock surfaces. It appears that these representative images may have been important to aboriginal groups constructing cists for storage at a majority of the shelters examined in southeastern Utah. Curvilinear elements were most often observed at those sites forming Group I, however, the definition of this category as used here may well mask any "meaningful" association recognized by aboriginal peoples.

Conclusions

Aboriginal use of the Colorado River drainage in southeastern Utah has always been viewed as complex in terms of the various "Anasazi" and "Fremont" groups believed to have used this area. Extreme variability in the topographic character of the area helped determine the spatial structure of resources on which these prehistoric groups depended. I have considered rock art as one means of conveying information to individuals and groups that enhanced their chances of survival in this environment. Questions about rock art and the prehistoric use of places in this area require that speculative assertions about any associations be explored. In this paper I have focused on an association between rock art and storage facilities in rockshelters. Rock art appears to vary with the presence of above ground storage structures and storage cists. It was argued that petroglyphs and pictographs served aboriginal individuals and/or groups in this area as a prelude and directive to behavior in settings with tended storage facilities.

Several postulates are summarized from these investigations:
Figure 5. Frequency of Rock Art Elements at Rockshelters with Storage Structures and Cists by Range of Information Measure.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>STORAGE STRUCTURES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I (n=39)</td>
<td>22(7)</td>
<td>14(5)</td>
<td>142(10)</td>
<td>0(0)</td>
<td>1(1)</td>
<td>3(2)</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
<td>1(1)</td>
<td>1(1)</td>
<td>32(3)</td>
<td>26(4)</td>
<td>38(5)</td>
</tr>
<tr>
<td>Group II (n=20)</td>
<td>51(16)</td>
<td>20(7)</td>
<td>22(5)</td>
<td>5(3)</td>
<td>2(2)</td>
<td>28(12)</td>
<td>4(1)</td>
<td>11(6)</td>
<td>7(2)</td>
<td>3(3)</td>
<td>28(11)</td>
<td>19(9)</td>
<td>11(7)</td>
<td>48(16)</td>
</tr>
<tr>
<td>CISTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I &amp; II (n=13)</td>
<td>82(8)</td>
<td>13(4)</td>
<td>20(4)</td>
<td>3(1)</td>
<td>1(1)</td>
<td>121(5)</td>
<td>20(1)</td>
<td>0(0)</td>
<td>14(1)</td>
<td>1(1)</td>
<td>20(5)</td>
<td>91(4)</td>
<td>13(4)</td>
<td>76(4)</td>
</tr>
<tr>
<td>Group III &amp; IV (n=8)</td>
<td>11(6)</td>
<td>20(4)</td>
<td>39(4)</td>
<td>0(0)</td>
<td>0(0)</td>
<td>21(5)</td>
<td>0(0)</td>
<td>1(1)</td>
<td>0(0)</td>
<td>12(2)</td>
<td>30(5)</td>
<td>7(4)</td>
<td>2(2)</td>
<td>40(8)</td>
</tr>
</tbody>
</table>

Number in parentheses indicates frequency of sites with this category present.
1. The prehistoric social environment of southeastern Utah was characterized by periodic and localized areas of competition especially after A.D. 1000.

2. Archeological manifestations of this behavior include defensive architecture and a rock art assemblage that reflects a very low measure of “information.”

3. Rockshelters where non-portable storage facilities are observed were, when tended, characterized by a rock art assemblage with a low measure of information content.

4. Petroglyphs and pictographs that were used to mark shelters with non-portable storage facilities were representations of human hands, anthropomorphs, or mammals.

5. The more frequent and variable the prehistoric use of a rockshelter, the higher the information measure of the rock art assemblage at that place.

These postulates are only weakly connected and therefore no “theory” can be implied, however, these statements allow for further evaluation in the realm of anthropological archeology.

I have avoided placing rock art designs into stylistic classifications. The potential of stylistic attributes in rock art to establish chronological and cultural controls is becoming increasingly doubted, challenging one to pursue ways by which this “artifact” of prehistoric life can inform us about the social and economic systems in which these peoples lived (Loendorf et al. 1991; Lorblanchet and Bahn 1991; Manning 1990).

Like Hill (1989) I believe future investigations of rock art will shy away from interpretations of an ideological nature. This exploration of data may be only one of many ways in which we can assess the role of rock art in the prehistoric social and economic systems of southeastern Utah. But if we accept rock art as being linked to the socioeconomics of this area it offers us one means by which to transcend the illusive cognitive ideologies of those prehistoric peoples using this environment.
Appendix

The rock art at the rockshelters examined for this study were assigned a quantitative index using the Shannon formula (Shannon and Weaver 1949) to calculate the initial measure of information for each rock art assemblage:

\[ H_n = \sum_{i} p_i \log_2 \left( \frac{1}{p_i} \right) \]

This measure, \( H_n \), lies on a scale that ranges from 0 to \( \log_2 n \). Zero, the minimum value, occurs where only one kind of the glyph element is observed. Maximum dispersion of a set of proportions occurs when each of the twenty-eight glyph element categories contain the same number of figures (Thomas 1981). This degree of dispersion can be standardized on a scale of 0 to 1 by further calculation:

\[ \text{Rel}.H_n = \frac{\sum_{i} p_i \log_2 \left( \frac{1}{p_i} \right)}{\log_2 n} \]

These standardized or relative measures of information (Rel.\( H_n \)) no longer express the magnitude of diversity or variety, but may be interpreted as an index of uniformity (Krippendorf 1986).

One of the most useful advantages of Rel.\( H_n \) over other indices of dispersion is that its value is invariant with the value of \( n \), permitting comparison between rock art assemblages that differ widely in the number of glyph elements present. Redundancy, the complement of Rel.\( H_n \), measures the amount of unutilized possibilities for carrying information:

\[ \text{Redundancy} = 1 - \text{Rel}.H_n \]

In the realm of communication, the property of Redundancy assigned to a source suggests that it becomes increasingly likely that mistakes in reception will be minimized. An assemblage of rock art that is highly redundant in terms of the kinds of images displayed therefore communicates a “message” that is relatively unambiguous.
Notes

1. This classification scheme potentially introduces variability in the elements that may be perceived by other observers, however, it reduces the potentially infinite variation of morphologically defined elements into a set of analytical units that permit systematic investigation and search for patterning irrespective of any illusive meanings assigned to these images in prehistory (Wiessner 1984).

2. Painted “dots” were included in this class, however rows of “dots” were considered classificatory units rather than the total number of “dots” (see Morphy 1977; Mithen 1988:301; Dowson 1989, for various considerations of this form).

3. Information, as used here, is not to be confused with meaning. Meaning is the signification of information to a system which processes it. In all forms of human communication, a piece of information is given meaning by the recipient; the meaning is not a part of the message as such. Meaning cannot yet be precisely measured, whereas information can (Miller 1978; Zeller 1984). It should be pointed out that this approach does not negate interpretations about ceremonial, magico-religious, and/or aesthetic functions that may have been served by the rock art images. Well over a half century ago Radin (1937) argued that economic conditions in a cultural system underlie the organizational character and the constituency of religion in that system. Rock art, when directly associated with the ideological components of a cultural system, served prehistoric peoples in ways we likely are never to have knowledge of through the examination of the images alone. Nevertheless, rock art, as a part of the archeological record, can be integrated into assessments of the kinds of functions these sites served in the socioeconomic system of these peoples in the absence of emic knowledge about the sociocultural “meaning” assigned to these images.
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Wrangham, R. W., and D. I. Rubenstein

Young, M. J.

Zeller, C.
Abstract

At the first Anasazi Symposium, Elizabeth Morris urged Four Corners southwestern archaeologists to be more alert for the presence of Archaic sites. Such sites may show the roots of Anasazi culture by displaying evidence for increasing reliance on plant foods and consequently greater sedentism.

During the past ten years, studies conducted for compliance with the National Historic Preservation Act have provided strong evidence for the presence of Archaic hunters and gatherers in southwest Colorado. Today, more than 500 sites in southwestern Colorado are at least tentatively interpreted as having an Archaic component based on surface indications; over 300 of these are best considered to be Archaic only. One tested site in La Plata County has yielded radiocarbon dates of 5720 and 3720 B.P., with the more recent date associated with ground stone implements used in plant food processing.

Analysis of flaked stone tools from various projects in the Southwest suggests that Anasazi flintnapping was more opportunistic and less refined than Archaic flaked stone tool industries. This observation holds potential for differentiating Archaic and Anasazi sites in the field.

In the northern Southwest, sites showing stone tools but lacking ceramics have posed a puzzle to survey archaeologists. Are these Basketmaker sites or special-use later Anasazi sites, do they date from the Archaic, or are they perhaps Protohistoric? Does an aceramic site indicate a nonceramic culture? To suggest that this is so would be a facile error—nobody carries his dishes around all the time. Yet by downgrading lithic sites to the domain of nonsignificant “scatters,” we may be overlooking valuable evidence for early
occupation by the precursors of the Anasazi.

When the first Pecos Conference developed its sequence of Anasazi cultural periods, Basketmaker I was a hypothetical stage reserved for the as yet undiscovered antecedents of the recognized southwestern agricultural Basketmaker II people. The Desert Tradition ultimately emerged as an earlier culture focused on the hunting of modern fauna, the foraging of wild foods, and the eventual domestication of maize (Jennings and Norbeck 1955).

While affirming the Desert Culture as an “eclectic adaptation to an arid or semiarid environment,” Cynthia Irwin-Williams believed that “on a historico-genetic level the term Desert Culture should be confined to the area of original definition in the Great Basin” (Irwin-Williams 1979:33); she preferred to discuss Archaic cultures, with four traditions in the southwestern United States—the Western or San Dieguito-Pinto Archaic tradition, the Southern or Cochise Archaic tradition, an unnamed southeastern Archaic tradition represented by Fresnal and Hueco Archaic complexes, and the Northern or Oshara Archaic tradition. It is the latter, Oshara Tradition that is said to characterize the Four Corners area, later to become the Anasazi homeland. The Oshara Tradition was defined on the basis of seven years of Irwin-Williams’s field work centered in the Arroyo Cuervo region of the eastern Rio Puerco drainage, in the general vicinity of Albuquerque (Irwin-Williams 1973).

Ten years ago, at the first Anasazi Symposium, Elizabeth Morris (1983) reminded the symposium of Irwin-Williams’s Oshara Tradition and questioned the fact that so few Archaic sites had been reported for the Four Corners area. It seems that archaeological surveyors were blinded by the dazzle of Anasazi ceramics and architecture, and were not sufficiently sensitive to the subtle lithics that comprise the surface remains of Archaic sites.

In their Southwest Colorado Prehistoric Context volume, Eddy, Kane, and Nickens (1984) reiterate Irwin-Williams’s (1973) observed correlation of Oshara Archaic Tradition sites with sand dune fields and note “an extensive distribution of local Archaic which extends all the way from the Arroyo Cuervo region near Bernalillo (New Mexico) in a curving arch through Hovenweep and into southeastern Utah in the Aneth area.” These authors note, like Morris, that Archaic remains are generally sparse to absent north of the San Juan River in southwestern Colorado proper, with the exception of the Hovenweep area. They go on to question the broad applicability of the Oshara Tradition projectile point typology to the area north of the San Juan River.

The recent definition of a Mountain Archaic Tradition is an exciting development, with potential ramifications for interpreting early developments in the northern Southwest. In a Plains Anthropologist article, Kevin Black (1991a) presents data to support year-round exploitation of the Colorado Rockies by nomadic to semi-nomadic sedentary groups, long-term continuity in such patterns of exploitation, and separate archaeological identity from adjacent lowland patterns beginning as early as late Paleo-Indian times. Evidence of Archaic mud-and-stick architecture near the Gunnison River has been dated as early as 8000 B.P. (5GN42, 8030±210, Black 1991b), while the completely excavated Mountain Archaic pithouse at the Yarmony Site near the Eagle River dates to 6320 B.P. (SEA799, 6320±90, Black 1991b). In the Gunnison area, Stiger has recently excavated Archaic camp sites that are 6,000 years old (5960 B.P.±80, Livermore 1991).

During the past ten years, surveys conducted for compliance with the National Historic Preservation Act (NHPA) have provided strong evidence for the presence of Archaic hunters and gatherers in southwest Colorado. For the purposes of cultural resource management, the Colorado Historical Society has divided Colorado into five regions defined in the state’s prehistoric Resource Protection Planning Process (RP3) or context volumes. The southwest Colorado prehistoric context area, as defined by Eddy, Kane, and Nickens (1984), contains portions of Archuleta, Dolores, La Plata, Montezuma, and San Miguel counties. Site records, primarily generated by the NHPA Section 106 process, are entered into an automated Site Files system, and can be sorted
and retrieved in numerous ways, including by location using the RP3 regional boundaries. At present, more than 500 cultural resources in the southwestern Colorado region are at least tentatively interpreted as having an Archaic component based on surface indications; over 300 of these are best considered to be Archaic only. Of this number, approximately 150 are isolated finds—typically, an Archaic projectile point found alone. The remaining 150 cultural resources are interpreted as Archaic single component sites.

Despite the large number of recorded Archaic cultural resources in Colorado’s southwest region, few Archaic sites have been excavated. One site on an aeolian sand-covered mesa in La Plata County, 5LP1754, was tested in conjunction with construction of a transmission line (Collins 1985; McDonald 1987; McDonald and Horn 1987). This multiple component site was initially recorded as a Pueblo I habitation or camp site, due to the surface presence of Moccasin Gray pottery, but excavation of soil stains revealed two hearths with charcoal samples dating to 5700 ±80 B.P. and 3720 ±140 B.P., respectively. The older of these hearths was a simple fired pit approximately 50 cm in diameter, while the more recent was lined with stones, including fragments of two milling stones. Both hearths contained nonutilized lithic debitage flakes, but no diagnostic flaked stone tools.

Review of the pertinent site survey forms shows that only a few lithic sites in Colorado have been interpreted as Archaic based on the absence of diagnostic Anasazi artifacts. Most have been assigned to this stage based on the presence of diagnostic stemmed or notched projectile points, with or without accompanying ground stone tools. Various point type names abound, including Northern side-notched, Armijo and Armijo serrated, Elko corner-notched and Elko eared, Bajada, Pinto and Pinto shouldered, Mallory-McKean, Hawken side-notched, Duncan, Pelican Lake, Shavano, San Jose and San Jose serrated, Robideau, and Sudden side-notched. This diversity of type names reflects not only a complex cultural record, but also the differing regional backgrounds of various archaeological surveyors. The phases of the Oshara Tradition have not been applied uniformly, either because they do not fit the record or because the Oshara phase names are unfamiliar to the various investigators.

Irwin-Williams’s (1973) discussion and illustration of projectile point forms typical of the Oshara Tradition phases (Figure 1) shows that each phase includes several manifestations of point form. These are interpreted as showing evolution not only between but within individual phases. The Oshara Tradition begins with the Jay Phase, marked by “large slightly shouldered projectile points (reminiscent of those term ‘Lake Mohave’ in California and Arizona)” (Irwin-Williams 1973:5). The succeeding Bajada Phase points are “distinguished from those of the Jay Phase principally by the presence of basal indentation and basal thinning, to a later variety with increasingly well defined shoulders and decreasing over-all length” (Irwin-Williams 1973:7). Of San Jose Phase points, Irwin-Williams states (1973:8):

- Continuity of projectile point forms is maintained, with the principal shifts being in the increasing use of serration along the blade and relatively shorter stem to blade ratio. Through time a trend develops toward decreased overall length, increasingly expanded stems and increasingly marked serration. The quality of workmanship continues to decline, and soft hammer percussion was rarely used.

For the late Archaic Armijo phase (Irwin-Williams 1973:11):

- Among the projectile points, evolved late forms of the old serrated San Jose style with short widely expanding stems and concave or [later] straight bases were commonest early in the period. Subsequently this class began to show increased internal variety, and a number of variations on a shallow corner notched or narrow-stemmed node made their appearance.

The Armijo complex points illustrated by Irwin-
Williams display quite an amazing mixture of attributes, including concave bases or convex bases, corner “ears” or stems, and side-notching or no notching. The one consistent attribute in this class seems to be a heavily serrated distal or upper half.

Are the defined Oshara tool complexes general enough to include the diverse projectile point types recorded in southwestern Colorado? Working from the list of projectile points recorded by CRM surveys, a few comments are in order. First, let us acknowledge that Oshara Tradition Bajada, San Jose, and Armijo points have been recorded at Archaic camp sites in southwestern Colorado. Other projectile point type names are more reminiscent of complexes defined elsewhere. Northern side-notched, Elko series, and Pinto series are defined Great Basin projectile point forms (Jennings 1986; Jennings et al. 1980), while Mallory-McKean, Hawken side-notched, Duncan, and Pelican Lake points are known from the northern Plains (Hibbets et al. 1979; Frison 1978). “Sudden” must refer to the Sudden Shelter site in Utah (Jennings et al. 1980), and Roubideau and Shavano are phase names of the Uncompahgre Complex, defined specifically for west-central Colorado (Buckles 1971).

It appears that the projectile point typology of the pre-Basketmaker Oshara Tradition complexes does not include the many Archaic styles found in southwestern Colorado. Specifically, this typology does not accommodate the unserrated side-notched points and corner-notched points that are well documented for the Great Basin, and which have indeed been recorded north of the San Juan river. (Parenthetically, it is these very shapes, in miniature, which were to become the standard Pueblo arrow point.)

In closing, while the Oshara Tradition may be under-represented north of the San Juan, Archaic people were definitely here, and the nomadic practitioners of contract archaeology have shown us the evidence. It is time for a new synthesis of the pre-Anasazi archaeology in the northern Southwest, and it is wise to continue looking far afield for comparative data.
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EARLY ANASAZI CERAMICS
AND THE BASKETMAKER TRANSITION

C. Dean Wilson and Eric Blinman

Abstract

Since the original Pecos Conference, sites dating to the earliest Anasazi occupations have been placed (with some notable exceptions) into one of two periods: a largely aceramic Basketmaker II Period dating between A.D. 100 and 300 or a Basketmaker III Period with distinctive Anasazi Tradition ceramics dating between A.D. 600 and 725. The rather abrupt nature of this division contrasts with contemporary sequences in other southwestern regions and has lead some to postulate a lack of relationship or hiatus between the Basketmaker II and Basketmaker III periods. It has been proposed that such gaps may indicate that later Basketmaker ceramic bearing occupations may not represent a local development but are the result of migrations or a series of migrations from the Mogollon country. Others assume a continual development during Basketmaker periods, but are often unable to find much evidence of transitions between these Basketmaker occupations. An examination of data from a number of sites, however, indicates that the characterization of this apparently abrupt transition is the result of weakness in the temporal classification system, and there is evidence for a widespread and distinct occupation intermediate between the Basketmaker II and Basketmaker III periods. This evidence indicates that from the late fourth to the late sixth century much of the Anasazi region was occupied by groups with distinctive undecorated ceramics and a material culture and architecture intermediate between that normally described for the aceramic Basketmaker II and Basketmaker III periods. Material culture is similar to that noted in other southwestern regions, and may indicate a generalized pan-regional adaptation associated with early horticultural developments at periods of low population densities rather than indicating localized developments and widespread migrations from a particular region. Recognition and investigation of sites representing occupations intermediate between those normally assigned to the Basketmaker II and Basketmaker III periods is critical and will provide an opportunity to study the nature and causes of this transition.
The Basketmaker stages of Anasazi prehistory were first described to encompass Anasazi developments transitional between the Archaic and Pueblo stages (Kidder 1927). The first stage was a hypothetical Basketmaker I occupation, thought to represent the initial adoption of agriculture by hunting and foraging groups. The next period in this scheme is labeled Basketmaker II and is defined as a time of increased reliance on agriculture and general absence of ceramics. Basketmaker II sites are best known from settlements consisting of shallow structures and rockshelters excavated in the Grand Gulch, Black Mesa, and Durango areas and appear to have been occupied sometime between 200 B.C. and A.D. 300 (Bearden 1984; Kidder and Guernsey 1919; Lipe and Matson 1971; Morris and Burgh 1954; Smiley 1985). The next phase, labeled Basketmaker III, is characterized as a time of increased importance of agriculture and permanent villages, and expansion through the Anasazi country as Basketmaker III settlements are relatively common and usually consist of one or a few pit structures generally deeper than those encountered during earlier periods, adjoined by antechambers and associated with surface storage rooms and features (Fuller 1987; Rohn 1989). Almost all sites with classic Basketmaker III features date sometime between A.D. 575 and A.D. 725.

Archaeologists investigating Basketmaker sites have focused on several issues, including the degree of dependence on agriculture, settlement and mobility, and the rate and nature of change during various Basketmaker stages. In this study we have focused on the latter issue, particularly with the nature of transition between the Basketmaker II and Basketmaker III periods.

Models of the Basketmaker Transition

Of importance is whether change during the Basketmaker stages is best understood in terms of gradual change and in situ developments or sudden changes involving abandonments, mass migrations, and large-scale replacements of populations. Archaeologists proposing gradualist models view changes in terms of series of responses to population pressures and deteriorating environmental conditions following the introduction of agriculture (Glassow 1972; Irwin-Williams 1973). Irwin-Williams (1973) interpreted data from sites in the Arroyo Cuervo area as indicating a series of local developments from hunting and gathering to sedentary agricultural life-styles. Other investigators view changes during the Basketmaker occupation in terms of sudden and abrupt regionally oriented changes rather than gradual developments.

Probably the best known of the abrupt change models is that proposed by Berry (1982) who asserts that most of the Pecos stages represent discrete episodes, separated from each other by abrupt transitional events. He claims these discontinuities were caused by periodic widespread droughts equivalent to the Great Drought of the thirteenth century. These transitions are characterized as periods of widespread abandonment of low-elevation Anasazi sites and migration to refugee areas, many of which are thought to have been outside the Anasazi region. The movement of immigrant groups back into the Anasazi core areas is thought to have resulted in the rapid synthesis of material culture traits characteristic of the various occupational stages. Based on his reevaluation of tree-ring and C-14 dates, Berry places occupations traditionally assigned to the three Basketmaker periods into discrete phases, which are separated by occupational hiatuses. The earliest of these is Period I, equivalent to the Late Archaic and Early Basketmaker II and postulated to date from 185 B.C. to A.D. 1. Next, is Period II, equivalent to the classic Basketmaker II and proposed to date between A.D. 200 and 370; some of these sites contain some ceramics. Period III, equivalent to the Basketmaker III, is proposed to date between A.D. 600 and 700.

Lucius (1981) presents a “frontier” model of Anasazi origins, which is similar to the model presented by Berry. Like Berry, Lucius proposes that the Basketmaker transitions were not the result of local developments but of migrations from the Mogollon region. He bases this view
both on observations concerning close similarities between contemporaneous early Basketmaker and Mogollon sites, and on the apparent abrupt nature of certain changes during the Basketmaker Period. Lucius proposes at least two major influxes of Mogollon settlers, including an initial migration of groups not possessing ceramics and subsequent arrival of ceramic bearing groups. Differences noted between the later Mogollon and Basketmaker III occupations are interpreted as resulting from subsequent isolation in a frontier situation.

LeBlanc (1982) presents a model that attempts to explain sudden developments associated with the earliest ceramic phases in the Mogollon, Hohokam, and Anasazi regions in terms of new trait complexes, without necessarily evoking abandonment or migrations. He is concerned with both the timing and nature of the introduction of pottery throughout much of the Southwest, as well as its relationship with other traits. He sees pottery as part of an adaptive complex adopted over a wide area of the Southwest during a relatively short period. This complex, as defined by LeBlanc, includes the following: (1) deep, large pithouses with major, large roof support beams; (2) intramural and extramural storage pits and/or attached storage areas or annexes; (3) trough metates and associated oblong manos; (4) ceramics in a variety of forms including cooking jars, water transport jars, seed jars, and small serving vessels, but apparently no large storage vessels; and (5) polished groundstone axes. LeBlanc feels this complex spread rapidly and was imported as a whole and was not the product of local development, although local modifications are expected. He feels this complex reached the Anasazi region during the Early Basketmaker III Period sometime in the late 400s or early 500s.

**Examination of Early Ceramic Sites**

Most investigators proposing abrupt changes between the Basketmaker II and Basketmaker III periods are particularly concerned with the distinctiveness of sites assigned to the two occupations and the lack of sites dating between the two periods. The distinctiveness of these periods is illustrated by the general absence of ceramics during the Basketmaker II and the common occurrence of well developed Anasazi gray and white ware types during the Basketmaker III. This is in contrast with the Mogollon country, in which such a transition is provided by the earliest Mogollon phases such as the Pine Lawn. The Mogollon transition appears to have been gradual, and sites are assigned to the earliest Mogollon phases rather than the San Pedro Phase of the Cochise solely on the basis of pottery (Stuart and Gauthier 1981). Sites dating to the Pine Lawn (early pithouse) Phase are dominated by undecorated brown wares and date between A.D. 250 and 550 (Haury 1936, 1947; Martin and Rinaldo 1947; Stuart and Gauthier 1981; Wheat 1955). It is likely that some early ceramic sites scattered through much of the Anasazi region belong to a similar phase (Schroedl 1982), but many associated sites have been lumped into the Basketmaker II or Basketmaker III phases.

We will attempt to examine various models of change during the Basketmaker Period through the examination of occupations that may be transitional between the Basketmaker II and Basketmaker III periods. We feel these two stages, as presently defined, do not adequately describe or document the nature of change occurring during this span, and information concerning the nature of the transition is lost by arbitrarily assigning all early Anasazi sites into either period. Thus, our efforts will concentrate on the identification of Basketmaker sites that contain ceramic assemblages that are similar to those found on the earliest Mogollon occupations and that date prior to the Basketmaker III occupation. Such assemblages are dominated by plain polished brown wares, and decorated ceramics are absent. Although similar assemblages occur over much of the Southwest, our focus is limited to areas in which ceramic assemblages associated with the Basketmaker III Period ultimately represent Anasazi types (as identified by the joint association of gray wares and decorated white wares).

Our strategy emphasizes the identification and characterization of early brown ware
Early Anasazi Ceramics and the Basketmaker Transition

ceramics at sites within the Anasazi region. This involves both a review of archaeological literature and a reanalysis of ceramic collections when possible. Early ceramic assemblages are compared to each other as well as to those recovered from sites in the Mogollon region. Information concerning architectural features and dating evaluations of components from which brown wares were recovered are also reviewed and discussed. Based on the information accumulated during these examinations, models concerning the nature of the Basketmaker transition are evaluated.

Our initial perusal of the archaeological literature indicated that early sites dominated by brown wares are rare but scattered throughout much of this region. Because of time constraints and problems locating certain collections, we decided to limit the present study to sites located within three somewhat arbitrarily defined areas of the Anasazi. The first area is the eastern portion of the northern San Juan region including the upper San Juan, Animas, La Plata, and Mancos river drainages. The second is in northeastern Arizona, primarily in the Prayer Rock District. The third area is the southern part of the Anasazi region and includes areas within the Zuni Indian Reservation and Petrified Forest National Park. Other sites containing similar ceramic assemblages which are probably also transitional between the Basketmaker II and Basketmaker III include the Little Jug site in the Grand Canyon area (Thompson and Thompson 1974), the Hay Hollow site in the Little Colorado area (Martin and Rinaldo 1960), and sites in Chaco Canyon. These sites are not included here due to problems in locating the ceramic collections and site descriptions, but we hope to incorporate these and other sites in future studies.

