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The Legacy of William Curry Holden: Texas Archeological Society Founder and Texas Tech Renaissance Man[1]

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Archeology has changed markedly over the last 80 or 90 years—as has the cultural context in which it was embedded. From the 1920s until World War II, disciplinary boundaries were lower and the distinctions between avocational and vocational archeologists were sometimes blurred. More than a decade ago, the late Mott Davis wrote about the early history of archeology in Texas in which enthusiastic individuals not trained in anthropology and/or archeology played key roles (Davis 1992). He noted that this kind of history of the emergence of archeology was not atypical for other parts of the United States in the 1920s and 1930s. He recognized James E. Pearce and Cyrus N. Ray as the two primary founding pioneers, listing my dad, William Curry Holden (Figure 1), as a third pioneer, while noting that his influence was not as great as that of either Pearce or Ray. Whether or not Curry should be regarded as a founding pioneer for the entire state, he certainly played a significant role in the development of West Texas archeology between the late 1920s and the 1950s.

I want to set the stage with something about the background of my dad and his family because he was definitely a product of that background. He was born in Limestone County, in East Texas, to Robert Lee Holden and Grace Davis Holden in 1896 (Figure 2). Both of his parents were born in Arkansas. Robert E. Lee Holden was the first of his immediate family to ride into Texas (on a horse named Rowdy) in the early 1890s. After a year, he returned to Arkansas to tell the family he was moving south. His parents and siblings soon followed. Grace Davis was already in Limestone County, having been taken from Arkansas to Texas as a small child in the 1870s.

The saga of the Holden family nicely illustrates one pattern of settlement of Texas. In this case, related families moved across the southern states

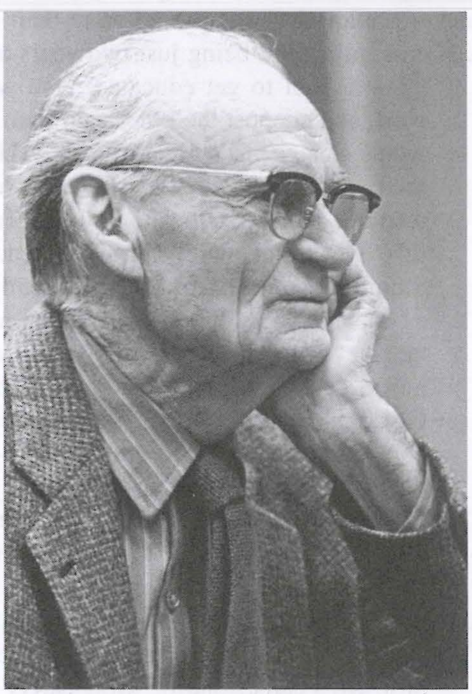

Figure 1. Curry Holden.

Figure 2. Curry about 1896 or 1897.

to Arkansas and thence to Texas. Within Texas, they progressively headed roughly west and southwest in clusters that broke up and reformed in different places. The first big family move within Texas was a jump from Limestone County to Colorado City in Mitchell County—a trip made on the train. Grandpa Davis is said to have had itchy feet, and was always wanting to move. So Robert and Grace regretfully sold a section of good farmland and moved back east to Macauley, and from there to Rotan (Figure 3).

Figure 3. The Holden clan about 1907. Grandma and Grandpa Holden are seated center front, with their sons and one daughter and their spouses and children. Curry is to the right of Grandma Holden and in front of his mother, Grace Davis Holden. Robert Lee Holden, Curry's father, is to Grace's right.

The three Holden brothers of Harral, Curry, and Tom did most of their growing up on a farm in the community of Pleasant Valley near Rotan. Their dad was a carpenter, builder, and farmer. The lure that took them to Rotan was the idea that the railroad would go through the town. In anticipation, there was a spurt of building, and Curry's father built many of the buildings on Main Street. He also bought some land in shinnery country that he and his sons broke for plowing. After the railroad bypassed Rotan, and the building boom collapsed, Robert turned more of his attention to farming, although he continued to use his carpentry and building skills for the family and others. The family was dirt poor, as Tom said, but they owned the dirt (T. Holden n.d.). And they were not a lot poorer than some of the other farmers around them. Pleasant Valley, although small, had a very strong sense of community, as is suggested in a photograph of a community cotton picking for the Pleasant Valley Church (Figure 4).

Grace had been a teacher, and Robert was self taught, and one of the most informed citizens in his community. They both had a high respect for reading and education that was passed on to their children. Harral and Curry, being just two years apart, made a pact to get educated. One would work and support the other, and then they would change places. Unfortunately, Harral died young and Curry had to provide the resources for his education alone. He did this by getting qualifications to teach at Stamford College, and teaching locally for a couple of years. In 1920, when he was 24, he went to the University of Texas, where he worked his way through joint majors in Government and History in three years, and completed his Ph.D. in another four—all the while holding various kinds of jobs. His interest in politics and government was initially stronger than his commitment to history, but he tilted toward history, with Eugene Barker as his doctoral supervisor. This part of his life story is not unlike that of J. M. Pearce, one of Mott Davis' two pioneers, except Pearce was never able to

Figure 4. Communal cotton picking for the church in Pleasant Valley.

finish his Ph.D. Like Pearce, my dad put in time at other universities, with summer schools at the University of Chicago and University of Colorado.

The three historians who influenced Curry most were W. E. Dodd at the University of Chicago during a summer course there, Eugene C. Barker, his supervisor and mentor, and, interestingly, Walter P. Webb of *The Great Plains* fame (Webb 1931)—a book that was itself a product of much the same factors as those that influenced Curry (Holden 1967-1968). Curry actually participated in a series of seminars with Webb at the University of Texas, and noted that Webb's chapter on the buffalo was essentially his own term paper from one of the seminars, a paper that he himself later used in his own Ph.D. thesis, *Alkali Trails*.

I have no idea if my dad knew Pearce in Austin. I never heard him talk about him. Pearce was sometimes identified as a historian, or an institutional historian, and he oversaw the shift from a department of Institutional History to the founding of an Anthropology department. Mott Davis sees "real" archeology as beginning when Pearce hired the University of Chicago-trained Gilbert McAllister for the anthropology department in the late 1930s. I had courses with McAllister in the early 1950s, and he definitely had a negative attitude about the quality of anthropology at Texas Tech, which, of course, meant my dad. Although I was entering the Master's program, McAllister insisted I take his beginning anthropology course, and this was the beginning of a distant but lasting friendship.

Pearce was at the University of Texas the entire time my dad was attending university, but I do not think my dad took any courses in that other department. Credit for the Holden family entry into anthropology must be given to my mother, Ira Olive Price Holden. It was my mother who took courses from George C. Engerrand in the mid-1920s, presumably in the department Pearce headed. I later took courses from Engerrand in the early 1950s when he was certainly in his 80s. (It was said that he never put his birth date on any document, and so the university had no legal grounds to retire him). Engerrand, incidentally, served on the founding board of the Texas Archeological and Paleontological Society (TAPS).

Partly through her courses with Engerrand, and partly through her training as a librarian, she developed a passionate and rather romantic interest in American Indians. This showed in the pueblo architecture of the house she designed on 20th St. in Lubbock, now a designated historical building by the state of Texas (Figure 5). When she and my

Figure 5. Curry and Olive Holden about 1933 in the Puebloan style house that Olive designed.

dad spent a summer in Chicago, she dedicated her time to copying out large sections of Schoolcraft (1884) by hand—that being in the pre-copier era. She read widely in the anthropological literature of the 1920s and 1930s, being especially fascinated by Southwestern groups and what she regarded as the beautiful poetry of translated Navaho myths and rituals. As a librarian, she did much of the search/find/annotate/copy/and show-to-my-dad of the relevant literature of the era.

Even before he finished his Ph.D., Curry was teaching history full time at McMurray College in Abilene, where he met the second pioneer chronicled by Mott Davis: Cyrus N. Ray. Dr. Ray was an Abilene osteopath with wide interests that ranged from mineralogy, to breeding irises, and to phosphorescence in earthworms (Davis 1992:208). As Mott notes, "he rode his hobbies hard," and he was "energetic, forceful, opinionated, courteous, upright and stubborn." Curry called him "a pack-rat with an inquiring mind" (Holden 1967-1968). I can remember enough about him to verify that he was indeed opinionated and stubborn, and to this list I can add: he was loud. Since my dad was one of the founders with Ray of the TAPS in 1929, and since we moved to Lubbock in the fall of 1929 when my dad accepted a job in the history department at Texas Tech, I assume that my dad knew Ray from Abilene, and had worked with him there.

Curry remembered that the Texas Archeological and Paleontological Society had been founded by Cyrus Ray, Ted Sayles, and himself (Holden 1967-1968). He mentioned that they got a number of West Texans to support the venture who had no interest in archeology per se, but who felt that it was worthwhile to support such ventures, presumably as part of the overall advancement of West Texas from frontier status to a more 'cultured' state. He mentioned a McMurray College faculty member and several men from Hardin Simmons, both in Abilene, as showing such support (Holden 1967-1968). In the same vein, Curry was one of those who were instrumental in creating the West Texas Historical Society in the same year that TAPS was founded, and he worked with that Society as much as he did with TAPS.

Ted Sayles worked with Ray in Abilene, published in the TAPS bulletin and served as the first vice president of the society. He later got a job with Harold Gladwin at Gila Pueblo (from whence he conducted the 1933 survey of Chihuahua—a marathon venture of great interest to me in my present work). The Ray/Sayles relationship deteriorated (as, seemingly most of Ray's relationships did sooner or later), with Ray later referring to Sayles as "that professional bushwacker and credit stealer" (Letter from Ray to W. C. Holden, quoted in Tunnell [2000:47]).

Mott Davis noted that Ray wrote to Hooton and other notables about his beliefs that his Clear Fork Culture was very old (as old as Folsom) and that the people were physically primitive. My dad told a related story in which Ray attended a meeting of the American Anthropological Association (AAA), setting up a table outside of a session he knew Hooton would attend. At the end of the session, he stood at the table beating together two femurs from a deeply buried site to attract Hooten's attention, which he did. Whether it was the letters, or the side-show at the AAA, Hooton (1933) published an article in the TAPS bulletin on five of the crania.

I remember Dr. Ray attending a TAPS meeting in Alpine in the early 1950s. The entire group was taken across the border to Ojinaga for supper. Ray strode around the place (and I use that verb advisedly) announcing that he could read Spanish—and fluently reading out the words Coca Cola, Ford, and the like.

Mott gave Ray credit for being more than a curio collector, as having a sense of the importance of cultural context, and—most importantly—as having a firm enough appreciation of science to establish a respectable journal that was rapidly accepted across the United States by high status anthropologists. However, Ray's own archeological work was so chaotically organized that Marie Wormington said that "the only way to approach the publications dealing with this area is with a large bottle of aspirin in either hand" (Wormington 1944:39-40, quoted in Davis [1992:209]).

I wonder, with no real knowledge, if one of my dad's contributions to the development of Texas archeology was to keep Cyrus Ray from self destructing. Judging by the correspondence published by Curtis Tunnell (2000), and the fact that Ray put his precious collections into the Museum at Texas Tech, it seems as if Ray never came to blows with Curry. Perhaps Curry provided a balancing factor that allowed that portion of the fragile boat of early Texas archeology represented in the structure of the TAPS to continue to function.

As one of the founding members of TAPS, my dad was quite active in the society from 1929 until at least 1950/1951. He was on the board for two decades, and was Editor of Publications for 1948/1949 and 1950/1951, taking over directly from Cyrus Ray who had been Editor from 1929 to 1948. I have the feeling that the division of labor was not as well defined as position titles published in the Bulletin might lead one to believe. Curry told the story of the way in which he managed to get out an issue of the *Bulletin of the Texas Archeological and Paleontological Society* during the depression, when membership in the society fell and their finances could not cover the production of a volume, this at a time when he was not the official editor. As Head of the Department of History at Texas Tech, he had left-over funds of $120. He requisitioned enough "files" to account for the $120, and used the money for the Bulletin. This sort of expedient problem solving was entirely characteristic of him.

He published four articles in the Bulletin and attended many of the annual meetings during those years. My dad's account of early TAPS meetings in Curtis Tunnell's interview brought back memories to me of all the people mentioned, from Judge Simms to Colonel Crimmins (Tunnell 2000). However, as a child I was not privy to the Lasso tequila at Judge Simms open bar, or to my dad's own Baptist (non-alcoholic) and Episcopalian (alcoholic) punches served when the TAPS met at the Museum in Lubbock.

It is interesting that in the years between leaving Rotan/Pleasant Valley for Austin, and the early days in Lubbock, my dad had not only left the farm behind, but he had abandoned the total abstinence patterns of his upbringing. In fact, he came to delight in bringing back tequila and other libations across the Mexican border, and I once counted a large number of bottles of tequila in a locked room in our basement. He specialized in frozen daiquiris during the 1950s, turning to margaritas for subsequent decades.

Not only does Curry's involvement in archeology date back to his McMurray days, but his entry into the museum field can be traced to this period. There was a problem of boys at McMurray stealing chickens and the like. The college president asked Curry to do something about this. He got the chicken stealers interested in local history and collecting local historical objects, taking over a small stone building that had been a dressing room for a sports team for a museum.

Dr. John C. Granberry, head of the history department at Texas Tech, invited Curry to leave McMurray and come to Texas Technological College, as it was then called, in 1929. Granberry is listed as a Regional Vice-President of TAPS from Lubbock in the first volume of the Bulletin, and I wonder if he and my dad were already interacting. Perhaps Granberry was one of those West Texas scholars who supported a range of cultural societies for the greater good of West Texas. In Curry's Southwest Collection interview, he credits a former McMurray student, who moved on to Tech to further his education, in interesting Granberry to hire him.

Upon arrival in Lubbock, Curry was put in charge of the collections that had gravitated to the young university on the basis of his McMurray "museum" experience. The collections were then housed in the ill-lit attic of the Chemistry building in a chicken wire enclosure. The thing I best remember was a stuffed two-headed calf.

From this beginning, Curry slowly built a museum from a hole in the ground, through the give-a–brick campaign, to the basement plus two stories-plus-attic building that filled out two sides of an proposed square that was finally completed many years later. Along the way he master-minded a great pageant based on Coronado's entry into Texas—complete with horses—at the Lubbock fair grounds for the 1936 Texas Centennial.

In my dad's credo, things had TO GET DONE. You did that by identifying needs and opportunities, and then by bulldogging through whatever seemed the best path at the time, as was illustrated by the way in which he got out a depression era issue of the TAPS Bulletin. You made opportunities, and you did not have to be an expert in a field to get involved. This is nowhere better illustrated in my dad's case than in the story of how Texas Tech got into the business of offering Ph.Ds, a story I take from a Texas Tech Ph.D. dissertation by Betsy Goebel Jones (1983). My multi-purpose dad was Graduate Dean at the time (as well as Museum director and head of the History department), under President Wiggins. In that role, he had been attending the Southern Conference of Graduate Deans for some years and observing how they operated and the standards that applied. He and Wiggins decided that nothing succeeds like a *fait accompli*. They agreed that four departments met the standards required for offering a Ph.D. They decided to go for it—*without* legislative approval, *without* approval from the Board of Governors, *without* approval from the Southern Conference of Graduate Deans, and *without* consulting the four departments selected. The latter discovered their new degree granting status when the annual calendar was put into their hands. My dad was later quoted as saying, with regard to the Southern Conference response, that they "appointed a committee to come out here and they toured and read and ripped and roared... But it didn't make any difference. It was done and done as well as if we'd had 400 committee meetings about it. It was time to do it, and we did it" (Jones 1983:114-115).

Curry jumped into field archeology with brashness equaling his becoming a Museum person, or his *fait accompli* of moving Tech into Ph.D. granting statue. His first field work was a disastrous affair that I never heard him discuss, but it is rather gleefully related in the Tunnell (2000) interview, and written up as his first article in TAPS. It seems that while he was still at McMurray, one of his "boys" (possibly one of the chicken stealers) had graduated and taken a job in Perryton. He wrote to my dad to say he had found a "buried city" at Wolf Creek, in the Panhandle, and that his old professor ought to get some of the "boys" and come up at Easter, 1929, and they would dig it out. Curry got three or four "boys" (judging by the photo in Tunnell [2000:12], which does not include my dad, contrary to the caption) and they proceeded to throw the dirt out of two slab-outlined rooms. One of the boys let people in Abilene know about the lost city, and this news hit both the Associated Press and the United Press. However, it turned out that the city was not lost at all, and was just one of many sites Floyd Studer of Canyon had recorded along the Canadian River between the New Mexico and Oklahoma lines. Studer was not pleased with the publicity about a site he knew well, and whose location he had been trying to keep secret to avoid such looting episodes. In time, Studer and Curry became good friends and fellow promoters of archeology, and it was Studer who encouraged Curry to dig at Saddleback Ruin.

The following year, after the move to Texas Tech, Curry ran a summer course that established a pattern for some of his anthropology and/or archeology summer courses for the next decade or more. This first group of students headquartered in an abandoned Forestry house at the San Geronimo Ranger Station near Las Vegas, New Mexico. Armed with nutritional advice from the Department of Home Economics, and food purchased in bulk, the group did their own cooking, had lectures, and, using the many boxes of books taken along, wrote term papers on some topic. Tecolote was nearby, and they visited the site and must have excavated there since there are collections from Tecolote in the Texas Tech Museum. The last week they did a camping tour of Santa Fe and Chaco Canyon (T. Holden n.d.).

In 1931, Curry moved into active fieldwork in the Canadian valley at Saddleback ruin (Holden 1933)—work that later formed the basis for Alex Krieger's (1946) Panhandle Aspect. After the Wolf Creek episode, this was his first "real" excavation, and— according to his brother Tom (who accompanied Curry on many of these 1930s excursions)—Curry was determined to do it "by the book." He seems to have gained some idea of excavation techniques from reading Moorehead's (1931) accounts of digging along the Arkansas River.

In 1932, Curry began work at Arrowhead Ruin, near Pecos. Again his brother Tom went along. They lived at the Arrowhead tourist court, then owned by the Slaughters. One of the students, J. M. Kayser, was chief cook and truck driver. The site was located on a mesa with a view of the mission at Pecos Pueblo several miles to the east. It was one of the several sites that grew up around Pecos in late prehistoric times. The squarish eastern room block contained a central plaza and an unusual D-shaped kiva. Several rooms and the kiva were excavated over the next 15 or so years. My dad, who had inherited his father's carpentry and building skills, reconstructed the kiva and a two-storied portion of the room block (Figure 6). At least one Master's thesis was written on Arrowhead Ruin, and I eventually wrote a short summary of it (J. Holden 1955).

The Arrowhead field seasons always included lectures on Rio Grande pueblo ethnography, attendance at rain dances (often at Santo Domingo), visits to San Ildefonso and Maria Martinez, visits to other pueblos, Saturday trips to Santa Fe, and a camping trip to major sites around the Southwest, always including Chaco, Mesa Verde, and Canyon de Chelly. In those days, we camped inside Pueblo Bonito! At least once, we attended a Hopi snake dance. My childhood memory of that event concerns not the Snake dance itself, but the fear of the Texas Tech group at their camp at the base of the mesa that night. The atmosphere of fear, that must have been quite pervasive for it to have entered my memory as it did, arose from the fact that so many rattlesnakes had just been turned loose in the vicinity.

My dad said that he and some of his students went to the first Pecos Conference—at Pecos—and they were snubbed and made to feel unwelcome by the "real" professionals like A. V. Kidder. This does not square at all with the account in Richard Woodbury's (1993) book on the History of the Pecos

Figure 6. Curry reconstructing the kiva at Arrowhead Ruin, 1930s.

Conference, where there is a list of all attendees from all conferences, and my dad's name does not appear. Nor do I feel that Kidder would have behaved in such a superior way, since he always seemed to me (and to others) to be such a nice gentleman. I can hardly conceive of Kidder being anything but polite.[2] On the other hand, I do not think my dad would have made up a story of that sort. So, who knows what happened? If nothing else, the story indicates the degree of isolation that my dad felt in his archeological work from "real" professionals during those early days.

Throughout the 1930s, my dad mostly alternated summer seasons between Arrowhead Ruin and taking groups of students to Mexico City, where they stayed in the Hotel Monte Carlo (with its drive-in lobby), and had lectures on all manners of topics dealing with Mexican history and prehistory, wrote papers on selected topics using the transported library, toured accessible sites and museums, visited the buildings with the Diego Rivera murals, ate at Sanborn's, thereby providing a rich cultural experience for West Texans. I went along in 1934 and 1938 (Kelley 2008).

Curry also found time to excavate Murrah Cave, a dry cave in the Big Bend area, which is one of the few actual cave sites in that region, as opposed to rock shelters. He routinely responded to requests for an archeologist to come look at sites and artifacts. For example, Jean Quinn and I went along on the Finger Cave exploration just off the Caprock, and my dad insisted that we be the ones to write it up, thereby giving me my first publication (Holden and Quinn 1949). One of his favorite stories concerned a Clovis point that someone had brought to him in the early 1930s. It was left on his desk as home, and, as the story went, I found it, took it outside, and promptly lost it. It is believed to reside under the pavement of 20th Street. My dad always ended the story by saying that because of my guilt in losing the Clovis point, I was forced to become an archeologist to expiate that particular sin.

My dad's teaching ability formed another aspect of his impact on West Texans. There was already an anthropology course on the books at Texas Tech when he arrived there in the fall of 1929, and he was assigned that course as part of his teaching duties. He wrote away for Kroeber's textbook and stayed one lecture ahead of his students. The course proved popular, and, in time, more courses were offered and more students took them. By 1936, a Master's degree was offered at Texas Tech in anthropology, which, insofar as I know, only involved archeology from its inception until well after World War II. I once heard Clyde Kluckhohn at Harvard discuss a survey he had done of graduate programs in anthropology at different dates, and in 1936, there were, as I recall, only 13 universities in the entire U.S. offering graduate programs, and one of these was the Master's program at Texas Tech set up by my Dad, the sole person doing or teaching anthropology from 1929 to after World War II.

I took all of the Anthropology courses offered at Texas Tech between 1945 and 1949 from him. He was a superb storyteller, and he made every lecture a story. He would get the entire class so wrapped up in the story of the day that if he ran 15 minutes or even half an hour over time, no one started packing up their books to leave at the designated hour.

He was teaching Evolution in the Bible Belt, and he was teaching anthropology of race in a racist area. There were occasional knee jerk responses to the evolutionary teaching and museum displays. I can remember such a time in the early 1940s. The West Texas Museum was just a basement containing a few cases depicting human and faunal evolution—as well as a very popular shrunken head exhibit and the durable two headed-calf. A fundamentalist minister stood just off campus on Broadway and College Ave. (as it was then), and handed out pamphlets about the heresy in the subterranean den of iniquity. Of course, all of us who volunteered or worked in the museum had to go by and pick up copies.

Later when I taught introductory anthropology at Texas Tech, I too received a series of reactions from fundamentalists. My favorite concerned the man who refused to believe in Clovis age mammoths. At the time of that particular class, the Clovis site was actively being investigated by individuals from different institutions, and five mammoth skeletons were exposed at the same time. I told my class that this was the chance of a lifetime to see so many exposed Clovis mammoths, suggesting that if they could arrange it, they ought to pay a visit that weekend because the mammoths would soon be removed. One man simply couldn't believe that there were "elephants" of that age. They were, if I would but admit it, circus elephants. He said, very sincerely, that he knew that I was such a nice "girl" that I couldn't possibly believe that, and if I would tell him who was forcing me to tell such lies, he would set them straight.

On the subject of race, I suppose you could call my dad an enlightened racist. He grew up in a rather pure white environment where there was a single Lebanese shopkeeper and one Jew in town. He may not have seen a black person until he was in his late teens in 1914 when blacks were brought into the Rotan community from the Dallas area to pick cotton for the first time. Earlier, there was a black cook at the Rotan hotel whose presence was known, but he was virtually invisible to local inhabitants. Curry knew that his mother's family, the Davises and/or the Trammels, had owned slaves in Arkansas before the Civil War (although the Holdens' had not), and both his maternal and paternal grandfather's had been in the Confederate army. Indeed, Curry's own father was named for General Robert E. Lee. I suspect that stories of the Indian wars (also embodying a strong dose of racism) were probably of greater interest to boys of his era in West Texas than stories of slavery, since the Indian frontier involved their own geographical area and was quite fresh in living memories (Figure 7). I can remember Saturday evenings in the 1930s when the Indian Wars dominated the story telling of get-togethers of the Horsethieves (see below), with at least one person, K. N. Klapp, giving what seemed to me, as a child, to be first-hand accounts of battles (but that I now suspect were second-hand), with all participants well informed on this topic.

When discussing race in anthropology classes, my dad would say that his own views had been formed by the time and place he had been raised, and he knew his views were not in line with anthropological views. However, what the class had to know was what the textbook said, and the main texts, year after year, tended to be by Kroeber, Hooten, and Linton.

Insofar as I can remember, he had relatively few students go on to become professional archeologists. Although several Master's theses were written on the Texas Tech summer school archeology projects—none were by people who went on to become archeologists. Joe Ben Wheat was, of course, the first of those from Texas Tech who made a name for himself in professional archeology. Earl Green did important work in Early Man studies. I suppose I should include myself since I became a professional archeologist—more or less in spite of myself. A number of people associated with the 1950s Sierra Blanca field schools went on to become archeologists, but by then my dad was not very involved in the actual operation of the field schools.

Figure 7. Curry dressed up with guns and knives, 1920s, perhaps illustrating his fascination with the "Wild West."

Joe Ben Wheat, a young man from Van Horn, was at Texas Tech when a high school student bought the first Folsom point from the Lubbock Lake site to my dad's office in the museum. Joe Ben undertook the initial work at the site, under the auspices of my dad and the museum. He went on to become the first Ph.D. out of the brand new Ph.D. program at the University of Arizona, beating out Charles Di Peso by a nose. He distinguished himself first with the monograph on the Mogollon culture (Wheat 1955), subsequently carving out other large niches for himself in Early Man studies as well as becoming a noted authority on Navaho weaving.

Earl Green was a crucial part of the 1950s Texas Tech field schools. He received his Ph.D. in geology and paleontology from Texas Tech, and worked at the Lubbock Lake and Blackwater Draw sites, and was, briefly, the director of the Museum here, before moving to Texas Parks and Wildlife.

I cannot say that either Joe Ben or Earl were really trained by my dad. Joe Ben was already interested in archeology by the time he got to Texas Tech. He had roamed the country around his hometown of Van Horn as a boy collecting arrowheads. However, it is fair to say that both Joe Ben and Earl got their first opportunity to do "real" archeology under the auspices of my dad, as I did. Personally, I have always felt the lack of having attended a field school like Point of Pines. Instead I carried out seven field seasons with the Sierra Blanca field schools on a shoe-string budget and learn-as-you-go basis: with the result that there was much that I never learned that I would have had the opportunity to learn in a more structured field school. When faced with the two tons of collected materials from which to extract a Harvard dissertation (rather than the settlement pattern study of Tula I had envisioned), I had to perform a large-scale salvage operation (Kelley 1984). My dad provided a major assist to my dissertation by acquiring the use of the hayloft of the old dairy barn on campus and setting up three rows of trestle tables running the length of the hayloft that allowed me to lay out two tons of collections. This kind of space providing visibility of the entire collection was a luxury I never again experienced.

After World War II, Curry handed off much of the summer teaching to another ranching historian, Bill Pearce. I dug at Arrowhead under Bill Pearce's direction in 1948, and Bill took the Mexico City summer course in 1949, and I was along on that one as well.

My dad's ethnographic and historical forays into Sonora were perhaps less stimulated by his anthropological interests than they were by the allure of stories about the Yaqui wars. These stories shared much with the stories of the Wild West that were common at the weekly Saturday night gatherings of an unchronicled group called the Horsethieves during the 1930s and later.[3]

In 1932, or thereabouts, Curry met a retired Border Patrolman named Williams who had worked for years along the Arizona border out of Nogales. He had seen a lot of Yaquis and gotten interested in their history; he told Curry about them. I do not know where Curry met Mr. Williams (perhaps in Van Horn), but their conversations captured Curry's attention. In 1934, Curry put together the first Yaqui expedition.

Curry had known a Mexican named Ramon Beteta at the University of Texas. Ramon Beteta (who moved up in Mexican politics through the PRI, and eventually became the Secretary of Hacienda, or Secretary of the Treasury, under President Miguel Aleman) was an asset in the dealings with both Mexicans and Yaquis and in arranging the trip. Rosalio Moises (whose life story was later published as *The Tall Candle*, Moises et al. 1971) was the Yaqui interpreter for the group, thereby beginning a 40 year relationship between Moises and the Holdens.

The two Yaqui expeditions of 1934 and 1936 occurred within a very few years of the last major Yaqui uprising, and there was still a strong Mexican military presence in the Yaqui towns. These trips had a great deal of public support and attention since notable local citizens went along, including: Charlie Guy, the editor of the *Lubbock Avalanche Journal*, who sent back regular columns to his newspaper; Dr. Charles Wagner, who excised Mexican bullets dating from the Yaqui wars out of Yaqui men in a surgery set up under mesquite trees; Dr. Armstrong, who treated chronic eye problems among the Yaqui in Torim; Dr. Studehalter, a Texas Tech biologist, who recorded Sonoran flora and fauna; and Bill McMillan, a local builder and contractor, who studied the *jacal* style houses in the Yaqui villages and filmed the Yaqui Easter ceremony. A truck driver, a Harvard physical anthropologist named Frank Seltzer, and my dad, as chief honcho, rounded out the intrepid group (Figure 8).

A slim and rather odd ethnography published by Texas Tech was based on these trips, with chapters by the different expedition members (Holden et al. 1936). By the standards of today's anthropology, that slim volume makes rather strange reading when it describes women "screeching" at a funeral.

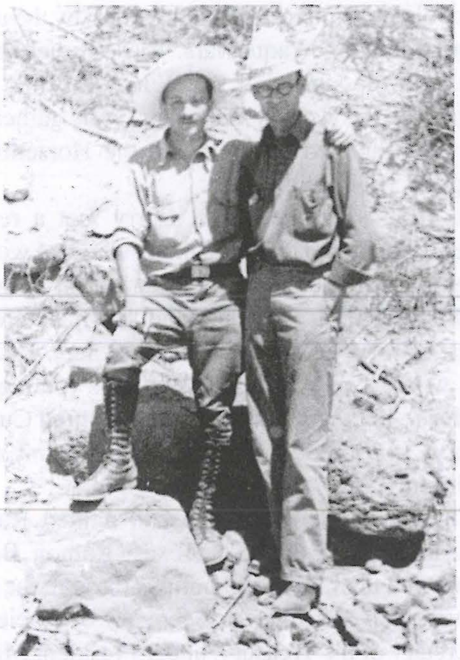

Figure 8. Frank Seltzer and Curry on the 1934 Yaqui Expedition. Photo courtesy of the Southwest Collection, Texas Tech University.

It demonstrates the isolation of West Texas from mainstream anthropology of that era, and it fails to demonstrate any in-depth understanding of the rituals they observed. Nonetheless, the results of that expedition provide a unique record of that time and place, in addition to offering practical medical, optical, and political assistance to the Yaqui. Bill McMillan's film of the Easter ceremony in Torim may represent the first visual documentation of that ritual.

The Yaqui experiences opened up other avenues for Curry to explore, and he eventually wrote a novel about the 1929 Hill of the Rooster massacre that a prominent Yaqui, Anselmo Valencia, once described to me as the best thing ever written about the Yaqui since it made them real people with real emotions who fell in love and otherwise acted like actual human beings (W.C. Holden 1956). This same individual later exercised what might be called reverse appropriation. Long annoyed at the way anthropologists intruded on and presented the Yaqui, he retaliated by taking the *Hill of the Rooster* and "publishing" it "As told by Rosario Moises Valencia Tori". Everything (including Pat Allgood's end map of the Yaqui valley) is simply xeroxed from the original, with the exception of the pages giving the original authorship. Curry also wrote a second book related to his Yaqui experiences---this one dealing with Teresita, a folk healer (W. C. Holden 1978).

Helping to found TAPS, doing archeology, teaching anthropology, and conducting expeditions to Sonora were not the only avenues through which the Holdens' helped to introduce West Texans to the broader world. Another tentacle of influence that grew from my mother's interest in the Southwest was the Ko Shari social club at Texas Tech. At least five female social clubs were organized at Texas Tech in the 1930s, and all of them had rush week, pledging, initiation, a series of formal dances, and other lady-like events such as afternoon teas. The Ko Shari was different from the others in having a Southwestern theme provided by my mother. She used translated Navaho chants as a basis for the club ritual, the initiation was held in Santa Fe at Easter (and after the kiva at Arrowhead was reconstructed, in that kiva by firelight), and all pledges had to read and report on two books: *Death Comes for the Archbishop*, and *The Delight Makers*. Later, during the 1950s, these social clubs were taken over by national sororities and that local touch was lost.

My mother's deep interests in Southwestern art, architecture, literature, and her involvement with college students set the course for the Holdens' involvement in many outreach activities. After her death, Curry married Frances Mayhugh Holden. My stepmother's interest in the museum and art worlds continued the family's involvement in the New Mexico art scene, as well as in the archeological scene. Some 20 to 40 Ko Sharis on their annual Easter trip routinely visited artist's homes and galleries and museums in Santa Fe and sometimes Taos. Over the years, a large number of women were impacted by this exposure. The summer archeological courses of the 1930s served as serious introductions to the art and archeology of northern New Mexico. I remember visits to Ernest Thompson Seton's home in Santa Fe, and visits to several artists' homes in Taos. Freda, the widow of D. H. Lawrence, once gave my dad a handwritten manuscript of her husband's. Art and archeology overlapped in several ways.

I do not know how my dad met Peter Hurd, an artist who lived in the Hondo valley. I assume it was part of the ongoing artistic outreach of the Holden's from Lubbock. Certainly Pete and Curry got along together famously, and later Pete came to Lubbock to paint the mural in the rotunda of the old museum, now Holden Hall (Figure 9). Peter Hurd told my dad of archeological sites in the Sierra Blanca region of New Mexico, and put him in contact with the Bon-

Figure 9. Curry and Peter Hurd at the dedication of the Peter Hurd mural in Holden Hall.

nell family just up the Ruidosa valley from the Hurd ranch at San Patricio. In 1950, my dad decided to transfer Texas Tech's archeological field school from Arrowhead Ruin to the Bonnell site. He was, for all seven field seasons from 1950-1956, the instructor of record. However, in terms of day-to-day operations, he relied on J. Merrill Kayser, his old cook and truck driver from the 1930s, Earl Green, Rex and Gini Gerald, and me.

By the late 1940s, and certainly after the Sierra Blanca era, my dad's attention was not again seriously devoted to archeology. The museum and other parts of his multi-faceted professional life took precedence: building the Southwest Collections and the Ranching Heritage Center, being department head or dean, and working on his manuscript of water as a scarce resource in the world. But he never lost his love of walking over a site and planning how he would excavate it. In 1983, my Dad, Fran, and Tom visited us while we were on sabbatical in Spain. I went with them on a short trip to Morocco, where we visited a Roman site near Ceuta (Figure 10). My Dad walked around "sniffing the air like an old war horse," as Fran said, laying out in some detail how he would approach that site, how it should be mapped, and where he would put his excavations. And then, like the museum person he was, he envisioned a small interpretive on-site museum for local school children. Even then, his dream of a local museum was fairly *avant garde*.

Many people came through our home and the museum in Lubbock, and I probably saw only a few of them. Two stick in my memory as exceptionally fascinating people: Glen Evans and Carl Chelf. Both were old-fashioned naturalists, as well as talented geologists/paleontologists. Glen Evans, who did major work at the Lubbock Lake, Blackwater Draw, and Plainview sites before he became an oil executive, could turn a drive from Midland to Lubbock into the most fascinating bit of landscape on earth as he talked about the geology, what grew in ponds, and the speed with which sand buried fence lines during the dust bowl. He had eyes that saw more than those of other people.

Glen and Carl were targets of some of the colorful disputes involving Cyrus Ray, as is indicated in Ray's description of them in a 1945 letter to my dad. He wrote: the "two Texas University non-cooperators who bushwhacked over my territory in 1940, and dug up mastodon and mammoth skeletons which I pointed out to them and never gave me any chance to see them in place. In fact after solemnly promising to notify me when excavation began, they got me to get owners' permission and then dug them out secretly and shipped the stuff all off to Austin without letting me see it. One of the worst offenders of all was this Glen fellow" (Tunnell 2000:47).

When we look back at archeological pioneers, we must acknowledge that the archeology of the 1920s and the 1930s was a far different beast than that of today. Curry was a product of growing up on a hardscrabble farm. He determined from an early age to leave farming and seek a different kind of life. He was encouraged by his unusually liberal parents and willing to undertake the hard and focused work that it took to get him to the university and a Ph.D. He began his professional life even before the dust bowl and depression, and these in turn also impacted his approach to life, although his family had always been so poor that the depression did not make as large an impact on him or his family as it did on urban dwellers, since they could raise their own food.[4]

These untrained archeologists of the 1920s and 1930s lived and worked in an era when disciplinary boundaries were lower, and, at the same time, individuality and personal initiative were valued. This era was also a time when West Texas was trying to upgrade itself into a more "cultured" status. Curry

Figure 10. Jane and Curry at a Roman site near Ceuta, Morocco, 1983.

parleyed his background into a multi-disciplinary career, mostly carried out at Texas Tech. He was more removed from state resources than was Pearce at the University of Texas. He fostered archeological fieldwork to the best of his ability by reading, visiting sites, and using his own practical background from house building and farm work. He was deprived of geographic proximity to other relevant professionals, with Floyd Studer in Canyon and Cyrus Ray being the closest. None of the people he interacted with archeologically in West Texas had any more official training than he did. The isolation of Lubbock vis a vis other archeologists was still true when my husband and I taught at Texas Tech in the late 1950s and early 1960s. In any direction, it was well over 300 miles to a fellow archeologist.

I wish I had a dollar for every time I heard ex-students return—years later—and tell my dad that they thought, when they were in Texas Tech, that anthropology was an easy and interesting, but essentially a useless, course. However, they discovered as a result of living their own lives that it had turned out to be the most valuable thing they did in college. It opened their eyes to the native people of the American Southwest, in particular, as well as art and artists, history, and many other topics. Curry was one of the people in Lubbock who, with a great deal of help from others over the decades, did two important things: First, he introduced local residents to the world and put other parts of the world in a favorable and approachable light. The Ko Shari Easter trips and the Navaho chants that formed the basis of their ritual, the archeological field schools, involvement with art and artists, many aspects of The Museum, the well publicized Yaqui expeditions of the 1930s, the books inspired by his interest in the Yaquis (Holden et al. 1936; W. C. Holden 1956, 1978) were all part of his contribution to opening up the world to West Texans. His second contribution, in my opinion, was turning local people on to the value of what they had and what they had experienced. West Texas history was important and legitimate. The Museum played a role here as well, as did the Southwest Collections and the Ranching

Heritage Center. Perhaps he would have made a good politician; he certainly attracted substantial moral and practical support for his many endeavors. However, his one early attempt to run for public office ended in failure.

In evaluating Curry's place in the history of archeology, it may be that, as Mott Davis argued, his greatest contribution to archeology came with his co-founding of the Texas Archaeological and Paleontological Society, and his attention to this organization throughout the 1930s, and even later. However, his early introduction of anthropology into the curriculum at Tech deserves mention, as well as the early introduction of a Master's program within anthropology/archeology. I leave others to decide on his place in the history of archeology of the entire state of Texas. From the perspective of West Texas, he must be seen as a pioneer. For my part, I will say he was a cool dad.

ACKNOWLEDGMENTS

I want to thank the organizing committee for the 2008 Annual meeting of the Texas Archeological Society for inviting me to return home and give this self-indulgent talk. Brett Houk was exceptionally helpful in providing information and pictures. Alice Kehoe, Christine VanPool, Brett Houk, and Grant Hall read earlier versions of this article and provided useful comments.

ENDNOTES

1. The Banquet Address of the Texas Archeological Society annual meeting, October, 2008, in Lubbock, Texas.

2. With regard to Kidder, I would argue that when Walter Taylor (1948) harshly criticized Kidder in his *A Study of Archeology,* much of the negative response arose from the perception of Kidder as a nice man who did not deserve such negativity. That may be one reason why the shifts that culminated in the New Archeology had to wait for, first, Caldwell, and then Binford, instead of starting off with Taylor—leading him to write an article entitled "New Wine in Old Skins" (Taylor 1972).

3. The Horsethieves were an interesting, self-selecting social group consisting, initially in the 1930s, of the husband/wife duos of a couple of bankers, a judge, a pioneer farmer or two, and my dad and mother. Indian wars and the settlement of the West were topics of which they never tired, and all the men were consummate story tellers. The Horsethieves evolved in 'membership' and lasted into the 1980s, always with a core of good food and story telling on Saturday nights.

4. He told stories about times during the depression when the state of Texas could not honor its payroll. The First National Bank in Lubbock would take the slips of paper that indicated that the professors would eventually be paid, and, while discounting them, nonetheless provided much needed cash.

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An 18,000 Year Old Occupation Along Petronila Creek in Texas

C. R. Lewis

ABSTRACT

In 1985 large bones were found eroding from the bed of Petronila Creek in Nueces County, Texas, near the town of Driscoll, 30 km from the coastal city of Corpus Christi. Investigations over the ensuing years have established that these bones were part of a major accumulation of Late Pleistocene mammal, bird, reptile, amphibian, fish, mollusc, arthropod, and plant remains. A human association with the deposit is indicated by mammoth molar tools, other bone tools, worked stone, evidence of fire, and cut marked bones. The bone deposit itself represents campsite litter. Radiocarbon dating of the bone and the overlying clay sediments place the age of the site at 18,000 years ago, during the Last Glacial Maximum. This age is supported by stratigraphic, climatological, and faunal evidence.

INTRODUCTION

The two central arguments of this article are that mammoth tooth and bone fragments have been found at a site in southern Texas that have been fabricated into tools, and that bones of the same mammoth have been radiocarbon dated at 18,000 years before present (B.P.).[1] These findings do not conform to the present expectations for the time period in which humans should be present in this region. The oldest generally accepted human presence in North America is the Clovis culture, which spans the time frame from 11,050-10,800 B.P. (Waters and Stafford 2007). Clovis sites are characterized by distinctive fluted projectile points believed to have been used to kill mammoths, whose remains are commonly associated with these points.

Many proposed earlier sites in North America have been challenged on various grounds. The Clovis-first paradigm is based on the assumption that northern ice sheets prevented the entry of Old World human populations until the ice breakup at the end of the Wisconsin glaciation, which coincides in time with the appearance of people using Clovis points. A widely accepted chronology of human occupation has these people contemporary with, and preying upon, the last mammoths, then their descendants using similar but smaller Folsom points to hunt the last giant bison. In turn, their Late Paleoindian and Archaic descendants used a varied arsenal to hunt the surviving Holocene fauna. There is one pre-Clovis site, however, that has withstood close scrutiny and is now generally regarded as being at least 1000 years older than the earliest North American Clovis sites, and that is the Monte Verde site in southern Chile (Dillehay 1989, 1997). It is about as far from the Bering land bridge as the globe allows.

The subject of this article, the Petronila Creek site (41NU246), as excavated to this point, is characterized by artifacts of mammoth bone and mammoth molar teeth. There are also several stone tools in good association with the mammoth remains, as well as others in suggestive but insecure association. None of these artifacts appear to have any connection to the distinctive Clovis stone tool technology.

SITE HISTORY AND GEOLOGIC SETTING

The site was discovered in 1985, when a nearby landowner reported large bones exposed in the bed of Petronila Creek, near the town of Driscoll on the Texas coastal plain (Figure 1). By the following year excavations had established that the source of the bones was a thin sand layer exposed in the deepest part of the creek some 5 m below the modern ground surface (Lewis 1988). By 1990, fieldwork had opened almost 18 m^2 of the deposits, and the sand layer had yielded 36,644 bones and other specimens.

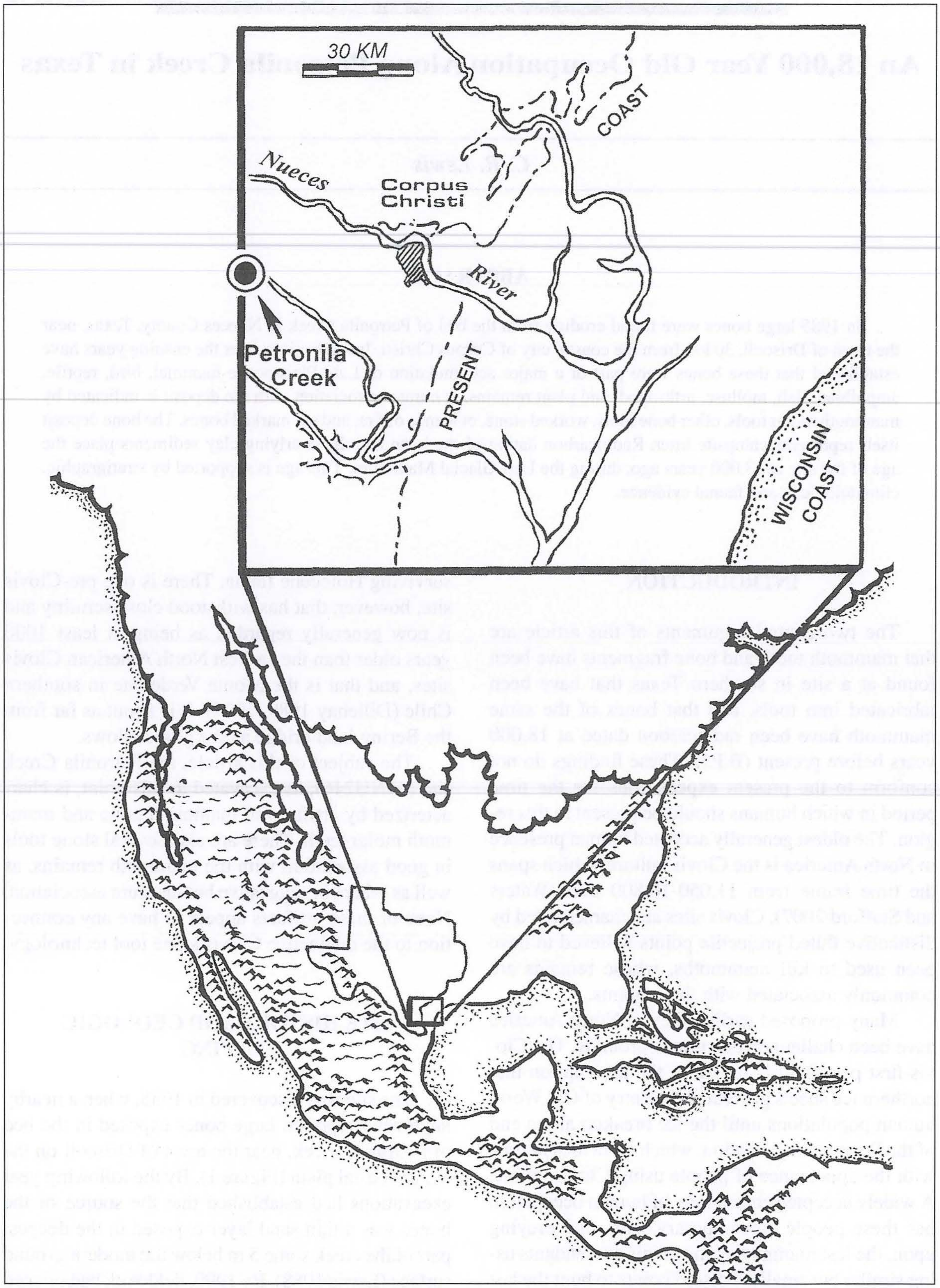

Figure 1. Petronila Creek site location, in glacial North America, with an inset of the Texas coastline at Last Glacial Maximum, after Brown (2006:Figure 2.8).

The bone deposit is thought to lie within the confines of the Sangamon delta of the Nueces River (Groat 1975) that was deposited during the high-water stand of 100,000 years ago (Aronow 1971). This delta was abandoned at the onset of the Wisconsin glaciation when sea levels fell some 100 m, causing the Nueces discharge to move 150 km gulfward. The following events are inferred from the geology of the site:

1. The wetter climate of the Wisconsin glacial period caused sizable rivers to form south of the Nueces (Suhm 1980), and one of these, the Petronila, drained an area that included parts of the old delta. This sluggish river incised a shallow channel in the old delta and meandered to some extent;

2. at roughly 18,000 years ago the river apparently moved east, forming a sand bar on its west bank. On this sand bar a hunting and fishing camp was established, and accumulating camp refuse built up a significant deposit of bones;

3. later, as the river moved farther from the sand bar, overbank waters that reached it covered it with clay; and

4. the Petronila did not again meander back over the site before the onset of the Holocene, after which it shrank to its present status as an intermittent creek. In recent years, salt water injection from oilfield operations caused the loss of vegetation, and gullying began. The gully has within the past few years cut deep enough to expose the old sand bar and bone deposit, which is now undergoing reworking for the first time.

Petronila Creek today typically floods for brief periods in the spring and fall, and otherwise sustains an insignificant trickle of water that flows between permanent pools dotted along the creek bed. The surrounding countryside is semi-arid with mixed grass and brush, and sizable trees grow along the creek. Large herds of grazing animals can be supported by the present environment, as attested by the King Ranch, some 30 km to the southwest.

The reconstructed ecosystem at ca. 18,000 years ago centers on a sluggish, good-sized permanent stream with wooded banks flowing through grassland 150 km from the sea. Stream characteristics are indicated by the types of fish and reptiles present in the bone deposit, and stream size is shown by bones from a gar's head that indicate a 2.3 m fish, an alligator tooth from an individual of about 3.2 m in length, and remains of other large fish and turtles. The wooded banks are indicated by the recovery of stag beetle remains and by such presumed browsers as the camel, ground sloth, and deer. Adjoining grasslands would be necessary for the horse, mammoth, bison, antelope, prairie dog, and other animals whose remains have been found in the bone deposit. Mild winter temperatures are suggested by two weevils now found restricted to the neotropics (Scott A. Elias, personal communication, 1989), and by the large tortoise.

METHODS OF INVESTIGATION

The site has two principal components: the late Wisconsin bone bed at the deepest level of the Petronila Creek gully, and an Archaic occupation on the immediately adjacent banks. In the creek bed lag there is a mixture of remains from these two components.

An initial grid 100 x 50 m in size was established to cover the immediate site area. Many Archaic points, tools, and bones were mapped and recovered on the banks. In the lower banks of the gully, in a region of Holocene channel fill, there were also extensive Archaic hearth zones containing many lithic artifacts that were being lost to erosion. These were mapped and tested in several controlled excavations.

Attention then turned to the loose material in the creek bed. It was felt that this material might contain important artifacts, and floods could disperse it down stream. Essentially all of this loose material was screened (11 mm mesh size) over a 17 m stretch of the stream bed downstream of the eroding Pleistocene bone deposit; significant bones and artifacts were mapped and recovered.

Excavations started in the Pleistocene bone bed after mapping the topography of the immediately surrounding area (with surveying instruments), and taking numerous photographs. The subsequent excavations were meticulous and exacting. Units 1 x 1 m in size were opened one at a time inside cofferdams to hold back the water. Excavations advanced in 5 cm levels. The surface of each level was drawn to scale, showing the distribution of sediment types. Burrows (by crayfish, probably) were noted and all larger hard objects were mapped individually, to the nearest 1 cm, with depth to the nearest 1 cm. Orientation was noted and a sketch of the object, with scale, was drawn in field notebooks. The sediments were lifted out in trowel-size scoops about 1 cm thick. This technique was used because delicate remains such as fish gill covers, fish scales, small bones, fish spines, etc. were very numerous and shattered if scraped with a trowel. When the sediments were carefully lifted out this material could be recovered on the screens.

Everything was water-screened through nested screens of 6 mm mesh hardware cloth over 1.5 mm mesh window screen. All objects, except caliche and clay clods, that stopped on the upper screen were collected. Only potentially identifiable bones and rocks were collected from the window screen. A lizard limb bone without either articular end and any small fragment of tooth was, for example, considered identifiable. All remains were counted and placed unsorted in labeled ziplock bags for eventual sorting and examination. In the later units it was customary to bag a sample of unwashed matrix from each level as well as a sample of the picked-over residue from the bottom screen.

Later, each bag was sorted according to the following categories: bone chunks (for large animal bones with no provenience and no diagnostic features), gar scales, fish parts, turtle shell parts, identifiable bones, teeth (including mammoth molar fragments, rodent teeth, fish teeth, lizard jaws with teeth, etc.), and miscellaneous (otoliths, burned clay, stone objects, sloth skin ossicles, snails, etc.). Each category of each 5 cm layer went in a separate bag. Every object was again examined, generally under magnification. The bags of teeth were sorted a third time, with micro-mammal teeth removed, mounted on pins, and labeled. Some preservation is remarkable: for instance, the pupa of a parasitic fly is attached to a prairie dog molar; the pupa is ruptured and parts of the fly are visible. Remains of an ant are wedged into a crack in a bone chunk.

Friable objects such as fish gill covers were removed from the wet sediments on blocks of matrix, dried, consolidated, and mounted in cases. Intermediate size bones were rebuilt with glue if needed and placed in cabinet drawers. Large bones, as of the mammoth, are separately housed in custom-made boxes. All are kept in an air-conditioned room.

Faunal and floral remains were either sent to appropriate specialists for identification or identified from reference material in consultation with specialists. Standard methods for establishing Minimum Number of Individuals (MNI) were employed. In the case of turtles, groupings by thickness of shell fragments separated individuals by size. Scale size and morphology separated the gars. The bowfin and bigmouth buffalo were separated by gill covers, and the catfish by dorsal and pectoral spines. The micro-mammals were separated by teeth. The sloth remains include teeth from animals of two sizes, and the mammoth remains include bones of a large adult and a small juvenile.