Early Ceramic Sites in the Northern San Juan

Archaeologists first recognized the earliest ceramic occupations in the northern part of the Anasazi region during investigations by the Navajo Reservoir Project along the Upper San Juan drainage (Dittert et al. 1963; Eddy 1961, 1966, 1972). Two distinctive early plain ware types, thought to be associated with the earliest ceramic bearing phases of this area, were defined during these investigations (Dittert et al. 1963; Eddy 1966). Los Pinos Phase sites were distinguished by the presence of distinctive structures and were postulated to date between A.D. 100 and 400 (Eddy 1961, 1966). This phase included both sites containing extremely small numbers of sherds classified as Los Pinos Brown and sites not yielding any ceramics. The Sambrito Phase was defined as the occupation following the Los Pinos Phase and was dated between A.D. 400 and A.D. 700. Ceramics associated with this occupation were assigned to a second brown ware type, Sambrito Brown, which was the sole ceramic type during earlier portions of the Sambrito Phase and was associated with Mesa Verde gray and white ware types later in this phase. Examination of ceramics recovered during the Navajo Reservoir Project and the discussion of these types during a recent conference on ceramics from this area (Wilson 1991) indicate that at present it is best to combine Los Pinos Brown and Sambrito Brown into a single type which is here referred to as Sambrito Utility. It may eventually be possible, however, to distinguish an earlier Los Pinos variety on the basis of more detailed analysis.

Sambrito Utility is the earliest known pottery in the northern Anasazi region, and it is defined on the basis of sherds and vessels recovered by the Navajo Reservoir Project (Dittert et al. 1963; Eddy 1961, 1966), as well as additional excavations at the Oven site (Bertram and Hammack 1991; Wilson 1989). Sambrito Utility represents true, well fired pottery of an established tradition, rather than the early stages of manufacture and experimentation. While Sambrito Utility is similar to Mogollon brown wares, distinctive paste characteristics warrant a separate type. Sambrito Utility vessels were produced by coiling and almost always have a plain surface. Necked jars are the most common vessel form, although seed jars, bowls, dippers, and pipes also occur. Surfaces are normally smoothed and are usually but not always polished. The degree of polish or smoothing may vary considerably over the surface of an
individual vessel. The paste is very soft and silty and sherds tend to spall easily. Surface color varies from gray or dark gray to brown, and sherds and vessels often exhibit a great deal of variation in color. Paste color is almost always dark red when refired in an oxidation atmosphere, and the use of clays with very high iron content is indicated (Hill 1988). Paste cores are often vitrified. Sand and sandstone particles occur within the paste, apparently as natural inclusions rather than separately added temper. These characteristics indicate that Sambrito Utility vessels were probably locally produced utilizing self-tempered alluvial clays that are available along the upper San Juan River and its tributaries.

Los Pinos Phase Sites

While ceramics are present at sites within the Navajo Reservoir area as early as A.D. 300, their distribution is very limited and sporadic. Ceramics are clearly associated with some Los Pinos Phase occupations but absent at others, and when present they occur in extremely low frequencies. In fact, pottery is so rarely found in surface contexts that the combination of the absence of ceramics and occurrence of burned adobe or other architectural remains form the major criteria proposed for the recognition of Los Pinos Phase sites in both the Durango and Navajo Reservoir areas (Fuller 1988, 1989; Hogan et al. 1990).

Los Pinos Phase structures from the Navajo Reservoir area are usually located on low ridges and arranged in open, seemingly haphazard patterns (Eddy 1966). Most structures are extremely shallow and oval to circular in shape. Floor area averages between 27-45 square meters. Of the 37 structures excavated, 9 contained both a main chamber and a slightly smaller antechamber linked by a hallway marked by two parallel rows of small upright posts. In the better preserved of these structures, horizontal logs were found laid end-to-end and held in place by the up-curving floor plaster. An additional one or two courses of logs were placed on the outer edges of the floor, laying parallel to the foundation, in Structure 10 at Valentine Village, and these dwellings were described as cribbed-log structures. Cobble pavements were present at some sites and probably represent wall fall from the superstructure. Pits and storage features are very common and quite varied in shape and size.

Similar sites occurring in the Durango area date between the first century and late fourth century A.D. (Dean 1975). Excavation of a number of sites in this area apparently yielded no ceramics (Fuller 1988; Morris and Burgh 1954), leading to a characterization of Basketmaker II in the Durango area as an aceramic occupation. However, there is some evidence that ceramics are associated with some Basketmaker II sites in the Durango area. While no ceramics were recovered in subsurface excavations in Bodo Canyon (Fuller 1988), a small number of sherds were noted on the surface of probable Basketmaker II sites in the Ridges Basin and Bodo Canyon area. These were described as friable gray ware sherds that were partially oxidized to a buff or light brown (Fuller 1988), and it is likely these sherds are Sambrito Utility. It is also likely that Earl Morris recovered a small amount of pottery during his excavations of Basketmaker sites in the Durango area. Alfred Dittert related that many years ago a curator at the University of Colorado Museum told him that Morris definitely recovered sherds during his Basketmaker II excavations, but that Morris felt they were intrusive. Dittert believes that these sherds are similar to those recovered in the Navajo Reservoir area and would be classified here as Sambrito Utility. Given the temporal span of the Durango area Basketmaker sites, it is likely that ceramics would have been associated with only the later occupations. Given the sporadic association of ceramics and long temporal spans indicated by tree-ring and C-14 dates from sites in the Durango and Navajo Reservoir area, it is likely that Los Pinos Phase as traditionally recognized includes both pre-ceramic and ceramic bearing subphases.

Sambrero Phase Sites

The second ceramic phase defined during
the Navajo Reservoir Project has evoked some controversy. The Sambrito Phase was defined, based on C-14 dates and stratigraphic evidence, fairly late during investigations by the Navajo Reservoir Project to fill the gap between the Los Pinos and Rosa phases (Eddy 1966). Pottery is thought to have become more important during this phase, and most sites assigned to this phase contain significant amounts of Sambrito Utility (Eddy 1966). This period is defined as witnessing the first appearance of the true pithouse in the northern San Juan region. Settlements consist of one to seven small shallow pithouses located along Pleistocene benches. At Sambrito Village the pithouses often contain ramps, irregular or ovoid ground plans, and steps in connection with entryways. These features have been interpreted as indicating increased Mogollon influence during this phase.

Berry’s evaluation of the dating of sites assigned to the Sambrito Phase led him to question the existence of this phase (1982:55). He suggests that sites assigned to the Sambrito Phase by Eddy were actually occupied during the Los Pinos Phase and that there was no Anasazi occupation in the Navajo Reservoir area between A.D. 400 and 700. He favors dropping the term Sambrito Phase and reassigning Sambrito Phase sites to the Los Pinos Phase.

Recent investigations, however, tend to support the validity of the Sambrito Phase. Much of this comes from recent excavations of the Oven site (Bertram and Hammack 1991; Wilson 1989), partially excavated during the Navajo Reservoir Project and assigned to the Sambrito Phase (Eddy 1966). The site consists of numerous pit features that were initially interpreted as ovens (Eddy 1966) and later as storage pits reconverted into burials (Bertram and Hammack 1991). Associated ceramics include Sambrito Utility, Chapin Gray, and Chapin Black-on-white. The tree-ring and archaeomagnetic dates indicate an occupation in the late sixth and early seventh century (Bertram and Hammack 1991). Based on this data and that presented from the Navajo Reservoir Project, we feel that the Sambrito Phase represents a real and distinctive phase which may be best viewed as a regional variant of the Basketmaker III (Vivian 1990). It is less clear whether the Navajo Reservoir area was occupied continuously from A.D. 400 to 600, although given the similarity between pottery recovered from Los Pinos and Sambrito phase sites along with stratigraphic evidence from Sambrito Village, the Oven site, and LA 3430 (Eddy 1966), it is likely that the Sambrito Phase represents a continuous occupation from A.D. 400 to A.D. 700.

Two sites in the La Plata Valley recently excavated as part of the La Plata Highway Project (Toll 1991) yield additional support for the existence and geographic extension of the Sambrito phase. Site LA 37594, a dominantly Pueblo II site, in addition contained an earlier shallow pithouse (Toll 1991). All the pottery associated with the early occupation represent Sambrito Utility, and C-14 dates indicate an occupation sometime during the sixth century. This structure is distinct from other Basketmaker III pithouses tested in the La Plata Valley. It was relatively shallow (40-50 centimeters deep), about 5-6 meters in diameter, and had an entryway to the south. This structure is very similar to, and is probably contemporaneous with, Structure 2 from LA 3430 excavated as part of the Navajo Reservoir Project. The second La Plata Valley site, LA 60751, is a fairly typical Basketmaker III pit structure. Ceramics recovered from this site include Sambrito Utility, Chapin Gray, and Chapin Black-on-white. Tree-ring samples date to the middle and late seventh century. The other Basketmaker III sites tested during the La Plata Highway Project did not contain Sambrito Utility sherds.

Thus, data from both the Navajo Reservoir Project and the La Plata Highway Project support the existence of at least two subphases of the Sambrito Phase. Sambrito Utility is the sole local ceramic type associated with the earlier subphase, which dates between A.D. 400 and 575 and which is temporally transitional between the Los Pinos Phase and the classic Basketmaker III stage. Sambrito Utility occurs with Chapin Gray and Chapin Black-on-white at sites dating to the later subphase, which represents a local variant of the widely
distributed Basketmaker III occupation dating between A.D. 575 and 725.

Samrito Utility also occurs at Basketmaker III sites in Mesa Verde National Park. Twin Trees Gray as originally described from excavations of Basketmaker III sites in Mesa Verde National Park (O'Bryan 1950) is identical to Samrito Utility as defined here. Investigations of some Basketmaker III sites in Mesa Verde National Park report the joint association of significant frequencies of Twin Trees Gray sherds along with Chapin Gray and Chapin Black-on-white sherds (O'Bryan 1950). The presence of Samrito Utility at Basketmaker III sites in scattered areas of the Mesa Verde region may indicate the continuance of an earlier technological tradition characterized by polished utility ware and the use of alluvial and pedogenic self-tempered clays. The persistence of this tradition alongside later ceramic technologies may indicate a gradual development from one technology to the next.

Other examples of early ceramic occupations are represented by adjacent sites (5MTUMR2344 and 5MTUMR2389) in Mancos Canyon south of Mesa Verde National Park. Initial reports described these sites as typical Basketmaker III sites dating sometime between A.D. 600 and 700 (Hallisy 1974), but later tree-ring dates indicate that at least one of these sites was occupied in the late A.D. 400s (Breternitz 1986). This site consists of a pithouse containing a main room and antechamber divided by a slab-lined adobe wall, four main postholes on the floor, and 46 smaller postholes on the bench of the main room (Hallisy 1974). Basketmaker III fill extended approximately 0.9 meters below the Pueblo II occupation and 1.5 meters below the present ground surface. Brown ware is present but appears to be distinct from Samrito Utility. Breternitz states that it is similar to Woodruff Smudged and San Francisco Red, but it has not been positively identified to the exact locale of origin. These characteristics indicate a distinctive Mogollon-like occupation that is contemporaneous with the early part of the Samrito Phase.

Prayer Rock District

Another area yielding early ceramic occupations is the Prayer Rock District in northeastern Arizona (Morris 1980). Tree-ring dates from sites in Obelisk Cave and Prayer Rock Cave indicate occupations in the late fifth to sixth centuries. A second later Basketmaker III component (dating to the seventh century) is also present at these sites. Ceramics associated with the early occupation are limited to Obelisk Gray, a polished plain ware, while later occupations contain unpolished Lino Gray and Lino Black-on-white (Gladwin 1957). Our examination of collections recovered from Prayer Rock and Obelisk caves indicates the presence of polished ceramics that are distinctive from later Lino Gray and similar to Samrito Utility. These ceramics are well polished and are usually dark gray, gray, or brown in color. Vessel forms include necked jars, seed jars, and bowls. Temper includes a finely crushed rock not found in Lino Gray sherds, as well as large sand and andesite particles also occurring in Lino Gray types. Some sherds with these characteristics were covered with a bright red slip. Polished plain and slipped ceramics may include both nonlocal types from the Mogollon country (Alma Plain and San Francisco Red) and locally produced (Obelisk Gray and Tallahogan Red) types.

The Basketmaker pithouses in the Prayer Rock caves had a distinct and fairly complex type of architecture (Morris 1980). It is difficult to discern earlier Basketmaker from later Basketmaker architecture but most structures appear to be comparatively deep and similar to later structures.

Zuni and Petrified Forest Area

Another area where plain ceramics are associated with very early Anasazi occupations is in the southern part of the Anasazi region near the Arizona-New Mexico border, including sites in the Zuni Indian Reservation and Petrified Forest National Park. The Flattop site and Sivu’ovi in Petrified Forest National Park may represent among the earliest sites in the Southwest yielding ceramics (Burton 1991;
Early Anasazi Ceramics and the Basketmaker Transition

Wendorf 1953). These sites contain ceramic bearing occupations dating before A.D. 300 and until the A.D. 400s (Burton 1991). Ceramics at these sites have been classified as Adamana Brown, a distinctive early plain type (Burton 1991; Mera 1934; Wendorf 1953). Adamana Brown vessels are well made and usually moderately polished. Surface color is light gray, dark gray, or brown, indicating that both neutral and slightly oxidized atmospheres were commonly obtained. Temper almost always consists of a fairly fine sand and sometimes includes angular quartz and mica fragments in addition (Shepard 1953). Vessel forms include necked jars, seed jars, and bowls. Thickness is fairly variable, and Adamana Brown has been classified as paddle and anvil technique, leading to speculation concerning its relationship with Hohokam pottery (Mera 1934). It should be noted, however, that our brief examination of Adamana Brown sherds indicated they were technologically very similar to other early brown ware types, and further studies concerning pottery construction are warranted.

Early sites within the Petrified Forest area are often quite large with the Flattop Ruin containing as many as 25 structures (Wendorf 1953). Pithouses at the Flattop site generally are small and round to oval in shape, containing long lateral entryways and slab-lined storage pits. All but one structure lacked defined firepits, which may indicate seasonal occupations (Wendorf 1953). Both pit structures at Sivu'ovi were similar to those at Flattop Ruin but were larger and contained large floor pits. The difference in size probably reflects construction constraints as structures from Flattop Ruin were excavated into bedrock.

Adamana Brown may have been produced until at least the early Basketmaker III Period. At early components at Twin Buttes Ruin, Adamana Brown is associated with Lino Gray and Lino Black-on-white (Wendorf 1953).

Early brown wares have also been recovered from three sites in the Zuni area (Fowler 1988; Varien 1990). Tree-ring dates indicate these sites were occupied in the fifth century. Very small amounts of plain ware pottery were recovered. While very similar to Adamana Brown, differences were observed in the paste and surface finish. Vessels were very well made and highly polished. Colors ranged from gray to dark gray, brown, or red. A few sherds also contain a distinctive red slip. Temper consists of a very fine sand and small amounts of crushed rock. This appears to be identical to temper found in sherds from the Mogollon region to the south, and it probably represents Alma Plain and San Francisco Red imports.

Early sites excavated in the Zuni area represent shallow, circular pit structures that had burned, several of which appeared to have been roofed with adobe placed over a framework of vegetal material (Fowler 1988; Varien 1990). The walls of some were lined with upright slabs.

Conclusion

The data presented in this study indicate the existence of an early ceramic phase within several areas of the Anasazi region, intermediate between the Basketmaker II and Basketmaker III as usually defined. A cursory examination of ceramic and other data from sites dating to this phase from three areas of the Anasazi indicate the following trends.

1. Ceramics were introduced to much of the Anasazi country at a very early date (A.D. 300 or earlier). While local differences in paste characteristics exist, certain characteristics (such as lack of decoration, presence of polishing, and high-iron clay) are shared by these early plain wares. Alma Plain, Sambrito Brown, Adamana Brown, Obelisk Gray, and Twin Trees Gray all represent local variations of an early “brown ware” ceramic technology present throughout much of the Southwest.

2. Within the Anasazi country, sites associated with this ceramic complex appear to be widely distributed but very rare. Their scarcity is a result of factors limiting their visibility (such as their location along alluvial terraces) and lack of archaeological sensitivity to this phase. Several of the sites described here exhibited no surface evidence whatsoever,
and the temporal association of others was initially unrecognized. We feel that while such sites are relatively rare when compared to other Anasazi occupations, these factors have led to a drastic underestimation of this occupation.

(3) Because the ceramics described in this study resemble Mogollon Tradition brown wares, there has been a tendency to assume a Mogollon affiliation or origin based on the characteristics of these ceramics. It is important to realize that pan-regional similarities may reflect a common technology associated with the earliest ceramic complexes rather than a common (Mogollon) cultural affiliation. The fact that “brown ware” pottery technology continued to be practiced only within the Mogollon region during later occupations does not necessarily indicate a Mogollon origin or affiliation during early periods. Also, early ceramic firing technology appears to have been extremely variable, and surface characteristics of some of the sherds occurring at these sites is not that different from later gray wares.

(4) While introduced as a developed technology with a variety of vessel forms, the initial impact of the introduction of ceramics to the Anasazi country appears to have been very slight. The total number of vessels associated with early collections is often incredibly small, and pottery is absent at some contemporaneous sites. Basic architectural patterns are very similar between sites containing the earliest ceramics and slightly earlier aceramic sites. These observations are in apparent contrast with models proposing sudden or abrupt changes associated with the introduction of early pottery technology.

(5) Similar polished utility wares appear to have been locally produced at least in the Navajo Reservoir and Petrified Forest areas over a very long period (from at least A.D. 300 to 700). They first occur as the sole type present, then associated with slipped red wares, and still later with local Basketmaker III gray ware and white ware types. This indicates long-lived traditions which may be the result of continual occupation by ceramic bearing groups within these areas. A shift in resource use associated with Anasazi gray ware and white ware technology occurred sometime during the sixth century and probably reflects the development of a ceramic technology better suited to local resources found in the Colorado Plateau.

(6) In addition to a long-lived local ceramic tradition, possible long distance migration is indicated by nonlocal ceramics at some sites dating to the A.D. 400s.

In conclusion, we feel the data presented indicate the existence of an early ceramic bearing occupation that is in many ways intermediate to traditional definitions of the Basketmaker II and Basketmaker III stages. We feel that the case for continuity and gradual development within the Anasazi area is stronger than indicated in some recent scenarios. This does not preclude the importance of migration and introduction of new traits from other regions, but these factors should not be viewed as the sole cause of change during the Basketmaker stages.
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AN ANASAZI MISCELLANY CONTINUED

Friday, October 4, 1991
Afternoon Session VI

Chair: Susan Collins
ADAPTIVE FOOD STORAGE AND CACHING BEHAVIOR IN THE PREHISTORIC SOUTHWEST

Alan J. Osborn and Anne M. Wolley Vawser

Abstract

Isolated ceramic vessels, chipped stone tool caches, and other tool or raw materials caches have been documented and discovered throughout the Southwest and especially in the area of Anasazi occupations. These isolated artifacts, like individual data points on a regression plot, are often believed to provide little insight into the patterns of aboriginal life. However, if archaeologists make use of a number of these occurrences, the data can be used to recognize suggestive patterns regarding past human activities that occurred beyond the perimeters of residential sites. Discussion focuses on aboriginal behavior patterns that might account for the occurrence of these isolated caches. A review of the archaeological and ethnographic data for the Southwest indicates that there are many occurrences of caching activity that fit these patterns of behavior. An isolated Mesa Verde Corrugated vessel cached in the area of Glen Canyon National Recreation Area also provides a case study of the behavioral implications of adaptive caching activities.

Introduction

The adoption of food storage strategies has recently become the focus of considerable attention among ecologists, archaeologists, ethnologists, and development anthropologists (e.g., Ames 1985, 1988; Bagsall 1987; Bahemuka 1987; Binford 1978, 1980; Brenton 1988; Goland 1983; Hitchcock 1988; Hunter-Anderson 1977, 1986; Ingold 1983; O'Shea 1981; Panowski 1983; Powell 1987; Schalk 1977, 1978, 1982; Smyth 1990; Soffer 1989; Sullivan 1983; Testart 1982, 1988; Thomas 1988; Vander Wall 1990; Wills 1988). Archaeological and anthropological interest in food storage has arisen primarily because this form of resource management is systemically related to risk minimization strategies and to the evolution of increased...

This paper will explore several implications of food storage for prehistoric human adaptations on the Colorado Plateau. Two previous studies (Osborn 1990; Wolley and Osborn 1991) have made use of an expanded version of Binford’s (1978, 1980) hunter-gatherer land use model, i.e., foragers, collectors, and cultivators, “ceramic ecology,” nutritional physiology, and ungulate ecology and hunting strategies, in order to understand aboriginal food caching. The present discussion will explore possible causal linkages between food storage, as evidenced by slab-lined cists, subfloor pits, isolated masonry structures, and isolated ceramic vessel caches, and increased human fertility in the American Southwest. This framework will include: (1) ecological aspects of food storage; (2) archaeology of prehistoric land use and food storage; and (3) human nutrition, physiology, and fertility. Specific attention will be given to an archaeological example of a possible Anasazi food cache from Glen Canyon in southern Utah. Archaeologists have recorded a number of isolated ceramic vessels, masonry “granaries,” and seed and nut caches throughout the Colorado Plateau, but these have not been studied within a broader interpretative perspective. We suggest that an integrated perspective based on these theoretical areas will ultimately enable archaeologists to gain a better understanding of aboriginal food storage in the American Southwest—particularly that of the Anasazi of the Colorado Plateau.

**Ecological Aspects of Food Caching**

Vander Wall (1990) provides an overview of the reproductive benefits of food hoarding for a variety of animals, i.e., arthropods, birds, and mammals. As Smith and Reichman (1984:347) point out, “Caching is only one way of avoiding food shortages during periods of unreliable or low productivity; migration, torpor, and fat storage are alternative strategies.” Animals including humans can buffer themselves against food shortages and periods of increased demands by storing body fat. This response is unsuitable for animals that must remain active during the period that fat stores are used because it hampers or reduces mobility. In addition, the physiological conversion of energy to fat and back to usable energy is wasteful, since a considerable percentage is “lost” in the conversion process (Smith and Reichman 1984:347).

Vander Wall (1990) argues that animals may adopt food hoarding, caching, or storage strategies to counteract seasonal declines in production, to meet increased nutritional demands during peak activity periods, to provide for offspring, or to minimize risks posed by predators and inclement weather (Figures 1 and 2). Ultimately, food storage is an adaptive response to these problems if hoarders achieve increased reproductive advantage over non-hoarders (Vander Wall 1990).

Two general types of food caching include scatter hoarding and larder hoarding (Smith and Reichman 1984; Vander Wall 1990). Scatter hoarding involves a number of relatively small food caches within an animal’s home range. Such caches are widely dispersed and concealed to minimize competition. Competitors for

![Figure 1. Food scarcity resulting from seasonal declines in food availability in a temperate environment (adapted from Vander Wall 1990:9, Figure 2.1).](image-url)
scatter hoarders are generally not aggressive and, therefore, active defense of stored food is not required. Scatter hoarding is generally used in environments that allow food retrieval throughout the annual cycle (Vander Wall 1990:97-103). Larder hoarding involves a few large food caches that are located within the home range. These large food caches are actively defended and are frequently associated with residential locations, e.g., dens, nests, and burrows. Larder hoards are frequently used in harsh environments where heavy rains, cold temperatures, and deep snows may inhibit access to caches (Vander Wall 1990).

Recent ecological studies of food hoarding suggest a number of problems that require further investigation—particularly with respect to humans (Smith and Reichman 1984; Vander Wall 1990). For example, how might the storage qualities of various foods affect optimal foraging strategies? Under what conditions might a variety of foods be stored and what factors (e.g., variable nutritional and physiological requirements) might, then, condition the sequence of cache use throughout the annual cycle? Predictions regarding optimal dispersal patterns for food caches can be tested with archaeological data. For example, optimal density of food caches should vary inversely with food value (e.g., calories, nutrients, or toxin content). Ecological studies predict that food caches should exhibit mean nearest neighbor distances that vary proportionately with food value (Vander Wall 1990:103). Such expectations can be tested using ethnographical and archaeological data like that presented later in this paper.

Archaeology of Land Use and Food Storage

Adaptive strategies for contemporary hunter-gatherers have been envisioned by Binford (1980, 1982, 1983) as a graded series of increasing organizational complexity from foragers to collectors. This continuum provides a conceptual basis for organizing the range of variation exhibited by ethnohistorically-documented hunter-gatherers throughout the world. This theoretical framework has been utilized in a number of archaeological studies (Camilli 1983; Chatters 1987; Ebert 1986; Ebert and Kohler 1988; Goland 1983; Hitchcock 1982; Kelly 1980, 1983, 1985; Kelly and Todd 1988; Schalk 1977, 1978; Thomas 1983, 1985; Torrence 1983).

The present discussion will concentrate on the collector end of this continuum given collectors' propensity to store food. Collectors exploit essential resources in a coarse-grained or specialized manner (Pianka 1983). Collectors tend to procure food resources that are abundant, clumped, and seasonally available. Considerable effort is expended by collectors to obtain large quantities of essential resources within a brief period of time for later use. Frequently, stored resources such as food exhibit high bulk and consequently inhibit residential mobility. Like horticulturists, collectors must devote considerable time and energy to food processing. Collectors that rely heavily on meat (e.g., bison, caribou, or fish) must process very large quantities of animal products prior to storage. This is particularly true if freezing is not an option. Plant-dependent
collectors must devote considerable effort to preliminary seed and nut processing including winnowing, toasting, and/or leaching. In a number of instances, such initial processing is designed to enhance the storage potential of the food resource.

Additional resources are usually obtained by various task groups within variable resource zones around the residential and food storage location. Binford (1980:344) states, “Logistical strategies are labor accommodations to incongruent distributions of critical resources or conditions which otherwise restrict mobility.” Hunter-gatherers in highly seasonal environments characterized by short growing seasons and marked variation in resource availability make use of extensive logistical networks involving a diversity of site types, e.g., monitoring stations, caches, field camps, and residential places (Binford 1978, 1980). Collectors must make use of logistical travel to accomplish multiple tasks including resource acquisition and monitoring (Kelly 1983).

Logistically-organized hunter-gatherers produce a more complex archaeological “landscape.” Residential sites tend to be highly visible archaeologically given the dependence on bulk storage, attendant storage facilities, domestic structures, midden accumulations, and so forth. Topographically-fixed loci such as mountain passes, rapids or cataracts, fords, caves and rockshelters, lithic source areas, and so forth frequently emerge as special purpose sites within collector land use systems. As a result, Binford (1978:491) states, “Special purpose locations are more discrete in their location and more redundant in their use and contents.” In contrast, residential sites and transient camps are less likely to be reused or reoccupied since their locations are more likely to be conditioned by the variable location and abundance of critical resources such as food, fuel, and water. Residential sites are “more flexible in their location and more variable in their content” (Binford 1978:491).

Residential sites for collectors would be expected to be reused as greater amounts of energy and time were invested in the adoption of a food storage strategy and the construction of permanent residential and storage facilities. Repetitive use of specific locations for residential and special purpose activities would increase as group mobility decreased and as home ranges contracted (Binford 1982). Archaeological deposits containing features, artifacts, and ecofactual remains should reflect more stable or consistent site histories.

Technological systems for collectors tend to be complex. A considerable portion of the total “tool kit” (i.e., implements, weapons, tended and untended facilities, and transport items) serves as “passive gear” or “insurance gear” that is stored or cached at a number of logistical points across the landscape. Passive gear is most apt to be cached at seasonally-used residential sites; whereas, insurance gear is generally cached along trails, near stream crossings, and at significant natural and constructed landmarks. Site furniture may frequently consist of household gear that has been laterally recycled from residential loci.

The land use and technology continuum for hunter-gatherers can be extended to allow us to examine horticultural groups in the American Southwest. In general, such groups would have been more dependent on select plant resources, food storage, and logistical mobility strategies than collectors. Binford (1980:18) states, “We would therefore tend to expect some increase [in logistically organized procurement strategies] associated with shifts toward agricultural production.” Increased dependence on energy-rich plants, particularly cereals in this case, would favor collapsed home ranges. A major reduction in residential mobility is frequently associated with decreased home range size, regional packing, and the emergence of territoriality (Binford 1982, 1983). On the other hand, logistical mobility related to animal protein procurement may increase dramatically in areas that lack domesticated animals.

Reduced residential mobility and heavy dependence on carbohydrate-rich food resources would also be associated with consequent changes in adult female body composition and reproductive physiology and resulting increases in fertility and population growth rates. On the Colorado Plateau, aboriginal food production
based on cereal crops (i.e., maize) would have intensified time constraints on labor required for field preparation, planting, weeding, and harvesting. As Schalk (1977) points out, the implementation of a specialized food storage strategy shifts environmental and organizational stresses from times of food scarcity to times of food abundance. With cereal cultivation, however, such organizational stresses of seasonal labor coincide with the growing season but precede the actual period of food abundance. Large quantities of food have to be planted, tended, and harvested within discrete, relatively short periods of time. Peak labor periods would have been stressful for reproductive age females due to loss of body fat stores. Furthermore, heavy dependence on food production and a more specialized diet based on carbohydrate or oil-rich plants require significant and dramatic increases in processing costs (Ember 1983; Howell 1986:183-185).

Like collectors, horticultural groups would be expected to occupy residential sites for greater portions of the annual cycle. Residential sites would be occupied by larger groups for longer periods of time. Domestic architecture might be expected to reflect increased permanence and year-round use (Gilman 1987). Cleanup or maintenance activities would produce very visible midden accumulations. Local soil depletion would also lead to the proliferation of more distant, seasonally-occupied field houses and/or agricultural intensification (e.g., terracing, gridding, and irrigation). Initial horticultural commitments would have been managed at the household level. Increased labor demands for cereal horticulture could have been met by adoption of a "household extending strategy" (Bender 1967; Minge-Kalman 1977; Netting 1965; Pasternak et al. 1976; Reyna 1976; Yanagisako 1979). Adoption of the household extending strategy serves to recruit adult producers into the domestic labor force. Given this response to labor stress, food production, storage, and consumption can still be handled at the household level among closely related kin.

Human Nutrition, Physiology, and Reproduction

Our understanding of food storage must also be firmly grounded in nutrition and physiology. Human diets composed of fat, protein, and carbohydrates supply 9 kcal, 4 kcal, and 4 kcal per gram, respectively. These three energy sources exhibit variable assimilation costs, i.e., specific dynamic action (SDA) or dietary-induced thermogenesis (DIT). Dietary-induced thermogenesis equals 4 percent (4 kcal per 100 kcal) for fat, 6 percent (6 kcal per 100 kcal) for carbohydrate, and 25-30 percent (25-30 kcal per 100 kcal) for protein (Jequier 1983; Woo et al. 1985). Protein resources cannot be used optimally as a source of nutrients unless calorie intake equals or is greater than 1.5 times basal metabolic rate (BMR). Furthermore, an animal protein diet has an extremely high DIT cost. Lean meat diets, therefore, must be supplemented with fat and/or carbohydrates to offset DIT costs (Speth 1983, 1987, 1990; Speth and Spielmann 1982). Excess protein is metabolized as a caloric source or it is excreted as urea; it is not stored in the body. Noli and Avery (1988) and Speth (1990) have proposed that sustained daily intake of animal protein should not exceed 300 g or 50 percent of total food energy. Animal protein intake above this level may cause kidney and liver damage, elevate blood ammonia levels, disrupt electrolyte balance, and create micronutrient deficiencies (Speth 1990:153). We might expect, then, to observe prehistoric caches of carbohydrate-rich plant resources that were utilized initially throughout the Colorado Plateau to offset high DIT costs and the toxic effects of a lean meat winter diet (Osborn 1990).

Carbohydrate and fat-based energy in excess of basal metabolic demands is either dissipated as heat or it is ultimately stored in adipose tissue as triglycerides. There are several disadvantages to energy storage in the human body. Fat storage in humans increases body mass and the energy costs of locomotion and decreases mechanical performance (Pond 1981). Certain populations contain individuals that exhibit "easy fattening" genotypes (Huss-Ashmore
Longhurst and Payne (1981:52) point out that fat storage in lean individuals is 25 percent efficient whereas in fat individuals it is 60 percent. Granary losses of stored food were approximately 10 percent; therefore, "...the use of the body as a store appears to be a less efficient option" (Longhurst and Payne 1981:52). In addition, increased deposits of subcutaneous fat may lead to heat stress during the growing season (Blurton Jones and Sibly 1978; Pond 1981).

Body fat in humans—particularly adult females—has significant implications for female fertility. Numerous studies have systematically linked fertility to fluctuations in body weight and, more specifically, in body composition, i.e., lean to fat ratios (Frisch 1975, 1978, 1984, 1985, 1988; Frisch and MacArthur 1974; Frisch and Revelle 1970; Huss-Ashmore 1980). For example, adolescent females in Europe and the United States typically achieve menarche at 47 kg after accumulating 11.5 kg of fat (fatness level equals 22-24 percent total body weight; Frisch 1975). Frisch (1985) points out that androgen is converted to estrogen in female adipose tissue; fat in the breasts, abdomen, omentum, and long bone marrow serves as extragonadal storage sites for estrogen. Critical fat also contributes to increased live birth weights that, in turn, favor increased infant viability. Fat reserves also support the increased energy demands during lactation, i.e., an additional 1,000 kcal per day. Insufficient energy intake does not affect breast milk quality but it does limit the duration of lactation. Periods of post-partum amenorrhea have been found to be inversely related to caloric intake in a number of populations in Zaire (Carael 1978), Mexico (Chavez and Martinez 1973), and Guatemala (Delgado et al. 1977; Delgado et al. 1978).

The systemic links between female diet, body composition, and fertility regulation are complex and the "critical fat hypothesis" has been challenged on analytical, interpretative, and ethical grounds (Cammeron 1976; Ellison 1981, 1982, 1990, 1991; Johnston et al. 1971; Johnston et al. 1975; Trussell 1978, 1980). The debate regarding body composition and fertility can be viewed along two dimensions. First, counter arguments frequently center on selection of relevant units of analysis, e.g., menarcheal age, age of optimal ovarian function, body weight, weight/height ratio, minimum fatness, average fatness, "critical" fatness, and so forth. Second, counter arguments propose that other physiological sub-systems actually are correlated with or regulate female fertility, e.g., nutritional status, energy balance, regularity of food intake, activity levels (periodic aerobic activity vs. low-level, chronic activity), breastfeeding, and skeletal development (i.e., pelvic maturation). Ellison (1990) discusses the additive, interactive effects of ecological, behavioral, and constitutional factors relative to ovarian function. He (1990:938) states,

The catalog of possible interaction effects is by no means completely studied even for dyadic combinations, much less for more complex suites of variables. Yet it is just such combinations of factors that are likely to be encountered in many natural fertility populations: high workloads in combination with poor energy balance, poor energy balance in combination with intense and prolonged lactation, and so on.

Hunter-gatherers, cultivators, and pastoralists have been observed to undergo marked fluctuations in body weight throughout an annual cycle (e.g., Ellison et al. 1989; Hausman and Wilmsen 1985; Howell 1979; Huss-Ashmore and Goodman 1988; Lee 1984; Leslie and Fry 1989; Little et al. 1988; Wilmsen 1978, 1982). Mean adult weight for the San in the northwestern Kalahari in 1975-1976 ranged from more than 46 kilograms in June-August to less than 44 kilograms in December-January (Wilmsen 1978:69). Average body weights for foragers were 4 kilograms less than body weights for pastoral Herero (Wilmsen 1978:69). For African horticultural societies, adult weights fluctuate from 5 to 7 percent throughout the annual cycle (Huss-Ashmore and Goodman 1988). Leslie and Fry (1989) discovered that nomadic Turkana pastoralists exhibited highly seasonal patterns of births that could be causally
linked to periodicities in rainfall and resulting food availability. Ellison et al. (1989) observed suppressed luteal progesterone levels and ovarian function in response to nutritional stress among Lese women in the Ituri Forest of Zaire. Ovarian function was compromised during the menstrual cycle that followed periods of relative food shortage (Ellison et al. 1989:524). Bailey (1991) has more recently documented correlations between rainfall, seasonal hunger, frequency of ovulation, and seasonality of births during a nine year period for Efe foragers and Lese cultivators in the Ituri Forest. These observed fluctuations in female body weight, lean to fat ratios, and fertility have been systematically linked to seasonal hunger and peak female labor periods. Intense work periods related to food production frequently impose severe stress on adult females leading to marked reductions in body fat stores, body weight, and probably ovarian function. Such periods of intense work reduce female fertility and also impose hardships on children due to reductions in time devoted to breast-feeding, food preparation, and other child care activities (Huss-Ashmore and Goodman 1988:41).

Anasazi Food Caching: Archaeological Cases

The previous discussion has focused on a broad adaptive continuum that includes foraging, collecting, and food producing systems. Ecological aspects of food caching, the archaeology of land use, and nutritional and reproductive physiology provide a broad adaptive framework within which archaeologists can account for aspects of food storage including the occurrence of ceramic vessel caches throughout the American Southwest and adjacent areas. There are a number of isolated archaeological cases that document food caching throughout the greater Southwest (Table 1 and Figure 3).

Ethnographic descriptions also offer a number of potential insights regarding food cache locations, construction, food processing, food sharing, and so forth. For example, such accounts contain descriptions of ceramic vessels that were laterally recycled from domestic use at residential sites to logistical locations such as field camps or hunting stands. Castetter and Bell (1942:184) describe lateral recycling among the Papago of southern Arizona. Food storage vessels were frequently large water jars or ollas that had lost their porosity. Such ollas were better suited for dry storage purposes. Campbell (1931:28) mentions that the Serrano of...
## Table 1. Archaeological examples of ceramic vessel caching and use for resource storage (see Figure 3 for locations).

<table>
<thead>
<tr>
<th>Location</th>
<th>Use Context</th>
<th>Archaeological Context</th>
<th>Comments</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Colorado Desert, SE California</td>
<td>Food storage</td>
<td>Rockshelter</td>
<td>Large olla contained several honey mesquite beans</td>
<td>Swenson 1984</td>
</tr>
<tr>
<td>2. Palm Springs, California</td>
<td>Food storage</td>
<td>Unknown</td>
<td>An olla containing panic grass seeds</td>
<td>Bean and Saubel 1972</td>
</tr>
<tr>
<td>3. Joshua Tree National Monument, California</td>
<td>Food storage</td>
<td>Rockshelter</td>
<td>Large olla containing goldfield and sage seeds; cache also contained burden basket, iron pan, and spirit sticks</td>
<td>King 1976</td>
</tr>
<tr>
<td>4. Lake Cahuilla, SE California</td>
<td>Food/Crop seed storage</td>
<td>Isolated find in dunes?</td>
<td>Small olla containing several squash seeds</td>
<td>Wilke et al. 1977</td>
</tr>
<tr>
<td>5. Twenty Nine Palms, South California</td>
<td>Food/water storage, site furniture</td>
<td>Caves and rockshelters Sand dunes</td>
<td>Numerous ollas, jars, and bowls</td>
<td>Campbell 1931</td>
</tr>
<tr>
<td>6. Southcott Cave, SE California</td>
<td>Site furniture</td>
<td>Cave</td>
<td>Six restorable vessels (4 jars, 1 olla, 1 cooking pot)</td>
<td>Sutton et al. 1987</td>
</tr>
<tr>
<td>7. Kingman, Arizona</td>
<td>Food storage</td>
<td>Cave</td>
<td>Lac sealed olla containing 45 mescoal cakes</td>
<td>Euler and Jones 1956</td>
</tr>
<tr>
<td>8. Lupton, Arizona</td>
<td>Food storage</td>
<td>Cave</td>
<td>Clay/mud sealed large jar containing 22 lbs. pinyon nuts</td>
<td>Euler and Jones 1956</td>
</tr>
<tr>
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<td>Food storage</td>
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<td>Large jar containing several maize kernels; covered with pine bark lid</td>
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<td>10. Hotevilla, Arizona</td>
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<td>Euler 1959</td>
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<td>In rock fissure</td>
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<td>Hevly 1970</td>
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<tr>
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<tr>
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<td>Gifford 1980</td>
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<td>15. E. Grand Canyon, Arizona</td>
<td>Insurance gear (?)</td>
<td>Small cave</td>
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<td>Euler 1971</td>
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</tbody>
</table>
Table 1. Archaeological examples of ceramic vessel caching and use for resource storage (continued).

<table>
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<th>Location</th>
<th>Use Context</th>
<th>Archaeological Context</th>
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<td>16. Navajo Canyon, Glen Canyon, Utah</td>
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<td>Cave</td>
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<td>17. Zion National Park, Utah</td>
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<td>Salt cache</td>
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<td>Unknown</td>
<td>Shallow alcove</td>
<td>Corrugated jar (?)</td>
<td>Sharrock et al. 1963; Schroedl 1977</td>
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<tr>
<td>24. 42GA436, Glen Canyon, Utah</td>
<td>Insurance gear (?)</td>
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<td>Shallow alcove</td>
<td>Corrugated jar (?)</td>
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<td>Crevice in sandstone ledge</td>
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</tr>
<tr>
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<td>Insurance gear(?)</td>
<td>Small crevice/overhang in bedrock</td>
<td>Corrugated jar and black-on-white bowl</td>
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<td>28. 42SA16858, Canyonlands National Park, Utah</td>
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<td>Placed in shallow pit</td>
<td>Large black-on-white olla (mended)</td>
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</tr>
<tr>
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<td>Unknown</td>
<td>Unknown</td>
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<td>Schroedl 1981</td>
</tr>
<tr>
<td>30. 42KA2688, Glen Canyon, Utah</td>
<td>Insurance gear (?), Food storage</td>
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<td>Moenkopi corrugated vessel with slab cover. Corn cobs nearby crevice with subterranean granary</td>
<td>Metzger and Chandler 1986</td>
</tr>
<tr>
<td>31. Navajo Canyon, Arizona</td>
<td>Insurance gear (?)</td>
<td>At top of rockslide near cave</td>
<td>1 bird effigy, 1 jar/canteen 1 dipper, 1 double bowl</td>
<td>Breternitz 1991, personal communication</td>
</tr>
</tbody>
</table>
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southern California removed ceramic ollas and bowls from archaeological cave sites and used them at their residential locations. As Binford (1978:264) points out, site furniture frequently consists of worn or damaged household gear that is laterally recycled from residential to special purpose sites.

Recycled household gear such as ceramic vessels might be expected to exhibit evidence of repair or modification. Campbell (1931:61) describes a number of methods for mending or repairing damaged ceramic vessels. These repair methods include pinyon pitch plugs, sherd patches, pinyon pitch “smears,” gluing, and “shoe lacing,” i.e., pairs of drilled holes on opposing margins of a fracture that are laced with bark, leather, or fiber cordage.

One example of ceramic vessel caching and possible scatter hoarding is an isolated artifact location 42SA20779. Site 42SA20779 consists of a single corrugated ceramic vessel, which was found partially buried in a narrow crevice along a ledge in the north central portion of Glen Canyon National Recreation Area. An outcrop of rock forms a protective cove around the crevice where the vessel was discovered just 15 meters above the canyon floor. The site, which contained no other features and limited associated material remains, is unique in that the vessel was found intact and partially buried with no evidence of having been disturbed by recent human activity. An extensive pack rat midden in the crevice had, however, resulted in displacement of associated material remains.

The site consists entirely of one feature that has been interpreted as a cached storage vessel. One large, decorated, corrugated olla was placed upright in the crevice and may have had slabs of rock or soil packed around the bottom to hold it upright. One or more of these small slabs may have originally sealed the vessel and its contents. The vessel has been classified as a Pueblo II to Pueblo III period Mesa Verde Corrugated circa A.D. 850 to 1300 (Dean Wilson, personal communication 1988).

The vessel is cracked from one side to the other across the bottom. A small piece of the pot along the break appears to have been broken out at one time, then replaced, and lodged in place with a pine pitch smear on the exterior near the vessel bottom. The vessel also appears to have been used over a fire as evidenced by the burning on the exterior surface and some interior staining.

Items recovered from macrofloral sampling as well as collection during excavation included numerous cactus spines, Cheno-am seeds, seeds from various other plants, several yucca seeds and pod fragments, one yucca leaf fragment, one small squash stem, and one twelve rowed corn cob (Cummings 1989; Wolley and Osborn 1991).

Pollen samples from the vessel interior, a vessel wash, and the soil surrounding the vessel revealed considerable consistency between them. This is believed to be due to the extensive disturbance of the vessel contents by pack rat activity (Cummings 1989). There were, however, several differences noted between the pollen samples. The frequency of juniper pollen was considerably higher in the vessel wash sample than in the fill sample, suggesting that the vessel may have been cached when juniper trees are pollinating in the spring (Cummings 1989). Corn pollen (Zea mays) was present in the fill sample as well as the wash sample indicating that corn was likely stored in the vessel and had also been greatly disturbed by pack rat activity (Cummings 1989). Discovery of the corn cob in the fill outside the vessel but within the crevice also supports this interpretation.

There were also several faunal materials recovered during excavation, most of them small species believed to be in the crevice as a result of pack rat activity. One exception is an antelope metatarsal found near the base of the pot exterior and exhibiting considerable weathering (Dominguez 1989). Given the size, location, and weathering on this specimen, as well as the fact that antelope have not been seen in the area since the early 1900s (Nelson 1925), it is believed that this item was culturally deposited with the vessel. Pack rats have, however, been known to move bone weighing up to 100 grams (Hoffman and Hays 1987), making it possible that this bone was deposited in the crevice by pack rats.

Interpretation of the vessel cache at site 42SA20779 within the previously discussed framework suggests the following scenario. The
large, decorated, corrugated olla at site 42SA20779 was cached in the crevice, possibly in the springtime, sometime between A.D. 850 and A.D. 1300. The vessel at site 42SA20779 is cracked but has also been repaired prehistorically indicating that it was probably "laterally recycled" from use at a residential or more permanent habitation site.

This cached vessel most likely represents an insurance cache of food associated with a nearby logistical activity locality or a hidden food reserve being stored at a safe distance from distantly related members of a residence locality. A review of the context of the site lends support to either possibility. Site 42SA20779 is surrounded by several possible logistical activity locals including lithic raw material quarries, potential upland hunting areas, and other wild food resources such as rice grass. The site is also located within two miles of several large residential sites, large storage locations, and river bottom land that would have been suitable for horticulture.

The vessel at site 42SA20779 was most likely cached by collectors or horticulturists as opposed to foragers. These kinds of food caching activities would be expected from collectors or from horticulturists who depend on stored food for at least part of the year. The presence of both the corn cob in the crevice and the Zea mays pollen in the vessel samples indicate caching of this vessel by horticulturists.

Discussion

What insights have we gained regarding several isolated ceramic vessel and food caches in southeastern Utah? First, the hunter-gatherer continuum formulated by Binford (1980, 1982, 1983) suggests that caching behavior, in general, is most frequently correlated with logistically-organized behavioral responses. As suggested previously, such behavioral patterns are exhibited by collectors such as the Owens Valley Paiute of the Great Basin. We can also extend this forager-collector continuum to include aboriginal groups like the Hopi, Zuni, Pima, and Papago that were increasingly dependent on domesticated crops. Second, such logistically-organized groups were less residentially mobile, lived a great portion of the year in homesteads, hamlets, or small villages, and utilized smaller task groups to move critical resources such as food, water, and raw materials to dependent consumer groups. Third, collectors and some horticulturists most probably produced a greater variety of more "ephemeral" sites including temporary field camps and resource and tool caches, stations, and locations. Fourth, frequently such reductions in residential mobility were closely tied to increased dependence on the storage of high bulk food resources (e.g., dried or frozen meat; wild seeds, nuts, and tubers; domesticated cereals). Fifth, optimal foraging theory predicts that upland ungulate hunting should have been the initial overwintering strategy throughout the Colorado Plateau (Osborn 1990; Simms 1984, 1987). Prehistoric hunter-gatherers would have faced increased diet-induced thermogenic costs due to winter fat loss in ungulates. High lean meat diets should have been supplemented via limited dependence on stored plant foods (e.g., pinyon seeds or "nuts," rice grass, wild rye, and other grass seeds). The bulk of these carbohydrate and oil-rich plant foods were generally obtained at lower elevations. Caches of these resources were placed in ceramic vessels and masonry storage structures close to productive patches of these resources during the harvest. Such caches could then be visited throughout the winter by logistical groups that resided at higher elevations. Sixth, increased dietary specialization involving carbohydrate-rich wild and domesticated plants might also be associated with more costly food processing activities involving the manufacture and use of ceramic vessels for cooking plant resources. Ceramic technology may have been critical in order to enhance digestibility and to reduce toxic and/or inhibitory secondary compounds. Seventh, increased dependence on more specialized diets was associated with increased human labor demands, which means that households, as well as residential group sizes, must have been larger in order to effectively procure and process large quantities of critical resources during and immediately following the
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caching, food storage, and ceramic technology has been presented here as an interpretative context within which we can begin to understand aboriginal food storage and caching in the American Southwest. Specific archaeological cases involving ceramic vessels (i.e., food or water caches, site furniture, or insurance gear) have also been presented in order to provide additional insights into caching strategies. Such relatively small archaeological sites have traditionally not received much attention by archaeologists. However, the study of caching behavior is now the focus of a number of provocative studies. Such prehistoric and historic occurrences offer archaeologists yet another pathway for investigating aboriginal adaptations to the arid environments of the American Southwest and adjacent regions.

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Yanagisako, S. J.

Abstract

In carrying out research on the effects of atmospheric pollutants and local microclimate on deterioration of sandstone masonry in cliff dwelling ruins at Mesa Verde National Park, a subtle but significant difference was observed between the chemistry of masonry blocks used by the Anasazi and the general sandstone within the surrounding areas in the park. The observation was based on six Anasazi cut and dressed stones which were analyzed in some detail. Considerable additional work would be needed to confirm this; however, if proven to be generally true, then the implication is that the Anasazi practiced some form of critical selection in gathering their building materials. Curiously, the sandstone specimens we examined are chemically more durable than the general sandstone to be found at Mesa Verde, particularly with respect to environmental chemistry; however, other criteria may have been used which effectively yielded the same result. The purpose of this paper is to advance one hypothesis regarding how such selection may have been practiced.

Introduction

The sandstones of Mesa Verde, within the vast spectrum of sandstones in general, exhibit a fairly narrow range of structural and chemical variation. As nearly all sandstones throughout the western United States, they consist basically of sedimentary quartz grains with minority grains of calcite and transition metal oxides. The original bonding phase was primarily calcium carbonate, with varying subsidiary amounts of other carbonates, such as those of magnesium and iron. However, over geological time this initial bonding dissolved gradually with the percolation of ground water through the porous sandstone strata. This process partially replaced...
the initial bonding material with quartz precipitated onto existing quartz grain surfaces. This euhedral overgrowth eventually led to significant impingement of the grains, establishing a relatively rigid matrix of interlocking intergranular links. The current state of Mesa Verde region sandstones is that they consist of a fairly high percentage of open porosity and varying amounts of quartz and residual carbonate bonding. It is this varying composition of the bonding phase that accounts for the variability in the sensitivity of the masonry units undergoing chemical and mechanical erosion and weathering. Quartz in the bonding phase is intrinsically more durable in acidic water than calcite, which is much more readily soluble and can decompose to lime and carbon dioxide gas.

**Hypothesis of Anasazi Criteria**

Sandstones containing the greatest fraction of quartz bonding exhibit the most porosity, but they are also the most brittle. That is, stress and strain energy in quartz is stored almost entirely as elastic energy—there is a little "give" in the system. This means that failure of the bonding is catastrophic, where cracks initiate and grow without any prior damage. On the other hand, calcite itself is not brittle, but possesses some of the characteristics of metals in that it suffers significant plastic (or permanent) deformation before it ultimately fails. This distinction in a microscopic chemical property thus gives rise to differences in a macroscopic mechanical property, the fracture behavior of the sandstone. For example, a hammer blow to a sandstone containing relatively more calcite bonding and relatively less quartz bonding would typically exhibit some degree of crushing or denting prior to fracturing. A stone of mostly quartz bonding breaks more cleanly. It can be deduced from this that the energy exerted in quartz bonded stone would go almost entirely into fracturing, while a significant amount of the energy would be absorbed in plastic deformation in calcite bonded stone. This is the basis of the present hypothesis.

It is clear that the Anasazi spent some effort and time in shaping and dressing their masonry, at least in the later period cliff dwelling construction. They likely used striking instruments, such as hammers, to split stones into rough orthogonal blocks, and then pecked the outer surfaces, giving the blocks a mottled appearance. The purpose of the pecked surface is not obvious, although it may have been done for aesthetic reasons. In any case, it seems likely that for a task which involved expending such effort, the Anasazi would have selected stones that were simply easier to work with, if they had the choice. The working of brittle stones would have proved to be most efficient and would naturally therefore become the preference of experienced masons.