EXCAVATIONS AND GEOLOGIC OBSERVATIONS

Eighteen entire or partial units have been excavated (Figures 2 and 3). Excavations along the south bank determined that the deposit extends beneath a 4 m-high cutbank of Pleistocene sediments, and excavations at right angles demonstrate that the deposit extends across the creek and under the bank on the far side. No limits to the deposit have been established.

Of particular note is the stratified nature of the deposits, with distinct sand and clay layers (Figure 4). The sand laminations grow progressively thinner with increasing height in the section. Sheets of calcium carbonate (caliche) are developed within the bone-bearing sand, and seams and nodules of caliche are present in the overlying clays. In some places, the bone-bearing sand, white and fine-grained, is underlain by a much coarser brownish sand that is barren of bones. On the north end of the excavation, the bone-bearing sand is, in places, intimately mixed with pea-size caliche nodules that may be developing in situ, but give the appearance of being a gravel. Where the modern creek channel has cut through the bone-bearing sand, 30 cm of green-yellow-white clay with caliche inclusions is exposed below it. The irregular upper surface of the bone-bearing sand is probably not an erosional feature, since it appears that the depressions are not connected by drainage channels (see Figure 4b, south wall at 100 cm).

THE BONE BED

The site is a species-rich paleontological locality, with at least 44 vertebrates present, 16 invertebrates, and five kinds of plant seeds (Table 1). Detailed identification work is expected to significantly increase the present count. Of the 36,644 recovered

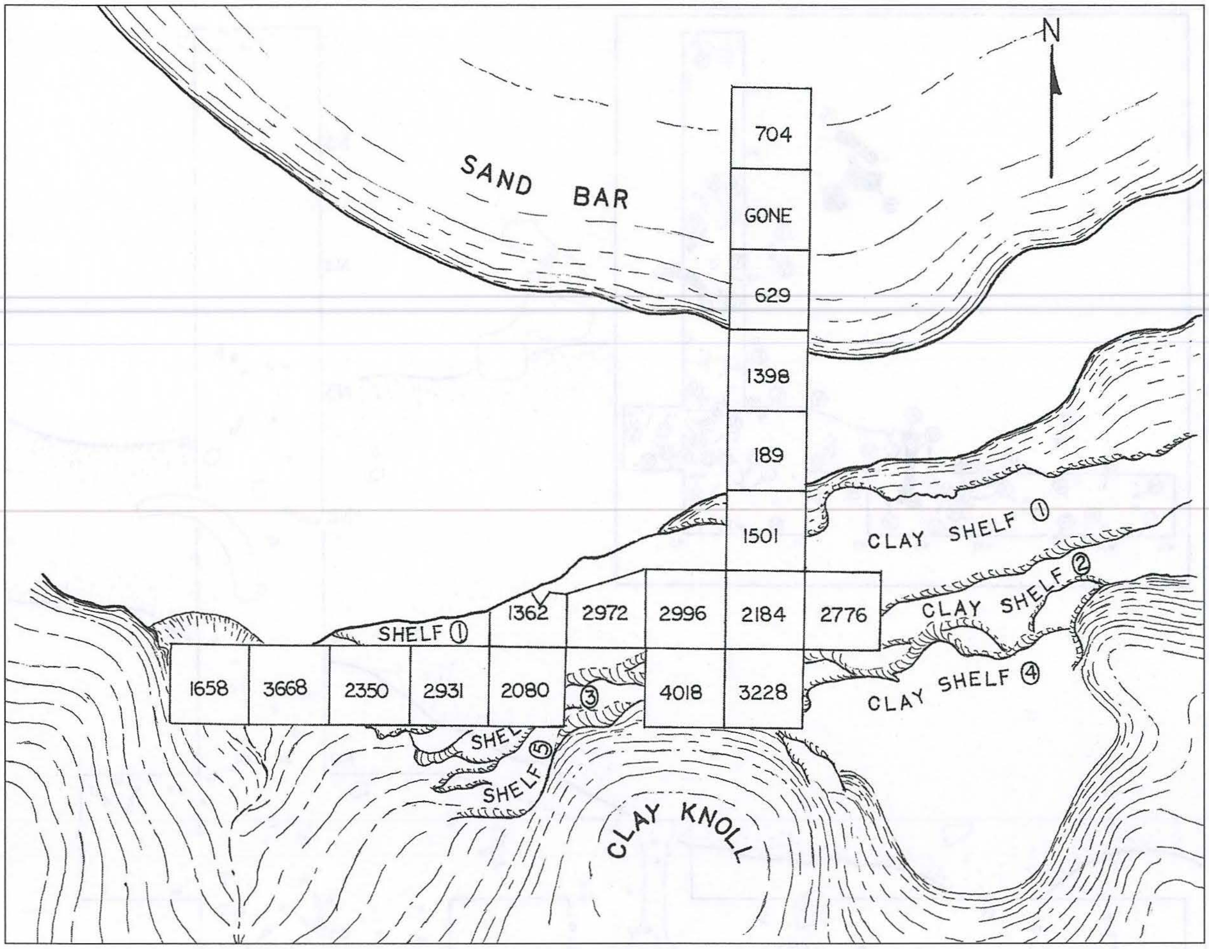

Figure 2. Plan view of excavations. Units are 1 m^2. Petronila Creek flows through from the west; the sand bar on the north bank is active. The south bank is Pleistocene clay with sand layers; clay shelves develop below eroding sand layers. Clay Shelf 1 overlies the bone bed. Numbers in excavation units denote the quantity of bones recovered, mostly small, and a few other objects.

objects, representing a minimum number of 265 individual animals, about 132 are large enough to be given a provenience. The distribution of the most significant of these is shown in Figure 3. Of the remainder, mostly recovered from the screens, a count by categories is provided in Table 2.

The bone bed appears to be a primary deposit and not a secondary accumulation of stream-transported bones. The distribution of bones is patchy, both vertically and horizontally, rather than uniformly mixed; multiple elements of individual animals are present (e.g. the adult mammoth, the large gar, and the large turtle); the mylodont sloth arrived with the skin intact, as indicated by numerous sloth skin ossicles; many bones are crushed and crumbling, yet intact; the bones show no stream tumbling wear; and elements such as the mammoth tusk could scarcely have been transported by the low-energy rivers of this flat coastal plain. Also, heavy mammoth bones are mingled with fish scales and insect parts, showing complete lack of sorting by transportability. In her study of the micro-mammal teeth, Johnson (1993:106) concluded that "the teeth are not water-worn, indicating little movement and a primary context for the remains."

The molluscan fauna, representing snails that apparently came to the site of their own volition, is for the most part terrestrial and consists of fungus-eating species that might inhabit a refuse heap (Jane Deisler, personal communication, 1992). This tends to confirm that the bone deposit formed above water, and was the attraction for the snails. Indeed, one tiny specimen, a terrestrial fungivore, was found in situ on the underside of a large bone fragment.

The bones are principally contained within the top 20 cm of the sand layer, as though they had been

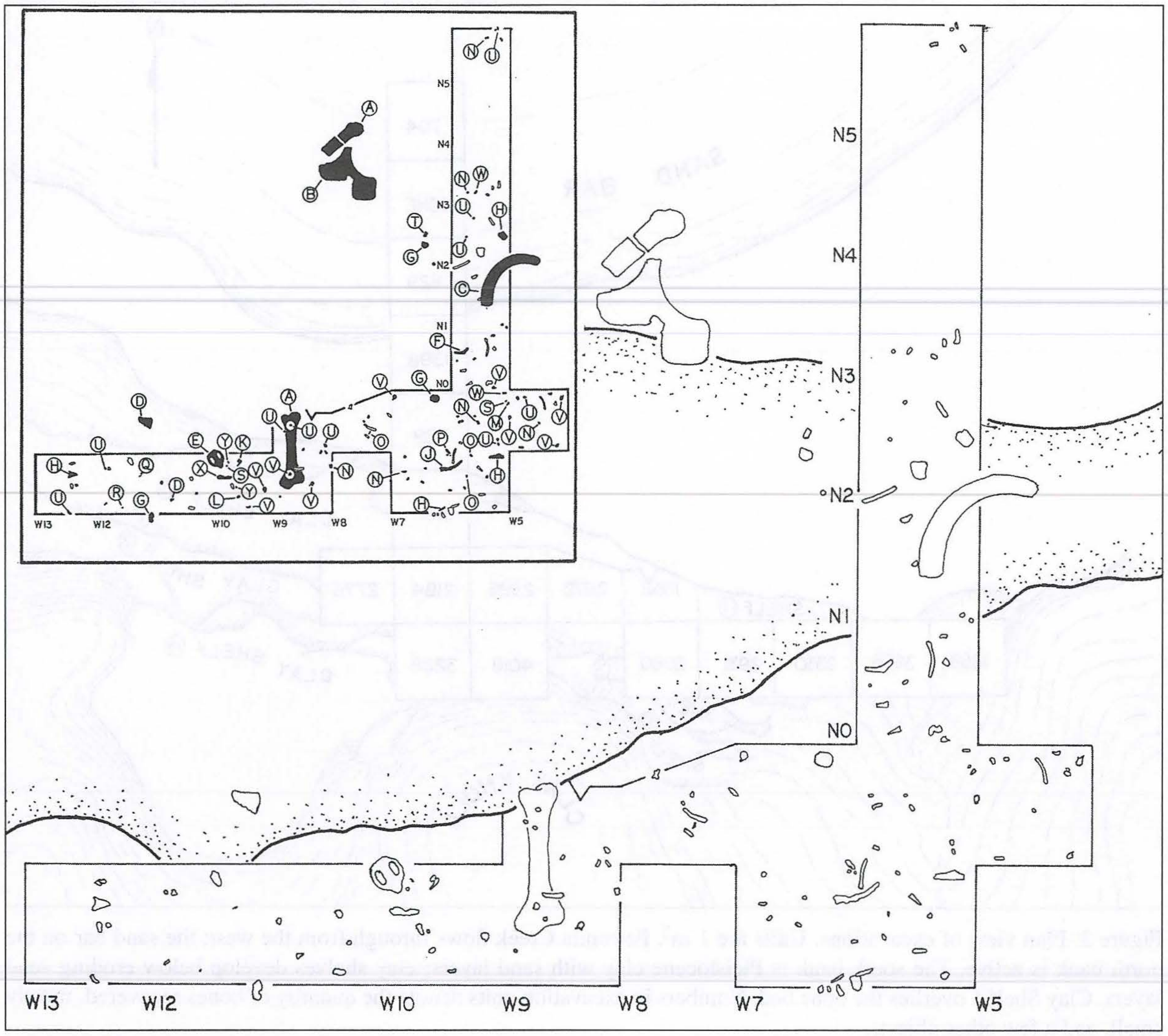

Figure 3. Plan view of larger bones and bone fragments from the principal bone bed, with identification key (insert): A, mammoth femurs; B, mammoth pelvis; C, mammoth tusk; D, mammoth molars; E, mammoth palate (juvenile); F, mammoth rib; G, mammoth molar tools; H, mammoth bone tools; J, ground sloth rib; K, horse jaw fragment; L, horse foot bone; M, horse splint bone; N, horse molars; O, horse incisor; P, camel incisors; Q, bison incisor; R, antelope molar; S, alligator tooth; T, land tortoise shell part; U, pond turtle shell part; V, fish gill covers; W, catfish spines; X, alligator gar skull bone; Y, broken stones.

deposited on its surface and worked into the sand by trampling or some form of bioturbation (laminations within the sand are largely absent). A minor scatter of small bones extends upward into the finely stratified overlying clay and probably represents localized redeposition of bones when the sandbar was being covered by silt and clay from intermittent inundations: the upstream edges of the bone-bearing sand would be locally eroded and their lighter contents carried a few meters out over the top of the sandbar to be redeposited as inclusions in the capping clays.

The lateral distribution of the bones is fairly uniform, but with some striking patchiness of certain elements. Near the surface of the sand, there are scattered lenses of very small bones that typically cover an area of 0.5 m^2 and are 2-3 cm thick. The concentration of tiny bones and bone fragments account for about half of the bulk sediment volume. These lenses have a characteristic orange color, imparted by the organic material, and have quite sharp vertical and lateral boundaries, as though they have experienced no significant bioturbation. One typical lens had lateral edges that graded into the surrounding matrix within a distance of 1 cm, and the upper and lower surfaces graded into the enclosing matrix within 0.1 cm. There was a parting line between

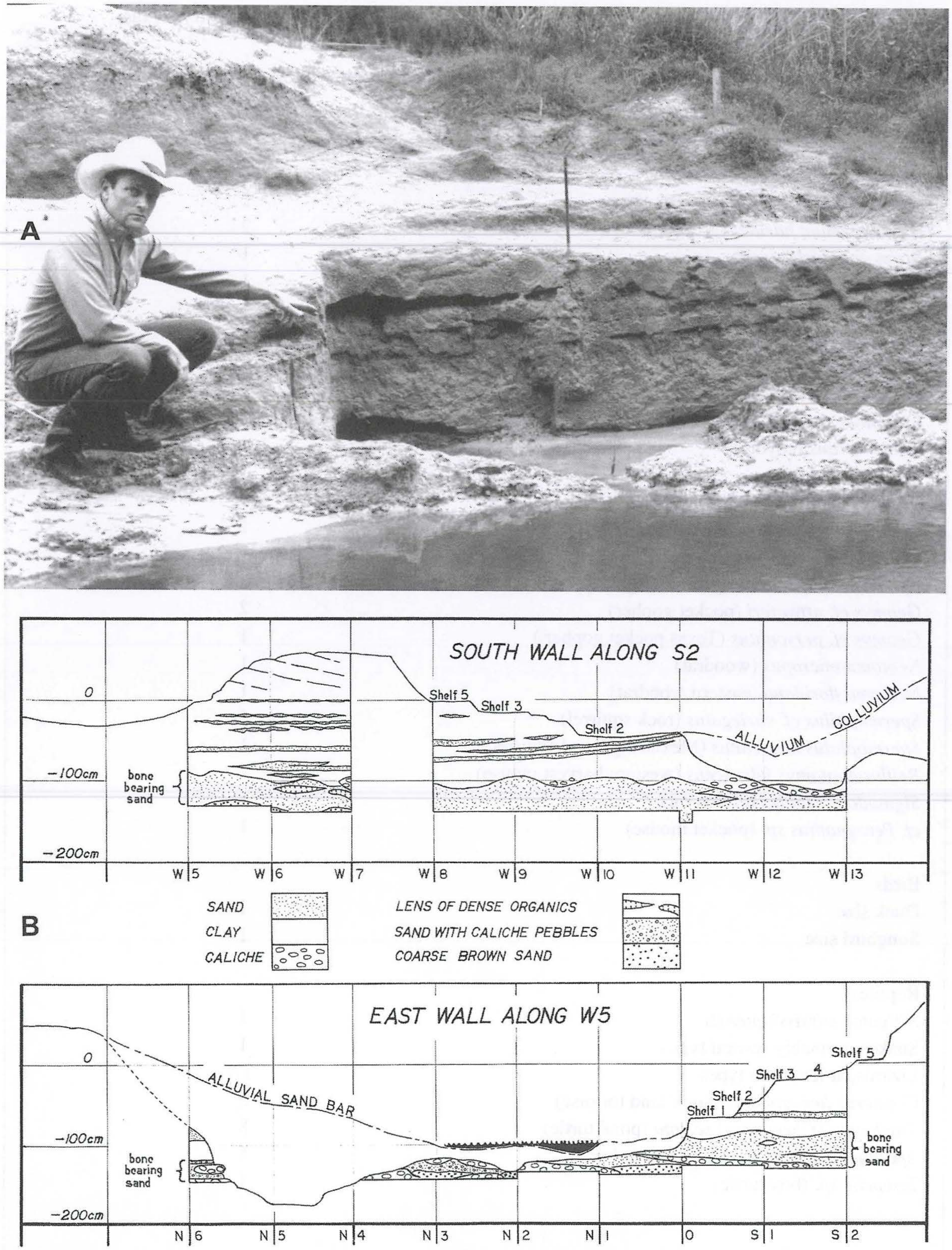

Figure 4. Stratigraphy of the Petronila Creek site: A, south wall after high water episode, author pointing to undercut sand layers; weed-filled clay extraction pit is in the background; B, profile drawings of the south and east walls of the excavations, each grid is 1 m. Note the surface of the present-day alluvium and the surface of undisturbed Pleistocene material in creek bed. Units were excavated inside cofferdams to exclude water.

Table 1. Provisional Faunal and Floral List from Petronila Creek Site, Nueces County, Texas, with Minimum Number of Individuals (MNI).

Faunal or Floral Species	MNI
Mammals	
Mammuthus jeffersonii (mammoth)	2
Glossotherium harlani (ground sloth)	2
Bison antiquus (bison)	1
Camelops hesternus (camel)	1
Equus sp. (large horse)	1
Equus sp. (small horse)	1
Odocoileus sp. (deer)	1
Platygonus compressus (peccary)	1
Capromeryx minor (small antelope)	1
Canis latrans (coyote)	1
A mustelid	1
Lepus cf. californicus (jack rabbit)	1
Sylvilagus sp. (cottontail)	1
cf. Ondatra zibethicus (muskrat)	1
Cynomys ludovicianus (prairie dog)	86
Geomys cf. attwateri (pocket gopher)	2
Geomys cf. personatus (Texas pocket gopher)	1
Neotoma micropus (woodrat)	1
Neotoma floridana (eastern woodrat)	1
Spermophilus cf. variegatus (rock squirrel)	5
Spermophilus mexicanus (Mexican ground squirrel)	1
Reithrodontomys fulvescens (western harvest mouse)	1
Sigmodon hispidus (cotton rat)	1
cf. Perognathus sp. (pocket mouse)	1
Birds	
Duck size	1
Songbird size	1
Reptiles	
Alligator mississippiensis	1
Snakes, probably several types	1
Lizards, at least two types	17
Gopherus hexagonatus (large land tortoise)	5
Trachemys (Chrysemys) scripta (pond turtle)	8
Apalone (Trionyx) sp. (softshell turtle)	5
Terepene sp. (box turtle)	1
Amphibians	
Frogs	1

Table 1. *(Continued)*

Faunal or Floral Species	MNI
Fish	
Lepisosteus spatula (alligator gar)	3
Lepisosteus cf. osseus	6
Lepisosteus sp. (a third gar)	5
Lepisosteus sp. (a forth gar)	6
Amia calva (bowfin)	9
Ictalurus cf. melas (black bull head)	42
Ictalurus punctatus (channel catfish)	3
Ictalurus sp. (a large catfish)	3
Ictiobus cyprinellus (bigmouth buffalo)	6
Unidentified small fish	Several individuals
Molluscs	
Unionidae *Gen. sp.* (freshwater clam)	1
Planorbella cf. scalaris (freshwater snail)	1
Rabdotus sp. (land snail)	5
Zonitoides cf. arboreus (land snail)	1
Polygyra sp. (land snail)	4
Olygyra orbiculata (land snail)	4
Praticolella cf. berlandieriana (land snail)	3
Crustaceans	
cf. Palaemonetes sp. (freshwater shrimp)	1
A second crustacean	1
Insects	
Cylindrocopturus armatus (weevil)	1
Compsus auricephalus (weevil)	1
cf. Pseudolucanus sp. (stag beetle)	1
Lygaeidae *Gen. sp.* (seed bug)	1
A parasitic wasp	1
An ant	1
A grub	1
Plant Seeds	
Celtis (Hackberry)	
Artiplex (Salt bush)	
Sapindus sp. (cf. Soapberry)	
Convolvulaceae - *cf. Ipomea* (Morning Glory)	
Unknown (has *Chenopodium* characteristics)	

Table 2. Categories, counts, and percentages of material recovered from screening of deposits at the Petronila Creek site.

Category	No.	Percentage
Gar scales	11,546	31.5
Fish parts (bones, spines, scales)	6,415	17.5
Bone chunks (from megafauna)	5,681	15.5
Identifiable small bones (from micro-fauna)	5,607	15.3
Tooth fragments (mammoth enamel)	1,092	3.0
Tooth fragments (other mega-mammal)	1,873	5.1
Teeth (micro-mammals)	1,352	3.7
Gar teeth	572	1.6
Miscellaneous teeth	51	0.1
Turtle shell fragments	1,099	3.0
Pebbles and lithic flakes	623	1.7
Miscellaneous objects	733	2.0
Totals	36,644	100.0

the orange-tinted organics and the overlying gray/white soft sand, with a mesh of thin rootlets in this parting line. The underlying sand was harder and more consolidated than the organic lens. Most of the rodent teeth from these lenses are acid-etched, and the working hypothesis is that these lenses are latrine deposits.

Obvious bone clusters are present. Sixteen lizard jaws came from a single 1 x 1 m unit; only 18 came from all the other units combined. Seventy catfish spines are clustered in the four western units, while the eight eastern units have a combined total of 10 spines. Johnson (1993:106) identified additional clustering among the micro-mammal teeth, with prairie dog teeth "particularly concentrated in one unit."

If the bone bed was not carried in and deposited by the river, as the above observations seem to demonstrate, one must look elsewhere to explain its origin. In the inanimate world, there are several agents other than rivers that act to concentrate bones. These are natural traps like sinkholes, fissures, caves, and boggy ground, and gathering places such as waterholes, springs, and ponds where animals die or are killed over a period of time. The sand bar is not a natural trap. Neither is it a component of a spring or pond deposit, but is "clearly fluvial in origin" (Michael D. Blum, personal communication, 1990). Nor would the sand bar have been expected to accumulate bones from the natural death of animals that merely crossed it to drink at the river. The possibility remains that some sort of freak incident in nature, such as an intense episode of cold, drought, or flood may have killed and concentrated the animals quickly, but the bone pile does not fit the patterns reported from any of these agents (Weigelt 1989; G. Haynes 1991:103, 166). After examining the age-at-death distribution of 474 micro-mammal teeth from the site, representing at least 86 individual prairie dogs, Johnson (1993:106) concluded that the distribution profile "fits neither an attritional nor a catastrophic mortality pattern, although it is closer to a catastrophic mode. Adult prairie dogs are being targeted." She concluded that a predator was involved.

When non-human animals are considered as a possible cause of the bone bed, such small animals as packrats or porcupines can be quickly ruled out by the size of certain bones, notably the mammoth femur. Likewise, large terrestrial predators such as wolves or lions would not have been expected to prey upon fish, birds, and mice, and alligators would not have been able to capture mammoths. Only humans would have preyed upon every animal present.

It seems then, upon preliminary examination, that the bone bed itself may be a unique product of human activity. A closer study of its attributes is worthwhile. Particularly germane is a study by

Brain (1981) of bone accumulations in southern Africa where his explicit purpose was to establish criteria for distinguishing hominid-derived bone deposits from those of other animals. It is reasonable to assume that his African work can be applied to Pleistocene North America where the fauna and megafauna were closely analogous, with such pairings as elephant-mammoth, giraffe-camel, Cape buffalo-giant bison, zebra-horse, antelope species-deer species, lion-lion, hyena-dire wolf, jackal-coyote, and so forth.

Brain and other workers considered that the only extant animals that regularly accumulate bones are humans, hyenas, certain other carnivores (particularly leopards), African porcupines, and birds of prey (Brain 1981; Klein and Cruz-Uribe 1984:6; Schick and Toth 1994:211). Brain's study examined a number of bone accumulations where the dominant collecting agent could be identified and he concluded that three independent criteria were useful for setting apart human accumulations from all others: first, the ratio of carnivore to ungulate bones in the deposit; second, the size distribution of bone flakes; and third, the relative abundance of broken tortoise shells.

A scarcity of carnivore bones is characteristic of human-made bone deposits and is thought to be the result of mutual avoidance by humans and large mammalian predators (Klein and Cruz-Uribe 1984:82). Brain summarizes his own results as follows: "One point that has emerged from the analyses is that remains of *carnivores* are not abundant in the human food refuse" (Brain 1981:140).[2] At Petronila Creek, carnivores that would have been a threat to humans are not represented in the bone deposit. Only a coyote-size canid is present. Wolves, dire wolves, lions, saber toothed cats, pumas, and the various bears that may have lived in the area are not found among the bones. The Petronila Creek deposit is similar in this respect to a human-made deposit.

Bone flake size is Brain's second discriminator. Humans break up long bones to obtain marrow and bone grease, and in so doing produce bone flakes that are characteristically smaller than those produced by hyenas. These broken pieces may accumulate in large numbers in human habitation areas. Hyenas break bones not only to obtain marrow but also to eat the bone itself. Brain was in fact unable to obtain a satisfactory sample of hyena-broken bone flakes because besides being eaten, they were also so thoroughly digested by hyenas that preserved flakes were scarce. Other animals are not considered to be significant bone-flake producers. Figure 5 illustrates the size distribution of bone flakes from Petronila Creek in comparison with Brain's data for human-made flakes and hyena-made flakes. The Petronila Creek flakes are consistent with the human-made type. Klein and Cruz-Uribe (1984:69-71) felt that post-depositional forces such as trampling, leaching, and compaction also act to break bones into smaller pieces, but the fine preservation of delicate objects would indicate that such processes were not an important factor at Petronila Creek.

The third criterion Brain identifies is tortoise shell parts as a share of the overall deposit. He dealt primarily with land tortoises, but mentioned freshwater turtles as well. It seems that animals other than humans do not incorporate tortoise parts in their bone deposits. His conclusion was: "In fact, I would go so far as to say that abundant fragmented remains of tortoises in a bone accumulation strongly suggest human involvement" (Brain 1981:51). At Petronila Creek, there are 882 turtle shell fragments in the portion of the collection that has been fully sorted. Most of these cannot be identified to genus. Of those 94 parts identified to the genus level, 30 are from tortoises, representing (on the basis of shell thickness) a minimum of five individuals. Pond turtles are represented by 49 parts from a minimum of eight individuals; softshells contribute 14 fragments from five individuals; and at least one box turtle contributed one fragment. Table 3 sets out comparisons between the Petronila Creek animal representations and Brain's comparable data for human, hyena, and leopard bone collections. The significance of the tortoise remains can be readily seen, and it is plain that the Petronila Creek bone deposit resembles the human collection.

The bone bed is compelling evidence for a human presence at Petronila Creek. Its attributes are readily presented in drawings, tables, and written descriptions. The material that follows describes artifacts of a non-standardized sort that do not photograph well, are difficult to draw, and embody elusive concepts such as "battered," "polished," and "faceted."