In summary, preliminary observations suggest that the Anasazi were aware of the variation in mechanical workability characteristics of the sandstones in their immediate environment, and, therefore, selected their building materials accordingly. However, this raises further questions as to how far these people were willing to carry stones from quarry regions to construction locations. There may have been specific quarry strata, or it is also possible that they were always able to find what they needed in the close vicinity of a dwelling site. There is a need for a detailed survey of the variation in sandstone compositions in Mesa Verde National Park and other concentrations of Anasazi dwellings in order to further elaborate this line of thinking. Visual inspection of cliffs around major ruins at Mesa Verde suggests that significant variations in compositions are possible within only tens of meters in some locations. This implies that the Anasazi could certainly have afforded to be selective. The end result of such selection of masonry units on the basis of efficiency in mechanical properties would be greater resistance to chemical deterioration than the "average" stone in much of the surrounding strata. This was precisely the case for the Anasazi selected and dressed stones used in test walls for the 1984-1988 acid rain study.
IMPACTS OF MICROCLIMATE AND AIR QUALITY ON SANDSTONE MASONRY OF ANASAZI DWELLING RUINS AT MESA VERDE NATIONAL PARK

Donald A. Dolske, William T. Petuskey, and David A. Richardson

Abstract

The Anasazi cliff dwelling ruins in the Four Corners region have been exposed for ca. 750 years to an environment which has been largely unaffected by human activity. However, in very recent years the rapidly increasing public visitation of cultural sites in the area, the construction and operation of large industrial facilities such as power plants and smelters, and a rapid regional population growth have changed this situation. Local air chemistry and microclimatic conditions may be changing sufficiently so as to affect the rate and type of deterioration of the masonry of the ruins. Airborne pollutant concentrations and local microclimate variations, as well as the rate of sandstone masonry deterioration, were monitored at Mesa Verde National Park from 1984 to 1988. The details of mechanisms by which pollutants, especially acid deposition, can cause acceleration of natural erosion processes were investigated. Although the magnitude of pollutant concentrations in the Southwest is low relative to the levels of northeastern North America, the relatively sudden recent changes could potentially lead to alteration in the structural and chemical integrity of the archaeological materials. The presence of moisture at the stone masonry surface is known to largely control the deposition of airborne pollutants. Precipitation and condensation on exposed surfaces thus increase susceptibility to pollution enhanced deterioration. Present rates of erosion of sandstone surfaces in cliff dwelling walls were found to be not different from inferred long term rates of surface recession. Walls exposed to moisture input by precipitation, however, are eroding much more rapidly than sites protected from direct precipitation.
Project Objectives

The initiation of this project in the mid-1980s occurred at an opportune time with respect to the current state of knowledge of the effects of acid precipitation in the Four Corners region. The past decades have been a period of abrupt changes in the environment surrounding Mesa Verde, due to population growth and industrialization. Although the magnitude of pollutant concentrations at Mesa Verde remains low relative to the levels experienced in northeastern North America, the relatively sudden changes could potentially lead to significant alteration in the structural and chemical makeup of the archaeological materials (specifically, sandstone masonry) exposed to the outdoor environment. There were two primary objectives of this research. The first objective was documentation of the present status of sandstone masonry with respect to weathering and possible deterioration. The second was determination of the potential effects of anthropogenic pollution upon the archaeological resources. To accomplish these objectives, gaseous and particulate pollutant concentrations and local climate variables were measured at the Spruce Tree House ruin at Mesa Verde National Park, Colorado, from 1984 through 1988. Two test walls, closely resembling nearby Anasazi structures, were constructed of sandstone specimens typical of the masonry units found at Mesa Verde. The surface erosion rates of stones were measured and the stone compositions were studied intensively without danger of disturbing the archaeological integrity of the actual ruins.

Technical Approach

The monitoring design was selected to facilitate a program of coordinated non-destructive materials deterioration monitoring and highly detailed environmental characterization measurements at one location. The site was selected as typical of environmental exposures of the nearly 600 ruins within the park. Spruce Tree House cliff dwelling ruin is located very near Mesa Verde park headquarters, in a rather shallow canyon head, typically piñon-juniper forested. Sandstone deterioration, measured as surface erosion, was investigated with respect to: 1) pollutant chemical constituents of the atmosphere (primarily sulfate and nitrate), 2) microclimate variables such as temperature and relative humidity, and 3) parameters of wind and water erosion.

The overall approach was to periodically assess any chemical and microstructural changes in the sandstone masonry and to measure the rate of physical surface erosion. A monitoring system was devised based on microphotography of stone surfaces and the chemical and microstructural analyses of specimens collected at regular intervals. This information was then compared by multivariate statistical methods to variations in the air chemistry and local meteorological conditions to search for any significant correlations. The environmental monitoring system was therefore designed to provide information consistent with the postulated mechanisms of sandstone weathering.

The sandstone masonry used by the Anasazi is generally thought to have originated from nearby cliffs, from which portions have spalled off due to the expansion and cracking forces associated with salts which percolate from behind the surface. Blocks scavenged from these rockfalls were shaped, dressed, and used by the Anasazi to construct the dwellings. Such stone blocks, selected in consultation with National Park Service archaeological personnel, were used to construct two test walls used for deterioration monitoring. These test blocks were taken from rubble left by crews who reconstructed and stabilized the existing ruins earlier this century. Generally, the blocks had lost their context with respect to any existing ruins and therefore were of small archaeological value. The selection criterion was that each stone should have an exposed and well-weathered surface which was reasonably flat for photographic inspection. A series of five stones was selected for each test wall. One wall is located on a rock ledge fully exposed to the elements and was near the environmental monitoring station. Twenty-five meters to the
north, the second site is located at the extreme
down-canyon side of Spruce Tree House, under
the protection of the alcove. The rate of surface
recession was measured by periodically
examining selected sandstone surfaces. By
comparing photographs taken at monthly
intervals, it was possible to determine when
each surface grain lost disappeared from the
surface. The very narrow distribution of sizes of
grains in these stones then allowed an average
recession rate to be calculated for each block.
Microstructural and microchemical alterations in
the bonding phase were observed using optical
and electron probing techniques. The two test
walls remain intact and could potentially be
used in future research. Sapphire positional
reference studs are embedded in the test wall
blocks.

The environmental monitoring system was
designed to provide adequate temporary
resolution for the observation of features in any
atmospheric input that may influence the
postulated mechanism of accelerated sandstone
deterioration. It is important to note that while
the sandstone deterioration measurements were
taken monthly, the environmental data are of
much finer temporal resolution. This was done
to allow the observation of effects due not only
to long term means of environmental
parameters, but also due to extremes and the
ranges of variations. Environmental parameters
were measured at Spruce Tree House. An active
air sampling system was also located at the base
of the meteorological tower. A four state series-
filtration system collected particulate and
gaseous pollutants.

**Results**

Deterioration of the stone was found to
occur through a combination of chemical and
mechanical processes which weaken the
materials which bond together the individual
quartz grains that comprise the bulk of the
sandstone. Consequently, those sandstones
which consist mostly of calcareous bonding
might be thought of as most susceptible to
chemical attack by pollutants and environmental
acids. Those sandstones consisting mostly of
authigenic quartz bonding would at the same
time appear to be chemically resistant to acids
and bases. This would then be reflected as
greater rates of deterioration for calcite bonded
sandstones. However, the results of this study
show that erosion of the calcite bonded materials
was no faster, and in some cases was slower,
than for the quartz bonded materials. The
explanation appears to be related to the
microstructural natures of the sandstones,
particularly to the amount of bonding. This is
explained in the following description of surface
recessions, microstructures, and chemistries of
several sandstone samples.

The total cumulative recession (over a
period of 33 months) for five sandstone samples
located in the exposed location are the basis for
discussion. Virtually no recession was observed
for the corresponding sandstone samples located
in the protected site, within the alcove. The
erosion of these stones occurred by an
incremental removal of the quartz grains from
the sandstone surface. Three different recession
patterns were seen. At intermediate rates, the
recession of sandstone blocks designated P2,
RH3, and ST4 are clustered together at a 33
month total of about 1.1 μm. This corresponds
to an average annual rate of about .40 μm per
year. What is significant about this result is that
these stones have significantly different
compositions. Sandstones P2 and RH3 have
carbonate contents on the order of 10 percent by
weight, whereas sandstone ST4 contains only
about 1 to 2 percent. If acid attack were a major
factor, the erosion of P2 and RH3 would be
much greater than that of ST4, which is not as
acid susceptible. Since the erosion rates are
similar, it must be concluded that acid attack
does not significantly accelerate erosion over
those mechanisms more solely dependent on
mechanical factors.

The conclusion is further supported after
examining the recession rates of the two other
sandstones studied. Sandstone F5 is quite
similar to sandstone ST4 in that it contains very
little calcite bonding, to the extent that quartz
bonding is predominant. Its overall recession is
nearly 50 percent higher, corresponding to an
annual average rate of .55 μm per year. At the
other extreme, the slowest recession rate of all samples corresponds to sandstone 820-1 which receded only .040 microns over the 33 month period. This is an average annual rate of about .015 μm per year. Unlike the other sandstones, 820-1 consists of high degrees of both calcite and quartz bonding. The porosity is also very low, being less than 5 percent. Expressed as a total erosion over some 750 years, these totals are consistent with the observed "softening" of surface details in the actual ruins, where original surface dressing, or "pecking" marks, are often still visible.

The relative content of calcium effectively did not change over the period of the study, whereas the iron exhibited a very slow decrease. It is speculated that the decrease in iron is due to the dissolution of limonite, which has a somewhat higher water solubility than calcium carbonate. The reason for the corresponding increase in the loss-on-ignition is unclear, however, it is speculated that the slow decomposition of iron oxide based phases is concurrent with the formation of such iron hydroxides as limonite. Upon subsequent heating, the water release appears as an increase in the loss-on-ignition. In any event, the chemical changes seem to be minor. Those associated with iron would appear to be more characteristic of normal weathering processes than of what might be attributed to accelerated attack by acidic water.

Some of the erosion producing physical factors show markedly consistent long term patterns. Air temperature is an example of such a factor. Temperature may have direct and/or indirect effects on the erosion rate through its influence on chemical reaction rates, wetting and drying cycles, stone temperature variations, expansion and contraction effects, and perhaps most importantly, freeze thaw cycles of moisture present in and on the sandstone. In any case, these temperature cycles seem to be produced from year to year with a remarkable degree of consistency. In the annual cycle of daily maximum and minimum temperature, for example, the progression of the seasons is obvious and rather consistent. It is also possible to derive from this data other types of annual cycles, corresponding to hypothesized direct or indirect effects on the erosion process. The number of freeze thaw cycles per day or week is easily computed from the observations of the hourly temperature. For the purposes of statistical process, temperature cycles represent "input signals" with periodicity (or frequency) of one year and reasonably repeatable amplitude (height or intensity). For other parameters, however, a smooth and repeatable annual pattern is not as immediately apparent. There is a slight tendency for more frequent lower RH values during the summer period. Thus, the annual cycle of differences between the maximum and minimum RH shows only a slight tendency for a greater range in daily RH changes during the summer period. An important aspect of interpretation of the environmental input signals to be considered in the erosion rate study is determination of the relative importance of each signal. That is, interpretation of the data must involve a characterization and generalization of trends in annual cycles and shorter term departures from longer term averages.

As compared to the rather smoothly varying temperature cycle, the annual nitrate concentration cycle consists of relatively constant values throughout the year, except for late summer when a distinct "peak" is apparent. Thus, nitrate nitrogen, if the hypothesized mechanism of sandstone erosion is valid, might provide an input signal for accelerated erosion of an episodic nature, recurring periodically at annual intervals. The time series history for sulfur dioxide gas concentration at the Spruce Tree House ruin site represents another type of variability. In this case, there is an even greater degree of variation and no significant annual trend, with the exception of a slight tendency for a minimum in early spring each year. The most outstanding feature to note in the sulfur dioxide data is large and persistent episodes of high concentrations. By persistent, it is meant that values higher than (or lower than) the long term average appear for several sequential weeks. This defines yet another distinct type of input signal, one lacking a regular periodic component, but rather having a dominant
episodic characteristic. The microclimatological and air and precipitation chemistry data base consists of time histories of measurements conducted at the site near Spruce Tree House over a period of three years.

Each of the monitored parameters of environmental conditions was measured over the minimum time scale feasible, using practical and reliable methods. These time series data represent directly measured "input signals" for the process of sandstone erosion, as described above. Other input signals, which may vary in periodicity and amplitude from the actual measured signals, can be derived from the data through mathematical (e.g., calculating daily ranges in temperatures of RH) or statistical (e.g., determining mean values or extremes, or quantifying departures from long term averages) manipulation of the data. Further, physical and chemical modeling can be used to combine effects of several variables into a separate parameter. An example of this would be relating temperature, wind, and surface moisture data to measured air concentrations of a pollutant and to an estimated deposition rate. All of these techniques provide an overall information base regarding the environmental exposure of the masonry units in the ruins (and test walls).

Discussion

Microstructural analyses show that principally the bonding phases disappear noticeably only at the outermost surface layer of grains. Although some chemical changes must be occurring within the bulk of the stone, the most drastic occur in areas immediately exposed to the environment. This explains in one sense why general changes in composition were minor for the overall sample. The proportion of material exposed to the surface is small relative to the overall quantity found within the bulk. The materials analysis data and environmental characterization data serve as the basis for detailed investigations of the erosion process. The sandstones examined in this investigation are, by virtue of their composition and structure, susceptible to chemical attack by environmental acids and airborne pollutants. However, no clear evidence was found which indicated significant chemical attack due to acid precipitation. For the time period of this study, the environment did not seem to be sufficiently wet or acidic to accelerate sandstone deterioration beyond what appears to be a natural erosion process. This conclusion was based on the observations that 1) sandstones consisting of bonding phases resistant to acidic attack eroded as fast, if not faster, than sandstones consisting of acid susceptible bonding phases and 2) measured erosion in 1984 through 1988 was consistent with the observed overall erosion of surface detail for the entire 750 year existence of the structures.

This is not to say, however, that acid precipitation and air pollution cannot become a serious problem at Mesa Verde. Significant changes in the environmental chemistry would upset the chemical integrity of these stones, to the point that pollution would be a major factor. Consequently, this study provides a baseline of information for future comparison of environment and materials interactions in future circumstances. This study focused on test specimens located near one cliff dwelling in one canyon at one park. It should be borne in mind that this was a relatively protected location compared to some other ruin sites, even within Mesa Verde. Excessive weathering of sandstones on mesa top sites has been reported by National Park Service personnel. Because those sites are more openly exposed to the weathering elements, acid deposition may have a more directly deleterious impact. Sandstone deterioration also appears to be most significant at the bases of some ruins walls. This is due to constant dampness caused by capillary action of ground water. In this case, absorption of acidic components from the atmosphere could accelerate chemical erosion. While these phenomena were not within the scope of this project and are therefore unsubstantiated by experimental results, it is clear that other problem areas exist, which may be exacerbated by changing environmental conditions.
Acknowledgments

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THE RESIDENCE UNIT IN ANASAZI AND PUEBLO HISTORY

Arthur H. Rohn

Abstract

The concept of the unit-type pueblo, and later the residence unit, has enjoyed a long period of acceptance among students of the Southwest, despite several serious challenges to its workability. When defined as bounded residential space(s) with associated storage and work facilities, occasional ceremonial space, and refuse dump, this residence unit appears to represent the habitation space for a unit of Puebloan social organization—the descent group and/or lineage segment. During the two Basketmaker stages (ca. 700 B.C. to A.D. 750), this unit consisted of a pithouse with nearby storage cists and granaries, outdoor work spaces including ramadas and the pithouse roof, and sheet trash scattered to the south. During the Pueblo I and II stages (A.D. 750 to 1100), the pithouse or protokiva was accompanied by above ground jacal or masonry blocks of living and storage rooms. The pit structure roof provided much of the outdoor workspace, and refuse was piled in a heap to the south. From A.D. 1050 to 1250 these same units tended to be built against one another forming the great pueblos of Pueblo III. By the late 1200s, newly built kivas tended to lack association with nearby roomblocks. During Pueblo IV (1300 to 1540), kivas rarely appear in room clusters, but there is some suggestion for small dance plazas instead. Throughout most of this history into the very late 1200s, the segments of the residence unit followed a favored orientation from the storage and living quarters on the north through the outdoor workspace and pit structure to the refuse on the south. The historic western Pueblos still retain a lineage or clan organizational level, although no longer clearly identified with the clustered residences. I suspect the intense pressures of Spanish colonial and church policies, enforcing Spanish social customs including patriliney, have nearly obliterated such traditional descent groupings among the eastern Pueblos.
Human groups define and arrange their space according to the dictates of their social system and their values. Consequently, archaeologists can often interpret aspects of social organization from observed patterns in the layout of architectural structures and features. I propose to trace the evolution of only one unit of architecture—the residence unit (derived from the "unit-type pueblo")—through Anasazi and Pueblo history as a reflection of social change.

Unit Pueblo Concepts

The concept of a "unit-type pueblo" was first expounded by T. Mitchell Prudden (1903, 1914, 1918) in the early 1900s during his surveys and excavations on Cañone Mesa, Colorado. He described a block of surface masonry-walled rooms situated to the north of a subterranean kiva with a rubbish mound lying toward the south. Since that time many southwestern archaeologists such as Kidder (1924), McGregor (1941, 1965), and Cordell (1984:239-240) have utilized this concept to describe Anasazi ruins of Pueblo II and Pueblo III age. In fact Pueblo II settlement pattern is often referred to as typified by the unit pueblo.

During the surge of "New Archaeology," the utility of a unit pueblo concept has occasionally been challenged (Gorman and Childs 1980). Unfortunately, the challengers only analyzed the concept in terms of static and mechanical attributes rather than for the humanistic implications and meanings attached to the unit pueblo.

Definition

The key to Prudden's original idea lies in the blend of three different components: a block of rooms, a subterranean kiva, and a rubbish heap. These three components were arranged along an axis from north to south. Absence of either the kiva or the rubbish heap does not automatically destroy the concept. Recognizing this basic concept for earlier times, Bullard (1962:110ff.) referred to pre-A.D. 900 pithouses with associated storage and living features as "habitation units." Both these concepts lie behind the designation of "courtyard units" in Mug House (Rohn 1971) and in Tsegi Phase sites (Dean 1969) in the thirteenth century.

To encompass all these cases, I propose to modify the unit pueblo concept to one of a "residence unit." Rather than focus on the various architectural attributes themselves, my definition emphasizes the implications (symbolism) and meaning inherent in the attributes.

The first and most important implication in this concept is the idea of a unit of residence symbolized by a block of rooms or by a pithouse. Living people constructed the buildings and arranged the spaces within culturally defined parameters.

A second implication recognizes different functions such as living and sleeping, storage, work space, refuse dumping, and ceremonial activities. All seem to be present in virtually all of the residence units, because they represent joint activities of the inhabitants of the unit. Regardless of how the architecture is configured, various features reflect the practice of all of these functions. Living and sleeping needs may be served by semisubterranean pithouses or by pithouse. Foodstuffs may have been stored in separate granaries, in attached rooms, or in enclosed storage cists. Various work activities could be conducted within living spaces, beneath shaded ramadas or porticos, atop the roofs of structures, or in open courtyard space. Refuse may have been scattered or dumped in piles to one side or in nearby depressions. Ceremonial activities may have taken place in an enclosed pithouse or kiva, on a specially designated plaza, or in open courtyard space.

A third implication lies in the arrangement of the various components within a residence unit. In Puebloan architecture, these components lie along an axis running from storage on the north through living and sleeping space, work space, and ceremonial space to refuse dumping on the south. Such a linear disposition persists even when external (environmental) factors skew the directional orientation.
Finally, the consistent replication of residence units provides yet another implication. At any given time, residence units generally look alike. In fact the residence unit undergoes a definite evolution in attributes through time. Also, residence units may stand alone, either as distinct units within a community or as relatively isolated hamlets, or they may abut one another (sharing common walls) to form quite large buildings. In other words, the residence unit forms both the basic unit of settlement (reflecting the social system) and a functional unit of architecture.

**Chronological Development**

With this definition in hand, we can trace the evolution of the residence unit through the time scale of Anasazi prehistory and history.

**Basketmaker and Modified Basketmaker.** During the two earliest stages of Anasazi prehistory—Basketmaker and Modified Basketmaker (ca. 700 B.C. through A.D. 750)—the residence unit focused around the pithouse (Kane and Gross 1986; Morris and Burgh 1954; Wheat 1955). This semisubterranean structure provided the primary living space and some storage for its occupants. To the north a series of storage cists or granaries augmented the interior storage features; outdoor workspace, including hearths and food processing features, surrounded the pithouse on its southern half; sheet refuse splayed out further to the south (Figure 1).

Several modifications on this pattern became manifest by the 600s in Modified Basketmaker. The northern granaries were often arranged in an arc. A series of ramadas (roofed spaces without walls) provided shaded outdoor workspace for cooking and food preparation along the south side of the granaries (Kane and Gross 1986; Rohn 1975). The pithouse roof became an important outside workspace (metates commonly are found on top of collapsed roof fall in Modified Basketmaker houses). The area immediately south of the pithouse was kept clear of trash that was scattered further to the south.

**Pueblo I.** Several dramatic changes occurred during the 700s with the transition into the Pueblo I stage. The former row of granaries and ramadas had been consolidated into an arc of contiguous living and storage rooms, with the
smaller storage rooms lining the north side of the arc. The living rooms contain hearths. One or two storage rooms open through the north wall for each living room, while an outdoor workspace (often roofed in portico style) abuts the exterior of the living room’s south wall. This combination of living room with attached storage rooms and adjacent outdoor workspace constitutes a suite (Rohn 1971) most probably inhabited by a single household. This suite makes its first appearance during Pueblo I (Varien and Lightfoot 1989).

Pithouses are now fully subterranean, and their roofs provide an extension of the outdoor workspaces in front of the living rooms (Figure 2). Undoubtedly many domestic activities still took place inside these pithouses. However, there seems to have been a significant shift of many more domestic activities to the above ground structures, together with the subdivision of the residence unit into two or more “household” suites. I am inclined to speculate that this series of changes marks the beginnings of lineages among the Anasazi, which later became formalized into clans.

Two other changes may be seen in the residence units of Pueblo I. Many of the individual residence units are arranged into contiguous rows forming large interconnected settlement groupings (Brew 1946; Brisbin et al. 1988; Gladwin 1945; Hayes and Lancaster 1975; Lipe et al. 1988; Morris 1939; Roberts 1931). At several of these larger settlements, communal refuse heaps may be found toward the south (Rohn 1977:270-273).

**Pueblo II.** The pace of change continued throughout the Pueblo II stage (A.D. 900 to 1050-1100). The earlier sandstone slab and jacal walls were replaced by stone masonry, although the layout of the residence unit remained basically the same and the orientation still faced south (Figure 3). The transfer of domestic activities to surface rooms triggered the use of the term “kiva” for the onetime pithouse, although most archaeologists tend to believe the kiva still housed a number of secular functions. In many parts of Anasaziland, the unattached unit pueblo became most typical of Pueblo II settlement with clusters of unit pueblos forming sometimes quite extensive communities (Rohn 1977). However, the Pueblo I pattern of contiguous units arranged

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**Figure 2.** Pueblo I residence unit at the Duckfoot Site, Colorado (after Varien and Lightfoot 1989).
in arcs of rows continued in use into Pueblo II in the Chaco Canyon where several such settlements apparently formed nuclei for many of the later large sites (Lekson 1984). Presumably (although it has not been adequately delineated) each unit pueblo contained one or more “household” suites sharing a single kiva and a common trash dump.

**Pueblo III.** By A.D. 1050, residence units were being built against one another in rows and even piled on top of one another to form multi-unit and multi-storied pueblos that became the hallmark of the Pueblo III stage (Dean 1969; Ferguson and Rohn 1987; Lister and Lister 1981). Each residence unit contained two or more “household” suites (Dean 1969; Rohn 1965, 1971) sharing the courtyard space formed by the roof of a partially enclosed kiva and the kiva itself (Figure 4). Whatever domestic functions the kiva possessed were apparently also shared.

In the 1200s, a new trend began in many northern San Juan settlements. New kivas were frequently built separately from domestic roomblocks (Bradley 1991; Rohn 1971). Perhaps their ceremonial functions were becoming more the responsibility of specialized kiva societies rather than of the lineage segment they had previously served. Despite this beginning trend, virtually every residence unit continued to include a kiva prior to the extensive migrations of the late 1200s.


**Pueblo IV.** When the Anasazi again settled down after the migrations of the thirteenth century, their residence units had assumed a somewhat different character. A cluster of living and storage rooms formed the nucleus of each unit. Small dance plazas and distinctive rock art panels served ceremonial needs for most of the residence (lineage or clan) units in Pueblo IV (1300 to 1540) settlements on the Pajarito Plateau (Figure 5), while kivas occurred in only about 20 percent of these residence units (Neff 1991; Rohn 1989). At many other Pueblo IV villages, such as Hawikuh (Smith et al. 1966) and Pecos (Kidder 1958), traces of residence units seem to be missing. Either the archaeological evidence is incomplete, or the architectural layout no longer reflected lineage or clan organization at many pueblos.

**Impact of Spanish Colonization**

When the Spanish explorers entered the Southwest and contacted first the Zunis, then the Hopis and the many villages along the Rio Grande, they initiated a bout of severe changes to Puebloan life. The Spaniards established both military and political domination over all the villages. Whenever they encountered some practice that was foreign to them, such as matrilineal descent, they quickly imposed their own system. Spanish names were assigned to all persons with whom they dealt and especially to newborn children, who were then reckoned as descended from their fathers. When the Spaniards could not identify chiefs or leaders, they simply appointed their own governors, lieutenant governors, war captains, and such, and granted them authority over the Pueblos within the Spanish governance hierarchy (Simmons 1979). They even influenced the layouts of some Rio Grande pueblos to approximate the pattern of villages in Old World Spain (Jojola 1991). Yet, despite these intense pressures, the Pueblos attempted to retain their traditional patterns of governance and descent, and many succeeded to some degree.

**Social Interpretations**

Because the residence unit pervades virtually all Puebloan architecture, it most likely reflects an important aspect of Puebloan social organization. I believe the most probable candidate is the lineage or clan, more precisely the lineage segment. The early residence units during Basketmaker and Modified Basketmaker centered around the pithouse and most likely represented an extended family sharing one
primary hearth. By Pueblo I, however, the residence unit seems to have subdivided into two or more individual households, each with its own primary hearth, but sharing the pithouse and other features (spaces). I suspect this change marks the beginnings of the lineage. As settlements grew in size during Pueblo II and Pueblo III, the practice of tracing descent through the lineage caused them to grow also. However, because the residence units remained roughly constant in size during this same time, I would suggest that they became reflections of lineage segments whose lineage affiliations cannot be seen in the architectural features. When and how some or all of these lineages became clans again cannot be seen in the architecture.

The historic western Pueblos (Hopi and Zuni) still retain a lineage or clan organizational level within their social system, although it is no longer clearly identified with clustered residences (Titiev 1944). I suspect the intense pressures of Spanish colonial and church policies have nearly obliterated such traditional descent groupings among the eastern Pueblos in the Rio Grande Valley. The official Spanish policy enforced Spanish social customs, including naming, governmental structure, and strict patriline. It seems no mere coincidence that the most patrilineal and bilateral modern practices are today found among those Pueblos who suffered the most intense Spanish dominance.
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MUCH TROUBLE SOME EXPENSE NO DANGER

Irving L. Diamond

Abstract

The controversy over Gustaf Nordenskiöld and his collection, now a century old, has become a legendary story with persistent themes identifying him as a villain. The documents from which this paper is derived pinpoint from government archives precisely what Nordenskiöld did, what the American government did about it, and which members and branches of our government took various actions. Fourteen American and Swedish officials are identified; one American, a federal official acting as a citizen, is also identified. Documentary and official records of how government officials of the United States and Sweden scrutinized what Nordenskiöld had done and agreed that he could take his collection to Sweden are presented. Nordenskiöld was arrested for trespassing on the Southern Ute Indian Reservation. Because he was a “foreigner” he ought to have had a permit according to Section 2134 of U.S. Statutes. The United States District Attorney, after he was convinced by the local Indian agent to arrest Nordenskiöld and after he had an opportunity to examine the situation a bit more closely, decided that the violation was merely technical. Three members of the president’s cabinet (State, Justice, and Interior) became involved and agreed quickly to drop the prosecution. The Bureau of Indian Affairs brought the charge in the first place and expressed doubts about the final outcome, but in the end did what the secretary of the interior wanted done. Nordenskiöld found two factions among the citizens of the San Juan Valley. Apparently, Reece McCloskey (involvement is based on a spoken record subject to written confirmation) led the anti-Nordenskiöld faction. The faction on Gustaf’s side was led by B. K. Ritter, an official in the U.S. Land Office. In order for the case to be dismissed, this formula for settlement, which Nordenskiöld was to follow, appears in a letter from the Commissioner of Indian Affairs:

In reply I transmit herewith a copy of a letter this day addressed to the Agent at the Southern Ute and Jicarilla Agency instructing him to permit the Baron to retain the relics removed with the exception of any skeletons or bones that there are in the lot, which are justly claimed by Indians as the bones of their ancestors or relatives.

The local Indian agent, although he brought about the arrest, was designated to and did notify Gustaf of these terms. After the matter of the arrest was settled, Nordenskiöld received permission from Secretary of the Interior John W. Noble to travel across Navajo country to the Hopis and beyond. Gustaf Nordenskiöld subjected himself to U.S. law; he honored his bail and accepted a formula written in Washington for settlement of his case. He was not charged with any violation relating to the collection of “relics”; in 1891 no such law existed.
Introduction

Near midnight on September 17, 1891, Gustaf Nordenskiöld was arrested at the Strater Hotel in Durango, Colorado (Rocky Mountain News 1891). This paper is a view of his arrest and subsequent events, based on official documents from U.S. and Swedish archives.

The controversy over his arrest, now a century old, has become legendary with persistent themes identifying him as a villain and a looter. The documents from which this paper is derived are from government archives, both U.S. and Swedish, and pinpoint precisely why he was arrested, what happened afterwards, what the American government did about it, and which branches and members of our government took various actions. Gustaf Nordenskiöld’s own letters, most of which have been located and published very recently, give his personal insights.

Nordenskiöld, after arriving in the United States at New York on May 26, 1891 (National Archives 1891), traveled to a number of cities including Washington, D.C., Philadelphia, and Chicago. For a young man in his early twenties, Gustaf had a broad view of how he should behave on his travels in America. On his arrival he became an instant critic of New York, calling it a “terribly unpleasant and dirty city” (Nordenskiöld 1991), although he did write that “the Museum of Natural History... is beautiful and well organized” (Nordenskiöld 1991). In New Haven he met with premier scientists (Nordenskiöld 1991). While in Washington, he met with leading figures at the Geologic Survey (Nordenskiöld 1991). He also met in Washington with Baron Beck-Friis, the Secretary of the Swedish-Norwegian Legation. A few months later after Nordenskiöld got into trouble, Beck-Friis would assist him.

Near the end of June he arrived in Denver where he learned of the 1888 discoveries of large cliff dwellings at the Mesa Verde in the southwestern portion of Colorado. Before his arrival in America, Nordenskiöld had read of discoveries made in the 1870s by the Hayden Survey along the course of the Mancos River on the fringe of the Mesa Verde plateau reported in the book L’Amérique Préhistorique by the Marquis De Nadaillac which was published in 1883 (Nadaillac 1883). With the new information and an introduction to the family of Benjamin K. Wetherill, he proceeded south to Mancos for what turned into a prolonged and highly productive stay.

Nordenskiöld spent July through mid-September exploring Mesa Verde and collecting relics from several of the cliff dwellings. This work is amply described in Nordenskiöld’s “monumental” (Brew 1946:21) classic The Cliff Dwellers of the Mesa Verde (Nordenskiöld 1893).

The arrest of Nordenskiöld was based on a presumed violation of a law enacted as Statute I, Chapter 161, Section 6, on June 30, 1834 (Public Statutes at Large 1834). This old law was part of legislation which had as its title “An act to regulate trade and intercourse with Indian tribes, and to preserve peace on the frontiers.”

When federal statutes were recodified by congress in 1873-1874, the old Section 6 was retained, word for word (Benson vs. United States) but was given a new identification as Section 2134, Revised Statutes of the United States. This is what it said:

Every foreigner who shall go into the Indian country without a passport from the Department of the Interior, superintendent, agent, or sub-agent of Indian affairs, or officer of the United States commanding the nearest military post on the frontiers, or who shall remain intentionally therein after expiration of such passport shall be liable to a penalty of one thousand dollars. Every passport shall express the object of such person, the time he is allowed to remain, and the route he is to travel. (Revised Statutes 1878).

On May 21, 1934, one hundred years after it became law, Section 2134 was repealed (Congressional Record 1934).

The drama of Nordenskiöld’s arrest was played on a stage that extended from Durango to Washington to Stockholm. The scenes were acted by many levels of officials, including three members of the president’s cabinet and the Prime Minister of Sweden.
Here is a roster of the players:

**A. Durango**

Reece McCloskey told Jesse Nusbaum many years later that he was retained by a group of citizens wishing to prevent removal of Nordenskiöld’s collection to Sweden (Nusbaum 1981:7). This would have been the anti-Nordenskiöld faction. McCloskey, a lawyer, served as City Attorney of Durango and had a distinguished career in corporate law (Semi-Centennial History 1913).

Cyrus Newcomb was the United States Commissioner who heard Nordenskiöld’s case. Newcomb was described as a pioneer of Colorado, having arrived at Georgetown in 1868. He had a varied career, including the hotel business, traveling sales, mayor of Del Norte, Colorado, and revenue collector. He authored a book on mound builders in Ohio. In the annual report of the Smithsonian Institution for 1888-1889 he is reported to have discovered a petroglyph on Rock Creek, 15 miles from Del Norte (Smithsonian Institution 1893:79).

Charles Bartholomew, Indian Agent at Ignacio, persuaded District Attorney Fleming to make the arrest (Bartholomew, Agent in Colorado 1891, 1892).

B. W. Ritter, Gustaf’s principal ally, worked for the United States Land Office. Although Ritter was an employee of the government, he claimed to be acting as a citizen. His letters, described below, make it clear that he was acquainted with the scene in Washington. His letters were sent at crucial moments and may have had the effect of accelerating and determining the outcome.

Adair Wilson, a resident of Durango since 1887, served as defense attorney to Nordenskiöld. A native of Missouri, he had also lived in California and Nevada. In a 1912 obituary, the Denver Post said, “The San Juan Valley has never produced a man so well known throughout the state as Adair Wilson” (Denver Post 1912).

In several letters Nordenskiöld speaks, not in a warm and friendly tone, of Adair Wilson. Nordenskiöld mentions a one thousand dollar fine, paid by Wilson. Where he obtained this amount or what amount he had to submit to the court as bail is not explicitly known.

On October 21 Nordenskiöld writes to his father: “I got a terribly unpleasant surprise when my attorney came and asked for 100 dollars more from me. Altogether, he has gotten 250 dollars, and has done a lot less for me than my friends have. These idiotic legal proceedings in their entirety have cost me over 400 dollars, and have been of no benefit to anyone.”

From existing documents showing only brief appearances in court and the crucial role of the Ritter letter of September 19 (see below), Adair Wilson’s role was minor and procedural in nature.

George Raymond. Clerk of District Court, Durango.

**B. Denver**

John D. Fleming. The United States District Attorney spent most of his career as a teacher of law. He began as a lecturer in 1893 at the University of Colorado School of Law. He served there as Dean from 1907 until his death in 1927 (Carlin 1927).

**C. Washington, D.C.**

William F. Wharton. Acting Secretary of State.


John W. Noble. Secretary of the Interior.

George Chandler. Acting Secretary of the Interior.

T. J. Morgan. Commissioner of Indian Affairs.

R. V. Belt. Acting Commissioner of Indian Affairs.

O. P. Hubbard. Secretary to Attorney General.


Beck-Friis served as a diplomat in Paris, Berlin, and St. Petersburg (Svenska Män och Kvinnor 1942a).

D. New York


E. Stockholm

Carl Lewenhaupt. The Swedish Foreign Secretary (Svenska biografiskt lexicon 1979:109).

Erik Gustaf Boström. Prime Minister of Sweden. The contents of the letters of October 3 and October 6 from Grip to Lewenhaupt were communicated to Prime Minister Boström. The note on the letter of October 10 from Grip to Lewenhaupt indicates that the contents of this letter were communicated to “Prof. Nordenskiöld,” Gustaf’s father, but not until November 26 (Svenska Män och Kvinnor 1942b; personal communication from Folke Ludwigs, National Archives, Stockholm).

Before the Arrest

Official documents dated before September 17, 1891, relating to the arrest have not been found. We know, however, that at least one was created for the post office notice about foreigners entering an Indian reservation, which Nordenskiöld mentions in a letter home (Nordenskiöld 1991:45).

Clearly, because he was arrested, we know that Nordenskiöld had his detractors. But he was also fortunate enough to have developed as friends a group of citizens in Durango. This group, which included some of the local elite, immediately came to his aid. Actually, this local elite plus the elite strata of society to which Nordenskiöld himself belonged gave him access to high government officials in Washington and Stockholm.

From Nordenskiöld’s letters or from other sources, the identity of persons wanting him arrested, besides Indian Agent Bartholomew, is not specifically known. However a letter dated March 10, 1894 from Richard McCloud of Durango to Nordenskiöld says, “The Postmaster at Mancos, Price, who made trouble for you, is now living here at Durango” (McCloud 1894). Price was probably a leading member of the faction which complained to Indian Agent Bartholomew and would be the person responsible for the notice in the Mancos Post Office.

Reece McCloskey, a lawyer, appears to have led the anti-Nordenskiöld faction (Nusbaum 1981:7). His allegiance, however, to one side or the other may not have extended beyond his lawyer’s role as advocate. The pro-Nordenskiöld faction was led by B. K. Ritter, an official in the United States Land Office, who claimed to be acting in a private capacity.

Ritter might have been the first person outside of the Alamo Ranch to be bitten by the Mesa Verde bug. He was the first person to sign the guest register at the Alamo Ranch on June 8, 1889 (Wetherill 1891). His son, Frank, was committed to go with Nordenskiöld to the Grand Canyon, but cancelled at the last minute. According to the elder Ritter: “He [Frank] had arranged everything for it and was ready to start but when this offer came up he could not, for business considerations, let it pass” (Ritter 1891a). B. W. Ritter was also not above collecting and trading. On June 13, 1892 he sent Nordenskiöld, via registered mail, “the skull you asked for” (Ritter 1892a). It was returned “with the statement that such articles are not mailable.” Ritter then sent the skull via express (Ritter 1892b).

In the next few paragraphs of this paper, Nordenskiöld’s letters (Nordenskiöld 1991) home are used to narrate how he faced his problems with the authorities starting in mid-August when he began sending artifacts to Sweden. His initial defensive response was to obtain a passport. He got the passport from Captain Lincoln at Fort Lewis, with assurances from “an influential acquaintance in Durango” that he would be allowed to excavate if he refrained from disturbing the cliff structures. He continued his work even though the passport explicitly forbade this activity. Ritter said in his
September 19 letter, “I was assured by the agent that no objection would be made to his research” (Bartholomew 1891a; Fletcher 1979; Ritter 1891a).

The letters Nordenskiöld sent home during the last few days of August are very cheerful. He speaks about his new camera from Denver and notes that he has shipped another small crate of artifacts to Sweden.

Still operating under the assumed conditions of his passport, he went on with his work. In a letter dated September 9, he wrote to his father that on the day before he “sent off 9 packages (7 crates and 2 barrels) of Cliff dwelling collections. I addressed them to the Swedish Consulate in New York, and have written to the consul that he should send them to the Mineralogical Department of the National Museum, which is going to pay for the freight charges” (Nordenskiöld 1991:51).

By September 16 his mood switches back to apprehension. He writes that he “will be sending off a shipment of 8 crates to the Swedish Consulate in New York tomorrow (the 17th of this month). It is getting to be time to leave Mancos. An ignorant newspaper article containing expressions such as ‘vandalism,’ ‘robbery,’ and ‘must be stopped at once’ appeared soon after I had made my first shipment, which is why I prefer to get the rest of my collection to safety as soon as possible” (Nordenskiöld 1991:51).

Nordenskiöld probably attempted to ship the eight crates on September 16, but the ire of the anti-Nordenskiöld faction was reaching a peak because on the very next day, September 17, he sent his father a telegram which read, “Much trouble Some expense No danger” (Nordenskiöld 1991:53). He had probably learned that his arrest was imminent. And he was arrested on this very day.

Charles Bartholomew, the agent at the Southern Ute and Jicarilla Apache Reservations, made a request for the arrest of Nordenskiöld to John D. Fleming, the United States District Attorney for Colorado. On September 17 Fleming advised the Commissioner of Indian Affairs in Washington as follows: “Have authorized arrest and detention at Durango, Colo. of one Nordeskold [sic], alleged Swedish Baron for devastation of aztec ruins at Mancos on Southern Ute Indian reservation. He shipped care Swedish Consul New York, Sept. 9th seven boxes, two barrels relics. Had permission am informed to view not work ruins. Arrest authorized under section twenty one thirty four revised statutes. Know of no other law applicable. Would ... your advise and instructions” (Fleming 1891a).

One way to evaluate Charles Bartholomew’s charges that members of the Ute tribe complained about Nordenskiöld is to look at the reports he submitted to the Commissioner of Indian Affairs for the years 1891 and 1892. These reports have a format, typical of other years of this period, which included a census, condition of livestock, an enumeration of police related events, and separate sections on the Southern Utes and Jicarilla Apaches. The report for 1891 is dated September 21 and begins a paragraph which relates the murder of a medicine man with this: “The year has been barren of notable events.” At a moment, then, when Nordenskiöld’s fate was not yet determined, his arrest at the Indian Agent’s insistence is not considered “notable” (Bartholomew, Agent in Colorado 1891).

One year later, less a few days, on September 12, 1892, Bartholomew submitted his next annual report. As usual it repeats certain material such as tribal use of native and Anglo clothing. It has sections on “intoxicants,” agriculture, crops, etc. This report contains no mention of police activities and not a hint of the Nordenskiöld affair of the previous year. Of course, since Bartholomew’s action was reversed by higher authority, he probably didn’t want to remind anyone about it so long after the event (Bartholomew, Agent in Colorado 1892).

**After the Arrest**

Two days after the arrest, on September 19, B. W. Ritter sent to Washington the single most important letter (Ritter 1891a) concerning this entire affair. For all practical purposes the outcome of exoneration for Nordenskiöld resulted directly from this letter.

Ritter directed his letter to O. P. Hubbard, secretary to the Attorney General of the United
States. This letter was a lengthy *apologia* for Nordenskiöld. One paragraph reads:

It does look hard that unscientific vandals both native and foreign should be permitted to efface and destroy and they have done that when an enthusiastic man who has some learning and preparation in such matters comes and does not even throw down a single stone but prosecutes his investigations intelligently and for a scientific purpose, we should arrest and hound him with every annoyance.

Just who were the “vandals both native and foreign” Ritter had in mind? This question, highly intriguing as it is, demands an entirely new research project.

O. P. Hubbard, Ritter’s friend in Washington and the recipient of this letter, gave it to the Attorney General. Ritter, then, went over the head of District Attorney Fleming to Fleming’s superior. Ritter also went over his own superior, the Secretary of the Interior. Such action discloses Ritter to have been a brave bureaucrat.

Also on September 19, Indian Agent Bartholomew writes to the Commissioner of Indian Affairs outlining the situation thusly: “I have the honor to report the arrest of a man claiming to be Baron Nordenskjöld [sic] of Stockholm, Sweden, for removing and shipping relics from the homes of the ancient cliff dwellers on this reservation without permission and contrary to his express promise... Holographic action in this matter may meet your approval and that such action will result in return of the relics to their proper resting place” (Bartholomew 1891a).

The Swedish authorities promptly agreed to hold shipments bound for Sweden (Woxen 1891a). That part of the collection not yet shipped was placed in a cellar in Durango (Nusbaum 1981:7).

On September 25 the Ritter letter has its intended effect, blunting the attack of the anti-Nordenskiöld faction when the Attorney General forwards it to the Secretary of the Interior, over the heads of the local Indian Agent and of the Commissioner of Indian Affairs, with this suggestion which he will also send to District Attorney Fleming: “Proceed with utmost caution in this matter and unless there are better grounds “such prosecution should be abandoned” (Miller 1891a).

On September 29 the exoneration of Nordenskiöld is assured by a letter from the Secretary of the Interior to the Attorney General wherein Interior offers to Justice a formula proposed by the Commissioner of Indian Affairs "that a *nolle prosequi* be entered in the case" (Noble 1891). This term has the following definition: An entry on the record of a legal action denoting that the prosecutor or plaintiff will proceed no further in his action or suit either as a whole or as to some count or as to one or more of several defendants (Webster’s 1984).

R. V. Belt, Acting Commissioner of Indian Affairs, was the person who sent the message on October 2 to “the Agent of the Southern Ute and Jicarilla Agency,” Charles Bartholomew, that would finally ground the attack on Nordenskiöld.

Belt reviewed the case and noted several pieces of correspondence between various government agencies. Here are some excerpts from this letter:

... a telegram had been received from the United States Minister at Stockholm, stating that the Baron is an explorer and is a son of the Swedish Arctic explorer, and of excellent repute in Sweden...

The relics secured consisted of mummies, pieces of pottery, some stone and bone tools and such like things. Of such things there are wagon loads there and in this country. He desired them however for comparison with other like relics and to complete his notes and surveys and to help throw what light might be thrown upon the subject.

This office recommended in said report that under the circumstances, the Attorney General be requested to take steps to secure entry of a *nolle prosequi* in
the case against the Baron, but that this office should not recede from its demand for the surrender of the relics.

I am now in receipt, by Department reference, of a letter from the Attorney General, dated the 25th ultimo, enclosing a copy of a letter dated Durango, Col., the 19th ultimo, from B. W. Ritter, Esq . . . .

Under all the circumstances, and as the relics taken seem to be but of little consequence and as there is an abundance of the same still to be had on the reservation, and noting the fact that the Baron did not deface any of the ruins, I have concluded to permit him to keep the relics with the exception of such skeletons or bones, if any, as may be in the lot, which are justly claimed by Indians as the bones of their ancestors.

(Belt 1891)

Acting Commissioner Belt’s comment that “the relics taken seem to be but of little consequence and as there is an abundance of the same still to be had on the reservation,” even “wagon loads” portrays an unfortunate attitude in Washington especially since most artifacts available on the surface had probably been removed. Neither Belt nor anyone else could have known what more could be excavated.

Gustaf Nordensköld would, after a perfunctory court appearance on October 5, be a free man. After a brief interval he would also be granted freedom to take his collection home.

The formula imposed on Nordensköld, communicated to him by Bartholomew, which would “require him to restore to you [Bartholomew] the bones claimed by Indians as those of their relatives or ancestors” resonates with the current issue of repatriation of Native American remains.

The letter of October 8, 1891, from District Attorney Fleming to the Attorney General (Fleming 1891b), considering the importance of these two offices in the American government, can be considered the “official” position of the United States as to the outcome of the Nordensköld affair. This letter includes the following:

I found upon inquiry into the case that the offense of Nordensköld was at best a technical one. He did, in fact, being a foreigner, go upon the Southern Ute Indian Reservation without a passport, in contravention of the letter of the statute (Section 2134 Rev. Stat.) but he only made a detour [sic] upon the reservation, with his guides, in order to get to a side cañon of the Mancos river, in which side cañon he made his explorations and dug his relics, at a point about four miles from the reservation line, and off and not on the reservation itself.

... The trouble arose from the Ute Indians (incited thereto by unknown persons) complaining to the Indian agent at Ignacio that some persons, presumably the foreigner and his men, were despoiling the Ute Indian graves on what is known as the Mesa Verde on the reservation . . . .

Referring to that portion of the letter of the Commissioner of Indian Affairs to Honorable Secretary of the Interior (copy sent to me) in which, while requesting that proceedings against Nordensköld be dismissed, he yet considers that his office should not recede from its demand for the surrender of the relics in question. I presume the Commissioner was still of the opinion that the relics were taken from the reservation; which, as stated, fuller inquiry does not show to be the case. They were dug up from public land, undoubtedly, but not from the reservation.

Here, Fleming introduces the idea to Washington that Nordensköld didn’t make his collection on the reservation after all. In this letter Fleming refers to the “foreigner and his men,” but the name of Wetherill, the family Nordensköld hired (Wetherill 1891), is never
mentioned in any of these letters from the National Archives in Washington or Stockholm. In Nordenskiöld’s own letters the Wetherills are never mentioned during the period of the arrest.

**Did Nordenskiöld Trespass?**

Yes, he did and no, he didn’t. Were the relics “undoubtedly” dug up from public land as Fleming reported to the Attorney General? Nordenskiöld said on September 27 in a telegram to the Swedish Legation: “have been in neighborhood of Mancos since July 2nd for scientific investigation; some times crossing the Indian reservation” (Nordenskiöld 1891a). On September 29 he sent a telegram to the Legation which said, “The relics I have collected are not from Ute reservation; am advised that I have violated no law as I had permit from military commander; and that district attorney here would dismiss case if directed by Indian department; could you secure such directions and save me vexatious delay and expenses” (Nordenskiöld 1891b). Of course, by the time these telegrams were sent, the issue had been resolved except for his appearance in court. Nevertheless, Nordenskiöld expresses his conviction again that the relics were not from the reservation.

Ritter, on September 19, thought he had trespassed: “Soon after coming here, Nordenskiöld’s [sic] attention was called to the fact that the major portion of these ruins were upon the Ute Indian reservation and also to sec. 2134 R.S.U.S. regulating the visits of foreigners to Indian reservations” (Ritter 1891a).

However, on October 8 Ritter put it this way: “At hearing [on October 5] of Nordenskiöld, the Swede, proof showed relics not gotten from any Indian Reservation. Nordenskiöld discharged. Letter, indorsed [sic] by Fleming, District Attorney, mailed you Tuesday. Indian Commissioner has claimed surrender of relics from Swedish Consul, New York. I think government will make no claim when letter & report of District Attorney are received. Could New York Consul retain goods until then? Have him so instructed. Answer my expense” (Ritter 1891b).

On October 12 a letter from the Attorney General forwarding a copy of Fleming’s October 8 letter to T. J. Morgan, Commissioner of Indian Affairs, read: “the relics . . . not obtained from reservation” (Miller 1891c). Almost everyone was now of the opinion that Nordenskiöld conducted his work outside the reservation boundaries.

The definitive answer to the question “did Nordenskiöld trespass?” requires knowledge of the exact boundary of the Southern Ute Indian Reservation through the Mesa Verde between Soda Canyon and Rock Canyon in 1891. In *The Cliff Dwellers of the Mesa Verde* Nordenskiöld says, “Somewhere near the mouth of Webber [sic] Cañon runs the northern boundary of the Ute Reservation, though the spot is not fixed by any boundary mark” (Nordenskiöld 1893:3). This spot is located within an eighth of a mile from the northern boundary shown on maps since the 1880s. The boundary was established fifteen miles north of the Colorado-New Mexico state line by an agreement of 1880 between the tribe and the government. *The Cliff Dwellers of the Mesa Verde* contains maps of “Wetherill’s [sic] Mesa” and “Chapin’s [sic] Mesa” which locate Nordenskiöld’s camp sites and most, if not all, the ruins which he explored and excavated. Superimposing the established boundary on these maps places all of his camping and excavation areas within the reservation.

However, one should not assume that this boundary line was not changed or shifted by an arrangement which might affect only a short segment, such as an allotment in severalty or a lease. Nevertheless, a search of two university map libraries, inquiries to two United States Geologic and Geographic Survey libraries, and to tribal and Bureau of Indian Affairs offices at Towaoc and Ignacio discloses no deviation from the established boundary.

Then the question becomes, did leases of reservation land exist? This cannot be answered positively. Records from 1884 disclose that the Secretary of the Interior rejected a lease request after a council of Southern Utes had agreed on one the year before. A Mr. Edward Wheeler of Fort Lewis wished to lease grazing land. The Secretary of the Interior said, “I do not think any leasing privileges should be given on the Uintah, Ouray, or Southern Ute reservations, even if an
act of Congress authorized it."

It is likely that this policy would remain in effect for the next few years, in part, because of the continuing efforts to relocate the Southern Utes.

It must be concluded, absent contrary information, that Nordenskiöld did trespass as charged and, had he been found guilty, was subject to a fine of one thousand dollars.

At this point, however, a bit of speculation and surmise may be in order. We may even find a scenario which makes Adair Wilson's role a bit more substantial. Maurine Fletcher reports that Bartholomew was not present at the October 5 hearing and that he claimed that some Indians had lied to him. Since Bartholomew was the plaintiff, his absence would make prosecution difficult and might have allowed Nordenskiöld to claim he was not on or was ignorant of the reservation boundaries. Perhaps Adair Wilson had something to do with the absence of the Indian Agent.

Nevertheless, if Bartholomew's letter of October 7 can be believed, he did not change his mind about where the relics originated. His letter to Nordenskiöld, which contained the settlement formula created by Belt (see above) said, "you [will] be allowed to retain in your possession the relics obtained by you from the Southern Ute reservation" (Bartholomew 1891b).

Acting Secretary of State Wharton corresponded with the Attorney General and the Secretary of the Interior and with the Swedes. The letters were largely informational, as opposed to a request for concurrence, for example, and his replies could be simply called acknowledgments. What the written record does not contain is information about face-to-face meetings that the State Department had with Swedes, for instance, with Secretary Beck-Friis of the Swedish-Norwegian Legation. Nordenskiöld had met with Beck-Friis while he was in Washington.

The decision to release Nordenskiöld's collection, made at the cabinet level, was a judgmental one. America prides itself as a government of law; as no preventive law existed, the "relics" would have to go. It seems that at the heart of this decision is the status in the United States of private property. Private property is given heavy constitutional protection; therefore, if some artifact or relic does not belong to the government, with every constitutional requirement met, it is private and belongs to the holder.

The Swedish View

The Swedish side of this story, from the view of diplomats, was obtained after asking the rhetorical question: Wouldn't Gustaf Nordenskiöld's father have gone to the foreign office when he heard of Gustaf's troubles? Inquiries which were sent to the Swedish Ambassador in Washington and the Foreign Minister of Sweden produced an interesting group of letters from the Riksarkivet, National Archives, in Stockholm.

During the early days after September 17, the Swedes are interested in exactly what happened and express a bit of interest in Nordenskiöld's welfare. On September 23 the Swedish-Norwegian Legation asks of Nordenskiöld: "do you [have] good lawyers assistance?" (Legation 1891). The earliest information going to Stockholm from the legation is on September 29 to the "Cabinet" saying, "Under bail, supposed sending away Indian relics" (Grip 1891a).