Taphonomic Observations

The bones from the Petronila Creek site are preserved and altered in different ways. The rodent teeth (an estimated 1,352 teeth), generally from ground squirrels (mostly prairie dogs), are often broken and at least 35 percent are etched by stomach acids (Johnson 1993:106). The calcareous nature

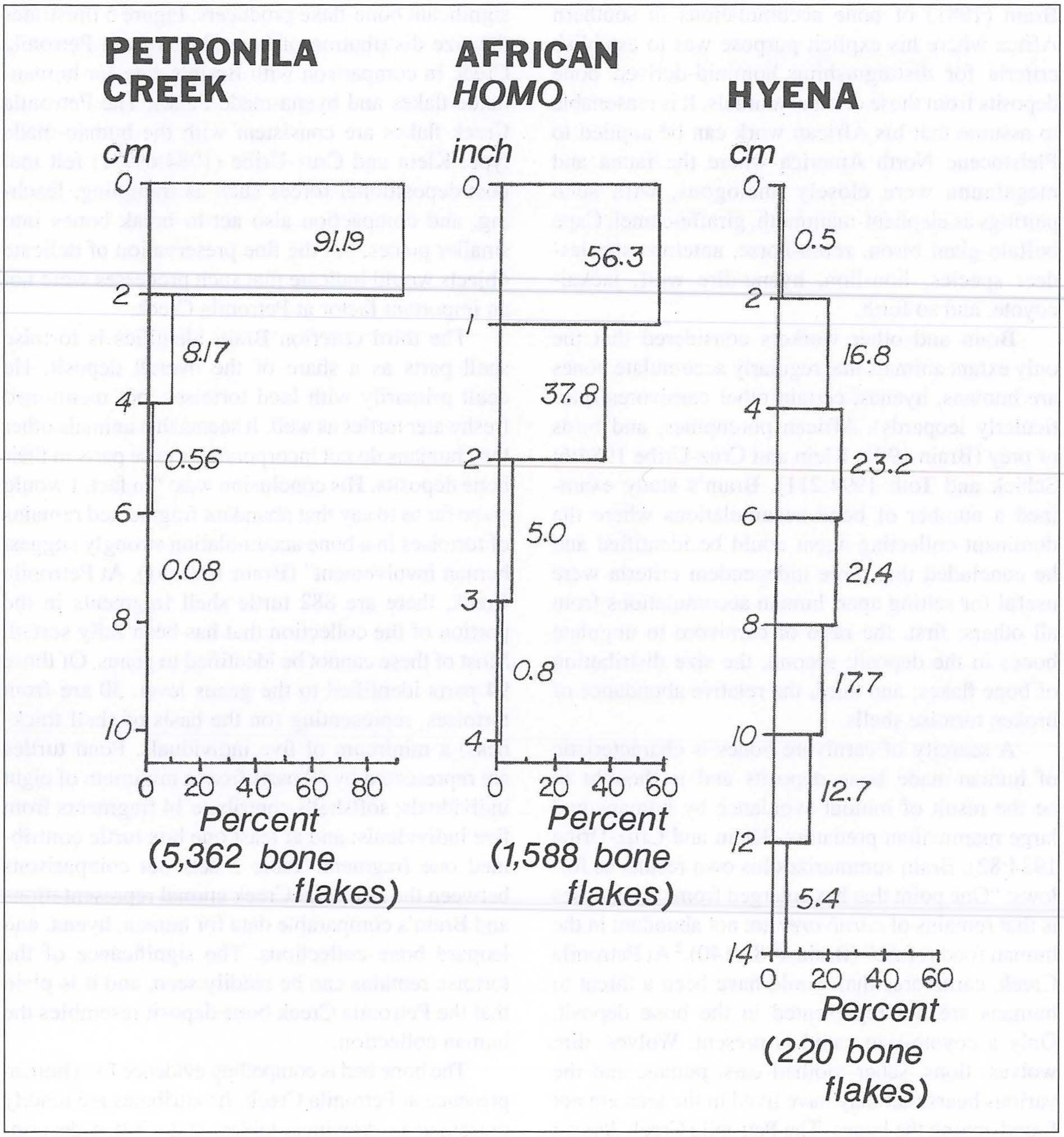

Figure 5. Size distribution of bone flakes from Petronila Creek in comparison with Brain's (1981) data for human-made flakes from Fackelträger Shelter (Africa) and for hyena-made flakes (Brain's combined example).

of the sediments rules out acidic ground waters in recent times as the cause of the etching. The degree of etching varies, but some are deeply pitted and highly degraded. The enamel is attacked more than the dentine. Strangely, none of the fragments of large mammal teeth (an estimated 1,873 fragments) seem to exhibit the etching, even though they are more numerous and often about the same size. Only three or four of the additional 1,092 (estimated) mammoth molar enamel fragments are etched. Possibly related to the differential frequency of etched teeth is the abundance of rodent toe bones. They number in the hundreds, and include the claw-bearing bone and those just behind it. They are in perfect condition, and they are virtually the only part of the rodent skeleton that is found at Petronila Creek.

This pattern of etched teeth and uniquely abundant toe bones suggests one of the possible

Table 3. Animals represented in the Petronila Creek bone deposit as compared to other deposits of various known origin, with an emphasis on tortoises.

PETRONILA CREEK			HUMAN			HYENA			LEOPARD	
Mammals, Reptiles, Birds (fish excluded)			From Fackelträger rock shelter			From droppings, regurgitations,			From droppings bone collections	
Type	MNI	%	Type	MNI	%	Type	No.	%	Type	%
Prairie dog	86	55.5	Hyrax	18	15.9	Med. Ant.	510	41.6	Hyrax	46.1
Tortoise, etc.	19	12.3	Tortoise	17	15.0	Giraffe	430	35.0	Sm. Ant.	18.1
Lizard	17	11.0	Sm. Ant.	15	13.3	Lg. Ant.	154	12.6	Hare	9.7
Rats, Mice	14	9.0	Hare	10	8.8	Zebra	63	5.1	Rats, Mice	8.0
Rabbit, Hare	2	1.3	Monitor	10	8.8	Sm. Ant.	30	2.4	Lg. Ant.	4.5
Mammoth	2	1.3	Med. Ant.	9	8.0	Baboon	9	0.7	Med. Ant.	3.6
Sloth	2	1.3	Pigeon	8	7.1	Hare	6	0.5	Bird	2.8
Horse	2	1.3	Rock Rat	6	5.3	Bird	6	0.5	Baboon	1.9
Bison	1	0.6	Shrew	3	2.7	Tortoise	5	0.4	Porcupine	0.6
Camel	1	0.6	Lg. Ant.	2	1.8	Porcupine	2	0.2	Sm.Carn	0.6
Deer	1	0.6	Sm. Carn.	2	1.8	Snake	2	0.2	V. Lg. Ant.	0.5
Peccary	1	0.6	Lizard	2	1.8	Sm. Carn.	1	0.1	Lg. Carn.	0.4
Sm. Ant.	1	0.6	Snake	2	1.8	Unident.	9	0.7	Snake	0.3
Med. Carn.	1	0.6	Lg. Carn.	1	0.9		1227	100.0	Bushpig	0.3
Sm. Carn.	1	0.6	Rhino	1	0.9				Hedgehog	0.3
Alligator	1	0.6	Ind. Birds	7	6.2				Scorpion	0.3
Snake	1	0.6		113	100.1				Unident.	1.8
Ind. Birds	2	1.3								99.8
	155	99.7								

Data from Brain (1981:Tables 31, 36, and 50); MNI=Minimum Number of Individuals; Sm. Ant.=Small Antelope; Med. Ant.=Medium Antelope; Lg. Ant.=Large Antelope; V. Lg. Ant.=Very Large Antelope; Sm. Carn=Small Carnivore; Med. Carn=Medium Carnivore; Lg. Carn=Large Carnivore; Ind. Birds=Indeterminate Birds; Unident.=Unidentified; Tortoise, etc.=Tortoise plus turtle

functions of the large pounders made of mammoth molar (see below). A possible scenario, supported by ethnographic accounts of similar practices (e.g., Bean 1972:66), would have aboriginal camp dwellers eating rodents after first skinning and cooking them, and then pounding the bones into a mush to be consumed in their entirety. The claw and toe bones would have remained attached to the pelt, and thus have escaped pounding; many teeth would have been broken by the pounding; and a number of teeth would have been inadvertently, or carelessly, swallowed. Occasionally, a bit of enamel would break off of the mammoth molar pounder, and this too would be swallowed with the meal of bone mush. Thus, someone rooting through the refuse of the camp would find intact toe bones, often-broken, often-etched rodent teeth, nothing else of the rodent, and the occasional etched flake of mammoth molar.

The differential preservation of the bones also shows some odd features. The smallest bones, such as the vertebrae of snakes, are always in perfect condition, yet most of the large mammal bones are preserved only as fragments. The only intact large bones are ribs and foot bones, which may have been spared destruction because of their low marrow and grease content. Long bones may have been broken for marrow extraction, then pounded up and boiled (for a modern analog, see Davis and Fisher [1990:258, 262-265]) or otherwise processed. The principal function of the mammoth molar pounders may have been to break up these bones.

The only reasonably intact long bone of a large mammal yet excavated at Petronila Creek is the femur of a mammoth (41NU246-1529). This femur has a large hole at one end where the spongy bone is missing, opening a passage into the marrow cavity. Opening from the knee-joint end, this hole is on the upper surface of the bone as it was found. (There are also numerous cut marks on its shaft surface, and a possible artifact made of turtle shell was recovered from inside the bone in the matrix filling the hole.) Compaction of the sediment has badly fractured this bone, with the hollow central shaft being collapsed. A second intact mammoth femur was seen at the site, and after a major flood one-half of what was probably this bone was recovered. The rest had disintegrated and washed away. The recovered half (41NU246-1531) preserves a crushed knee joint that also appears to have been breached.

These breached mammoth femora would seem to be consistent with marrow-extracting activity, since the technique of cutting into the bone through the soft spongy material at the end is practiced by modern elephant hunters as well as Clovis-age mammoth/mastodon hunters. Two butchered proboscidean skeletons from Wisconsin dating to the terminal Pleistocene both have leg bones cut open at the joint ends, reportedly to extract marrow (Allison 1991). Bailey (1989) photographed a modern Pygmy standing astride a fresh elephant leg bone, chopping at the joint end with an iron axe to gain access to the marrow cavity. G. Haynes (1991:292) noted that when the Ba-Mbuti Pygmy people killed an elephant they "chopped open leg bones to eat the oil-rich cancellous interiors," and he further noted that elephant limb bones contain extensive deposits of marrow in a boney internal latticework that is of high nutritional value.

BONE TOOLS

Abrading Tools

In Late Pleistocene North America there existed a tool-making industry based on the thick cortical shaft bone of proboscideans, generally broken into manageable pieces by percussion flaking (Johnson 1985:202). One manifestation of this industry is an undated Late Pleistocene tool from Florida that consists of the central shaft of the radius of a mastodon that has been wear-modified during abrading or milling activity, resulting in the removal of massive amounts of bone (Dunbar and Webb 1996). Intriguingly similar tools have been identified at Petronila Creek that display flat wear facets. Wear facets, caused by back-and-forth rubbing, are almost never caused by inanimate forces (although unidirectional sliding wear caused by slipping faults or flowing glaciers can produce similar surfaces), and are only infrequently caused by animals (facets on the tusks of wild hogs, for example), but are abundantly caused by human hands at work (any eraser will illustrate the point).

There are three notable examples of faceted bone tools from the bone bed at Petronila Creek. The best specimen is a large chunk of solid bone (41NU246-1542) from the central shaft of a mammoth-size leg bone (Figure 6). It measures 18 x 8 x 3.5 cm in length, width, and thickness and has a large polished facet on that surface which would be toward the hollow interior of the intact bone. This facet covers 32 cm^2 (8 x 4 cm) and has parallel striations on its surface. As much as 1 cm of bone has been worn away. A second massive bone chunk (41NU246-1543) has a smaller facet, but similar enough to the one on the first tool to suggest they both are the result of the same distinct type of tool use. A third chunk, also from solid shaft bone (41NU246-1558), measures 11 x 6 x 2.5 cm and has a pronounced 15 cm^2 facet along one edge.

A faceted tooth tool (41NU246-1540) made from a chunk of mammoth molar also appears to be a grinder. A mammoth molar (Figure 7a-c) is made up of a series of disks bound together by cement. Each disk is composed of an inner core of dentine encased in a layer of enamel. These teeth can be split up into chunks suitable for use as tools. The tooth tool (Figures 8a and 9) has a massive wear facet on one side that may be the result of back-and-forth rubbing or grinding during the milling of plant parts or seeds. The facet exposes regions of enamel, dentine, and cement where the hard enamel defines the basic contours of the surface. Within the enclosing loops of enamel, the dentine is worn to the same level as the enamel, but outside the enamel loops the cement is more deeply worn into channels (Figures 8a and 9). These channels may have developed as gutters for the flow of ground-up plant material between the grinder and whatever milling platform was employed. It should be noted that this wear facet, with material worn away to a depth of at least 2 cm and covering an area of 12 cm^2, is located on what would have been the side of the tooth in the living mammoth, and thus could not be some abnormal

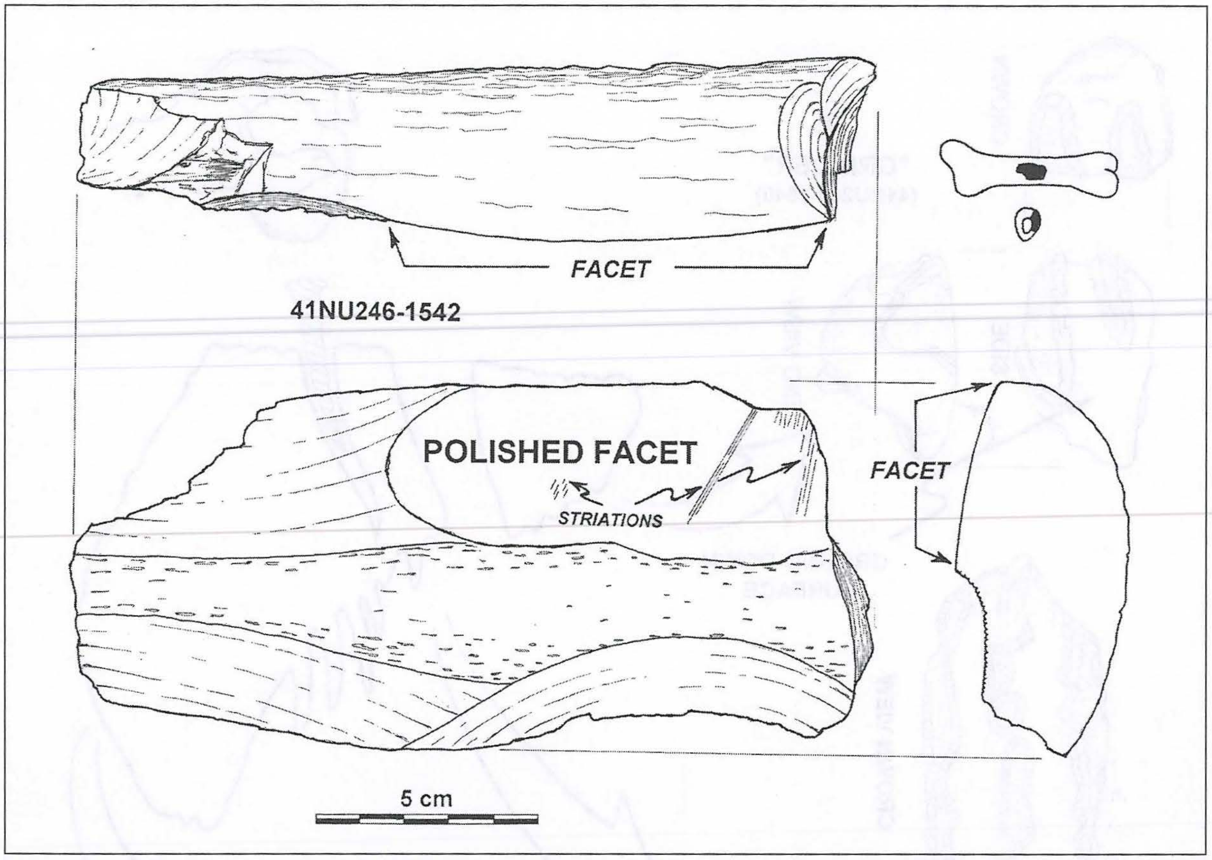

Figure 6. Bone tool showing large facet; striations and polish appear on the facet. The key locates the approximate origin of the object within the shaft of elephantine limb bone.

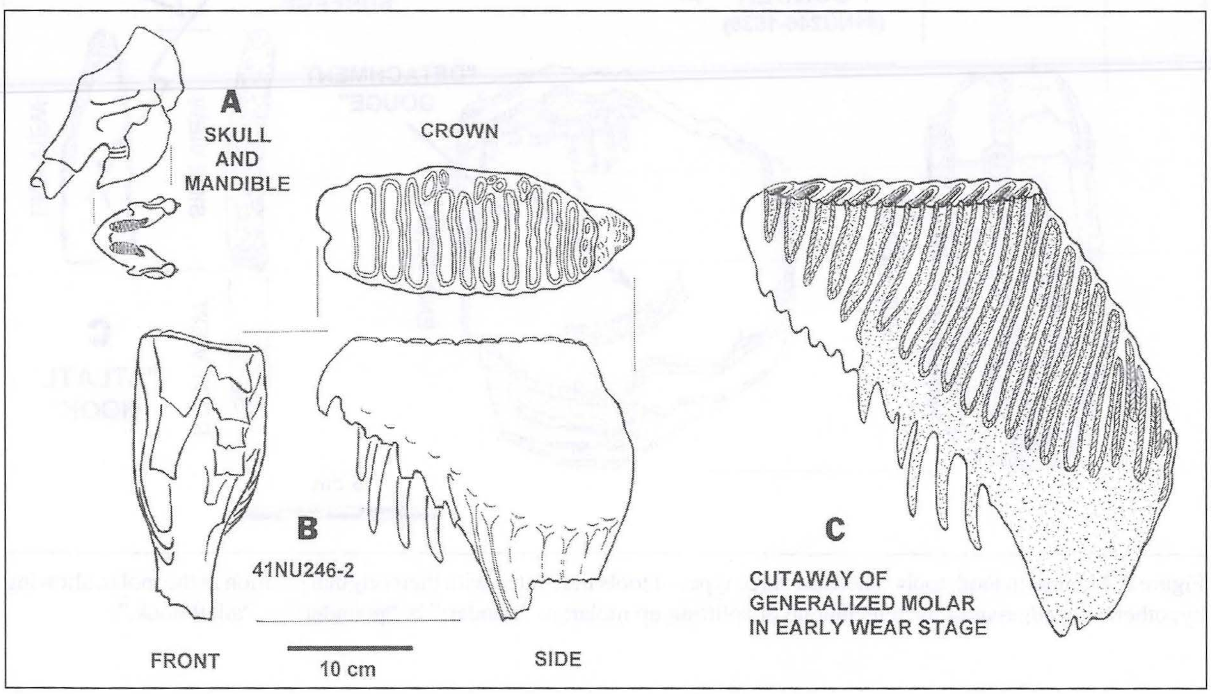

Figure 7. Structure of a mammoth molar: a, skull and mandible to show position of the molars; b, intact molar 41NU246-2; c, generalized molar in cutaway view to show enamel (hatched), dentine (stippled), and cement (white). Hatch orientation indicates prism orientation within the enamel.

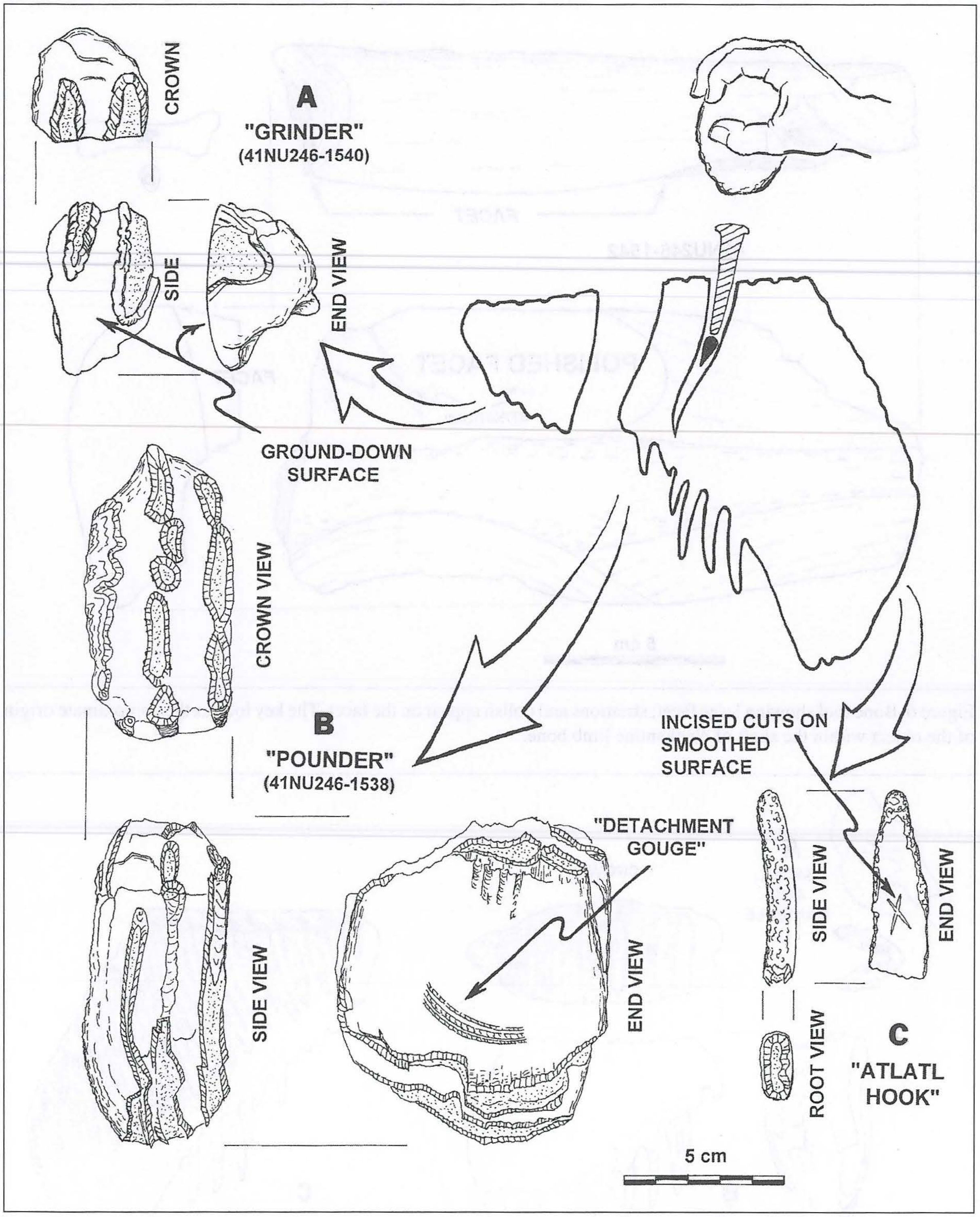

Figure 8. Mammoth tooth tools. There are three types of tools illustrated with their original position in the molar, showing hypothetical wedge-and-punch technique of splitting up molar: a, "grinder;" b, "pounder;" c, "atlatl hook."

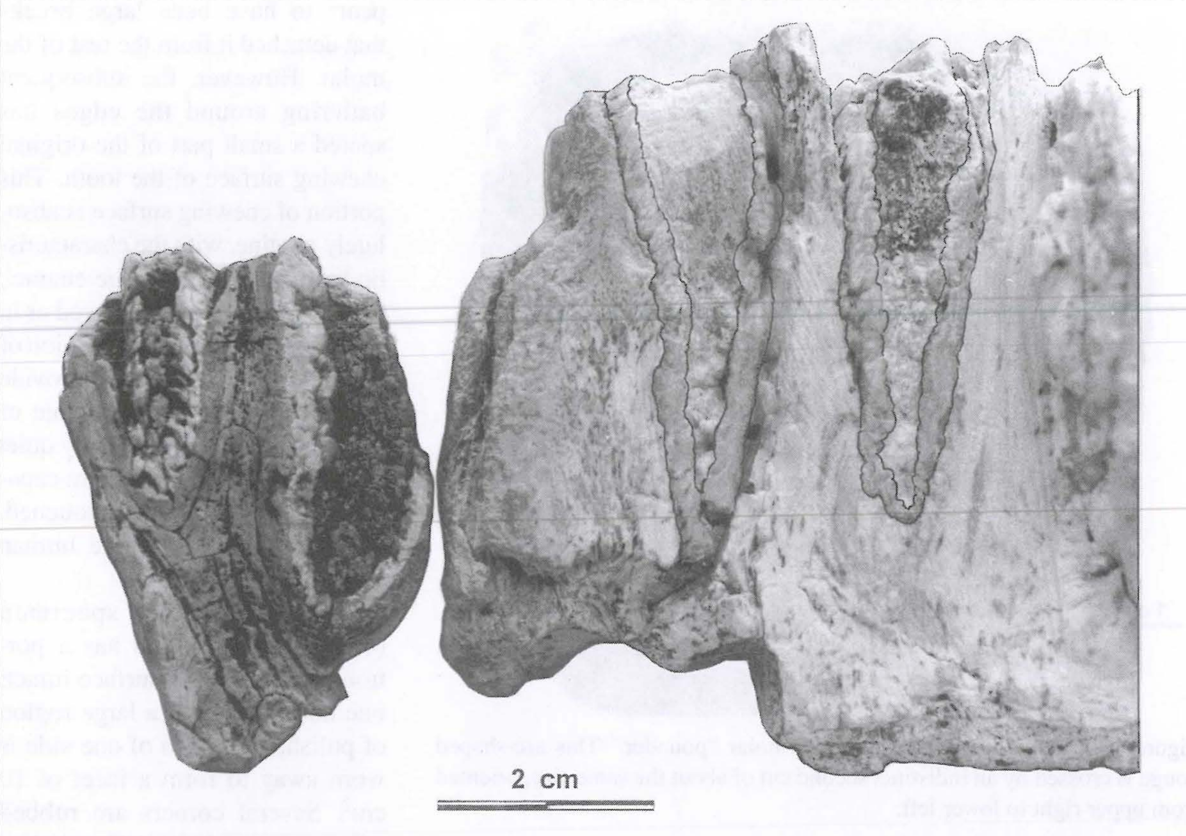

Figure 9. "Grinder" made from a mammoth molar. View (left) is of the ground-down side of a molar chunk, effectively creating a sectioned view of the interior structure of the molar. Compare this to an unrelated gravel pit specimen (right), sectioned with a hacksaw to reveal identical internal structure. Note the polished cement and sand-papered texture of the enamel in the "grinder."

form of chewing surface. A normal chewing surface has rounded and polished enamel ridges protruding above valleys of polished dentine and cement. Such surfaces are located on the crown of the tooth and are unmistakable.

Pounding Tools

A second tool type from the Petronila Creek site is provisionally classified as a kind of pounder. These tools are made of chunks of mammoth molar, and although they often have rubbed and polished areas on their surfaces, they are primarily characterized by extensively battered surfaces that apparently were formed by pounding.

In inanimate nature, the erosion of a surface by impact processes is common. Wind-exposed surfaces erode from the impact of sand and dust grains, river bed rocks erode from water-driven impact, and rockslides in mountainous areas break up large boulders. An impact-battered surface, then, is nothing remarkable unless it is out of its natural context: an object battered by heavy blows is conspicuous only if it is found in an environment where heavy blows do not naturally occur. In a low-energy setting, such as the coastal plain of Texas, an object with a surface eroded by heavy impacts is conspicuously out of place.

In the animate world, very few species regularly employ pounding action, about the only examples being woodpeckers and humans. Thus, a heavily-pounded fragment of mammoth molar found on the Texas coastal plain probably was produced at the hand of a human. Seven such tools have been recovered from the Petronila Creek site.