By October 3, two days before final hearing, the legation had been fully informed of the U.S. decision and this was included in a letter to the Minister for Foreign Affairs:

the Minister of the Interior as well as the Minister of Justice have given orders that the legal orders taken against Mr. Nordenskiöld in the State of Colorado be dropped. . . . In my opinion, it was of great importance to have the case itself dropped; for if a court of law were to find him guilty of having taken into his own possession objects which might be seen as the property of others or of the State, and that he had desecrated graves, he would most likely not have been able to avoid serious punishment. Since there are definitely no further facts to this matter than those which have already been presented, I hope that before this
letter is even delivered, I shall be able to telegraph that the authorities have decided to have the case dropped entirely. (Grip 1891b)

Now the Swedish diplomats become worried about consequences of Nordenskiöld’s activities and express relief that a favorable outcome is in sight.

A few days later on October 6, after learning of Nordenskiöld’s release, Minister Grip seems even less enchanted by what Nordenskiöld had been doing:

Mr. Nordenskiöld has certainly telegraphed me previously to inform me that this collection of artifacts, which given as the evidence for his arrest, was made outside the above-mentioned Indian reservation. However, the dropping of the charges against him cannot be taken as an approval of his statement.

Minister Grip then goes on, rather doubtfully:

Naturally, it is indeed possible that he is indeed innocent; but a decisive proclamation in this respect could only be made by a court of law. Had a legal decision been made against him, the results would not have led to his favorable treatment. If one were to assume that the authorities were in the right, his actions would naturally have to be ascribed to a youthful lack of forethought. The wisest course of action here would be to avoid running these risks in the first place.

And Minister Grip closes: “The State Department has promised to release to the newspapers, including the New York Herald and its various editions, a statement that the case has been dropped, without mentioning the Royal Swedish-Norwegian Consulate (Grip 1891c).

The concluding letter about which this report is concerned allows us to close, for Gustaf Nordenskiöld at least, on an upbeat note. Karl C. Woxen, the Swedish Consul in New York who agreed to hold the relics in the first place, reported on November 11:

Doctoral candidate G. Nordenskiöld has sent 7 crates and two barrels containing ethnographic artifacts to this address, for further delivery to the Mineralogical Department of the Museum of Natural History. It is my pleasure to report that I have sent the above-mentioned 9 packages to the address of the Swedish and Norwegian Consulate in Copenhagen by the steamship “Thingvalla,” which departed for that city from New York on the 7th of this month.

For the loading of these items, and their insurance during the voyage to Copenhagen, the Consulate has paid a total of $12.54, the reimbursement of which sum should be made as soon as possible by wire to New York. (Woxen 1891b)

A few days earlier, with the arrest disposed of, Nordenskiöld had received permission from the Interior Secretary, John W. Noble, for his trip across Navajo country to the Hopis and beyond. This trip turned into a visit to the Grand Canyon and Monument Valley (Acting Secretary of Interior 1891).
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Nordenskiöld’s monumental work on Mesa Verde appeared in 1893, describing field work during the summer of 1891. The report is magnificently illustrated and describes site, associated artifacts, kiva paintings, and reservoirs of Mesa Verde proper. It includes a description of the largest ruin on the Mesa, Cliff Palace, which had not been found by Jackson and Holmes. With true nobility Nordenskiöld gives full credit to his nonacademic associates. ‘The honour of discovery of these remarkable ruins belongs to Richard and Alfred Wetherill.’

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ANASAZI: PHYSICAL ANTHROPOLOGY'S TURN

Saturday, October 5, 1991
Morning Session VII

Chair: Kathy Fiero
Abstract

The Dan Canyon Burial (42SA21339) yielded a unique assemblage of corporeal remains, coprolites, and associated burial goods of an Anasazi child. This was found near Moqui Canyon, near the Colorado River, and near the maximum range of Anasazi expansion. The burial goods included many perishables and an anomalous ceramic canteen produced in a style similar to Doghozhi-style Tusayan Black-on-red. Ceramic and basketry characteristics indicate this burial is Late Pueblo III, or Horsefly Hollow Phase (Lipe 1970), the final Anasazi occupation of this area. Investigations in nearby areas suggest this was a period of decreased precipitation and major economic shifts.

The coprolites are uniquely homogeneous, consisting only of highly processed rice grass seeds. No evidence of cultivated plants was found. Results of pollen analysis suggest medicinal use of Mormon tea and may also indicate this was a winter death. Developmental characteristics indicate this individual was approximately 3.5 years old at death. The absence of features indicative of pathologies suggest this person was in good health. However, six regularly spaced Harris lines indicate some form of periodic stress.

Compared with goods in other burials, the burial goods are commensurate with those expected for an individual of “average” economic and social status. The human remains and associated food remains indicate that this average, healthy child experienced periodic stress, probably due to an inadequate and homogeneous diet. It is believed that this death resulted from starvation and that this death occurred in winter. It is likely that these results could be generalized to other Late Pueblo III Anasazi living in this area.
Termination of a Life at the Edge: The Dan Canyon Burial

Introduction

As this rather melodramatic title implies, this paper discusses a life at the edge: the edge of the Pueblo III Anasazi world, near the end of the occupation of the Red Rock Plateau. Also, as the title implies, the paper is a case study of the exigencies of life for a single individual who lived in this context. While studies of development and pathology from skeletal materials and studies of diet from coprolites are relatively common, to date no studies have combined both in materials from the Four Corners region. Use of both of these techniques in a single case has allowed a close look at the health and diet of one Pueblo III child who lived immediately prior to abandonment of the region.

The Dan Canyon Burial (42SA21339) was discovered in June 17, 1990 by boaters, and emergency excavation was conducted between June 18 and 19. Subsequent to consultation with the Hopi Cultural Preservation Office, analysis was conducted over a period of five months by personnel of the Midwest Archeological Center (MWAC) and the University of Nebraska in Lincoln (UNL).

This burial yielded a unique assemblage of food, ceramics, and textiles, as well as the skeleton and coprolites of an individual of approximately 3.5 years of age. Analysis of the corporeal remains recovered unique data regarding the development, pathology, and perimortem diet of this child. Attributes of the grave assemblage allowed the circumstances of the child’s death to be placed in context of environmental and cultural events which occurred within the Red Rock Plateau and surrounding areas. This paper provides a brief summary of the results. Further details regarding the history and the results of the project are provided in Dominguez et al. (1992).

Natural and Cultural Environment

The site is located approximately one mile northeast of the confluence of Moqui Canyon and the Colorado River, in Dan Canyon, a small south-flowing tributary of Moqui Canyon. This is southwest of the Abajo Mountains, on the west slope of the Red Rock Plateau, an area with a number of narrow, roughly parallel canyons which drain from east to west. Although rainfall is very sparse and the area has been characterized by Lipe (1970) as marginal, the canyon habitats can support small horticultural communities. The canyons have alluvial and aeolian sand deposits which tend to trap runoff from the uplands or from the highlands where the canyons head. These conditions would have allowed dryland horticulture similar to that used by modern Hopi (Hack 1942). Currently riparian and shrub communities occur in these areas. Overhangs and alcoves are common in the canyon walls.

Uplands between the canyons are flat to rolling expanses of bare rock with intermittent patches of aeolian sand. These poorly watered and thinly vegetated areas form natural barriers between the canyon systems and probably constituted outland regions where wild foods were collected. Vegetation on sand dunes commonly includes edible ruderals, occasionally in dense stands.

The location of the Dan Canyon Burial must be considered to be at the edge of the Anasazi world. In the area southwest of Moqui Canyon the Anasazi communities of the Kaiparowitz Plateau and the Escalante River drainage extend northwest from Glen Canyon. However, in the area surrounding Moqui Canyon the Colorado River constitutes the maximum northwestern range of architecture and horticulture of the Kayenta and Mesa Verde Anasazi. Surveys conducted in areas across the Colorado River north and west of the Moqui Canyon area have yielded limited assemblages of ceramics, no architectural remains, and no evidence of horticulture (e.g., Christenson 1983; Geib and Bremer 1988; Suhm 1959). These assemblages appear to be results of seasonal outland use of this area (Geib and Bremer 1988; Geib et al. 1987).

For the west slope of the Red Rock Plateau two periods of Anasazi occupation were identified by Lipe (1970): the Late Pueblo II to Early Pueblo III Klethla Phase (A.D. 1100 to 1150) and the Late Pueblo III Horsefly Hollow Phase (A.D. 1210 to 1260). As discussed below, the Dan Canyon Burial has been determined to
have resulted from the later Horsefly Hollow occupation.

Horsefly Hollow Phase Anasazi communities of the west slope of the Red Rock Plateau were described by Lipe (1970). The canyons and the intervening upland barriers naturally define the limits of communities. Small, functionally differentiated sites consisting of one to seven residential and storage structures are distributed throughout most of the canyons. Each canyon has one kiva or several kivas distributed among sites. Most of the sites have small assemblages of ceramics, flaked stone, and groundstone. Considered in aggregate the processing, storage, residential, and ceremonial facilities distributed among the sites in a canyon constitute the full suite of facilities considered necessary for Anasazi communities. It is not known if these sites were occupied year-round or if these were summer farming communities of larger sites in the highlands to the east. The Horsefly Hollow Phase community group in Moqui Canyon is one of the larger in the area.

Dan Canyon is at the west end of the Moqui Canyon community. The burial site is within five miles of nine of the Horsefly Hollow Phase sites. These sites include seven with residential and/or storage structures and two with storage and residential structures and kivas.

Paleoenvironmental and cultural events in surrounding areas suggest that Late Pueblo III was a period of decreased precipitation and increased erosion in the Four Corners region. For example, on Mesa Verde Fritts et al. (1965), in the Dolores area Peterson (1988), and in the Navajo Mountain area Geib et al. (1985) have identified drier conditions during Pueblo III. Dean et al. (1985) see this as a period of high temporal variability in precipitation and dropping water levels with erosion on Black Mesa. Agenbroad and Mead (1986) have identified an erosional event in the Upper Glen Canyon area which corresponds with Hack's (1942) Tsegi/Naha erosion. However, Moqui Canyon was apparently not discernably affected by this erosional event (Lance 1963).

Several cultural responses to these conditions are indicated by events in areas near the Moqui Canyon community cluster. Evidence regarding responses to environmental change around the lower San Juan River have been well summarized by Geib et al. (1985). This includes Tsegi Phase changes in settlement location, size, and organization, as well as probable intensification of agriculture (Lindsay 1969), and development of water control and field systems (Lindsay 1961; Lindsay et al. 1968; Sharrock et al. 1961; Stewart and Donnelly 1943). Geib et al. (1985:496) see this intensification as an effort to increase the reliability of horticulture. In addition, Geib et al. (1985) also see evidence for increased use of wild plants in this area during Pueblo III, as do Heath and Schroedl (1989).

The Burial

The site is in a southwest-facing overhang at the top of a talus slope near the pool line of Lake Powell. It consisted of two features, the foundation of a small storage structure and the burial. The only artifacts observed on the site were in the burial. The burial was at the base of the cliff adjacent to several large boulders which were leaning against the cliff.

The pit for the burial was prepared by removing cobbles and boulders from the talus and piling them to the side. The child was laid loosely flexed, on its left side adjacent to the cliff, facing away from the cliff and with the head to the southeast. It was covered with approximately 20 cm of sand and gravel.

Wave action had partially uncovered the burial, and the cranium, mandible, and other elements had been moved. Excepting some of the phalanges, metacarpals, and metatarsals, most of the skeleton was present. Overall the bone was in good condition, with a small amount of flesh remaining on phalanges and cranium. Coprolites were present in the abdominal cavity.

A ceramic canteen had been placed superior and posterior to the head. A leather bag containing approximately 0.25 liters of unprocessed rice grass seeds had been placed below the thorax. Several of the items had been eroded and moved by wave action and their original locations could not be ascertained. Three yucca ring baskets had apparently been placed over the body, but had been moved by
wave action. At least one fine-plaited sandal, a microcline (Amazonstone) pendant, two cottonwood spoons, a hollowed cottonwood knot, an unidentifiable coarse-twined textile, an unidentifiable fine-twined textile, one sumac seed, at least four piñon seeds, eight squash seeds, some possible squash rind, one hackberry seed, and two small flakes had been placed near the body. Approximately three grams of cottonwood and juniper wood fragments and charcoal were also recovered from the screen.

**Dating Criteria**

Artifacts with chronologically diagnostic attributes included the ceramic canteen, the basketry, and the sandals. All of the identifiable woven materials consisted of fine-plaited yucca, suggesting these materials are Pueblo III (Magers 1986). The canteen is similar to Tusayan Black-on-red, Doghozhi-style, but had been executed with white pigment rather than black carbon paint and slipped only over the upper one-half to two-thirds of the body. These attributes suggest that this vessel postdates A.D. 1250 (Dominguez et al. 1992; Geib 1990).

Results of C14 analysis were inconsistent with the dating suggested by the artifacts. The first sample, consisting of yucca fragments disarticulated from the baskets, yielded a date of 1120 ± 110 B.P. (A.D. 720-940; Beta 42344). The second sample, charcoal from the screen, yielded a date of 1300 ± 110 B.P. (A.D. 540-760; Beta 42661).

Not only are these dates too early for the diagnostics from the burial, they are too early for all Anasazi occupation in the area. Several possibilities for this discrepancy were explored and rejected: sample sizes, natural hydrocarbon contamination, and calcium carbonate contamination from the soil. The most likely explanation is hydrocarbon contamination in the reservoir. Two years previous to the excavation a large gasoline leak was discovered at the marina approximately two miles to the west, and concern has grown over other sources of contaminants in the lake. Another burial site recently exposed by wave action at the pool line of Lake Powell has also yielded C14 dates which are too early for the artifacts included as burial goods. This was the Rock Creek Site (Nickens et al. 1986), several Basketmaker II burials in a rockshelter. Charcoal in the burial matrix yielded a date of 8660 ± 80 B.P. However, this can be discounted due to uncertain association. Material believed to be soft tissue from Burial 1 yielded a date of 2420 ± 100 B.P. The authors suggest that either this period began earlier than previously believed or the date had been skewed by some agent related to inundation (Nickens et al. 1986:251).

**Material Culture**

Several generalizations regarding the grave goods can be abstracted out of the descriptions provided in the report (Dominguez et al. 1992). Among the nonfood items all were constructed by methods well documented for the Anasazi. None of the items are necessarily exogenous or suggestive of trade. Excepting a single item of unknown use (the hollowed cottonwood knot), all appear to be related to daily activities: the sandals, ceramic canteen, and spoons show wear. Comparison with burial assemblages for this age group from other Pueblo III sites to the south (Crotty 1983) suggests that this individual could be considered to have had “average” status. For 15 children of 0 to 12 years of age (Crotty 1983:28) the number of nonperishable items included averaged 1.6, commensurate with the two nonperishable items (the canteen and the pendant) in the Dan Canyon Burial.

The food remains included very limited remains of domesticates. The only confirmed domesticate was represented by eight squash seeds. This may have also included approximately 0.025 liters of an unidentified orange material, believed to be mashed squash pulp. Wild foods were less limited in quantity. These included approximately 0.25 liters of unprocessed rice grass seeds in a leather bag, one squawberry seed, one hackberry seed, and fragments of four piñon seeds.

**Corporeal Remains**

Skeletal: In compliance with requests of the Hopi, analysis of the human remains was limited to nondestructive methods. The
intermediate stage of fusion of the occipital, incipient fusion of the cervical and lumbar vertebrae, and absence of long bone fusion indicate an age of three to four years, consistent with the age indicated by tooth eruption.

No abnormalities in growth were detected in cortical thickness of the bone or long bone measurements. Diaphyseal measurements of the humeri, ulnae, radii, femora, tibiae, and fibulae all fell near the median values of Ubelaker's (1989) standard growth estimates for children of 2.5 to 3.5 years of age. This is considered well within the range of variability for a prehistoric Native American child of approximately 3.5 years.

Macroscopic examination, microscopic examination, and radiographic images of the dentition revealed normal development patterns, including the absence of hypoplasias. Only one pathological condition was observed in examination of the skeleton. Six Harris lines were observed in the radiographs: three vague and three well-defined and regularly spaced.

Coprolites: Macroscopic remains consisted exclusively of ground grass seed (Poaceae). This material was so finely ground that it is impossible to identify the taxon with certainty, although it is comparable to Indian rice grass (Oryzopsis). No good evidence of parching was observed. Modern ethnobotanical records suggest that use of the rice grass was dietary rather than medicinal (Whiting 1939).

The majority of microscopic remains consisted of extremely small seed fragments, apparently a result of grinding. The surfaces of these fragments compare well with the macroscopic seed remains. Pollen grain per gram ranged from 19,900 to 49,500. Averaged across three samples, Poaceae comprised 97 percent of the pollen, while Ephedra constituted 1.5 percent, Pinus 0.5 percent, and Artemesia and Chen-amos constituted traces.

No evidence of parasitism was found in the coprolites, even after repeated examination of three preparations from each coprolite. Consequently, it is unlikely that this individual was parasitized by the reproductive phases of intestinal worms. No evidence of mites or lice was found.

These coprolites may represent as much as three days of perimortal diet. The complete absence of domesticates or of other wild foods is not unique to this area. However, it is noteworthy, particularly when considered in relationship to the food remains included in the burial and in context of contemporaneous events to the south (as discussed later).

Besides indicating an extremely homogeneous diet, the materials from the coprolites suggest, but do not confirm, several additional factors, including medicinal treatment and time of death. The presence of Ephedra (Mormon tea) in frequencies higher than Pinus may indicate ingestion of this plant, probably as a tea, due to the absence of macroscopic remains. The Ephedra pollen occurred in clumps, suggesting use of floral parts.

It appears the coprolites yielded a winter or early spring pollen spectrum, and several factors suggest that both preparation and ingestion of this food did occur in winter. It is likely that the rice grass within the coprolites had not been processed immediately after collection: the rice grass seeds with the burial goods showed no signs of immediate processing; they were neither parched nor ground and may have been stored in this form. A large proportion of pollen contaminants enter during seed processing. Due to the pollen spectrum recovered from seed processing. Due to the pollen spectrum recovered from the coprolites, it is likely that processing of the seeds within the coprolites did not occur during summer when a wide variety of pollen contaminants are available. Consequently, it is likely that processing occurred in winter or early spring, just prior to ingestion.

Summary

Of the items included in the burial all were manufactured by standard techniques well documented for the Anasazi. Almost all are items generally considered to be utilitarian. Several of these show attrition from use and were probably items used in daily life. There is no evidence any were made specially for this event, and none are recognizable ceremonial items. None of the items are necessarily exogenous. Comparisons with other grave goods (Crotty 1983) suggest this is an individual
of "average" status, that this individual was well cared for, and that death did not result from neglect or abuse.

The food included in the burial was limited in diversity and nutritional quality. The low representation of domesticates is consistent with events in other areas which indicate difficulties in production, such as the construction of water control systems seen in Pueblo III sites around the lower San Juan River, and the greater use of wild foods in this area.

Information from the coprolites is consistent with observations from the food remains. The coprolites might represent as much as three days' worth of food, with the only macrobotanical remains consisting of rice grass. Due to the absence of other background pollen, this may be a winter or early spring pollen spectrum. This is consistent with the common notion that nutritional stress was highest in winter and early spring. The pollen spectrum indicates *Ephedra* may have been ingested in tea form, possibly as a medicine.

Dry farmed domesticates, such as corn and beans, were absent from both the coprolites and the grave goods. Squash is the only domesticate present, suggesting that limited gardening around springs or other sources of water continued to be successful at this time. The most common plant was rice grass, which grows well in dry sand. This may reflect declining environmental conditions.

Overall skeletal attributes indicated the child was a healthy three- to four-year-old, with a stature normal for the child's age and hereditary background. Growth arrest lines indicate at least three moderate stress periods that occurred at regular intervals. Considered in conjunction with the food in the burial and the probable time of death, these growth arrest periods were probably due to winter food shortages. Attainment of normal stature in spite of growth arrest lines indicates compensatory growth and overall good nutritional status. Considered in aggregate, these facts suggest this was a case of winter-spring starvation.

This case study constitutes a single instance where much of the perimortal circumstance can be determined and fits well within the context of the events reconstructed for the area. Summarily, this was a child of approximately 3.5 years of age who experienced regularly spaced episodes of stress, probably seasonal food shortages. In spite of periodic nutritional stress, the child's health was good. Compensatory growth indicates good nutritional status at other times. Death probably occurred in winter or early spring, usually considered the seasons of greatest nutritional stress. Although evidence suggests the child was well cared for and probably of "average" economic status, it was buried with very little cultivated food, mostly wild plant foods. This occurred in an area that is ordinarily marginal for both horticulture and procurement of wild foods and was during a period of drought as well as erosion in many areas. Other communities in the region were building water control devices or show evidence of use of larger percentages of wild foods at this time.

**Acknowledgments**

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Ubelaker, D. H.

Whiting, A. F.
Abstract

The patterns of developmental defects present in Pueblo IV skeletal collections from the Pajarito Plateau provide insight into the underlying genetics of its populations. For the first time, a morphogenetic approach to the analysis of developmental disturbances in the axial skeleton is applied to the study of prehistoric populations. Skeletal collections from the communities of Puye, Otowi, Tsankawi, and Tsirege share similar overall patterns of developmental disturbances of the axial skeleton. These biological data support the ethnohistoric evidence that the residents of these communities were part of the same general population considered to be Tewa. However, frequency variations from one community to another suggest cultural influences. Marriage patterns can have a distinctive impact on the gene pool. Certain environmental factors, particularly nutrition, can also have some influence. Since all the Pajarito communities represented in this study share the same natural environment and subsistence base within the same general time period, the differences in the frequencies of developmental defects most likely relate to marriage patterns. Similar studies of other Anasazi skeletal collections from different regions of the Southwest should provide additional clues to the movements of the various populations from one region to another.

A newly developed method for analysis of developmental defects in the axial skeleton provides a new approach for assessing underlying genetic relationships in prehistoric skeletal populations (Barnes 1991). This approach is based on an in-depth study of the development of the embryonic axial skeleton—skull, vertebral column, ribs, and sternum—during the first eight weeks following conception.

The axial skeleton begins to form from blastemal (membranous) tissue in the embryo...
Patterns of Developmental Defects... during these first eight weeks, along with the other organs of the body. This is a critical time for organ development, known as morphogenesis, setting the stage for the many organic components of the body. As embryonic, blastemal cells migrate, gather, and organize to form tissue components of the various organs, they become vulnerable to disruptive influences at critical times of rapid change. These periods of rapid change in developing embryonic tissue are known as critical threshold events (Arey 1965; Saxon and Rapola 1969; Williams et al. 1989).

The underlying genetic codes governing the timing of these critical events can be altered by variant genes. Sometimes external factors, particularly nutritional factors, can modify the underlying genetic code. The upset in genetic signals usually results in the delay of a threshold event, which in turn interferes with the synchronized occurrence of other critical events in the developing tissue. Delay of a critical threshold event can lead to incomplete or absent formation of the blastemal precursor of an organ or structure, or of any of its parts. Some genetic backgrounds appear to be more susceptible to alteration during critical threshold events than others. Knowing this, we can identify families and/or populations that are at risk for specific developmental disturbances (Falconer 1965; Fraser 1981; Gruneberg 1964; Saxon and Rapola 1969; Smith and Aase 1970).

The various structural components of the axial skeleton can be traced to their place of origin within specific primordial tissue concentrations within the developing embryo, known as developmental fields (Gruneberg 1964; Opitz et al. 1969; Spranger et al. 1982). Developmental defects can be organized into a comprehensive identification system based on the developmental field of origin and type of developmental disturbance. Variable expressions of these disturbances can be recognized and classified according to this approach. Defects can range from a very minor expression to a major expression of a particular disturbance in development.

Delay in development of a structural part can lead to various expressions of hypoplasia or aplasia, depending on the timing of the disturbance in relation to the critical threshold event responsible for its occurrence. Too much delay and the part does not form at all, particularly where bone is usually thin (Gruneberg 1963). For example, the various forms of cleft neural arch in the vertebral column represent hypoplasia-aplasia of one or both sides of the neural arch as it forms from blastemal tissue. Various forms of cleft palate result from this same phenomenon. Block vertebrae result from the failure of blastemal tissue to separate properly at the right moment in embryonic development. Interference with normal differentiation or segmental shifting within the vertebral column leads to an array of vertebral defects (Arey 1965; Epstein 1976; Walmsley 1959; Williams et al. 1989). Some developmental disturbances, particularly of the cranium (e.g., fontanelle bones), are not clinically significant and are usually referred to as anomalies. Some of these minor disturbances in development are used as nonmetric variants in skeletal population studies.

The major significance behind the morphogenetic study of developmental defects of the axial skeleton is the underlying genetic base that allows for particular disturbances to take place. Sporadic appearances of developmental defects appear in all populations, reflecting an occasional aberrant genetic base sensitive to genetic or environmental influences (Barnes 1991; Fraser 1959; Gruneberg 1963; Leck 1972; Saxon and Rapola 1969). Clustering of unusual defects within a single population indicates a sporadic defect following a familial line. Definite patterns in the expression of specific developmental defects within a population provide a genetic profile for that population that can be compared with other groups to determine biological relationships. Trends toward particular expressions of developmental disturbances reflect sensitive areas in the underlying genetic base of the gene pool.

For the first time, the morphogenetic approach to the analysis of developmental disturbances in the axial skeleton is applied to the study of prehistoric populations (Barnes 1991).
Skeletal collections from the Pajarito Plateau in north central New Mexico were selected for the first of a series of studies of Anasazi skeletal collections to determine patterns of developmental defects that reflect underlying genetic relationships. The collections were made available to this study by the Museum of Natural History at the Smithsonian Institution.

The skeletal collections were procured by Edgar L. Hewett between 1905 and 1909 from the Pueblo IV communities of Puye, Otowi, Tsankawi, and Tsirege. Puye is located in the northern region of the Pajarito Plateau, overlooking Santa Clara Creek, and is claimed by the modern day Tewa people of Santa Clara village as one of their ancestral homes (Hewett 1953; Hewett and Dutton 1945). Otowi, Tsankawi, and Tsirege are located in the central portion of the plateau, above White Rock Canyon near Los Alamos. The Tewa of San Ildefonso village claim Otowi and Tsankawi as earlier ancestral homes (Hewett 1953). Tsirege, the largest of the prehistoric towns on the plateau, and located south of Tsankawi, is probably related to Otowi and Tsankawi, based on the archaeological evidence (Hewett 1906, 1953). The southern portion of the Pajarito Plateau was settled by the ancestors of the modern Keresans (Cordell 1979; Dozier 1970; Ferguson and Rohn 1987). Skeletal collections from this area were not available for this study.

The skeletal collections from Puye, Otowi, Tsankawi, and Tsirege represent a total of 354 individuals, mostly adults. Despite the underrepresentation of younger individuals, analysis of the patterns or trends in developmental defects of the axial skeleton can be determined from adult skeletal material. Most developmental defects, including mild forms of severe defects leading to death in infancy, are present in adults. The axial skeleton of each individual was inventoried and recorded with the presence or absence of developmental defects, according to the specified fields of development.