The first pounding tool (41NU246-1538) is fist-size, hard and durable, and completely untouched by micro-impacts such as would result from stream rounding (Figure 10; see also Figure 8b). It represents a piece of the core region of a mammoth

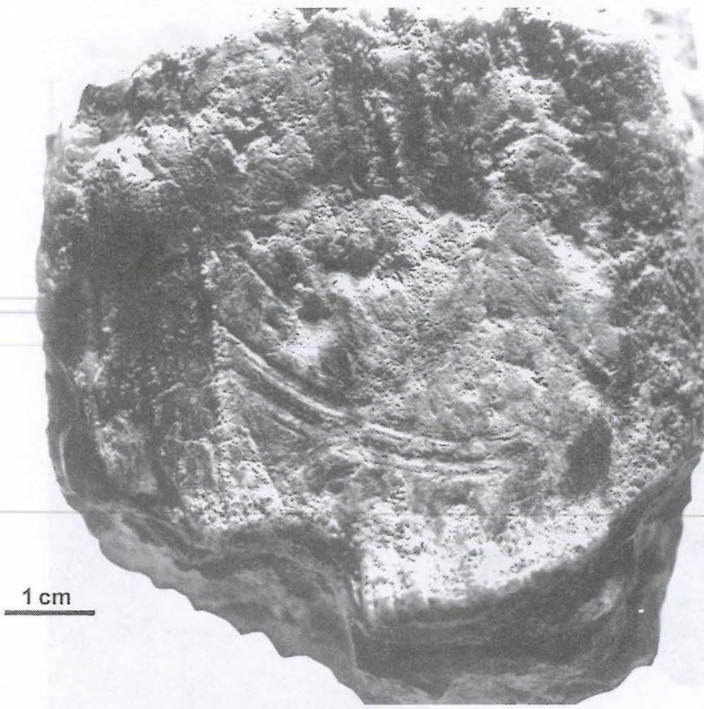

Figure 10. Cut mark on the mammoth molar "pounder." This arc-shaped gouge is crossed by an indistinct second cut of about the same size, oriented from upper right to lower left.

molar, with virtually none of the natural surfaces remaining. The sequence of breakage may have started with a large break on each of the two flat surfaces that detached this section of two plates from the rest of the molar. The peripheral edges then have been beaten away by heavy blows; over 1,000 chips and flakes of mammoth molar enamel have been recovered from the Petronila Creek site, possibly representing the debitage from such battering. There is also a pronounced facet of 15 cm^2 on one side, as well as a large, deep, multi-grooved, arc-shaped gouge on one of the flat surfaces (see Figure 8b). This gouge has the peculiar characteristic that it does not follow the undulating surface of the break, but glides over low spots and digs into high spots. The molar chunk must have been firmly immobilized when this gouge was made, and the gouging object was constrained in its motion. The gouge may have been caused by a wedge being forced into a crack in the intact tooth, possibly while the tooth was still anchored in the bone of the jaw, so as to split off and extract a chunk of molar.

The second specimen (41NU246-1539) is very similar to the first pounding tool. It, too, is composed of two plates, and the first stage of its reduction appears to have been large breaks that detached it from the rest of the molar. However, the subsequent battering around the edges has spared a small part of the original chewing surface of the tooth. This portion of chewing surface is absolutely pristine, with the characteristic wear and polish of the enamel, dentine, and cement preserved as in the living animal. An explanation of the surface battering must provide a mechanism not only capable of heavy blows in a geologically quiet region, but also a mechanism capable of leaving a portion untouched. No agents other than the human hand come to mind.

A third similar specimen (41NU246-1537) also has a portion of the chewing surface intact; one flat surface has a large region of polish, and much of one side is worn away to form a facet of 10 cm^2. Several corners are rubbed off, leaving striated and polished surfaces.

A fourth specimen (41NU246-1533), also composed of two plates and the same size as the others, has one corner rounded off, with dentine surfaces showing striations and polish. A fifth example (41NU246-1534), somewhat smaller than the others, also has a large rubbing-wear surface and polish, and two more fragmentary specimens (41NU246-1535 and 41NU246-1536) retain abraded, polished facets.

These battered, fist-size chunks of mammoth molar conform to the notion of a tool as being something deliberately made to a preconceived pattern and intended for a specific use or set of uses. Their similarity in size and form suggests that they represent a fully evolved tool type.

Atlatl Hook

A third type of tool made from a mammoth molar was suggested by Joe Ben Wheat (personal communication, 1990) as being a possible atlatl hook. This object (see Figure 8c) is fashioned from an aberrant spur of a type often developed within a mammoth molar. Wheat (1979:136 and Figure 73) described and illustrated similar atlatl hooks from the Paleoindian Jurgens site:

These hooks were made by breaking a bison molar and extracting the central core. The core was then flattened on the bottom by grinding, smoothed on the sides and top, and the naturally conical root converted into the hook by grinding and polishing it to a finished point.

The finished hook was then bound to the flattened end of the atlatl. This description precisely fits the mammoth molar object from Petronila Creek, which also has a pronounced "X" incised on the flattened attachment surface.

Digging Tools

Three bone objects may be digging tools, because of their size, shape, chisel-shaped cutting edges, and heavy wear on the chisel edge. This wear has resulted in the rounding off of the edge from the bottom face of the chisel as though each chisel was used with a scooping motion in hard, abrasive dirt. The first (41NU246-1543) is 24 x 7 x 4 cm in length, width, and thickness and is a chunk of solid shaft bone from an elephant-sized leg bone (Figure 11); this object also has a large polished use facet elsewhere on its surface. The second tool (41NU246-1544) is much smaller (14 x 3 x 1.5 cm); is also solid shaft material; is not as heavily worn on the chisel edge (but does have some chipping of the edge); and has a small but pronounced striated facet on the other end. The third (41NU246-1559) bone tool is similar to the first, but shorter and broader (15 x 9 x 2.5 cm), and is heavily rounded on the bottom edge of the scoop-shaped end, with several cut marks near the opposite end.

Work Benches

Three major bones were recovered lying in their original positions (see Figure 3) that are liberally covered with cuts, scrapes, and scratches on their upward facing surfaces, with no marks on the bottom side. These bones are the femora of an adult mammoth (41NU246-1529 and 41NU246-1531) and a partial mammoth pelvis (41NU246-1532). Calcareous crusts partly cover some cuts, and other cuts cross major cracks onto collapsed surfaces, which suggests that the cuts were made when the bones were new. Their surfaces may have been used as work benches. Gruhn and Bryan (1984:132) report similar use of mastodont femora at the Taima-taima site.

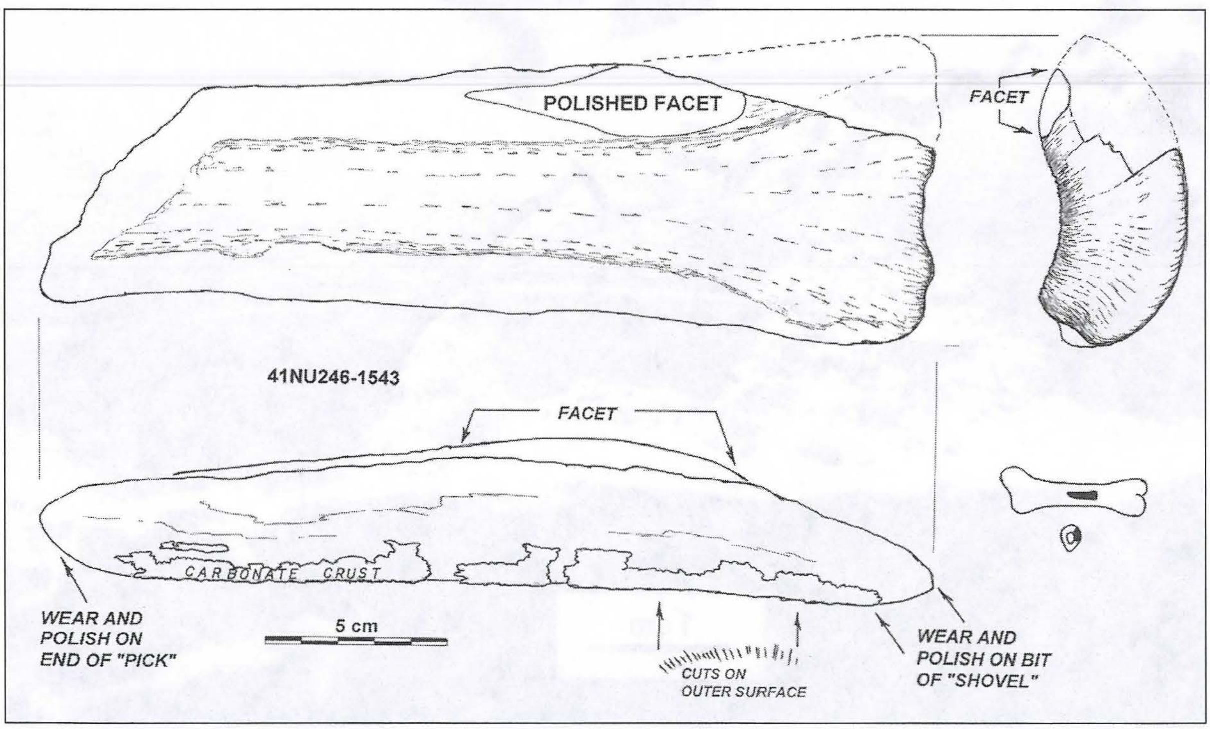

Figure 11. Bone tool that is suggestive of a digging tool. A facet and regions of wear and polish are indicated as well as a pattern of cuts. Key locates the object in the approximate region of origin in the shaft of elephantine limb bone.

MARKS ON BONE

Cut Marks

Marks on bones have been studied by numerous researchers, generally for the explicit purpose of developing criteria to separate human-made cut marks from those made by teeth, trampling, or other agencies. Lyman (1987:Table 5.4) has summarized the results of 11 significant studies that provide the attributes of tooth scratches, tooth punctures, gnawing by rodents, slicing marks resulting from stone, bone, and metal tools, chopping marks from stone or metal tools, scraping marks, sawing marks, flake scars produced by tools and by carnivores, and preparator's marks. In separate works, Behrensmeyer et al. (1986) and G. Haynes (1991) have examined trampling marks caused by large to very large animals.

Lyman's criteria for slicing and/or chopping marks produced by stone tools are that the marks be elongated, V-shaped in cross section, often multiple, not always following the bone contour, deeper in the middle, and commonly divided into multiple, discrete striae at one end. Brain (1981:53) is less analytical, but powerful in his appeal to common sense when he states that "chopping and cutting with sharp stone tools produce occasional marks on bones that could not have been caused by the teeth of carnivores or by other agencies. When these are found, human involvement is confirmed."

In the following consideration of the cut marks at Petronila Creek it is well to keep in mind that these are big, forceful cuts in very hard material. Cut marks on bones from the bone bed are numerous. A tally of bones with at least one mark runs to 36, and many of these have multiple marks; many are very large and obvious.

The largest and most obvious cut mark (Figure 12) is oriented lengthwise down the shaft of the mammoth femur (41NU246-1529). It is 100 mm in length, 3 mm wide, and 0.15 mm deep. This cut meets most of Lyman's criteria, and is probably what Brain would consider to be a self-evident stone tool cut mark.

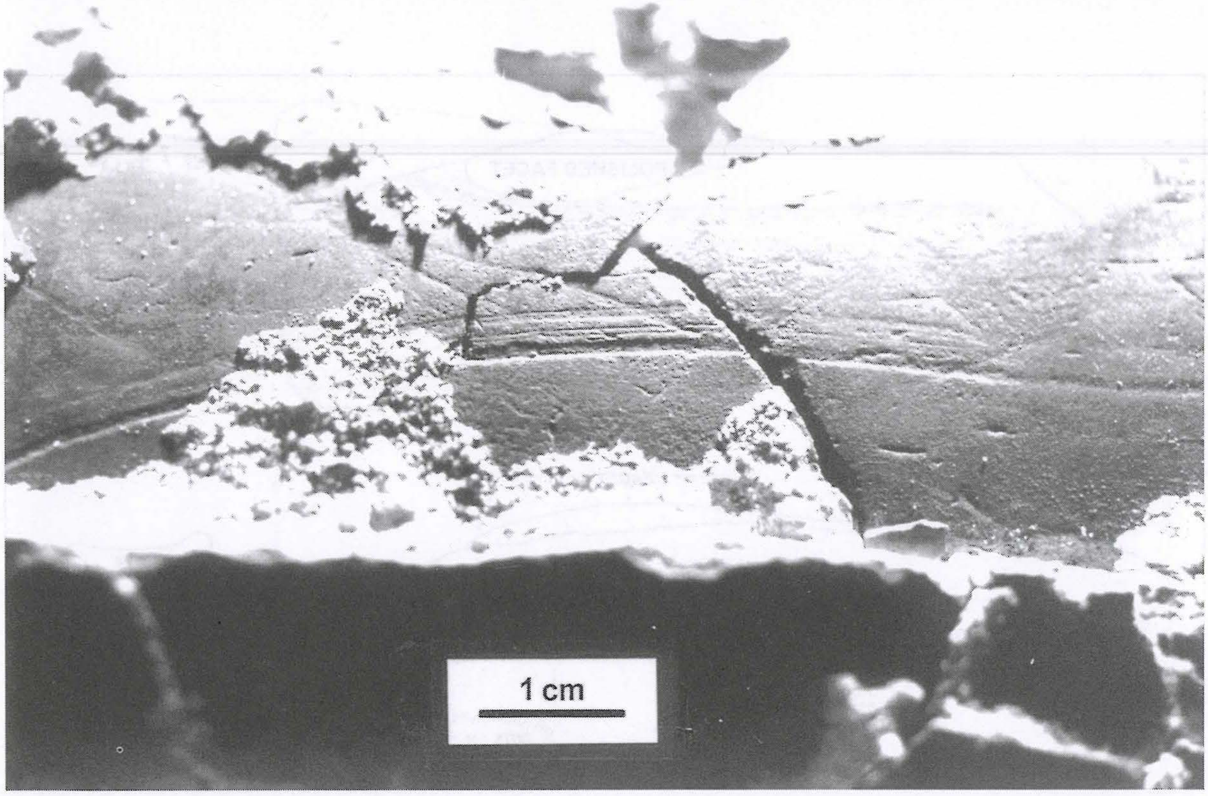

Figure 12. Cut mark on the shaft of a mammoth femur; note the carbonate crust covering the cut. Other less distinct cuts can also be seen.

Three main grooves comprise the cut mark, each composed of a double channel, and they run parallel to each other. The deepest groove is the longest, the second longest is the second deepest, and the shortest is the shallowest. On all three, the deepest area of the cut mark is at the same place: midway down the length of the cut. This cut structure would result from the action of a single cutting surface that has three projections (teeth) of unequal length that passed once across the bone with the maximum contact pressure occurring at the middle of the stroke. The orientation of the three principal cutting teeth does not vary down the length of the cut, indicating that the cutting object was firmly held and did not roll or twist from the force of the teeth dragging through the bone. The overall cut follows a gentle arc of decreasing radius except at the straightest end, where a little "skip" is observed. This corresponds to a small irregularity in the force and direction of the stroke, which otherwise exhibits smoothly varying force and smoothly varying direction. The bone was recovered from undisturbed Pleistocene matrix, and a firmly cemented carbonate crust covers part of the cut, so most likely the cut dates from the time the bone was fresh.

The second largest cut mark (see Figure 10) is the large arc-shaped gouge on the split-off surface of a chunk of mammoth molar (41NU246-1538). It is 40 mm long, 6 mm wide, and 0.3 mm deep. Again, three principal grooves comprise the cut, with one being broad and rather flat-bottomed, and the other two being narrow. The projections on the cutting tool must have been of about equal length since all three grooves make contact with the surface at about the same point and all break contact at about the same place. The cut follows a pronounced arc of constant radius. It is a very forceful cut, the object being cut did not move, and the cutting object did not roll, twist, or follow the surface undulations of the molar chunk. This indicates that the molar chunk was immobilized and the cutting object was constrained to follow its path; the molar chunk may have been attached to the molar proper, which was quite possibly still rooted in the jaw bone of the mammoth. The object doing the cutting must then have been massive and moving fast (so that inertia can account for its failure to follow the irregular surface contour) or it was mechanically constrained in its motion, as a wedge would be. Judging by the shape of the grooves, the cutting object was probably stone. The resulting cut satisfies both Lyman's and Brain's definition of a human-made cut mark.

The third cut mark discussed herein is really a pattern of cuts. These are on the inside surface of a piece (41NU246-1546) from the top shell of a pond turtle, and these cuts deliberately removed a buttress that strengthens the shell (Figure 13). This buttress would be an impediment to utilizing the shell as a bowl, so there is good reason for its removal. The series of cuts form a complex pattern of crisscrossing grooves and ridges reminiscent of the surface left by a coarse-toothed steel file. It may be that the buttress was scraped away by a piece of broken mammoth molar enamel, since the individual coarse prisms of enamel exposed along a broken edge provide jagged points capable of creating patterned cuts of this sort. Several other bits of turtle shell have a similar scraped area on their inside surfaces that removed a projection. Brain's less formalized definition would find that this filed surface "could not have been caused by the teeth of carnivores or by other agencies."

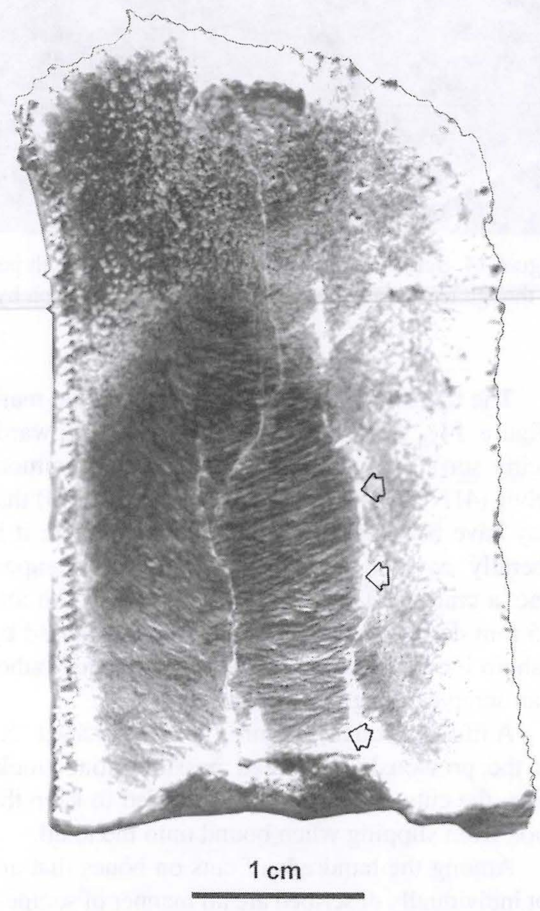

Figure 13. Patterned cuts on the interior surface of a pond turtle shell segment. The cuts removed an internal buttress of the shell, as though to clean it for use as a bowl.

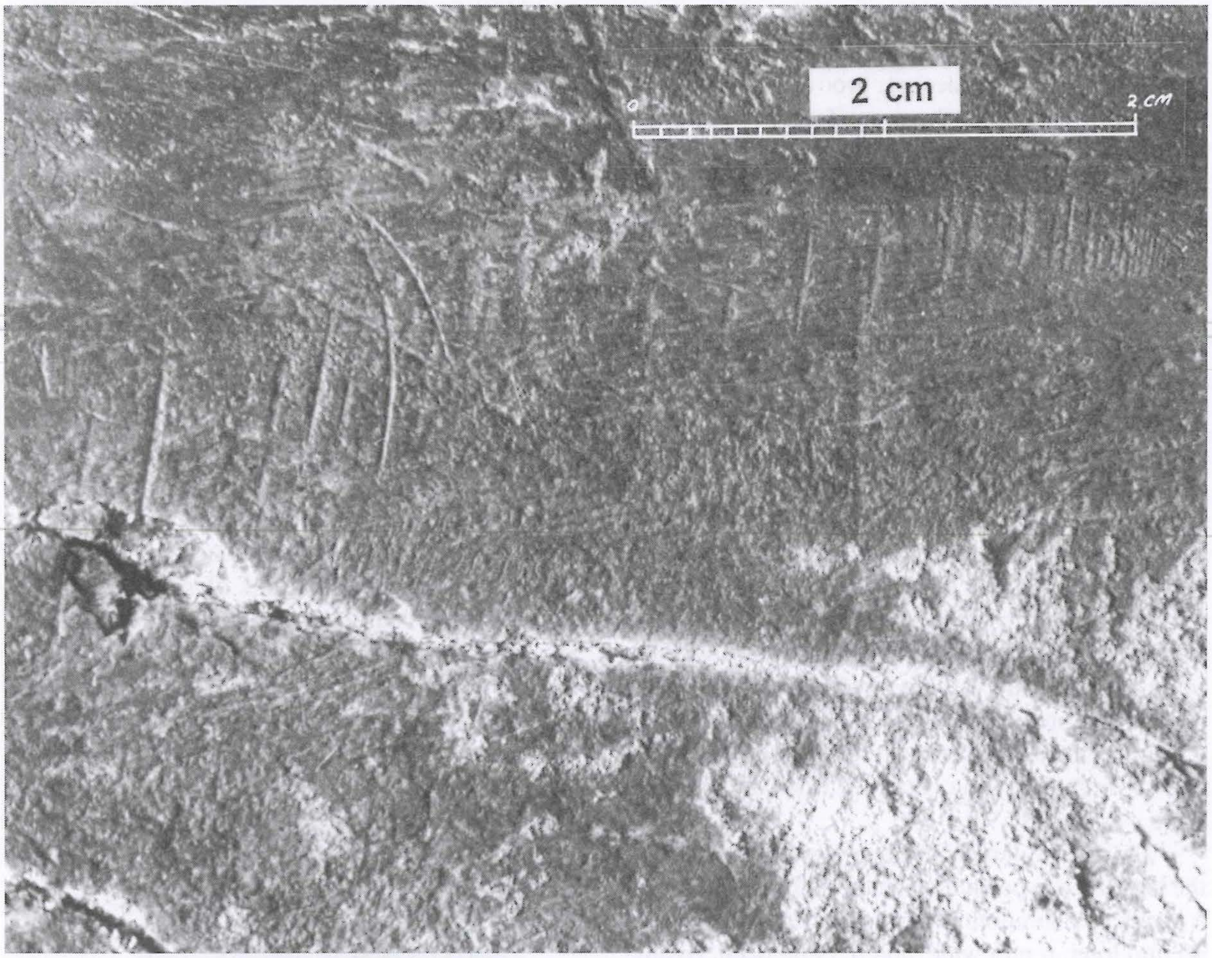

Figure 14. Scuff mark on the surface of a mammoth pelvis; other marks can be seen. The surface is liberally marked, as though from service as a work bench (photograph by Kenneth M. Brown).

The fourth cut mark represents an impact mark (Figure 14). This mark is found on the upward-facing surface of the large fragment of mammoth pelvis (41NU246-1530) (see Figure 3, bone B) that may have been used as a general workbench; it is liberally covered with various cuts and scrapes. One, a crater (20 x 7 mm in length and width and 1.5 mm deep), illustrates a class of cuts caused by a sharp blow where the impactor rebounded rather than scraped along the surface.

A fifth cut pattern (Figure 15) is the incised "X" on the previously described possible atlatl hook. Here, the cuts may have been intended to keep the hook from slipping when bound onto the atlatl.

Among the hundreds of cuts on bones that are not individually described are all manner of scrapes, scratches, gouges, nicks, and dents interpreted as resulting from human activity. There are no cuts and no context that would seem to imply any other agent. When rodents or carnivores gnaw on bones, they work around corners and edges where they can get the bone between teeth of the upper and lower jaws. They are incapable of making tooth marks on flat surfaces. Diligent searches have failed to find any examples of gnawing. Because the sediments are free of sharp stones, trampling would not produce anything but microscopic scratches.

Scuffed Surfaces

Gar scales are thick, boney, diamond-shaped plates that in the living fish are connected together edge-to-edge like bricks in a wall, so that the hide of a gar is a sheet of tough armor. There is a type of scuff found on about 30 percent of the extremely abundant gar scales found at the site. The scuffing typically consists of parallel microscopic scratches on the enamel-like outer surface of the scale, but on

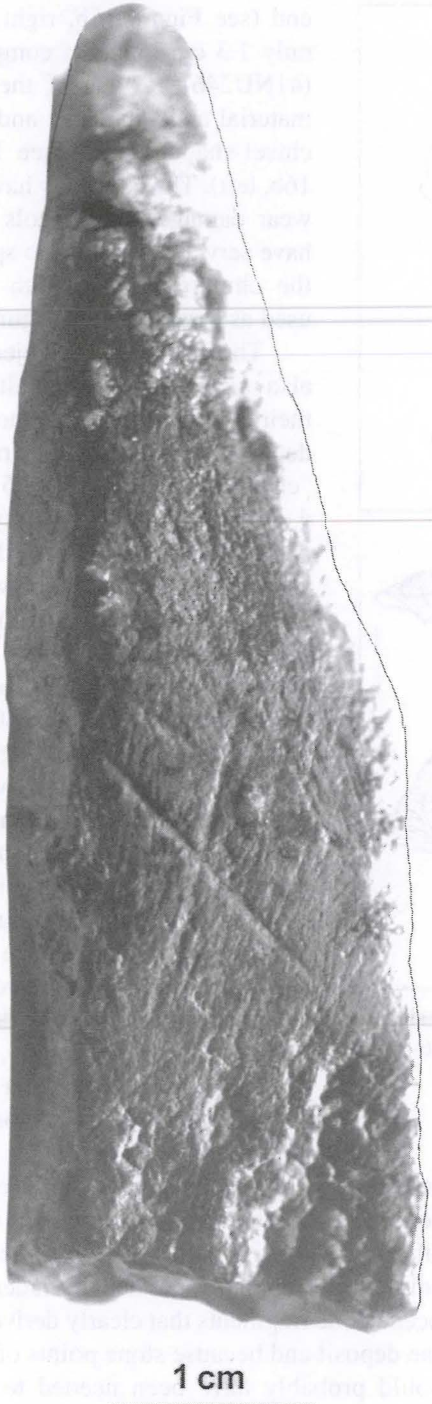

Figure 15. Incised "X" on smoothed surface of mammoth molar fragment that may have served as an atlatl hook.

about 30 percent of the examples, the scuff is on the inner surface of the scale (the side toward the fish in the living animal). These scuffs have a preferred orientation parallel to the long axis of the scale, which would also be the long axis of the hide, suggesting that the thousands of gar scales at the site represent remains of gar hides that were used in some fashion, perhaps as slips to drag objects over the ground.

Polished Surfaces

"Polish" is a surface condition where a sufficient portion of a surface is sufficiently smooth to begin to reflect a coherent image. This is generally a subjective visual determination based upon observing a glint of reflected light from the affected surface.[3]

Of the objects recovered from the Petronila Creek site, many are obviously polished. The above-described faceted bone chunks have slight polish on parts of their facets; the grinder made from mammoth molar has slight polish on the cement portion of its facet; and five of the seven specimens of pounded mammoth molar have polish on one or more of their surfaces. An eighth chunk of mammoth molar (41NU246-1541), composed of a single plate, has polish along one edge. An intact mammoth molar (41NU246-2) also has heavy wear on the side of the tooth along the edge where the crown meets the side and forms a right angle. This right-angle edge seems to have been employed as a scraping edge, for the cement and enamel are extensively worn away, exposing the inner disks of dentine. These exposed dentine surfaces are polished (as well as having striations). Thus, a number of surfaces can be said to exhibit some polish, and in every case the polished region is on an appropriate surface: one that is either a clear wear facet or a surface that is a part of an edge that may have formed a functional cutting or abrading surface. No polish is seen on inappropriate surfaces such as the bottoms of depressions or pits.

CHERT FLAKES AND OTHER STONE OBJECTS

A number of small pebbles have been recovered in situ in the excavations at the Petronila Creek site. The distribution of these pebbles directly tracks the distribution of the bones, and the overlying and underlying clays and fine sands are essentially free of pebbles. Those pebbles found with the bones range from pigeon-egg size on down. Some of the larger pebbles were found close together, and some are broken. One (41NU246-1204) appears to have been tested, for several small flakes have been knocked off its perimeter to expose a red core under a white cortex.

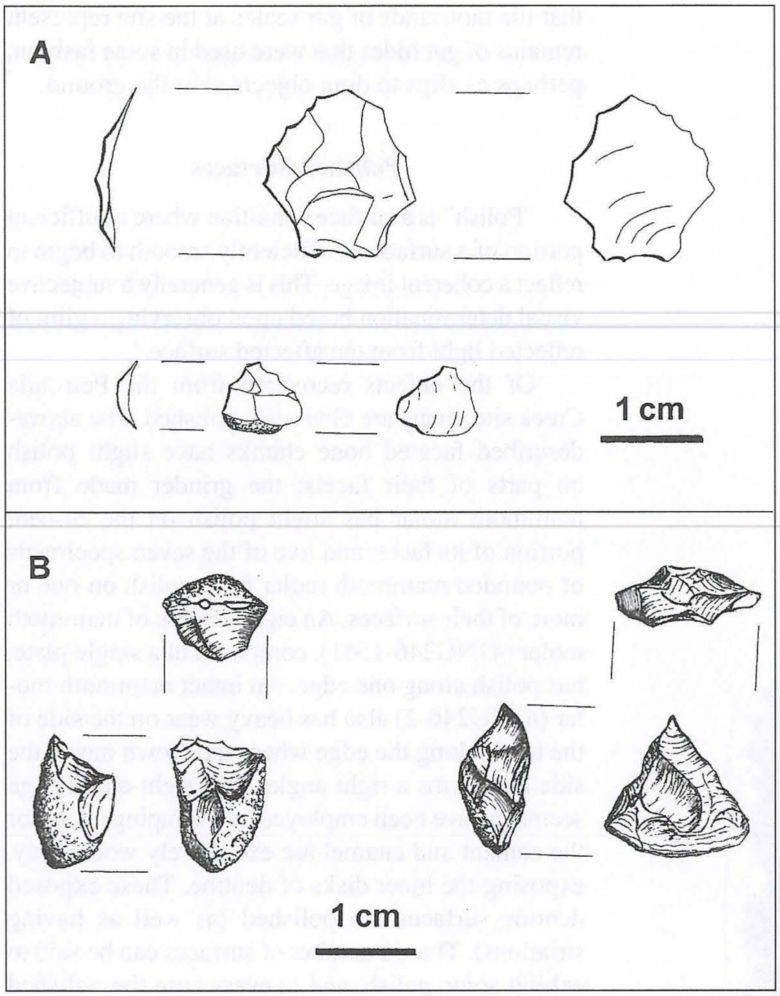

Figure 16. Chert flakes and chipped stone tools, unquestionably in situ in the bone-bearing sand: a, flakes 41NU246-1330 (top) and 41NU246-1013 (bottom); b, tools 41NU246-1120 (left) and 41NU246-1364 (right).

There are several convincing examples of man-made flakes recovered from the bone-bed sand. Two of the best (41NU246-1330 and 41NU246-1013) are thin, sharp flakes from high-quality stone that have numerous flake removal scars on one surface and a single detachment scar on the other (Figure 16a). The larger flake is of translucent dark chert with feathery inclusions and extensive white patination. The smaller is translucent amber chert. Both flakes seem to derive from the manufacture of relatively larger, better made tools than any yet recovered in situ from the site.

Two little "wedges" made of stone were also found in the bone-bed sand. The first (41NU246-1364), of red chert (the same material as the tested pebble), has had pieces broken away to form a point, backed by a knob of white cortex on the other end (see Figure 16b, right). It is only 1.3 cm long. Its companion (41NU246-1120) is of the same material and same size and has a chisel-shaped point (see Figure 16b, left). The edge may have use-wear damage. These tools might have served as wedges to split off the chunks of mammoth molar used as pounders (see Figure 8).

Three other stone objects are also noted at the site, although their associations with the bone deposit are varied. The first is a "chopper" (tool A-61) (7.5 x 4 x 4 cm), made of a low quality chert and retaining much cortex, that has an obvious denticulated bit worked into one end (Figure 17a). This object was found directly above the bones, embedded in the clay layer (dated at 18,560 ± 280 B.P.) that caps the bone-bearing sand, and was exposed by flood waters. It is encrusted with the same carbonate material that coats many of the bones, and was clearly in situ. It was about 30 cm higher in the 4 m sequence of Pleistocene sands and clays, and would be roughly the same age as the bone deposit. It was in close proximity to, and is from the same stratum as, a nearly complete scattered skeleton of a large male *Bison antiquus*.

Two broken projectile points (Figure 17b) were loose in the creek bed sediments, but within the scatter of mammoth bones. Because the creek bed sediments at this point are heavily laden with Pleistocene bone fragments that clearly derive from the bone deposit and because stone points of some sort would probably have been needed to bring down the Pleistocene animals, it is reasonable to suspect that these two points also came from the bone bed.[4]

One of the points (see Figure 17b, left) is the mid-section of a large spear/dart point of white chert (from grid N5E3). This unfluted lanceolate point is heavily ground on the entire length of the edges. The breaks, however, are sharp edged, indicating no significant stream transport. The second represents the stem of a small fish-tailed dart point (see Figure

17b, right), thick, unfluted, and with grinding on all edges (from grid N5E2). Where the stem is broken, the point flares, suggesting it is a shouldered or barbed form. It has a small patch of carbonate encrustation, indicating that it too has experienced no significant stream transport.

FIRE-ALTERED MATERIAL

Fires were present at the site. About a dozen small (pea-sized) nodules of burned clay have been recovered in the bone-bearing sand layer. Nodules like these are commonly found in coastal Texas Indian campsites, and result from campfires baking the ground beneath them into a layer of low-grade brick. The raw white sandy clay is altered to a bed of hard clods ranging in color from dark gray to brick red. They are quite unmistakable. The nodules from the site have a brick red color.

About an equal number of what appear to be burned bones, teeth, and scales have been recovered. All of these are small, but they display the distinctive silvery color of burned bone, and are very distinct from the unaltered specimens. The apparently burned material includes gar scales, fish spines, rodent bones, rodent teeth, and possibly small pieces of mammoth molar enamel.

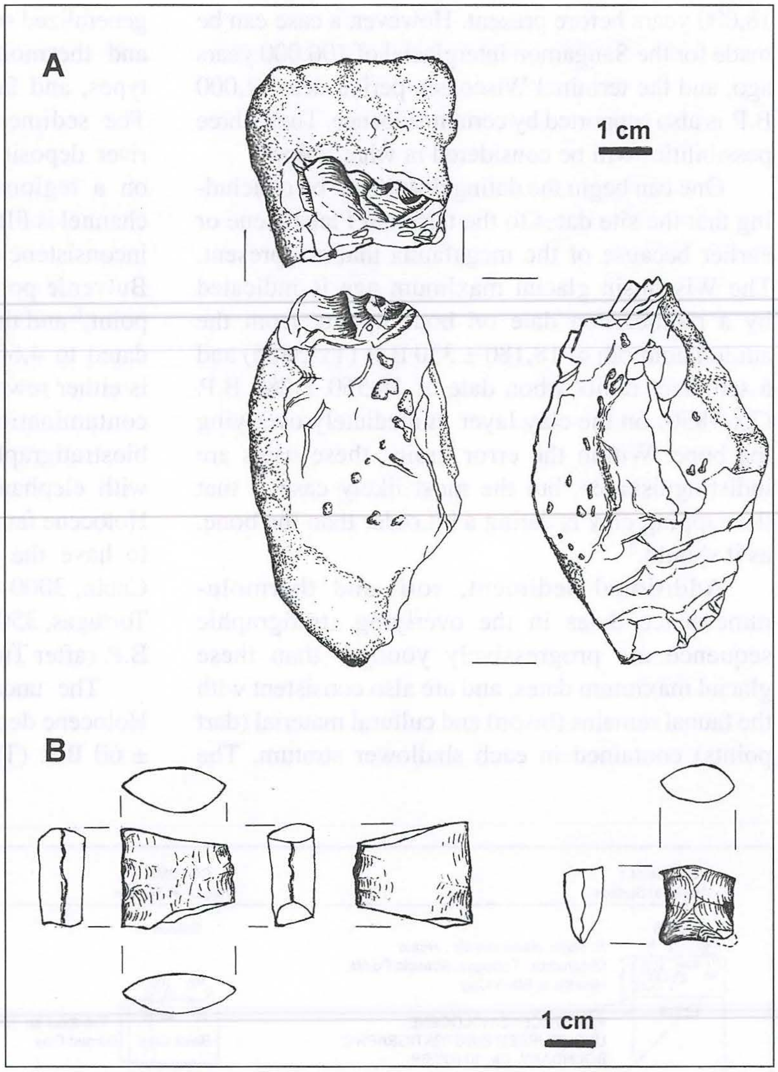

Figure 17. Stone artifacts in close association with the bone bed: a, chopper of coarse-grained chert. Note denticulated bit, patches of carbonate crust, and wear along lateral right-angle edge. Recovered in situ from clay capping the bone bed; b, Projectile point fragments: left, mid-section of opaque white chert with heavily ground edges and indistinct flake scars, sharp broken edges; found loose amid mammoth bones; right, opaque brown chert stem with ground edges and a patch of carbonate crust, also loose amid Pleistocene bones.

Robert C. Dunnell has studied the burned clay and certain teeth. Of the clay nodules, he states "the specimens are burned." He could not establish a thermoluminescence date for the burned clay nodules because of their small size, and because they had been exposed to strong sunlight while being excavated. He was provided a silver-colored rodent incisor for examination under a scanning electron microscope, and stated: "We have examined the burned tooth. There is no doubt that the tooth is actually burned; the temperature, given its structure and its color, can be safely fixed around 600°-650° C" (Robert C. Dunnell, personal communication, 1992).

DATING

There are a variety of absolute and relative dating techniques available to determine the age of the Petronila Creek site. It should be noted that the time of site formation has not been conclusively established. The most likely date is at the time of the glacial maximum of the Wisconsin glaciation, some

18,000 years before present. However, a case can be made for the Sangamon interglacial of 100,000 years ago, and the terminal Wisconsin period near 11,000 B.P. is also supported by certain evidence. These three possibilities will be considered in what follows.

One can begin the dating discussion by concluding that the site dates to the terminal Pleistocene or earlier because of the megafauna that are present. The Wisconsin glacial maximum age is indicated by a radiocarbon date on bone apatite from the adult mammoth of 18,180 ± 330 B.P. (Tx-5835) and a sediment radiocarbon date of 18,560 ± 280 B.P. (Tx-7850) on the clay layer immediately overlying the bone. Within the error limits, these dates are indistinguishable, but the most likely case is that the capping clay is dating a bit older than the bone, as it should.[5]

Additional sediment, soil, and thermoluminescence dates in the overlying stratigraphic sequence are progressively younger than these glacial maximum dates, and are also consistent with the faunal remains (bison) and cultural material (dart points) contained in each shallower stratum. The generalized stratigraphy of the site, with radiocarbon and thermoluminescence dates, projectile point types, and faunal remains is shown in Figure 18. The sedimentary matrix is a white Pleistocene river deposit with a black Holocene soil forming on a regionally eroding surface. An abandoned channel is filled with Holocene sediments. The only inconsistencies revealed in the stratigraphy are a Bulverde point found above the level of the Catán point,[6] and the elephantine bone fragment at a level dated to 4,600 ± 180 B.P. (Column 3). The bone is either reworked or, more likely, the date reflects contamination by new carbon. An undisturbed biostratigraphic boundary is seen in Column 1, with elephantine bone found immediately below Holocene fauna. The projectile points are considered to have the following approximate time ranges: Catán, 3000-400 B.P.; Matamoros, 3000-400 B.P.; Tortugas, 3500-2600 B.P.; and Bulverde, 5000-4500 B.P. (after Turner and Hester 1999:82, 89, 188).

The uncalibrated radiocarbon dates from the Holocene deposits are 700 ± 60 B.P. (Tx-5417); 770 ± 60 B.P. (Tx-5416); 1350 ± 240 B.P. (Tx-5415);

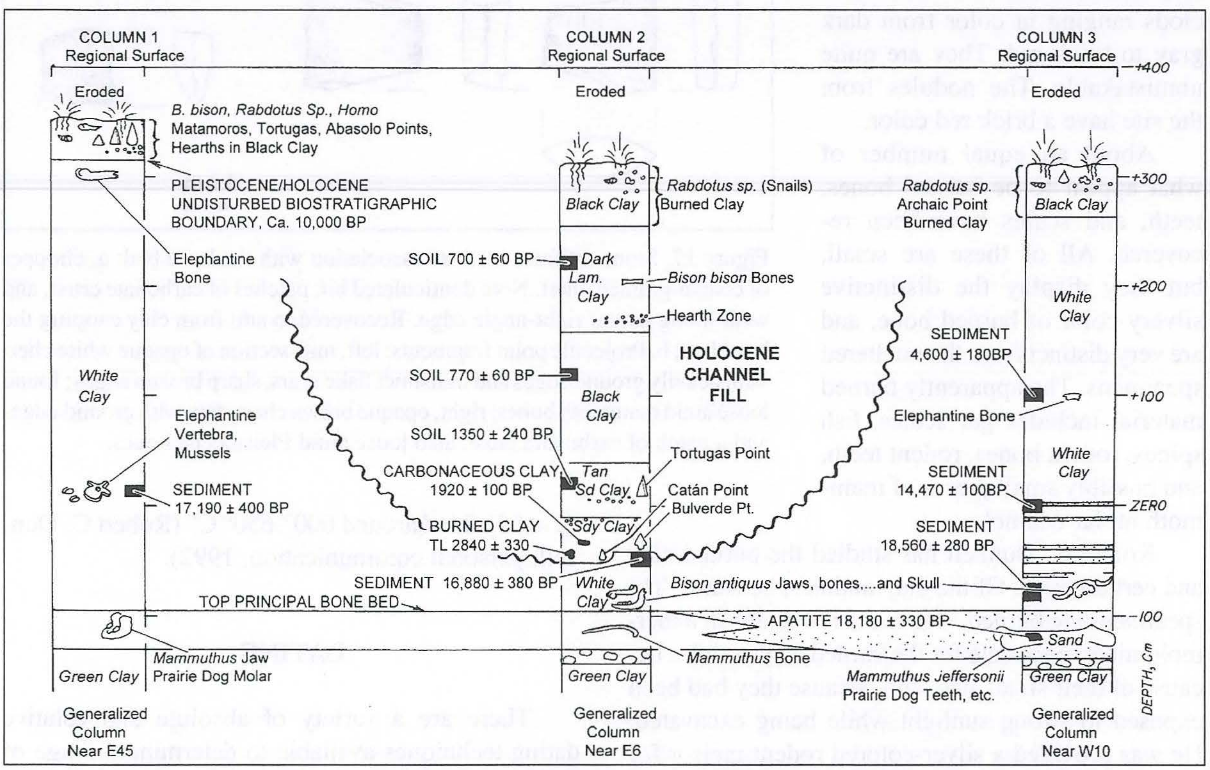

Figure 18. Generalized stratigraphy along 55 m of cutbank with radiocarbon and thermoluminescence dates, projectile point types, and faunal remains. Locations identified at base of each column. The upper two sediment dates in Column 3 are probably too young due to prolonged exposure on the cutbank and contamination with new carbon. The sediment date in Column 2 may be too young due to contamination from the Holocene channel material.

and 1920 ± 100 B.P. (Beta-15995) (see Figure 18). Dates from Pleistocene contexts in Columns 1-3 are: 14,470 ± 100 B.P. (Tx-7852); 16,880 ± 380 B.P. (Tx-5373); 17,190 ± 400 B.P. (Tx-5372); and the aforementioned dates of 18,180 ± 330 B.P. (Tx-5835) and18,560 ± 280 B.P. (Tx-7850). The thermoluminescence date on burned clay from Holocene channel fill is 2,840 ± 330 B.P. (Alpha-3015). Although the materials dated are not as reliable as charcoal (none of which is available) or bone amino acid (none remaining; Thomas W. Stafford Jr., personal communication, 1990, 1994), they generally have yielded acceptable dates. David Meltzer has advised that both bone apatite and soil dates needed to be given higher ratings on the Mead-Meltzer rating scale because of improvements in the dating techniques in recent years (personal communication, 1991).[7]

Besides the radiocarbon dates, additional evidence for a Wisconsin glacial maximum age comes from several sources. First, the assemblage is physically "deep" in the Pleistocene, well below the Pleistocene/Holocene biostratigraphic boundary, being some 5 m deep in sediments that contain isolated mega-mammal bones almost to the surface. Second, the degree of physical diagenesis of the overlying clays is consistent with an 18,000 year age (Michael D. Blum, personal communication, 1990). Third, the inferred hydrological regime—high effective rainfall, giving rise to a perennial stream large enough to support large fish, turtles, and alligators—fits the full glacial Tahoka Pluvial period of 22,500-14,000 B.P. (Bryant and Holloway 1985:44-50). At that time the lake basins of West Texas were full, and increased rainfall may have extended into South Texas to swell the Petronila Creek into a river. Suhm (1980) established that the now-dry Palo Blanco, farther south than Petronila Creek and farther into the present arid zone, was a broad meandering river during "pluvial times" of the "humid Wisconsin glacial stage."

Finally, the faunal assemblage—the types of animals present—is what would be expected from an assemblage dating to the middle Wisconsin period. Mead and Meltzer (1984:Figure 19.3) reviewed the extinction record and concluded that the terminal Pleistocene extinctions had not yet begun at 18,000 B.P. The Petronila Creek deposit contains at least nine species (in seven genera) of large mammals and reptiles that later became extinct.

On the negative side, a full glacial time period seems inappropriate for the insect fauna, and possibly for parts of the reptile fauna, found at the site. The weevils *Compsus auricephalus* and *Cylindrocopturus armatus* are now confined to southern Mexico and parts of Central America (Scott A. Elias, personal communication, 1989), which would indicate that they are warm-weather species. Also, the large tortoise (*Gopherus hexagonatus*) has generally been considered intolerant of freezing weather (e.g., Lundelius 1972:5). But counter arguments can in turn be made: the weevils, being plant feeders, may have followed their food source south rather than their climate niche (Elias 1994:75). Pleistocene species assemblages often included mixtures of tropical and temperate species that have no modern analog (Guthrie 1984:263-267). Of six beetles studied by Elias that lived in or near Texas during the Wisconsin period, four moved north when the climate warmed and one moved east, but one also moved south (Elias 1994:104-105). So a southward migration of the Petronila Creek weevils may not be a chronological problem. As to the big tortoises, Westgate (1987) has provided convincing evidence, in the form of tortoise remains found inside apparent burrows, that *Gopherus hexagonatus* was able to burrow (and thus escape freezing weather). Further, while climatological reconstructions for the period of the Wisconsin glacial maximum are fairly certain for the reduction of mean July temperature, with southwest Texas and Central Texas being 5° C to 5.5° C (about 10° F) cooler in midsummer (Bryant and Holloway 1985:47, 49), the pollen records say little about winter temperature. Elias (1994:85-87) offers evidence from beetle fossils that the central U.S. and Rocky Mountain regions were indeed much colder during the glacial maximum, but the Chihuahuan Desert of northern Mexico and the southwestern U.S. experienced little temperature change. Thus, the presence of tropical beetles and giant tortoises at Petronila Creek during the glacial maximum may not be climatically inappropriate.

In the absence of any radiocarbon dates one might well conclude that the Petronila Creek site dates from the Sangamon interglacial of roughly 100,000 years ago. Both the Sangamon and Wisconsin periods fall within the Rancholabrean Land Mammal Age, which means that there are no obvious index species to separate the two periods. Both *Bison latifrons* and *Bison antiquus* are reported from the Sangamon (McDonald 1981:75, 82; Kurtén and Anderson 1980:337-338), so the presence of *B. antiquus* would not be an anomaly. In fact, the *Bison* at Petronila Creek, as seen from a semi-complete skeleton obtained from the layer just above the main bone deposit, while clearly a *B. antiquus* based upon horn core measurements, has some decidedly *B. latifrons* features in other parts of the skeleton: all of the skull measurements overlap with *B. latifrons* and most of the limb measurements are too large for *B. antiquus* but fall within the range of *B. latifrons* (Lewis 1994).[8] If *B. antiquus* arose from *latifrons* stock during the Sangamon, as seems plausible based upon McDonald's work (1981), such a mixture of characteristics as seen in the Petronila Creek specimen could be expected in Sangamon stock.

The *Mammuthus* dentition, based on one intact molar and several fragments, is relatively primitive when measured according to the criteria set forth by Maglio (1973). It fits within Kurtén and Anderson's (1980:352) "early *jeffersonii*" group (Figure 19), which as they define it is really the transition group from *M. columbi* to *M. jeffersonii.* They imply that this transition took place during the Sangamon, with *M. columbi* terminating in the "middle Rancholabrean" (i.e., Sangamon) and *M. jeffersonii* being the Wisconsinan form (Kurtén and Anderson 1980:351-352). Anderson (1984:86) refers to *M. jeffersonii* as being "the Sangamonian-Wisconsinan species." Thus, the situation for the *Mammuthus* is the same as for the *Bison*: the Petronila Creek specimen fits best as a Sangamonian intermediate between *M. columbi* and *M. jeffersonii*.

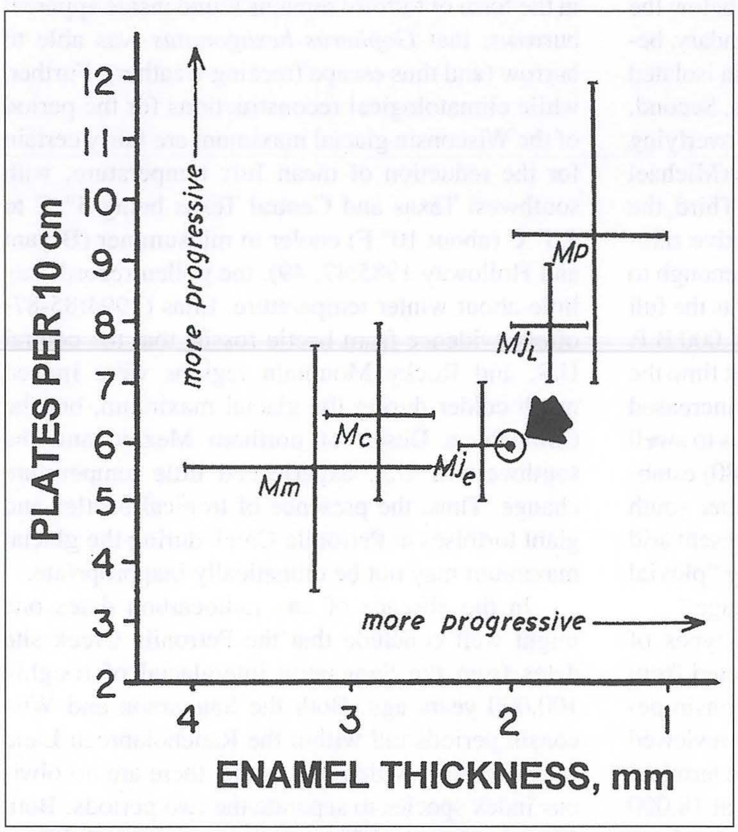

Figure 19. Two-variable plot of dental characteristics of New World mammoths, showing the developmental position of the Petronila Creek mammoth (after Kurtén and Anderson 1980): *Mm=Mammuthus meridionalis* (1.5-1 million years B.P.); *Mc=Mammuthus columbi* (1.0 to 0.1 million years B.P.); *Mje=early Mammuthus jeffersonii* (100,000 to 50,000 years B.P.); *Mjl=late Mammuthus jeffersonii* (50,000 to 10,000 years B.P.); *Mp= Mammuthus primigenius* (to 10,000 years B.P.).

Among the rest of the mammalian fauna, only the rodents are well represented and well studied (Johnson 1993). They are for the most part grassland species that have a temporal range from the Sangamon to recent times. The Petronila Creek area may have been grassland during the Sangamon (an interglacial) because it is presently (an interglacial period) at the edge of a grassland; however, the glacial maximum also produced probable grasslands in the area (Bryant and Holloway 1985:50). Therefore, so far as can be seen, the small mammals could be of Sangamon age.

As noted earlier, the two weevils and the giant tortoise present at Petronila Creek are most readily interpreted as species that should have inhabited the region at a time when the climate was warmer than at present, not when it was colder. The Sangamon probably was such a warmer period. It can be deduced from the Sangamon sea level stand (some 25 ft. higher than at present) (e.g., Lundelius 1972:6), that more of the Earth's polar ice was melted then than now, and Elias (1994:144, 148, 150, 156, 164, 183, 187, 196-197) has established that at least the northern hemisphere was warmer during the Sangamon than at present.

Finally, the entire deposit is emplaced within the Sangamon delta of the Nueces River (Aronow 1971). To argue a glacial maximum age for the archeological deposit at the Petronila Creek site, it has been necessary to assert that the Petronila Creek of that time was a substantial river flowing across, and reworking, the abandoned Sangamon delta of the Nueces. This "Petronila River" is needed to account for the large catfish, giant garfish, large aquatic turtles, large alligators, and other evidence of a big, permanently flowing river. But a simpler explanation for the presence of a big river is to conclude that this river was the Nueces itself, and that it was occupying and building its Sangamon delta at the time these large aquatic animals were taken from it and incorporated into the bone deposit that is now 41NU246.

The only evidence contradicting a Sangamon age is the series of radiocarbon dates. They get progressively older with stratigraphic depth and reach only 18,000 B.P. at the level of the bone deposit (see Figure 18). If a Sangamon age is correct, and the radiocarbon dates are too young, this by itself would not be too surprising. Bone apatite and sediments are subject to contamination by modern carbon and their dates should be taken as minimum ages (Salvatore Valastro, Jr., personal communication, 1994).