The largest number of individuals come from Puye, with 230 represented. Otowi is represented by 86 individuals, Tsankawi with 25 individuals, and Tsirege with 13 individuals. Only the skull of the axial skeleton is represented in the Tsirege collection. However, developmental disturbances associated with the cranium strongly resemble those recorded for Otowi, Tsankawi, and Puye.

Each collection was analyzed separately to determine any similarities or differences in their patterns of defects. Similar patterns of developmental defects are to be expected if they are part of a homogeneous population. Otherwise, different patterns reflect separate populations.

Despite the smaller sample sizes of Otowi, Tsankawi, and Tsirege, similarities with each other and Puye in the expression of a number of specific developmental defects were detected. There are relatively high frequencies (over 20 percent) for minor disturbances in the embryonic blastemal desmocranium, primarily in the form of numerous lambdoid ossicles in all of the collections. Bregma and obelion fontanelle bones occur sporadically in the Puye collection, and a similar obelion fontanelle bone appears in the Otowi collection. The number of individual crania for Tsankawi (4) and Tsirege (10) are too small to determine sporadic occurrence of these anomalies.

The closing membrane of the first branchial arch in the developing embryo forms the bony
Figure 1. Location of Puye, Otowi, Tsankawi, and Tsireg on the Pajarito Plateau in north central New Mexico.
ympnic plate that borders the external auditory meatus (Williams et al. 1989). Delay in development of this membrane results in hypoplasia or aplasia of the antecedent of the tympanic plate. Hypoplasia leads to a persistent opening or cleft in the tympanic plate into adulthood, which is often referred to as Huschke’s foramen or tympanic dehiscence, but should be referred to as a tympanic aperture. The skeletal collection from Puye exhibits a high frequency (over 20 percent) of this defect, with more than twice as many females affected as males affected. A similar pattern is seen with Otowi and with Tsirege. Only female crania are available from Tsankawi, and the majority have this same anomaly.

Sometimes one or more of the borders between the different types of vertebrae represented in the vertebral column shift during embryonic development. Depending upon whether the shift is upward (cranial) or downward (caudal), the bordering vertebral segment affected by the shift takes on the characteristics of the adjacent vertebra. Varying degrees of expression of these shifts can appear, depending upon the extent of the shift. The direction of the shift, as well as the expression, is known to be under genetic control (Kohler and Zimmer 1968; Schmorl and Junghanns 1971).

Puye, Otowi, and Tsankawi share a common tendency for minor expressions of segmental shifting at the lumbosacral border. Cranial shifting is much more common than caudal shifting at this border. Complete cranial shifting in the form of bilateral sacralization of the last lumbar vertebra is uncommon (1/109), as is complete caudal shifting in the form of lumbarization of the first sacral segment (2/109). The majority of border shifting disturbances (cranial shifts) appear as transitional, wide, ala-like transverse processes on the last lumbar vertebra, sometimes articulating with the sacrum.

Segmental shifting at the sacrococcygeal border also has a strong tendency to appear in these collections, with a trend toward incorporation of the first caudal segment (cranial shifting) into the sacrum. No cranial shifting, separation of the last sacral segment, was detected.

Puye, Otowi, and Tsankawi share a rare form of minor caudal segmental shifting at the occipitocervical border. This appears as a precondylyar facet on the anterior rim of the foramen magnum, articulating with the dens of C2 and/or the anterior arch of C1. It does not appear in the Tsirege collection (0/8), but small sample size is probably an inhibiting factor (Figure 2).

Block vertebrae appear when the embryonic precursor segments fail to separate, leaving two or more vertebrae as one vertebral unit (Bailey 1974; Gunderson et al. 1967). Puye, Otowi, and Tsankawi share a genetic tendency toward the expression of block vertebrae, most commonly found in the second and third cervical vertebral segments.

Developmental delay of the embryonic sacral neural arches can produce a variety of clefts and bifurcations in the dorsal aspect of the sacrum (Schmorl and Junghanns 1971). There is a tendency toward developmental delay in the sacral neural arches of the sacra from the Pajarito Plateau collections. Distinctive, related expressions of clefts and bifurcations are common to the skeletal collections of Puye, Otowi, and Tsankawi.

There are strong tendencies for delay in the development of the sternal precursors in the Pajarito Plateau collections. The mesosternum and xiphoid process are formed from two embryonic sternal bands of mesenchyme that come together from the ventrolateral portions of the embryonic body and unite in the midsection. Union begins at the cranial end, progressing caudally, as the bands subdivide into four segments known as sternebrae (Arey 1965; Williams et al. 1989). Delay in caudal cohesion results in an abnormally wide mesosternum and/or xiphoid process. Incomplete cohesion often accompanies delayed caudal cohesion in the form of a foramen or cleft in the mesosternum or xiphoid (Ashley 1956; Chang et al. 1961; Eijgelaar and Bijtel 1970; Jewett et al. 1962). Puye, Otowi, and Tsankawi share similar expressions of abnormally wide sterna, sternal foramina and clefts, abnormally wide xiphoids, and xiphoid foramina and clefts.

The embryonic precursor of the manubrium
Figure 2. Major developmental defects of the axial skeleton common in the Pajarito Plateau skeletal collections: (A) numerous lambdoid ossicles; (B) tympanic aperture; (C) precondylar facet (minor caudal shift); (D) block vertebrae (C2-C3); (E) fusion of the manubrio-mesosternal joint; (F) sternal foramen (incomplete caudal cohesion); (G) fusion of the xiphisternal joint; (H) wide, ala-like transverse processes of L5 (minor cranial shift); (I) first caudal segment fused to sacrum (cranial shift); (J) cleft neural arch of S1.
forms from the upper ends of the sternal bands uniting with another mesenchymal center in the upper midsection of the embryo, with bilateral suprasternal structures contributing to the cartilaginous joint between the manubrium and clavicles. A thin layer of fibrous membrane forms between the developing manubrium and first sternebra of the mesosternum, a prelude to the cartilaginous joint that forms later (Ashley 1954). A similar phenomenon takes place at the xiphisternal connection (Jit and Bakshi 1986). If the fibrous membrane fails to develop completely or not at all, the cartilaginous joint fails to develop and fusion takes place. There is a common trend for fusion of the manubriomesosternal joint and xiphisternal joint in the Puye, Otowi, and Tsankawi collections.

The shared tendencies for the development of similar patterns of developmental disturbances in the axial skeleton by the residents of Puye, Otowi, Tsankawi, and Tsirege suggest a common gene pool. This supports the ethnohistoric and archaeological data of a homogeneous population, considered to be Tewa, for the northern and central portions of the Pajarito Plateau during the Pueblo IV time period.

Frequencies in the appearance of developmental defects vary from one community to another. Small sample sizes from Otowi, Tsankawi, and Tsirege may be an influencing factor. If not, frequency variations from one community to another suggest cultural influences. The variation in frequencies may indicate selective mating practices typical of community endogamy. The frequencies would tend to be similar with community exogamy.

Certain environmental factors, particularly nutritional, can influence the expression of some defects. Communities experiencing different environmental influences should have some differences in comparative patterns of developmental defects. Puye, Otowi, Tsankawi, and Tsirege shared the same environment and subsistence base within the same general time period. Therefore, the differences in frequencies most likely relate to marriage and residence patterns.

An earlier study of metric and nonmetric studies of the Puye skeletal collection by Corruccini (1972) pointed out that the females were more alike than the males. Corruccini interprets this as a reflection of a matrilocal social order with exogamous matrilineal clans, similar to the Zuni tradition. Related females stayed in the same clan settlement, increasing the effects of genetic drift, while husbands came from outside the clan, yet from the same community.

Similar sexual differences were found in this study. Females in all of the Pajarito skeletal collections examined have higher frequencies of some defects than do males, particularly with the tympanic aperture, segmental border shifting of the vertebral column, and manubriomesosternal fusion. Sporadic developmental defects tend to occur primarily in females. However, a few defects tend to occur more often in males than in females. Males tend to have a greater frequency of sacral clefting, xiphisternal fusion, and delayed or incomplete caudal cohesion defects of the sternum (male sterna are usually wider than female sterna and therefore are probably more prone to such defects). More research is needed to determine why these sexual differences are found, whether they are influenced by sex or by marriage and residence patterns.

There are scattered reports in the literature of some developmental defects noted in other Pueblo IV populations that migrated into the northern Rio Grande, as well as in Anasazi populations in other areas. However, the information is not complete enough for a morphogenetic comparative analysis. Reexamination of previously studied Anasazi skeletal collections using the morphogenetic approach will expand our knowledge of their genetic relationships and provide additional clues to Anasazi migrations.
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OCCLUSAL DISEASE: RAMPANT IN THE ANASAZI—BUT WHY?  
A PRELIMINARY REPORT

Abstract

Those who have examined the skeletal remains of the Anasazi have noted excessive tooth wear in the adult dentition. It has been, in fact, a measure of the individual’s age. This is explained by the abrasives found in their food. Investigators have explained the idea of stone ground corn (so prevalent in the Anasazi culture) to be the obvious cause of tooth wear or abrasion. The abrasion has been called occlusal disease and is prevalent in our society today. Since our diet is nonabrasive, what is the cause? In this preliminary report I will postulate possible reasons.

Thank you for the honor, privilege, and genuine thrill in joining you, if in spirit only, at this 1991 Anasazi Symposium!

As a result of my professional interest in dental disease in general, over the past three decades I have been led to study what has been called dental attrition. I am a prosthodontist, that is, a dentist involved with the restoration of the crowns of natural teeth and/or missing teeth and their occluding surfaces. Since I also have an amateur interest in archeology and anthropology, I have been prompted to investigate something that has intrigued me for years. It is the concept of occlusal disease of the Ancient Ones. This concept transcends not only dentistry and archeology, but also medicine, quantitative analysis, physiology, and many other scientific disciplines.

As a clinician, I am primarily interested in the practical aspects of occlusal wear. Those of us in practice want to know what works and what doesn’t in our daily effort to treat and restore form and function to the dentition. We need to know what promotes health and comfort for our patients. When we then change hats and examine the dentition of the skeletal remains of
other cultures, we bring this practical diagnostic aspect to our study.

**Thesis**

To be sure, there are many dental maladies that we have observed in the Mesa Verde population which have already been reported (Rohn 1971). Even severe temporomandibular joint disease (TMD) is among the bony pathoses observed, and it can be related to occlusal dysfunction or hyperfunction (Reade et al. 1985). TMD (often called TMJ) even now is a popular topic both in dentistry and in the everyday media. However, my thesis for this preliminary report has to do specifically with the clinical attrition of the occluding or chewing surfaces of the teeth and its cause. It has long been postulated that heavy occlusal wear, observed in the Anasazi and other early cultures, is obviously the result of an abrasive material in the diet, especially the stone ground meal so commonly used by these people (Leek 1966, 1972; Smith 1984). That is, the mano and metate, used to crush and process the corn kernels, deteriorate, and these particles of stone are included as "grit" in the ground meal. One author even states:

> It became quite evident that the abrasive particles found in these samples of bread would more than account for all the attrition to be seen on the teeth in ancient Egyptian skulls, so much so that further investigation was clearly unwarranted. (Leek 1972)

In a 1990 paper published in the *International Journal of Periodontics and Restorative Dentistry*, I described the phenomenon of occlusal disease in modern man (Lytle 1990). This phenomenon has been referred to by many as an all inclusive group—dental attrition. However, dental attrition can be more accurately described first as an adaptive phase following eruption and then in four levels of progressive wear, known as occlusal disease. This process is, by definition, a disease entity (Shafer et al. 1974).

The deleterious effects of this attrition-disease are reflected not only on the teeth but in the supporting alveolar bone and in the temporomandibular joint as noted previously. In light of this paper, relative to the occlusal disease of modern man whose diet is essentially nonabrasive, I was prompted to project backwards in time the concept that bruxism or grinding of the teeth was in fact the cause of tooth wear in the Anasazi. That is to say, chewing food even with abrasive inclusions does not cause excessive tooth wear but that habitual or parafunctional habits are the cause. In our culture the abrasive component may only be tooth to tooth contact or fractured enamel particles that are the purveyors of destruction. For the Anasazi, the abrasives may also have included particles of stone or airborne grit as was apparently true in ancient Egypt (Leek 1972; Storey 1976). Here the abrasives are but a vehicle, as we know that during the chewing of food, teeth make minimal contact. This is an important fact to keep in mind (Ahlgren 1976).

There are reports in the dental literature of farmers (Ingle 1952) and those working in a dusty environment, such as road construction, gravel pits, or coal mines (Enbom et al. 1986), whose teeth are heavily abraded. These peoples' working environment is replete with grit. In the absence of food, the problem is obvious—bruxism. Here again grit is the vehicle, but bruxism is the cause.

Why certain individuals are prompted to abuse their dentition is not entirely understood. Is it stress? Does the grit itself promote grinding? Is it frustration, self-mutilation, or a chemical imbalance of the neuromuscular system? We are not completely sure. As an aside, some interesting studies are now being done in sleep labs relating to the neurophysiology involved in bruxism.

Teeth, then, have been understood not only as the mechanism for processing food (the first stage of digestion), but also as tools, particularly for the primitives, and now as instruments of bruxism, whatever its cause.

**Bruxism**

There is the idea in recorded history, noted as far back as in biblical times, that grinding and gnashing of teeth were part of everyday life (Psalm 102:10; Numbers 11:8). In fact, the
stresses of life, whatever they were, could be enough to cause tooth grinding and/or gnashing. This we, in dentistry, have termed bruxism. It has been defined as follows:

Bruxism is the habitual grinding of the teeth either during sleep or as an unconscious habit during the waking hours. This term is generally applied both to the clenching habit, during which pressure is exerted on the teeth and periodontium by the actual grinding or clamping of the teeth, and also to the repeated tapping of the teeth. (Shafer et al. 1974:491)

One cannot help but think of the incredible environmental stress of the Anasazi, of which you are more tutored than I. Reflect for a moment with me, back in time, when one of these individuals—Brother A—is scraping around in the cold of winter or the heat of summer for a few berries or roots, because the corn was all killed by storm or blight. Maybe he's hoping to catch a ground squirrel before the next snow. He is hungry! And so is his family. Maybe he is worried about the nearby tribal unrest. He is stressed! Therefore, he grinds his teeth. Possibly the very grit in his windswept environment accumulates in his mouth and is enough to precipitate grinding.

Meanwhile (back at the ranch), Sister A has been processing what's left of the corn supply, taking care of a sick child, and at the same time dealing with diarrhea, or even tuberculosis. She too is clenching, gritting, and grinding. Wouldn't you? Do you?

A number of papers within the dental literature report different incidences of bruxism in our culture (Shafer et al. 1974; Schluger et al. 1977:121). My clinical experience is that at different points in time bruxism, at some level, is axiomatic with living. Further, I believe that we can easily recognize occlusal disease by observing the six upper anterior teeth. The amount of wear noted on these teeth, even in our society today, is strong evidence of the bruxing phenomenon. For those of you who are particularly interested in this concept, please write me for a copy of my paper, “Occlusal Disease.”

Dental Occlusion

At some risk I will attempt to simplify the idea of the so-called “functional occlusion.” Functional occlusion relates to the chewing of food and certain physiologic uses of the dentition such as swallowing. Ideally, these are the only times that teeth should touch in contemporary humans: the sum of these contacting times is but a few minutes a day. As for bruxism, the contacting times may total hours. Other aspects of the use of teeth can be termed parafunctional. There is a broad range of parafunctional habit patterns that include bruxism. However, the variety of habits that include the use of teeth as tools, or as a third hand, may be useful but are not accepted as functional (i.e., physiologic). If you are listening to this paper with your teeth together, then you are performing at least a low level of clenching or bruxism. If you see someone near you with the muscles moving at the angle of the jaw or on the temples, then you know the person is clenching or grinding—bruxing. Conversely, the mouth without parafunction has been termed a “quiet mouth.”

The most important concept to understand relative to functional and parafunctional occlusion is the role of incisal guidance (McHorris 1979a, 1979b; Schuyler 1959). This is the descriptive term used to explain the overlap of the upper six anterior teeth over the lower anterior teeth. In an ideal arrangement, these teeth “free up” the lateral contact of the posterior teeth when a lateral or protrusive movement of the mandible is made. This is to say that when all the teeth are kept in contact and the mandible is moved in any eccentric position (i.e., non-full closure position), then the posterior teeth are separated by the more steeply overlapping anterior teeth (i.e., incisal guidance). However, when the posterior teeth come into contact on the opposite side to the direction of mandibular movement (this is called the nonworking side), then excessive force is brought to bear on both the temporomandibular joint and the supporting
alveolar bone. This force is more stressful than with unilateral posterior contact because of the leverage that is created. The posterior eccentric nonworking contact may be the very “hangnail” that encourages bruxism. Electromyographic studies have shown greater potential for “quiet” musculature if the posterior teeth do not contact eccentrically (Williamson 1983). Conversely, bruxism is magnified by undesirable contacts.

In the ideal arrangement, the anterior teeth must wear down to decrease the incisal guidance before the posterior teeth can gain eccentric or lateral contact. We say that the anterior teeth protect the posteriors. Therefore, we can make a value judgment of incisal wear by rating quantitatively the attrition of the anterior teeth. My paper on occlusal disease treats this in more detail.

If the natural incisal guidance (i.e., anterior overlap) is minimal in an individual or in an ethnic group, then the potential for early posterior wear is enhanced. Therefore, the greater the degree of prognathism (i.e., protruded mandible, like Dick Tracy), the less incisal guidance is a factor in the protection of the posterior teeth. Conversely, as the anterior and posterior teeth wear, with ensuing loss of incisal guidance, the mandible becomes more prognathic.

Visualize a skull with all the upper teeth missing but with the lower anteriors in place. As the mandible is moved toward closure, the lower anterior teeth are not stopped by the uppers. This arc of closure allows the lower anteriors to be more forward or protruded the more the mandible closes.

Pathologic Anterior Wear

We can state that biting food is done on the anterior teeth or bicuspids which are forward in the mouth. However, the most efficient chewing is done only on the more posterior teeth. This is accomplished by a powerful vertical crushing movement, utilizing the molar cusps, before the dentition is mutilated, not by a grinding motion.

Interestingly, individuals who use their front teeth as tools exhibit an irregular wear pattern at the interface between the upper and lower teeth. The test of this is to move the mandible in a protrusive or lateral protrusive position until the worn anterior teeth are edge to edge. If, with minor adjustment, the occluding surfaces match, then bruxism is the culprit. If they do not, then foreign objects have been regularly interposed between the teeth. This edge to edge positioning of the anterior teeth is not a normal functioning position. Biting food or chewing is best accomplished with the mandible moving toward a centrically related (retruded) position, one where the mandibular condyles can seat and brace in their respective fossae. Think of how you bite through a sandwich. The anterior edge to edge position may be thought of as a “test” position or one of parafunction.

What I’ve observed in the Mesa Verde population who have a full complement of teeth is essentially the same kind of matching of upper and lower anterior teeth seen in our culture where bruxism is a major factor. That is, the upper and lower edges are worn and interdigitate perfectly when placed in an edge to edge position. Remember, bruxism is the cause, abrasives the vehicle, and occlusal disease the effect. You’ve heard the adage that “guns don’t kill people—people kill people.” What we can say is “grit doesn’t destroy teeth—people destroy teeth.”

Some Other Supporting Evidence

Consider with me the amount of wear on the occluding surfaces of young children’s teeth. By the time the first permanent molar erupts, about age 6, the deciduous anterior teeth are usually well worn. Often the dentinal layer is exposed. This has not only been observed in Anasazi children’s teeth, but it is also very common in our society today where added abrasives are absent. Bruxism in children has been studied and found to be widespread (Almad 1986). Many of you may have even heard or observed your own children grinding their teeth. Because children’s teeth are smaller than adults’, the destruction is more obvious.

Another point of interest is the study done by Colyer and Osborne (1965) of Anasazi fecal material at Mesa Verde. Apparently at least some of the coprolites studied contained large
pieces of incompletely chewed material, including small animal teeth. If the advanced attrition came solely from chewing, then it is hard to follow that the Anasazi's chewing was thus incomplete. We are now in the process of studying more completely the coprolites from several Mesa Verde sites.

Some yet unpublished research by P. Scuilli of the Ohio State University's Department of Anthropology (1991, personal communication), during two time periods of the same general locals, revealed interesting facts relative to tooth wear. He measured the crown heights (CH) of the teeth and compared them to the individual's age. The age was computed by means other than dental. The first group were Late Archaic, about 3000 B.P., and the second, late prehistoric about 700 B.P. The latter group could be considered contemporaries of the Anasazi. This study was done only on skulls with no premortem tooth loss and near full complements of teeth.

Scuilli found that the Late Archaic from Lima in west central Ohio, lost about .33 mm of CH per year on the average for anterior teeth and about .2 mm per year of CH for the posteriors. The late prehistoric, from Sandusky near Lake Erie in north central Ohio, lost about .15 mm of CH per year for the anteriors and about .08 mm per year of CH for the posteriors. The second group's attrition was about one-half that of the first group even though both were excessive.

What I discovered, in looking at Scuilli's numbers, was that the late prehistoric, with less overall wear, had even less posterior wear proportionately compared to the Late Archaic. What this implies is that the anterior teeth (i.e., incisal guidance) had to be worn down first before significant posterior wear was evident.

Additionally, Scuilli showed that individuals who had lost some teeth (usually posteriors), exhibited less wear than those with a more full complement. This is exactly the opposite of what he had predicted (i.e., fewer teeth would show more wear if they perform the same chewing function). I extrapolated first that chewing, therefore, was not the only agent in tooth wear (albeit the amount of "grit" may have been different in the two groups). Also, there is less neuromuscular stress with posterior teeth missing and consequently less bruxism. In this case the posterior contact is decreased or eliminated by tooth loss which is another way of quieting the musculature (Williamson 1983).

**Conclusion**

My purpose in presenting these thoughts to you today is to stimulate your interest and to challenge you to rethink the old axiom of tooth wear in light of bruxism. I hope that a better understanding of this attrition phenomenon or occlusal disease and its cause will help contribute to knowledge of the life of the Anasazi. It is my sincere desire that, indeed, it will be a significant piece in the great puzzle of the Anasazi we all seek to know.

Finally, as an outsider to archeology, I am concerned about the Native Americans' desire to retrieve their ancestral remains. This by nature puts pressure on us all to act on the research potential for studies of skeletal material including occlusal disease. If you have access to relevant material, please contact me. Since this is a preliminary report, your insight and wisdom are solicited.

Thank you very much for your interest and attention.

Special thanks to Jack E. Smith, Chief Archeologist at Mesa Verde National Park, for his help, encouragement, and inspiration in the preparation of this paper.
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ANASAZI DIET: VARIETY AND NUTRITIONAL ANALYSIS

Linda Scott Cummings

Abstract

Published analyses of coprolites from Hoy House and Lion House, both Pueblo III sites, are reviewed for their evidence of diet. Both plant and animal portions of the diet are discussed, as they are represented by pollen, macrofloral, and faunal studies. Diets, as represented by these data bases, are examined for nutritional completeness. Probable nutritional deficiencies and strengths of the diet are noted and discussed. Deficiency-related diseases that might have affected these populations, based on interpretation of the nutritional adequacy of the diet, are also noted.

Introduction

Coprolites collected during archaeological investigations at Hoy House (now being referred to by the Ute Indians as Porcupine House) and Lion House during the summer of 1974 have been examined for pollen (Scott 1979), macrofloral, faunal, and parasite (Stiger 1977) data. Material recovered from coprolites is considered to be direct evidence of diet. Hoy House, a large Pueblo III cliff dwelling containing at least 60 rooms and 4 kivas, and Lion House, a slightly smaller Pueblo III cliff dwelling with 46 rooms and 6 kivas, are both located in tributaries of Johnson Canyon, immediately south of Mesa Verde National Park on the Ute Mountain Ute Indian Reservation. Two periods of construction activity are noted at each of these cliff dwellings between 1130 and 1150 and during the early 1200s (Nickens 1977:74). Coprolites examined in this study were not dated other than through association with the occupation of Hoy House and Lion House. Johnson Canyon is peripheral to Mesa Verde in terms of precipitation and would have been more severely affected by climatic
deteriorations or droughts. Environmental stress and drought, resulting in a strain on all levels of the trophic structure, including human and nonhuman food chains, had been postulated for Johnson Canyon. If this postulate is true, evidence of disease and malnutrition should be more prevalent in the Johnson Canyon materials than in coprolite records from elsewhere in the Mesa Verde area. Evidence of possible crop failure for Hoy House is noted in the pollen record for the midden (Scott 1976).

Fifty-nine coprolites were examined from Hoy House and Lion House, indicating that the diet was composed primarily of the cultigens Zea mays, Cucurbita, and Phaseolus, with heavy reliance on the possibly encouraged Cleome and other manipulated or wild plants including Cheno-ams, Oryzopsis, Physalis, and the Umbelliferae. Animals for which the most evidence was recovered include dog/coyote, deer, jackrabbit, birds, and small rodents.

The pollen data from a stratigraphic column in the trash midden at Hoy House (Scott 1976) indicates that a nearly climaxated forest probably existed on top of the mesas near Johnson Canyon at the time of the initial occupation of Hoy House during the mid 1100s and that extensive clearing of arable land on nearby mesa tops began shortly after establishment of the community. This activity appears to have continued with greater efficiency during the second occupation of Hoy House in the early 1200s. The final and rapid rise in arboreal pollen, particularly Pinus (pine) pollen, following abandonment is typical of pollen records from the Mesa Verde district. In fact Martin and Byers (1965:125) state that “The rise in tree pollen is so clear cut that we have come to expect a similar rise in any late prehistoric profile from Mesa Verde which extends through the thirteenth century.” This rise in arboreal pollen frequency is linked to natural reforestation of the area following abandonment rather than to any climatic change.

Pollen samples from a midden at Hoy House provide the only temporal data concerning the relationship between possible use and discard of plants at this cliff dwelling during its occupation. The pollen record from the trash midden at Hoy House (Scott 1976) notes a very large percentage of Cleome (beeweed) throughout the second period of occupation. Zea (corn) pollen is initially moderately high in the lowest sample of this midden, but declines and does not rise again in frequency until shortly before the final abandonment of the site. From this evidence it appears that corn was not as plentiful at this site as might be expected and that people were relying more heavily on encouraged plants such as Cleome, Cheno-ams, and gathered plants. Several workers, myself included, have inferred a population too large for the carrying capacity of the land, possible overuse and exhaustion of agricultural lands, destruction of the watershed, reduction in available calories, and subsequent partial abandonment followed by full abandonment of these sites (Nickens 1977; Scott 1976).

Stratigraphic pollen samples from both Hoy House and Mug House exhibit considerable increases in the quantity of Cleome pollen deposited in trash middens during Pueblo III occupations. While Cleome is noted in trash middens outside the Mesa Verde area, it is only occasionally noted in extremely large frequencies at a time coinciding with a decline in Zea mays pollen.