A final possibility is that the site dates from the terminal Wisconsin period, about 11,000 B.P. The reason to consider this date is the presence of man, for until quite recently, the entrance of humans into the region was almost universally taken to have occurred at the end of the Pleistocene and just prior to the start of the Holocene period. If this view is correct, and if it is accepted that humans are present at the site, then humans in conjunction with *Mammuthus* and other Pleistocene species found at Petronila Creek makes the site contemporary with Clovis, if not in fact a Clovis site, and narrowly confines the date to near 11,000 B.P.

The counter argument to a terminal Wisconsin date must start with the radiocarbon time series from the Petronila Creek site (see Figure 18). In the shallower strata of the Holocene channel fill the soil dates appear to be too young, with 700 B.P. and 770 B.P. radiocarbon dates for strata beneath Matamoros dart points (with a temporal range of 3000-400 B.P.) in the younger overlying stratum, and a 1920 B.P. radiocarbon date for a stratum dated at 2840 B.P. by thermoluminescence and containing Bulverde points (dating ca. 5000-4500 B.P.) (Lewis 1994). In the deeper stratum, clay sediments have been dated at 18,560 B.P. when freshly exposed, but after a few years of exposure have acquired enough modern carbon to date at only 3040 B.P.[9] Thus, it seems that the soil/sediment dates at this site tend to be erroneously young, not old. The case for the bone apatite date is similar. The tendency of bone apatite is to date too young, despite the infamous case of the Old Crow "flesher" (Nelson et al. 1986). In studies of the various bone extracts from the Clovis age Domebo mammoth, for instance, Stafford et al. (1987) found that untreated apatite dated 36.4 percent younger than the true age (from bone amino acid and associated wood), and treated apatite still dated 18.9 percent too young. One is therefore hard-pressed to explain why bone and sediment dates of 18,000 B.P. should be "corrected" to 11,000 B.P.

A second objection to a terminal Wisconsin date may be the implied wetness of the Petronila Creek region at the time of deposition of the bone bed. A Sangamon date is conceivable, because the river in question would have been the Nueces. A glacial maximum age is also plausible, because it corresponds to the Tahoka Pluvial period when high rainfall filled the lake basins of West Texas and created rivers in now-arid regions of South Texas. A terminal Wisconsin date, however, seems less likely. A long term trend toward increased aridity (since the Glacial Maximum) had by that time caused the West Texas lakes to dry up (Bryant and Holloway 1985:52). C. Haynes (1984:345-351, 1991:438-450) provided evidence that the Clovis period coincided with a drought-caused erosional episode well documented in western North America and seen as far east as New York. He felt that this dry period lasted about 500 years before wetter conditions returned. Considering that the Petronila Creek catchment upstream of 41NU246 is both small and semi-arid (at present), being composed of the northern part of Jim Wells County and a bit of Duval County, it may be that a substantial river could not have been sustained during the Clovis drought.

Additionally, the diversity of now-extinct animals also argues against a terminal Wisconsin age. Grayson (1991) pointed out that of the 35 genera of mammals that became extinct in North America toward the end of the Pleistocene, only two, *Mammut* and *Mammuthus*, have convincingly been found in Clovis (or later) kill sites (note that the genus *Bison* did not become extinct.) Of the remainder, Grayson (1991:220) found "strong hints that many of the taxa involved may have been on their way to extinction, if not already gone, by 12,000 years ago." The Petronila Creek site contains five of these missing genera (in addition to mammoth), which tends to indicate that they were still abundant during the time when the Petronila Creek site was being formed. Approaching the problem from a different angle, Grayson further noted that "good" radiocarbon dates for the last occurrence of these 35 genera place only eight in the last 2,000 years of the Pleistocene (12,000 to 10,000 years ago). He contended that there is no good evidence that three of the genera found at Petronila Creek survived into this terminal

Wisconsin period (*Glossotherium, Platygonus,* and *Capromeryx*). Grayson's work is conservative, and future work will no doubt alter the placement of genera in the above lists, but the conclusion is probably solid that several genera at Petronila Creek were scarce or absent by Clovis time.

Further, a general dwarfing of the terminal Wisconsin megamammals may have taken place on a worldwide basis (Guthrie 1984:269-271), which does not square with the *Bison antiquus* at Petronila Creek, which was for the most part beyond the size range of *B. antiquus* and within the size range of the larger *B. latifrons*. The *Mammuthus jeffersonii* femur from Petronila Creek is also that of a very large specimen, possibly the largest mammoth known from the New World (Table 4).[10]

Intact femora of Southern mammoths are not abundant. Osborn (1942) and his associates almost certainly published the largest known to them. No larger specimen appears to have been published since 1942, other than the Petronila Creek specimen. The width/length ratio indicates that the Petronila Creek femur is bulkier than average despite its great length. As to available forelimb material, the largest known to Osborn (1942:1022-1023) was that designated *A. imperator maibeni* (University of Nebraska Museum 5-9-22). This was estimated to represent a living animal more than 4 m high at the shoulder. The incomplete femur associated with these forelimbs has a transverse diameter of the shaft of 157 mm; the Petronila Creek femur measures 165 mm at this point. The tusk fragment associated with the Petronila Creek mammoth, from near the tip of the tusk, is also large and bulky, being 1.8 m long with a circumference of 56 cm. Guthrie (1984:270) states that "virtually all mammoths associated with Clovis points in the New World are diminutive and have reduced tusks." Gary Haynes (1991:26-27, 53) noted that "toward the end of the last glacial advance in the Pleistocene, mammoth body size and stature apparently decreased." This was "possibly in response to climatic deterioration after 18,000 years ago." He expected to see size reduction in a specimen dated at 11,450 B.P., declaring that "if that date is correct, perhaps the animal is a small male whose stature reflects the overall trend toward body size reduction in late Pleistocene *Mammuthus*." Thus, the outsized Petronila Creek mammoth, with relatively primitive dentition, does not appear to be the sort expected to have been present at the terminal Wisconsin, but would not seem out of context 7000 years earlier at the glacial maximum.

After considering the evidence bearing on the age of the Petronila Creek site, it is reasonable to conclude that the site dates from the Wisconsin glacial maximum. The radiocarbon dates indicate this, and stratigraphic, hydrological, and faunal evidence also support this conclusion. Most persuasive is the fact that two different dated materials, bone and sediment, have provided radiocarbon ages that are in such close agreement. Also persuasive is the orderly stacking of radiocarbon dates in the obviously stratified sedimentary sequence, corroborated by a thermoluminescence date, adequately correlated with the assumed age of dart points in the younger zones, and always consistent with the fauna of each level.

DISCUSSION

The Petronila Creek site is of more than ordinary importance because there appears to have been human activity there roughly 7000 years before the advent of the Clovis culture in North America. The first question that presents itself is: is this reasonably possible in the context of what we presently know? A recent review of the status of our knowledge of archeological sites, genetic material, and the timing of northern ice barriers (Goebel et al. 2008) concludes that it was modern humans who first colonized the Americas. The authors find that these people dispersed from Africa across Eurasia beginning about 50,000 years ago, and had occupied western Beringia by 32,000 years ago, a relatively warm time when no glacial ice sheets would have blocked their movement into the interior of North America. Based on these observations, and accepting other evidence that people reached the interior of the continent before the Clovis period, Goebel et al. conclude that humans possibly colonized the Americas before the Last Glacial Maximum. Therefore, a human occupation at Petronila Creek 18,000 years ago should be considered to be reasonable. The data that have been presented above in this article will now be discussed with the objective of evaluating the strength of the evidence.

Evidence becomes more convincing as various independent lines of investigation point to the same result; this has a statistical foundation but is also a product of common sense. At Petronila Creek it would not be correct to say that the burned clay nodules and the fire-altered animal parts both point to human activity, because they are not independent indicators of human activity: what they do point to is

Table 4. Femur Measurements of Southern Mammoths of North America.

Name	Greatest length, mm	Greatest width, mm	Width/ Length ratio	Reference
Petronila Creek (41NU246-1529)	1429	400	0.28	This article
Reynolds (Neb. Mus. 13-24-10-14)	1422	–	–	Osborn 1942:1018
Bradenton (Amer. Mus. 26821)	1393	–	–	Osborn 1942:1113
Denver Museum (1359)	1390	–	–	Osborn 1942:1036
Lange-Ferguson (SDSM 12468)	1372	–	–	Mol and Agenbroad 1994:243
Amherst Museum 25-1	1340	–	–	Osborn 1942:1080
Crawford (UNSM 2448)	1325	–	–	R. George Corner, personal communication,1997
Hot Springs 86-076/093	1317	319	0.24	Agenbroad 1994b:206
Hot Springs "V"	1308	372	0.28	Agenbroad 1994b:206
Ft. Robinson (NSM 1597-62-2)(left)	1281	–	–	Mol and Agenbroad 1994:241
Hot Springs 83-105/008	1274	–	–	Agenbroad 1994b:206
Hot Springs 86-076/439	1260	370	0.29	Agenbroad 1994b:206
Huntington Reservoir (Utah)	1255	–	–	Haynes 1991:16
Type (*M. jeffersonii*)(Am. Mus. 9950)	1250	–	–	Osborn 1942:1095
Bradenton (Amer. Mus. 26820)	1230	–	–	Osborn 1942:1113
Ft. Robinson (NSM 1597-62-2)(right)	1228	–	–	Mol and Agenbroad 1994:241
Hot Springs /221	1147	295	0.26	Agenbroad 1994b:206

fire, because they are independent indicators of fire. One can look at the fire in isolation and see that it affected the sediments, creating low-grade brick (a hot fire), and burned a rodent incisor and other animal remains. A typical grassland/woodland fire does not burn hot enough to bake the soil into brick, and would char, but not incinerate, a rodent caught in it (the rodent tooth reached a temperature at which iron begins to glow red). Nor would a natural fire catch multiple animals, including fish, at the same spot. A human campfire, on the other hand, fed a supply of wood, can achieve the sustained high temperature needed to fire brick and incinerate any animal remains cast into it. On the subject of fire, then, one can say that it was present, hot, and involved the bone bed, and one can say, therefore, that this particular fire is evidence of human activity at the site.

The bone bed itself is an independent indication of human activity, all things being considered. First, bone piles of this sort are not common. Most physical agents act to disperse bones. Those few inanimate agents that work to build a bone deposit have been found not to be a factor at Petronila Creek. The only well-studied animals that may have gathered at least some of the bones are for the most part recent species of the Old World—leopards, hyenas, and African porcupines—none of which were present in Late Pleistocene North America. Nevertheless, because certain extinct American mammals might have mimicked their behavior—namely the dire wolf (*Canis dirus*), which may have behaved somewhat like a hyena (Kurtën and Anderson 1980:171), and the scimitar cat (*Homotherium serum*), considered responsible for a collection of proboscidean remains in Friesenhahn Cave (Kurtën and Anderson 1980:190)—these recent animal species have been employed as proxies and found to be unlikely accumulators of the bones. Bone-eating mammals seem to produce bone flakes of a different size, and produce them to be eaten, not to be left laying about by the thousands. Predators seem also not to leave many tortoise fragments in their bone accumulations, and for that matter tend to create bone piles in their dens or lairs (Brain 1981), not on an exposed sand bar. As to raptors, it is conceivable that certain elements of the Petronila Creek bone pile could have formed beneath a nest or favorite perch of an eagle or hawk (Brain 1981), but this seems contrived.

But it is not only by a process of elimination that one arrives at humans as the causative agent of the bone pile. The heavy utilization of long bones, the considerable reliance on turtles and tortoises, the use of animals from every part of the ecosystem, and the open-air location of the deposit all seem to be characteristic of human activity. Therefore, it is reasonable to consider the bone pile to be separate and independent evidence of a human presence at Petronila Creek.

Cut marks on bones caused by sharp stone edges are not to be naturally expected in regions where there are no sharp stones. The cut marks found at Petronila Creek are not mere scratches. They are large, deep, gouges in hard bone. Anyone who has not used hand tools to work bone may not appreciate how hard it is to produce cuts of this sort. Some of these cuts are on surfaces that are hard to get at, and on objects that are hard to hold while being worked. A great deal of deliberate effort would have been needed to make them, even if they are themselves incidental to some other purpose. They appear to be good examples of what Brain (1981:53) meant when he wrote that humans using stone tools "produce occasional marks on bones that could not have been caused by the teeth of carnivores or by other agencies. When these are found, human involvement is confirmed."

Probably independent of the cut marks—because one does not necessarily occur with the other—is the class of large, often polished, facets seen on the bone tools and mammoth molar chunks. It must again be emphasized that these are not casual by-products of a little rubbing. If one set out to replicate the facet on 41NU246-1542 (see Figure 6) by rubbing elephant bone on sandstone, one would be tired and frustrated before one gave up trying. Since this facet was almost certainly not made for its own sake, but probably was the result of milling something like nuts or seeds (see Dunbar and Webb 1996), and as the milling table would not have been sandstone (none is available in the area) but may have been wood, it becomes clear that a lot of time and effort went into the incidental creation of this facet. Because similar facets are seen on similar bone chunks, and on mammoth molar chunks, and all are of a handy size for tools, it seems inescapable that they are the product of some rubbing task at which humans were willing to work very hard.

The pounding tools made of mammoth molar, although they too have some faceted surfaces, seem to have had a different, independent, purpose from the faceted bone tools. A ready explanation for their existence can be found in the lack of suitable rocks and the need to pound up bones for marrow and grease extraction. Evidence of their use as pounders is provided by the hundreds of chips of molar enamel and the thousands of bone fragments found at Petronila Creek. Is there any explanation for them except as human tools? Petronila Creek does experience some impressive out-of-bank floods, but the low gradient permits only low water velocity, and the stream bed "gravels," mostly small caliche nodules, often do not move much. Experimental pieces of bricks placed in the stream bed move only a short distance when they move at all. So clashing rocks, which do not exist in the first place, would not do much clashing if they did exist. The battered chunks of mammoth molar, therefore, are reasonably interpreted to be human tools, used as pounders.

The stone flakes and tools are clearly independent evidence of human activity except insofar as tools like them were apparently used to make the bone cut marks and possibly split off the mammoth molar pounders. For our purposes these stone objects fall into two classes: those clearly associated with the bones but not good examples of formally recognized tools, and those loosely associated with the bone bed but certainly conventional tools. One would prefer that the associations were reversed. The rough stone "chopper" and the two small "wedges" are unlikely to be geofacts because, again, there were no clashing rocks in the bed of the ancient Petronila River. They are also securely associated with 18,000 year old radiocarbon dates. As to the fragments of two dart points, it seems an improbable coincidence that even one such point with characteristics of Late Pleistocene manufacturing techniques (e.g., a lanceolate form and ground edges) should have been found loose amid the scatter of bone bed material. Yet two such points were found, neither exhibiting evidence of stream transport, and one still having patches of the same type of carbonate crust seen on the larger bones from the bone bed.

One can reach solid conclusions from the evidence discussed above. Recognizing that the word "proof" is best confined to mathematics, it is only possible to establish a certain probability that humans were responsible for the formation of the Petronila Creek site. One should consider that each of the site attributes discussed above is, by itself, evidence of human involvement: the fire, the bone bed, the cut marks, the faceted bones, the mammoth molar pounders, and the stone tools. If humans were indeed present at the site, all of these artifacts and indications are to be expected. On the other hand, it is almost impossible to expect that the chance vagaries of nature created each of these as false artifacts and did so all at the same time and place. To state the concept more poetically, the laws of physics allow Nature to create an assemblage of this sort, but the laws of probability do not allow that the one found will be her handiwork. Thus, it is highly probable that people were present at Petronila Creek.

The evidence for the 18,000 year old age of the site can be considered in the same way. Starting with the radiocarbon dates, it should be noted that in most contexts both bone apatite and sediment dates are accepted as reasonably accurate (e.g., Agenbroad 1994a:26-27). If they were not, they would never be used. The dates are certainly accurate at Petronila Creek in indicating that the site is Pleistocene in age, because the fauna is Pleistocene in character. And, the dates are not being used to argue that the site was occupied only a few hundred years before Clovis, but rather a full 7000 years before the Clovis era.

The half-life for a carbon 14 atom is about 5,000 years, so a 10,000 year old bone must lose half of its radiocarbon content to date at 15,000 years, and about as much again to date at 18,000 years ago. If this loss is not due to radioactive decay of the atoms, but is a product of replacement by ancient carbon that is devoid of carbon 14 atoms, then well over half of the bulk carbon must be replaced by geological and chemical processes.[11] The same, of course, is true of sediment dates, except in bone the carbon is contained in crystals of apatite while in sediment it is in the form of organic remains. It seems highly unlikely that the different geological and chemical processes that would need to act to replace original carbon with such great amounts of old and depleted carbon in bone, on the one hand, and sediment on the other, would act in such perfect concert that both "contaminated" materials would date to the same 18,000 year old time period, indistinguishable within the measurement errors. Such gross and unlikely contamination by "old" carbon is even less likely in view of the evidence that such contamination as has taken place has been by "new" carbon, producing dates that are in fact too recent.

When the data from Petronila Creek are examined to determine if there is independent evidence that would support or refute the 18,000 year old radiocarbon dates, it is found that two additional lines of evidence point to a glacial maximum or earlier date for the occupation: the climate and the fauna. Here we find that a large river was sustained by pluvial conditions, and an undepleted Pleistocene fauna contained exceptionally large bison and mammoths, both with relatively primitive features. This supports a glacial maximum age but not a terminal Wisconsin age, at which time there is evidence of drought, extinction, and dwarfing of the surviving megafauna.

Thus, if Nature is not being exceptionally capricious with the evidence, people were present in southern Texas at the Last Glacial Maximum.

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END NOTES

1. The abbreviation B.P. means radiocarbon years before present. Some numbers quoted from source material could not be identified as being in calendar years or radiocarbon years, but for the purposes of this article the difference is immaterial.

2. Carnivore bones were also scarce in the leopard droppings studied by Brain (1981), since carnivores ordinarily do not eat other carnivores. But in carnivore dens where bone deposits build up, bones of the carnivore itself also accumulate. In Friesenhahn Cave (Kurtén and Anderson 1980:190), numerous skeletons of the scimitar cat *Homotherium serum* were found with remains of its prey: baby mammoths.

3. The test employed to establish polish was that the metallic part of a pencil eraser, when held against the surface, showed some degree of reflected image. The metallic nature of the pencil eraser helped discriminate between a shadow, which would be dark, and a reflection, which was metallic.

4. Site 41NU110 lies 0.75 km upstream from 41NU246. This surface site, on a bend in the creek, about 50 m from the creek channel, has produced three Late Paleoindian dart points. The surface is a well vegetated black soil with large trees, a thicket of brush, weeds, vines, and grass. No discernable erosion is taking place, and thus the erosion of archeological materials into the creek is probably nil.

5. A sediment date is derived from detrital water-borne carbon deposited with the mineral fraction. This carbon originates upstream as decomposing vegetable matter and eroding surface soils, and is on the order of a few hundred years old at the time of its reincorporation in sediment. A soil, on the other hand, derives most of its carbon from plant and animal material emplaced in the sediment after deposition and will thus date younger than the deposition time (Kenneth M. Brown, personal communication, 1993).

6. Stratigraphy within the Holocene channel fill is not fully established. Bulverde points come from the west side of the channel, a Tortugas point comes from the east side, and a Catán has been found in the center of the channel. All are from unreworked hearth zones. Following Turner and Hester (1999), Bulverde and Tortugas points are expected to be older than Catán points. They may be buried on the "higher terraces" of the channel, and thus predate the Catán, which is the youngest, and associated with the deepest channel incision. Alternatively, the Catán point may be misidentified, or its time range imperfectly understood.

7. The Mead-Meltzer scale rates the suitability of various substances for radiocarbon dating. As formalized by Meltzer and Mead (1985), it ranks substances according to the reliability of the dates they yield. Charcoal is among those rated highest, amino acids are in the next group, collagen in the third group, followed by apatite and soil (of equal rank), and shell, then finally a group including terrestrial carbonate and whole bone. This scale actually rates susceptibility to contamination, since all of the materials yield good dates if uncontaminated.

8. For the front limb (humerus, radius, and metacarpal), eight of nine measurements are larger than the upper limit seen for *B. antiquus* males, but seven of nine are within the range for *B. latifrons* males (five of nine are too large for *B. latifrons* females). For the horn cores, of six measurements, all are within the range of *B. antiquus* males (most in the upper range), but only one is in the range of *B. latifrons* males (three of six are in the range of female *B. latifrons,* but the core morphology is clearly that of a male). For the skull, of four available measurements, all are in the upper range for *B. antiquus* males; relative to *B. latifrons* males, three are in the lower range, and one is in the upper range (three of four are too large for female *B. latifrons*) (Lewis 1994).

9. Accepted practice to obtain accurate sediment radiocarbon dates is to date only freshly exposed material. Exposed sediments are promptly colonized by carbon-capturing organisms. The clay shelves capping the bone bed dated 16,880 and 18,560 B.P. at two fresh exposures. After approximately four years of exposure, this clay dated at 5560 ± 60 B.P. (Beta-74184) and 3040 ± 60 B.P. (Beta-72308).

10. Femur length measurements can be taken in two ways. Agenbroad (1994b:206) illustrates a measurement parallel with the shaft, while Averianov (1996:264) illustrates a diagonal length "from caput to distal epiphysis lateral edge" which in most bones is probably slightly greater. Osborn (1942:1112) appears to use the potentially greater diagonal length, since his measurement of the Type *M. jeffersonii* is 1250 mm whereas Haynes (1991:16) measures the same femur at 1230 mm (apparently using the parallel method). Also Osborn has measured the Denver Museum specimen at 1390 mm, while Logan Ivy (personal communication 1997) measures the largest of these two femora at 1372 mm. Osborn's Figure 988 showing the "new standard method (1930) of skeletal measurement" is ambiguous as it is a side view but appears to show the diagonal. Using the diagonal measure, the Petronila Creek femur, at 1429 mm, is larger than any other; using the parallel measure of 1422 mm, it is equaled by Osborn's measurements, probably diagonal, of the Reynolds femur.

11. The caliche associated with the bones dates to 7450 ± 50 B.P. (Beta-226546) and is the only apparent source of bulk extraneous carbon. Any contamination from this source would cause the bones to date too young.

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The Gatlin Site and the Early-to-Middle Archaic Chronology of the Southern Edwards Plateau, Texas

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ABSTRACT

Recent excavations at the Gatlin site (41KR621) in Kerr County, Texas, yielded one of the most robust assemblages thus far recovered from a stratified Early Archaic to Middle Archaic site on the southern margins of the Edwards Plateau. The radiometric dates from the Gatlin site contribute greatly to our understanding of the chronology and culture history of the region and are important anchors for evaluating existing chronologies with temporally poorly anchored style intervals. This article reconsiders the chronology for southern Central Texas during the latter half of the Early Archaic through the transition into the Middle Archaic based on new data from the Gatlin site, and proposes calendrical ages for several major Central Texas projectile point styles, including Gower, Martindale, Early Triangular, Nolan, and La Jita.

INTRODUCTION

In the most recent synthesis of the archeology in the region, Michael B. Collins (2004:109) lists "chronology" as one of the accomplishments in Central Texas archeology at the end of the last century. While it is certainly true that tremendous advancements in establishing the general chronological framework have been made in the past 60 years, for a variety of reasons there still remain significant issues with the chronometric dating of many time periods in Central Texas prehistory. As is the case in many parts of North America, diagnostic projectile points are the primary technological indicator of the age of cultural components at sites in Central Texas. Although the relative sequence of projectile points has been fairly well established for the region as a whole, the actual calendar ages of many diagnostic "projectile point style intervals," to borrow a term from Collins (2004:102), are not well known, particularly at sub-regional spatial and temporal scales. In many cases, cross-dating of sites and features using projectile point styles is the only available means of determining the age of cultural remains in Central Texas. Therefore, poorly documented absolute ages for diagnostic artifacts in a given area often result in the application of temporal ranges for projectile points based on dates—or all too frequently, based on relative age estimates—from adjacent sub-regions or even outside of the Central Texas archeological region altogether. The span of the Early Archaic through Middle Archaic period is particularly deficient in absolute dates from secure contexts. In fact, of the sites often cited as representative of the Early Archaic in southern Central Texas (see Collins 2004:Figure 3.9a and Table 3.2), only Hall's Cave in Kerr County has chronometric dates associated with Early Archaic diagnostic artifacts.

As a result of recent excavations, the Gatlin site (41KR621) in Kerr County, Texas, has yielded one of the most robust assemblages thus far recovered from an Early Archaic to Middle Archaic site on the southern margins of the Edwards Plateau and, as such, contributes greatly to our understanding of the chronology and culture history of the region (Figure 1). The radiometric dates from the Gatlin site, therefore, are important anchors for evaluating existing chronologies with temporally "floating" style intervals. In this article, we reconsider the chronology for southern Central Texas during the latter half of the Early Archaic through the transition into the Middle Archaic based on new data from the Gatlin site.

BACKGROUND ON THE GATLIN SITE

The Gatlin site represents one of the largest excavated samples of Early Archaic deposits in the

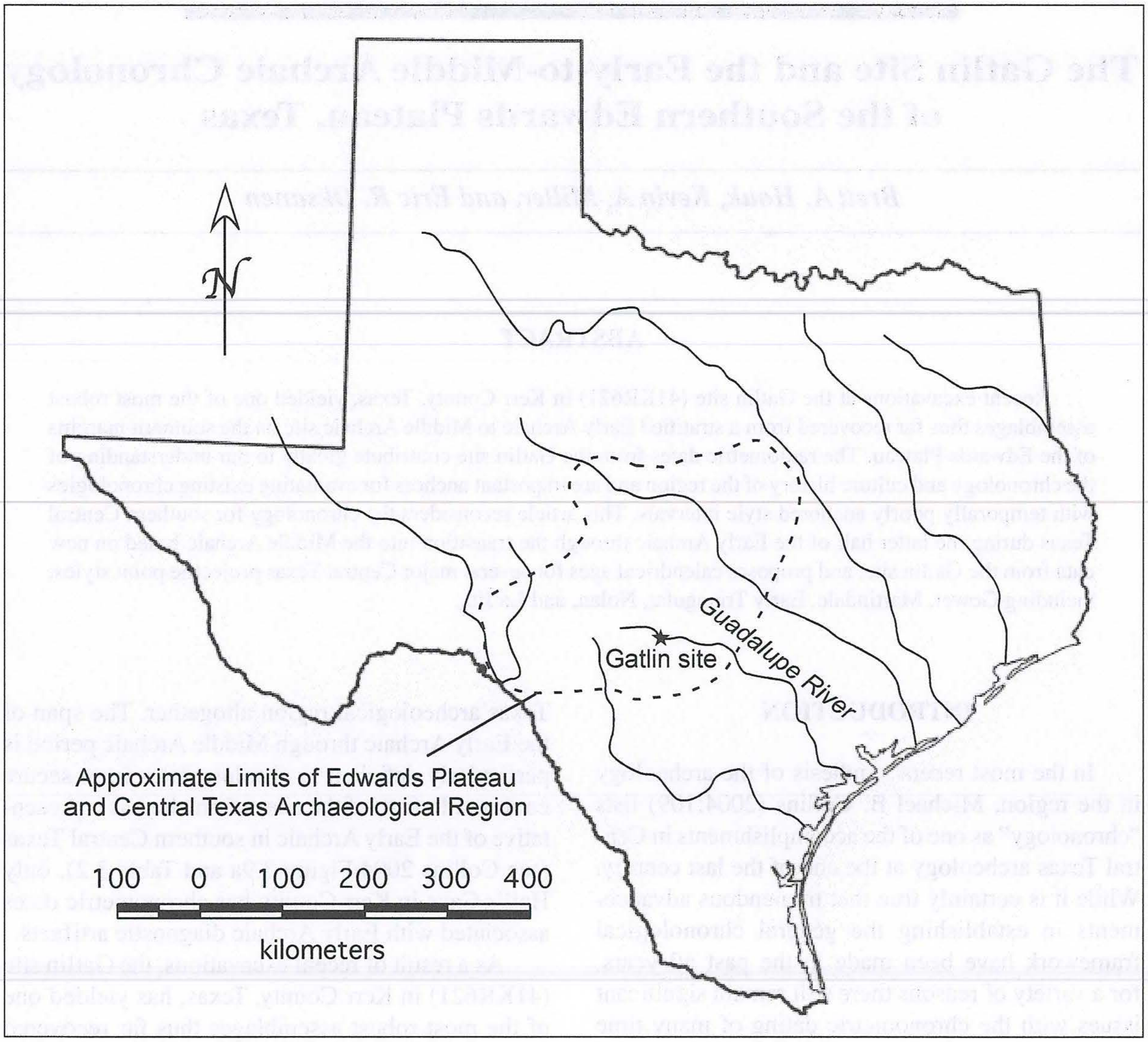

Figure 1. The Gatlin site (41KR621) location map.