**Discussion**

The most common elements of the diet for occupants of Hoy House and Lion House, based on coprolite analysis, include Zea mays (maize, corn), Cheno-ams (goosefoot, amaranth, or pigweed), Cleome (beeweed), Cucurbita (squash), Oryzopsis (Indian ricegrass), Umbelliferae (carrot/parsley family), Portulaca (purslane), Physalis (groundcherry), Opuntia (prickly pear), Lepidium (pepperweed), Phaseolus (common beans), Typha (cattail), Pinus (pine), deer, jackrabbit, bird/turkey, small rodents, and probably dog/coyote (Table 1). Remnants of these plants, in the form of macrofloral remains or pollen, and animals, noted from the presence of hair, feathers, and/or bone, were recovered sufficiently regularly from these coprolites to be interpreted as regular components of the diet.
Table 1. Ubiquity of Pollen and Macrofloral Remains.

<table>
<thead>
<tr>
<th>Pollen Type</th>
<th>Presence Pollen</th>
<th>Absence Macrofloral</th>
<th>1st Dominant Pollen Type</th>
<th>2nd Dominant Pollen Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juniperus</td>
<td>59%</td>
<td>3%</td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>Picea</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinus</td>
<td>90%</td>
<td>12%</td>
<td>3%</td>
<td>10%</td>
</tr>
<tr>
<td>Populus</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quercus</td>
<td>56%</td>
<td></td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>Ambrosia</td>
<td>44%</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Artemisia</td>
<td>81%</td>
<td>6%</td>
<td>5%</td>
<td>10%</td>
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<tr>
<td>Compositae</td>
<td>63%</td>
<td>2%</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td>Cercocarpus</td>
<td>56%</td>
<td></td>
<td>24%</td>
<td>27%</td>
</tr>
<tr>
<td>Cheno-ams</td>
<td>100%</td>
<td>32%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleome</td>
<td>95%</td>
<td>5%</td>
<td>39%</td>
<td>15%</td>
</tr>
<tr>
<td>Cucurbita pepo</td>
<td>24%</td>
<td>20%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Cucurbita moschata-type</td>
<td>37%</td>
<td></td>
<td>7%</td>
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</tr>
<tr>
<td>Ephedra nevadensis-type</td>
<td>20%</td>
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</tr>
<tr>
<td>Ephedra Torreyana-type</td>
<td>2%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Eriogonum</td>
<td>5%</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erodium</td>
<td>2%</td>
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</tr>
<tr>
<td>Gramineae</td>
<td>10%</td>
<td></td>
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</tr>
<tr>
<td>Labiatae</td>
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<td></td>
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</tr>
<tr>
<td>Lepidium</td>
<td>19%</td>
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</tr>
<tr>
<td>Coryphantha vivipara</td>
<td>9%</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Opuntia</td>
<td>14%</td>
<td>23%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oryzopsis</td>
<td>54%</td>
<td>3%</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Phaseolus</td>
<td>7%</td>
<td>17%</td>
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<tr>
<td>Phlox</td>
<td>2%</td>
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<tr>
<td>Physalis</td>
<td></td>
<td>28%</td>
<td></td>
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</tr>
<tr>
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<td>2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portulaca</td>
<td>27%</td>
<td>18%</td>
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<td></td>
</tr>
<tr>
<td>Prunus</td>
<td></td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribes</td>
<td>2%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Sarcobatus</td>
<td>17%</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Scirpus</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shepherdia</td>
<td>2%</td>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphaeralkea</td>
<td>7%</td>
<td></td>
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<tr>
<td>Typha</td>
<td>17%</td>
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<td></td>
</tr>
<tr>
<td>Umbelliferae</td>
<td>46%</td>
<td>7%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Zea</td>
<td>95%</td>
<td>95%</td>
<td>5%</td>
<td>7%</td>
</tr>
</tbody>
</table>
Meat included in the diet cannot be recognized either microscopically or macroscopically. Therefore, it is likely that recovery of hair, feathers, and/or bone grossly underestimates meat consumption. Examination of dietary components for nutritional values will focus on these plants and animals as being the most likely regular components of the diet.

Minor components of the diet for which pollen and/or macrofloral evidence exists include *Artemisia* (sagebrush), *Compositae* (sunflower family), *Eriogonum* (wild buckwheat), *Coryphantha* (ball cactus), *Plantago* (plantain), *Prunus* (chokecherry), *Ribes* (currant), and *Shepherdia* (buffaloberry). The pollen record also indicates the presence of several plants that might have been used medicinally, including *Ephedra* (Mormon tea), *Labiatae* (mint family) specifically *Poliumintha* or *Salvia*, and *Sphaeralcea* (globe mallow). Animal remains recorded infrequently include mouse, squirrel, and cicada.

While we cannot reconstruct quantities of food consumed, we can examine diet on the basis of nutritional completeness assuming an adequate supply of food. Recommended dietary allowances, as established by the Committee on Dietary Allowances (Tables 2 and 3), are used as guidelines to identify required quantities of nutrients for health.

<table>
<thead>
<tr>
<th>Category</th>
<th>Age (years)</th>
<th>Protein (g)</th>
<th>Vit A (ug)</th>
<th>Vit D (IU)</th>
<th>Vit E (mg)</th>
<th>Vit C (mg)</th>
<th>Thiamin (mg)</th>
<th>Riboflavin (mg)</th>
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<tr>
<td>Infants</td>
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<td>kg2.2</td>
<td>420</td>
<td>400</td>
<td>8</td>
<td>35</td>
<td>0.3</td>
<td>0.4</td>
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<tr>
<td></td>
<td>0.5-1</td>
<td>kg2.0</td>
<td>400</td>
<td>400</td>
<td>3</td>
<td>35</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
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<td>400</td>
<td>5</td>
<td>45</td>
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<td>0.8</td>
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<tr>
<td></td>
<td>4-6</td>
<td>30</td>
<td>500</td>
<td>400</td>
<td>6</td>
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<td>1.0</td>
</tr>
<tr>
<td></td>
<td>7-10</td>
<td>34</td>
<td>700</td>
<td>400</td>
<td>7</td>
<td>45</td>
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<td>1.4</td>
</tr>
<tr>
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<td>11-14</td>
<td>45</td>
<td>1000</td>
<td>400</td>
<td>8</td>
<td>50</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>15-18</td>
<td>56</td>
<td>1000</td>
<td>400</td>
<td>10</td>
<td>60</td>
<td>1.4</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>19-22</td>
<td>56</td>
<td>1000</td>
<td>300</td>
<td>10</td>
<td>60</td>
<td>1.5</td>
<td>1.7</td>
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<td></td>
<td>263-50</td>
<td>56</td>
<td>1000</td>
<td>200</td>
<td>10</td>
<td>60</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>51+</td>
<td>56</td>
<td>1000</td>
<td>200</td>
<td>10</td>
<td>60</td>
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<td>1.4</td>
</tr>
<tr>
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<tr>
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<td>56</td>
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<td>60</td>
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<td>1.2</td>
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<td>Lactating</td>
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<td>+2</td>
<td>+20</td>
<td>+0.4</td>
<td>+0.3</td>
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</tbody>
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1 ug retinol = 6 ug B-carotene or
= 3.33 IU vitamin activity from retinol
= 10 IU vitamin A activity from B-carotene

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Niacin (mg)</th>
<th>Vit B-6 (mg)</th>
<th>Folic Acid (ug)</th>
<th>Vit B-12 (ug)</th>
<th>Calcium (mg)</th>
<th>Potas. (mg)</th>
<th>Magnes (mg)</th>
<th>Iron (mg)</th>
<th>Zinc (mg)</th>
<th>Iodine (ug)</th>
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<td>30</td>
<td>0.5</td>
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<td>240</td>
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<tr>
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<td>45</td>
<td>1.5</td>
<td>540</td>
<td>360</td>
<td>70</td>
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<td>5</td>
<td>50</td>
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<tr>
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<td>100</td>
<td>2.0</td>
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<td>15</td>
<td>10</td>
<td>70</td>
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<tr>
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<td>200</td>
<td>2.5</td>
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<td>90</td>
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</tr>
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<td>10</td>
<td>120</td>
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<tr>
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<td>1.8</td>
<td>400</td>
<td>3.0</td>
<td>1200</td>
<td>1200</td>
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</tr>
<tr>
<td>19</td>
<td>2.0</td>
<td>400</td>
<td>3.0</td>
<td>1200</td>
<td>1200</td>
<td>350</td>
<td>18</td>
<td>15</td>
<td>150</td>
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<td>18</td>
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<td>3.0</td>
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<td>2.0</td>
<td>400</td>
<td>3.0</td>
<td>800</td>
<td>800</td>
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</tr>
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<td>3.0</td>
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<td>18</td>
<td>15</td>
<td>150</td>
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<td>400</td>
<td>3.0</td>
<td>800</td>
<td>800</td>
<td>350</td>
<td>10</td>
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<td>150</td>
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</tr>
<tr>
<td>+2</td>
<td>+0.6</td>
<td>+400</td>
<td>+3.0</td>
<td>+400</td>
<td>+400</td>
<td>+150</td>
<td>+5</td>
<td>+25</td>
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</tr>
<tr>
<td>+5</td>
<td>+0.5</td>
<td>+100</td>
<td>+3.0</td>
<td>+400</td>
<td>+400</td>
<td>+150</td>
<td>+10</td>
<td>+50</td>
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</tr>
</tbody>
</table>

Source: Committee on Dietary Allowances 1980.
TABLE 3
ESTIMATED DAILY DIETARY INTAKES OF SELECTED VITAMINS AND MINERALS

<table>
<thead>
<tr>
<th>Vitamins and Minerals</th>
<th>Infants</th>
<th>Children</th>
<th>Adolescents</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Age (years)</td>
<td>Vit K (µg)</td>
<td>Biotin (µg)</td>
<td>Pantothenic Acid B-5 (mg)</td>
</tr>
<tr>
<td><strong>Infants</strong></td>
<td>0.5</td>
<td>12</td>
<td>35</td>
<td>2</td>
</tr>
<tr>
<td>0-.5</td>
<td>.5-1</td>
<td>10-20</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td><strong>Children</strong></td>
<td>1-3</td>
<td>15-30</td>
<td>65</td>
<td>3</td>
</tr>
<tr>
<td>4-6</td>
<td>20-40</td>
<td>85</td>
<td>3-4</td>
<td>4-5</td>
</tr>
<tr>
<td>7-10</td>
<td>30-60</td>
<td>120</td>
<td>4-7</td>
<td>4-7</td>
</tr>
<tr>
<td>11+</td>
<td>50-100</td>
<td>100-200</td>
<td>4-7</td>
<td>4-7</td>
</tr>
<tr>
<td>Adults</td>
<td>70-140</td>
<td>100-200</td>
<td>4-7</td>
<td>4-7</td>
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</table>

<table>
<thead>
<tr>
<th>Vitamin (mg)</th>
<th>0-0.5</th>
<th>.5-1</th>
<th>1-3</th>
<th>4-6</th>
<th>7-10</th>
<th>11+</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium</td>
<td>.01-.04</td>
<td>.02-.06</td>
<td>.02-.06</td>
<td>.02-.06</td>
<td>.05-.10</td>
<td>.06-.15</td>
<td>.05-.20</td>
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<tr>
<td>Selenium</td>
<td>.01-.04</td>
<td>.02-.06</td>
<td>.02-.06</td>
<td>.02-.06</td>
<td>.05-.10</td>
<td>.06-.15</td>
<td>.05-.20</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>.03-.03</td>
<td>.02-.06</td>
<td>.02-.06</td>
<td>.02-.06</td>
<td>.05-.10</td>
<td>.06-.15</td>
<td>.05-.20</td>
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<tr>
<td>Sodium</td>
<td>115-350</td>
<td>250-750</td>
<td>325-975</td>
<td>450-1350</td>
<td>600-1800</td>
<td>900-2700</td>
<td>1000-3300</td>
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<tr>
<td>Potassium</td>
<td>350-925</td>
<td>425-1275</td>
<td>550-1650</td>
<td>775-2325</td>
<td>1000-3000</td>
<td>1525-4575</td>
<td>1875-5625</td>
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<tr>
<td>Chloride</td>
<td>275-700</td>
<td>400-1200</td>
<td>500-1500</td>
<td>700-2100</td>
<td>925-2775</td>
<td>1400-4200</td>
<td>1700-5100</td>
</tr>
</tbody>
</table>

Amaranthus) are excellent sources of protein (Table 4). Ground Opuntia seeds are also good sources of protein, as are Portulaca and Eriogonum seeds. Zea mays flour and Phaseolus contribute smaller quantities of protein to the diet per 100 gram serving. Meat, of course, contributes larger quantities of and more complete proteins (Table 5).

Dark green, leafy vegetables and orange fruits and vegetables contribute the largest quantities of Vitamin A to the diet per 100 gram serving. Widely available greens, at least on a seasonal basis, including Chenopodium, Cleome, Portulaca, and to a lesser extent Lepidium greens, are good sources of Vitamin A. Zea mays flour is also an excellent source of Vitamin A, making it the most reliable source on a year-round basis.

Relatively few foods have been tested for Vitamins D and E content. Therefore, it is not possible to address probable quantities consumed in the diet. However, since Vitamin D is synthesized in the body, it is likely that people living in temperate climates spent enough time in the sun for their bodies to function adequately in synthesizing this vitamin. Vitamins B-6, B-12, and folacin were also not regularly reported for most of the wild plants examined, so no interpretation of availability is attempted for these vitamins. We may note, however, that beans and sunflower seeds are rich sources of the B vitamins.

Vitamin C is present in relatively large quantities in many foods consumed by the Anasazi, including Phaseolus, Artemisia leaves, Amaranthus and Chenopodium greens, Cucurbita, Opuntia, Ribes, and Zea mays. Of the storable foods, Cucurbita (squash) and Opuntia fruits are good sources of Vitamin C. Opuntia stems are available for harvest year-round and are also good sources of Vitamin C. Vitamin C appears to have been readily available on a seasonal basis. Because Vitamin C deteriorates in stored foods and is often at least partially destroyed by cooking, it is likely that seasonal deficiencies of Vitamin C were common. Bean sprouts would have been an excellent source of Vitamin C if they were available for consumption during the winter when other fresh vegetables and greens were not.

The best plant sources of calcium in the diet are Chenopodium, Amaranthus, and Cleome greens, Opuntia tunas, and Chenopodium and Amaranthus seeds. Animal bones that are cracked and boiled often add calcium to soup or stew, increasing the calcium value. If fresh greens were not available, it is possible that calcium deficiency was common on a seasonal basis.

The best sources for potassium in the diet are seeds, including Chenopodium, Helianthus (sunflower), Lepidium, Pinus edulis (piñon pine
<table>
<thead>
<tr>
<th>Food Category</th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Cooking Method</th>
<th>Energy (kcal)</th>
<th>Carbo (grams)</th>
<th>Fiber (grams)</th>
<th>Protein (grams)</th>
<th>Fat (grams)</th>
</tr>
</thead>
<tbody>
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<td>Legumes</td>
<td>Phaseolus vulgaris</td>
<td>Common Bean</td>
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<td>9.56</td>
<td>1.92</td>
<td>4.47</td>
<td>0.57</td>
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<tr>
<td>Leaf and stalk vegetables</td>
<td>Artemisia</td>
<td>Sagebrush</td>
<td>Dried/ground</td>
<td>295.00</td>
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<td>2.41</td>
<td>22.76</td>
<td>7.24</td>
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<td></td>
<td>Amaranthus</td>
<td>Amaranthus</td>
<td>Boiled</td>
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<td>4.11</td>
<td>1.31</td>
<td>2.11</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>Chenopodium</td>
<td>Lamb's 1/4/</td>
<td>Raw</td>
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TABLE 4 (Continued)

VITAMINS

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<td>(mg)</td>
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This table was compiled largely with the aid of a computer program Nutricom written and distributed by Joseph Laferriere in which numerous other sources are referenced. These other sources are included in the Bibliography.
# TABLE 5
## NUTRITIONAL CONTENTS OF ANIMAL FOOD REMAINS IDENTIFIED IN COPRITES

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<th>Meat Category</th>
<th>Scientific Name</th>
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<th>Cooking Method</th>
<th>Energy (kcal)</th>
<th>Carbo (grams)</th>
<th>Fiber (grams)</th>
<th>Protein (grams)</th>
<th>Fat (grams)</th>
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## VITAMINS

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<td>--</td>
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<tr>
<td>Liver-Ck</td>
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## MINERALS, ELECTROLYTES, AND TRACE ELEMENTS

<table>
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<tr>
<th>Food</th>
<th>Minerals</th>
<th>Electrolytes</th>
<th>Trace Elements</th>
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<tbody>
<tr>
<td>Cicada</td>
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<td>Deer</td>
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<tr>
<td>Flesh-Raw</td>
<td>10.0</td>
<td>249.0</td>
<td>--</td>
</tr>
<tr>
<td>Dog/coyote</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Grasshopper</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
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<td>Mouse</td>
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<tr>
<td>Liver-Ck</td>
<td>11.0</td>
<td>272.0</td>
<td>55.0</td>
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nuts), and Typha (cattail). Amaranthus and Lepidium greens are also good sources of potassium.

Iron is most abundant in meats and Chenopodium and Cleome seeds, sunflower seeds, Amaranthus seeds, Opuntia seeds, and Artemisia greens. Corn has a relatively low iron bioavailability (1-7 percent), while meat has a higher absorption rate (12-20 percent) (Bothwell and Charlton 1981:11). Corn is certainly not the most important element in the Anasazi diet for providing iron. Indeed, ground Chenopodium seeds are a much more important source for iron.

Evidence of animals represented in the Anasazi diet, based on coprolite evidence from Hoy House and Lion House, includes squirrel, small rodents, sheep, cicada, deer, dog/coyote, gopher, jackrabbit, mouse, and bird/turkey. Presence of bones and other remains in coprolites indicates that meat was probably a common component of the diet. Liver is the most concentrated form of animal iron and was likely consumed by prehistoric peoples, including the Anasazi. Meat likely contributed the majority of the iron to the diet, being supplemented by small quantities from plant sources.

Many of the animals represented in the Anasazi diet were common pests around villages, such as deer and rodents, which tend to frequent agricultural fields. These animals could have been readily hunted in or near the gardens, providing additional meat for the diet and a reduction of pests to the agricultural crops. Turkeys appear to have been kept in increasingly large numbers through time. The utilization of mule deer and jackrabbits appears to have increased, while that of bighorn sheep and cottontail rabbits decreased (Emslie 1977; Stiger 1977:54). Bighorn sheep and cottontail rabbits are commonly found in forested areas, whereas jackrabbits prefer grasses and open shrubby habitats and fields. Deer may be found in both habitats (Shelford 1963:285-289; Stiger 1977:57). Decreases in bighorn sheep and cottontail rabbit consumption, accompanied by an increase in jackrabbit consumption suggests a decline in forested areas and an increase in cleared areas probably used as agricultural fields.

Skeletal analysis of burials from the Dolores Archaeological Program provides the nearest data for examination of physical remains for anomalies. Evidence of cribra orbitalia and porotic hyperostosis are the only nutritional deficiencies in bodies from this area, although there is evidence for growth arrest (Stodder 1987). Because cribra orbitalia may result from a deficiency in iron or possible general nutritional deficiency associated with an insufficient food supply, a large portion of this population appears to have suffered some degree of iron deficiency anemia. Sandford (1984) notes that cribra orbitalia may result from a combination of magnesium and iron deficiencies, age-related stresses including weanling diarrhea, growth requirements, and possibly inadequate dietary intake. The most precarious time of life nutritionally is the “period of transition from breast feeding to a diet of semi-solid and solid foods” (Pearson 1980:3).

Because cribra orbitalia is often associated with iron deficiency, specific examination of factors that contribute to iron deficiency is important. These factors include insufficient iron intake, malabsorption, and iron losses. Synergistic relationships between Vitamins C, B-6, B-12, and folacin and iron absorption may mean that deficiencies of these vitamins contribute to malabsorption or inefficient use of iron (Cummings 1989). Other factors influencing iron absorption include bioavailability of iron, which is higher in meat sources and lower in vegetable sources, presence or absence of phytates, tannins, and fiber, and pathological blood loss resulting from such conditions as wounds, gastrointestinal bleeding, nosebleeds, and menorrhagia, as well as parasitism (Carlson et al. 1984; Cummings 1989; Hummert 1983; Sandford 1984; Sandford et al. 1983; Van Gerven et al. 1981).

Evidence of pinworm infestation was recovered from 7 percent of the Hoy House coprolites. Modern recovery of evidence of pinworm infestation through direct fecal examination is not an effective method for determining pinworm infestation. In fact, a
positive result of 5 percent recovery during fecal examination is expected when 100 percent of the modern population is known to be infested. Therefore, nearly all Hoy House inhabitants were probably infested with pinworms (Stiger 1977:44).

"Iron deficiency is the most prevalent nutritional problem in the world today" (Scrimshaw 1991:46). Iron deficiency is often unrecognized in modern societies and might have been in prehistoric societies, because symptoms are often subtle, including listlessness and fatigue. Iron deficiency can result in diminished work capacity and productivity and increases the possibility of acquiring and dying from infections, because the deficiency impairs the immune system. Iron deficiency is noted most often where diets are predominantly vegetarian. When meats are consumed with vegetables, a larger portion of the iron in the vegetable is absorbed. Vitamin C also enhances the absorption of iron, while tannins, fibers, and phytates inhibit absorption. Iron absorption also increases if the individual is deficient and in need of iron.

Summary and Conclusion

Examination of the prehistoric Anasazi diet for nutritional components indicates that the most likely deficiencies are of water soluble vitamins, which do not store well if the source plant is dried and do not readily survive cooking, and also of iron. Sufficient intake of iron was probably tied directly to quantity of meat available in the diet, although certainly some of the vegetable foods contributed significant quantities of iron as well.

Chenopodium and Amaranthus seeds were a nutritionally important and significant part of the Anasazi diet. Amaranthus seeds contributed large quantities of Vitamin A to the diet. Approximately six times the daily recommended allowance of Vitamin A could be obtained from approximately 100 grams of Amaranthus seeds. Because this vitamin is stored by the body, it is unlikely, given the diet of the Anasazi, that they were deficient in this vitamin. Ground Chenopodium seeds are also high in calcium containing approximately three times the quantity of calcium as Amaranthus seeds. Either seed, however, made a valuable contribution to the calcium intake in the diet. Opuntia (prickly pear) tunas are also excellent sources of calcium. Chenopodium seeds contain a large quantity of potassium, approximately five times that contained by Amaranthus seeds, although both appear to have been good sources of potassium. Chenopodium seeds are also much better sources of iron than are Amaranthus seeds. Approximately 100 grams of ground Chenopodium seeds contain two to three times the amount of iron necessary per day for a healthy male or female adult. However, because iron is not readily bioavailable from plant sources, it is likely that several hundred grams of ground Chenopodium seeds would need to be eaten to actually provide the recommended daily amount necessary.

While fresh Chenopodium and Amaranthus greens are good sources of Vitamin C, as are other greens, the seeds are relatively poor sources, containing approximately one-tenth or less the quantity of Vitamin C per unit weight as the greens. The best sources of riboflavin are Opuntia (prickly pear) buds and Physalis (ground cherry) fruits. Sunflower seeds and Opuntia (prickly pear) buds are high in niacin. Figures and quantities of folate or folacin are not available for many native plants, so none have been identified as good sources of this nutrient.

Coprolite studies demonstrate that the Anasazi diet included many more plants than the often referenced triad of corn-beans-squash. The assemblage of plant and animal foods recovered from the coprolites at Hoy House and Lion House is very similar to that noted in coprolites from other Anasazi sites. The total complement of foods selected and consumed by the Anasazi appears to have provided a good nutritional base for healthy living. Insufficient quantities of food (and hence calories), seasonal deficiencies of fresh greens, and periodic hunting failures were probably the cause of the majority of the nutritional problems associated with the Anasazi diet. Seasonal availability of greens high in Vitamin C and destruction of this vitamin during storage were probably
important contributing factors not only in conditions directly occurring from Vitamin C deficiency, such as scurvy, but also in iron deficiency anemia, because Vitamin C is important in facilitating iron absorption. Perhaps these seasonal fluctuations are responsible for the historic practice of sprouting beans in kivas, which is common among modern Pueblo Indians. Bean sprouts are an excellent source of Vitamin C at a time of year when the diet is deficient in this nutrient. Decrease in diversity of the Anasazi diet resulting from heavy reliance on cultigens in response to increased population pressures would also have had an adverse affect on the nutritional adequacy of the diet.
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I don't know whether I'm happy to do this or not. Because it has been such an exciting two and one-half days, I'm kind of sorry to see it come to an end.

In 1981, we did the first Anasazi Symposium here at the park, and that was such a great time that we wondered if we might be pushing our luck to try it ten years later to see if it would come off as well. I think it really did. I think it's just been a great time, and I hope you all feel the same. The papers, discussions, questions, after hours, during breaks, during the social hours, exchanges we have had all have been stimulating, interesting, and very provocative. I think it has been a true symposium; it has been a congenial gathering for exchange, sharing of ideas, discussions, and so forth.

How do you sum this up? I think I actually just did. I think that has sort of been the heart of what we have been about for the last two and one-half days. We have heard lots of new ideas, new approaches to old subjects, and accounts of interesting work in many different areas dealing with the Anasazi. Dave Stuart certainly launched us with an exciting and interesting discussion, and the other speakers all along the way have carried that spirit and carried that feeling very well. The success, of course, is due to all of you—the speakers, those people who came and asked questions, listened, just participated, and shared in this whole endeavor. I think that now what we need to do is to go home and digest it all, think it over, mull over some of the ideas, and give it a lot of thought.

In winding this up, I would like to give some special thanks. First of all to Superintendent Robert Heyder, who has supported and encouraged this all along the way since its inception.

Special thanks to Dr. Dixon, who came up today and presented Jim Lytle's very provocative paper.

I would like to thank the ARA-Mesa Verde Company for providing for all the coffee breaks, the cocktail parties, the excellent meal we had the other night, and just helping to
kind of lubricate the whole symposium.

Thanks to the Mesa Verde Museum Association for agreeing to publish the Proceedings of this symposium and for helping us with the various announcements and other published pieces that we have used to attract all of you to Mesa Verde.

Two particularly helpful people have been Margie Pruitt and Becky Brock, who took time from their secretarial duties to help with the registration, to run errands, and generally to smooth the process, answering questions and helping people along the way.

I would like finally to offer special thanks to Art Hutchinson, who has been present throughout this whole thing. He has been shepherding this entire symposium; and it was his hard work organizing, arranging, getting everything together over the past four weeks that has made this symposium possible. He has done a sterling job, and he certainly deserves a little appreciation.

As far as the future is concerned, I hope that others will again take up the idea as they did in the intervening ten years since the first Anasazi Symposium so that there will be other Anasazi Symposia in various other places. Maybe ten years from now we can do it again up here. I hope that I will be here again, and I hope that all of you will be here again too.

On behalf of the whole park staff and the contributing groups that have all helped to make this worthwhile, thank you very, very much.