Central Texas archeological region (Houk et al. 2008). The extension of Spur 98 and the construction of a new bridge across the Guadalupe River provided the impetus for the archeological investigations. SWCA, Inc. performed survey, testing, and data recovery investigations at the site on behalf of the Texas Department of Transportation in 2004, the full results of which have recently been published by Houk et al. (2008).

The site is in the Central Texas archeological region, an area generally corresponding to the limits of the Edwards Plateau, an uplifted limestone plateau fronted on the south and east by the Balcones Escarpment, the dominant expression in Central Texas of the Balcones fault zone that originates in the Ouachita Mountains in Southeast Oklahoma and extends southwards through Texas to the Rio Grande (Abbott and Woodruff 1986). The eastern and southern margins of the Edwards Plateau contain deeply dissected stream valleys that formed through erosion. The southern margin of the plateau, west of San Antonio, is sometimes called the Balcones Canyonlands because of its rugged appearance. The rivers in the region, including the Guadalupe River, are supplemented by spring flow, and several large springs emerge along the margins of the escarpment. The Edwards Plateau is the southern extension of the Great Plains (Riskind and Diamond 1986), and the Balcones Escarpment marks the boundary between the Edwards Plateau to the north and west and the Blackland Prairie to the east and Coastal Plains to the south.

The Gatlin site occupies the right descending bank of the Guadalupe River on wide, nearly level, alluvial terraces. SWCA's investigations determined that the site is spatially extensive, presumably continuing well beyond the 30.5 to 61 m wide (100 to 220 ft. wide) right-of-way (ROW). Archeological deposits extend from the base of an upland toeslope at the southern end of the site to the scarp of the terrace above the river, a distance of approximately 200 m (Figure 2).

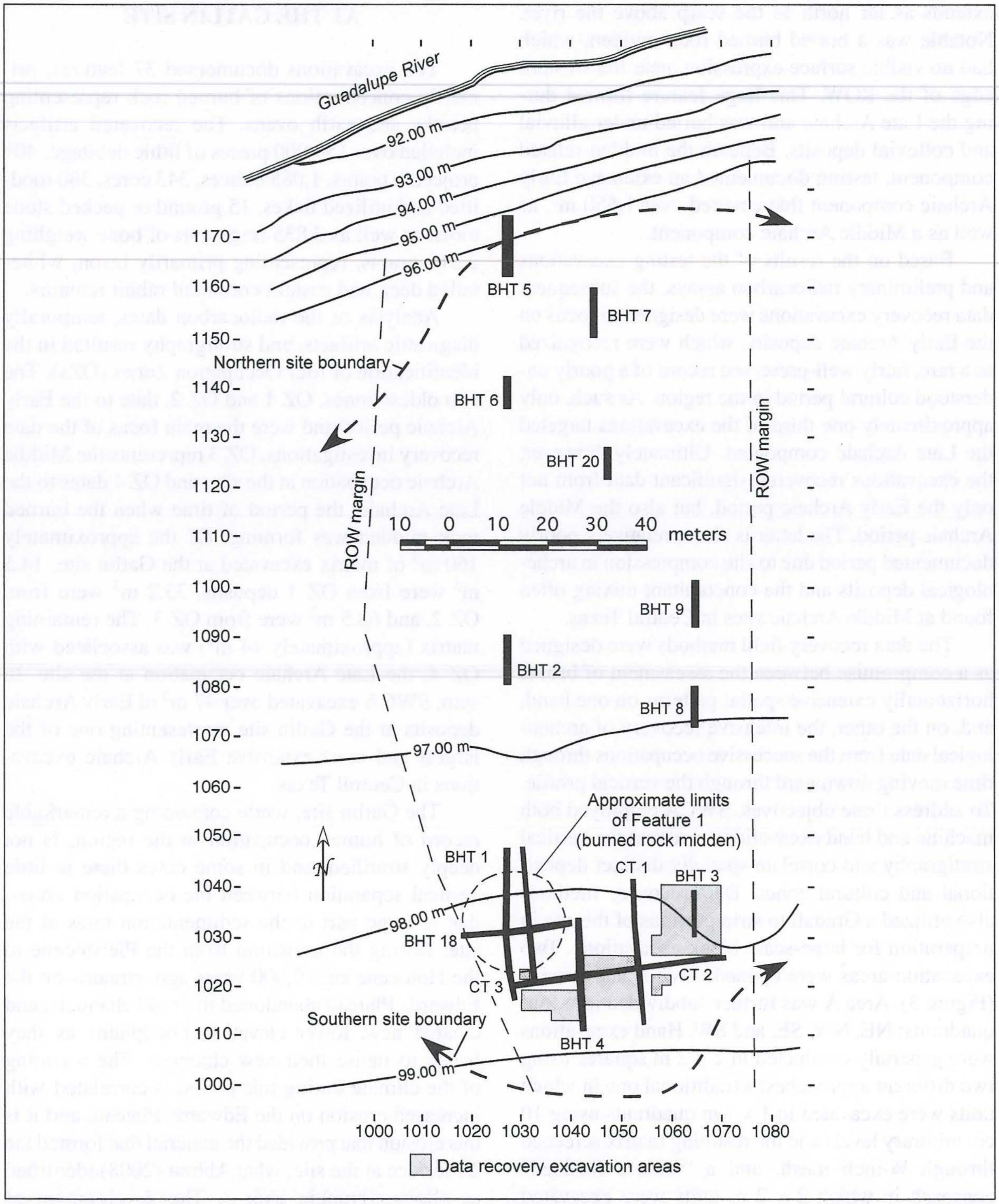

Figure 2. Map showing known limits of the Gatlin site, backhoe trenches (BHT), control trenches (CT), and data recovery excavation areas within the Spur 98 ROW.

Subsurface survey using backhoe trenching and power-auguring initially discovered the Gatlin site within the Spur 98 ROW and determined that the greatest density of cultural materials was concentrated at the southern end of the terrace at the base of the toeslope, although diffuse occupational debris extends as far north as the scarp above the river. Notable was a buried burned rock midden, which had no visible surface expression, near the western edge of the ROW. This large feature formed during the Late Archaic and was buried under alluvial and colluvial deposits. Beneath the midden-related component, testing documented an extensive Early Archaic component that covered over 1,650 m^2, as well as a Middle Archaic component.

Based on the results of the testing excavations and preliminary radiocarbon assays, the subsequent data recovery excavations were designed to focus on the Early Archaic deposits, which were recognized as a rare, fairly well-preserved record of a poorly understood cultural period in the region. As such, only approximately one-third of the excavations targeted the Late Archaic component. Ultimately, however, the excavations recovered significant data from not only the Early Archaic period, but also the Middle Archaic period. The latter is also a relatively poorly documented period due to site compression in archeological deposits and the concomitant mixing often found at Middle Archaic sites in Central Texas.

The data recovery field methods were designed as a compromise between the assessment of broad, horizontally extensive spatial patterns on one hand, and, on the other, the intensive recovery of archeological data from the successive occupations through time moving downward through the vertical profile. To address these objectives, SWCA employed both machine and hand excavations to assess the vertical stratigraphy and correlate spatially distinct depositional and cultural zones. Data recovery methods also utilized a Gradall to strip portions of the site in preparation for large-scale block excavations. Two excavation areas were opened: Area A and Area B (Figure 3). Area A was further subdivided into four quadrants: NE, NW, SE, and SW. Hand excavations were generally conducted in 2 x 2 m squares using two different approaches: a traditional one in which units were excavated in 1 x 1 m quadrants using 10 cm arbitrary levels and the resulting matrix screened through ¼-inch mesh, and a "feature focused" approach in which 2 x 2 m units were excavated without screening unless a feature was discovered. The latter approach was employed to expose a larger area then could be accomplished by traditional hand excavations alone within the time and budget allotted (Houk, Oksanen, and Miller 2008).

CULTURAL COMPONENTS AT THE GATLIN SITE

The excavations documented 37 features, primarily concentrations of burned rock representing hearths and earth ovens. The recovered artifacts included over 150,000 pieces of lithic debitage, 409 projectile points, 1,085 bifaces, 343 cores, 380 modified and utilized flakes, 15 ground or pecked stone tools, as well as 3,835 fragments of bone weighing 2,218 grams, representing primarily bison, white-tailed deer, and eastern cottontail rabbit remains.

Analysis of the radiocarbon dates, temporally diagnostic artifacts, and stratigraphy resulted in the identification of four Occupation Zones (OZs). The two oldest zones, OZ 1 and OZ 2, date to the Early Archaic period and were the main focus of the data recovery investigations. OZ 3 represents the Middle Archaic occupation at the site, and OZ 4 dates to the Late Archaic, the period of time when the burned rock midden was forming. Of the approximately 160 m^3 of matrix excavated at the Gatlin site, 14.5 m^3 were from OZ 1 deposits, 33.2 m^3 were from OZ 2, and 68.5 m^3 were from OZ 3. The remaining matrix (approximately 44 m^3) was associated with OZ 4, the Late Archaic occupation at the site. In sum, SWCA excavated over 47 m^3 of Early Archaic deposits at the Gatlin site, representing one of the largest and most extensive Early Archaic excavations in Central Texas.

The Gatlin site, while containing a remarkable record of human occupation in the region, is not deeply stratified, and in some cases there is little vertical separation between the occupation zones, due in large part to the sedimentation rates at the site. During the transition from the Pleistocene to the Holocene ca. 10,000 years ago, streams on the Edwards Plateau abandoned their old channels, and created new, lower elevation floodplains as they began to incise their new channels. The warming of the climate during this period is correlated with increased erosion on the Edwards Plateau, and it is this erosion that provided the material that formed the T1 terrace at the site, what Abbott (2008) identified as allostratigraphic Unit 3. The development of Unit 3, which contains the occupation zones, was a combination of lateral accretion and vertical

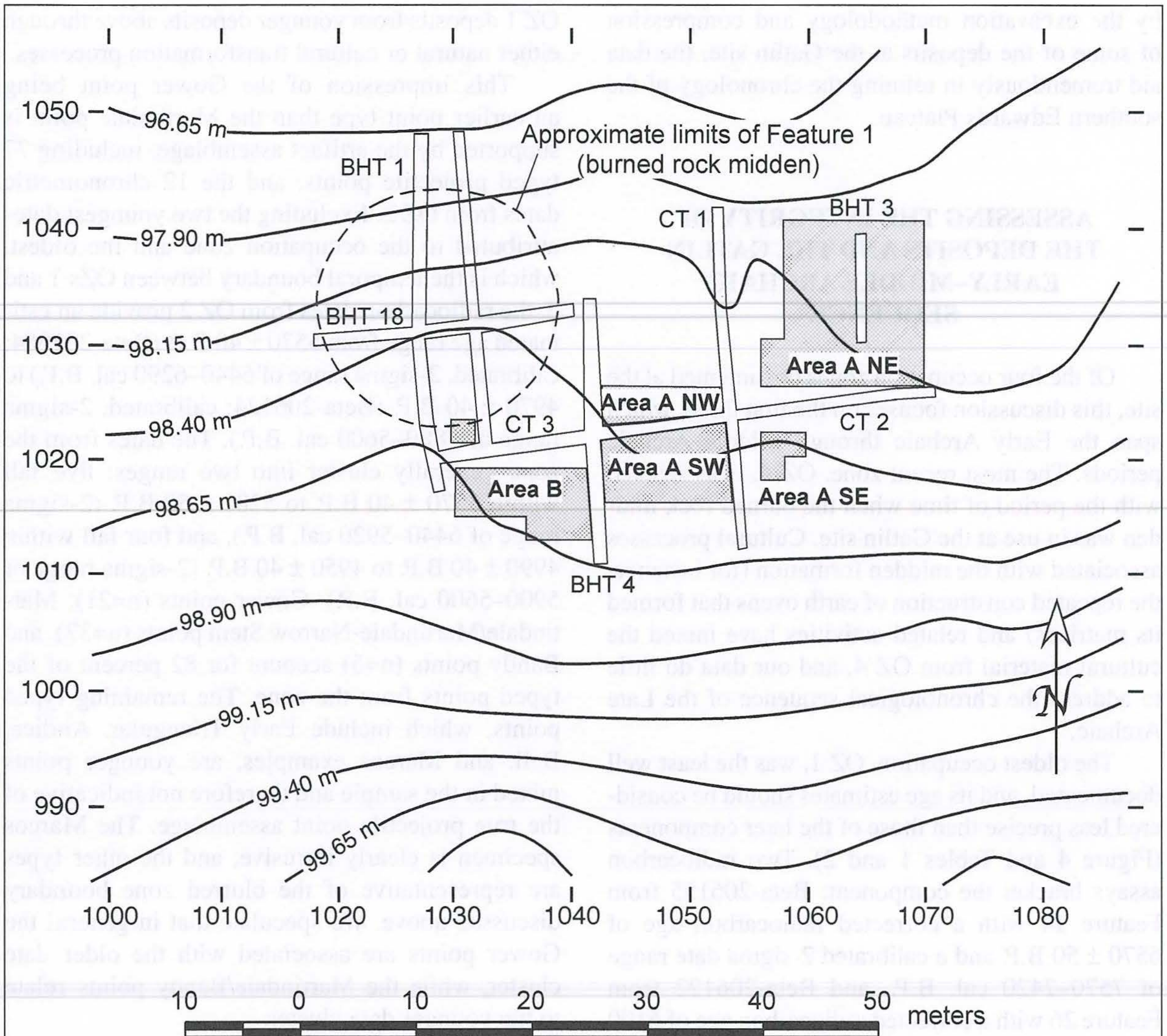

Figure 3. Map of the Gatlin site showing area investigated by data recovery excavations. Test units and column sample locations not shown at this scale.

accretion, with lateral accretion having been the dominant process during its initial formation.

The rate of alluvial accumulation was greatest during the Late Pleistocene, beginning at ca. 12,400 B.P., and decreased during the Holocene, ca. 10,000 B.P. By ca. 5000 B.P., or even earlier, the Guadalupe River channel was fully entrenched, and alluviation decreased dramatically. By the time of the occupations represented in OZ 1, alluviation rates had declined from the Late Pleistocene/Early Holocene rate of 0.95 mm/yr to approximately 0.42 mm/yr. This further decreased during the times of OZ 3 and OZ 4 to half as much, 0.21 mm/yr (Frederick 2008:6-16). It is worth noting that the sedimentation rates observed within Unit 3, the culture-bearing unit, at the Gatlin site are similar to other alluvial terrace deposits in Central Texas in that it was fairly rapid during the early phases (0.95 mm/year) and gradually became slower (0.21 mm/year in the block excavations, i.e., during the period of occupation) through time as the floodplain became progressively higher (Frederick 2008).

This is not to imply, however, that the various occupation zones at the Gatlin site are of poor integrity. On the contrary, when compared to other Early Archaic–Middle Archaic sequences from Central Texas sites, the Gatlin site deposits offer relatively good integrity, abundant chronometric dates, and a large assemblage of diagnostic artifacts. Therefore, despite limitations imposed by the excavation methodology and compression of some of the deposits at the Gatlin site, the data aid tremendously in refining the chronology of the southern Edwards Plateau.

ASSESSING THE INTEGRITY OF THE DEPOSITS AND THE GATLIN EARLY–MIDDLE ARCHAIC SEQUENCE

Of the four occupation zones documented at the site, this discussion focuses on the first three, which span the Early Archaic through Middle Archaic periods. The most recent zone, OZ 4, is associated with the period of time when the burned rock midden was in use at the Gatlin site. Cultural processes associated with the midden formation (for instance, the repeated construction of earth ovens that formed its matrices) and related activities have mixed the cultural material from OZ 4, and our data do little to address the chronological sequence of the Late Archaic.

The oldest occupation, OZ 1, was the least well documented, and its age estimates should be considered less precise than those of the later components (Figure 4 and Tables 1 and 2). Two radiocarbon assays bracket the component: Beta-206155 from Feature 14 with a corrected radiocarbon age of 6570 ± 50 B.P. and a calibrated 2-sigma date range of 7570–7420 cal. B.P., and Beta-206122 from Feature 26 with a corrected radiocarbon age of 6100 ± 40 B.P. and a calibrated 2-sigma date range of 7160–6860 cal. B.P. The older sample is considered to represent the stratigraphic and temporal lower boundary for the occupation of the site.

The diagnostic point types associated with OZ 1 include a Gower point, two Early Barbed Devils River variant, a Martindale point, and a Pandale point (Figure 5). The Early Barbed specimens are the only two examples of the type found during the excavations, and it is likely that they are associated with the earliest occupation, represented by Feature 14. Both the Gower and Martindale points could be associated with the Feature 26 period of use of the site, although it is our impression—based on the seriation of projectile point types and their frequencies within the occupation zones—that the Gower type appeared first at the Gatlin site and was followed several centuries later by the Martindale type (Figure 6). If accurate, it is likely that the Martindale and Pandale specimens were incorporated into the older OZ 1 deposits from younger deposits above through either natural or cultural transformation processes.

This impression of the Gower point being an earlier point type than the Martindale point is supported by the artifact assemblage, including 77 typed projectile points, and the 12 chronometric dates from OZ 2. Excluding the two youngest dates attributed to the occupation zone and the oldest, which is the temporal boundary between OZs 1 and 2, the radiocarbon dates from OZ 2 provide an estimated age range from 5570 ± 40 B.P. (Beta-207384; calibrated, 2-sigma range of 6440–6290 cal. B.P.) to 4970 ± 40 B.P. (Beta-206124; calibrated, 2-sigma range of 5880–5600 cal. B.P.). The dates from the zone generally cluster into two ranges: five fall within 5570 ± 40 B.P. to 5280 ± 50 B.P. (2-sigma range of 6440–5920 cal. B.P.), and four fall within 4990 ± 40 B.P. to 4950 ± 40 B.P. (2-sigma range of 5900–5600 cal. B.P.). Gower points (n=21), Martindale/Martindale-Narrow Stem points (n=37), and Bandy points (n=5) account for 82 percent of the typed points from the zone. The remaining typed points, which include Early Triangular, Andice, Bell, and Marcos examples, are younger points mixed in the sample and therefore not indicative of the true projectile point assemblage. The Marcos specimen is clearly intrusive, and the other types are representative of the blurred zone boundary discussed above. We speculate that in general the Gower points are associated with the older date cluster, while the Martindale/Bandy points relate to the younger date cluster.

OZ 3 is perhaps the most problematic of the four occupation zones at the Gatlin site because it has the most compressed stratigraphy. Four radiocarbon dates from features provide a range of 4530 ± 40 B.P. (Beta-206131; calibrated 2-sigma range of 5320 to 5040 cal. B.P.) to 4110 ± 40 B.P. (Beta-206116; calibrated 2-sigma range of 4830 to 4440 cal. B.P.). Three dates all cluster between 4110 ± 40 B.P. to 4210 ± 40 B.P. (2-sigma range of 4850–4440 cal. B.P.), a much tighter interval of time. The projectile point assemblage shows some blurring of the boundaries of the occupation zones above and below OZ 2, or perhaps the persistent use of projectile point styles at the site through time. The Early Archaic point types in the OZ 3 assemblage include a handful of Gower points (n=5) and over a dozen Bandy/Martindale points (n=17). The bulk of the assemblage includes the traditional early Middle Archaic Early Triangular (n=38), Andice (n=5), and Bell (n=4) point types (Figure 7). The

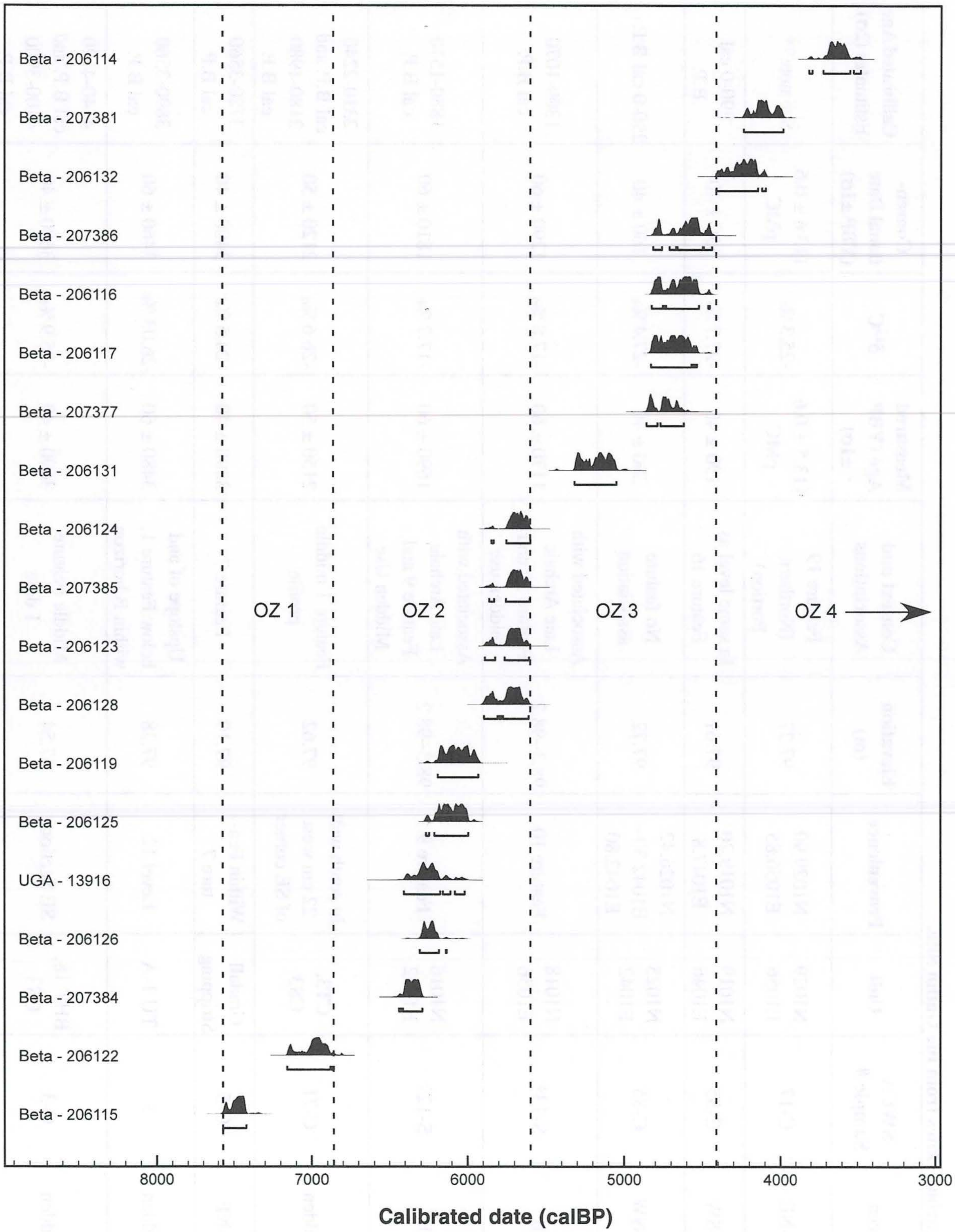

Figure 4. Proposed chronological divisions of Gatlin site Occupation Zones (OZs) based on C-14 dates.

Table 1. Radiocarbon Dates from the Gatlin Site.

Lab No.	Area	SWCA Sample #	Unit	Provenience	Elevation (m)	Context and Associations	Measured Age (YBP ±1σ)	δ[13]C	Conventional Date (YBP ±1σ)	Calibrated Age Estimates (2σ)
Beta-206118	A-NE	C-17	N1029 E1056	N1029.90 E1056.85	97.27	Feature 19 (Northern Portion)	113.5 ± 0.6 pMC	-25.3 ‰	113.6 ± 0.6 pMC	See note**
Beta-207383	A-SW	C-55	N1019 E1046	N1019.20 E1047.8	97.61	In same level as Feature 16	190 ± 40	-27.7 ‰	150 ± 40	290-0 cal B.P.
Beta-207388	A-NW	C-85	N1025 E1042	N1026.42 E1042.30–E1042.80	97.72	No feature association	200 ± 40	-27.4 ‰	160 ± 40	290-0 cal B.P.
Beta-207392	B	S-13†	N1018 E1036	Feature 10	98.3–98.2	Associated with Late Archaic Feature 10 and midden use	1170 ± 60	-17.8 ‰	1290 ± 60	1300-1070 cal B.P.
Beta-207391	B	S-12†	N1016 E1032	Feature 9	98.3–98.2	Associated with Late Archaic Feature 9 and Midden Use	1690 ± 60	-17.7 ‰	1810 ± 60	1880-1570 cal B.P.
Beta-206127	Midden	C-71	CT3, CS3	In south wall 22 cm west of SE corner	97.62	Feature 1 middle profile	2150 ± 50	-26.6 ‰	2120 ± 50	2310-2240 cal B.P. and 2180-1980 cal B.P.
Beta-206114	A-NE	C-5	Gradall Stripping	Within Feature 7	97.19	Feature 7	3390 ± 40	-24.5 ‰	3400 ± 40	3720-3560 cal B.P
UGA-13820*	Midden	3	TU 1-A	Level 12	97.38	Upslope of and below Feature 1, within B horizon	3480 ± 60	-26.03 ‰	3460 ± 60	3890-3560 cal B.P.
Beta-207376	Midden	C-3	BHT 18, CS3	SE Section	97.54	Middle Feature 1 date	3690 ± 40	-25.9 ‰	3680 ± 40	4140-4120 cal B.P. and 4100-3900 cal B.P.

Table 1. *(Continued)*

Lab No.	Area	SWCA Sample #	Unit	Provenience	Elevation (m)	Context and Associations	Measured Age (YBP ±1σ)	δ13C	Conventional Date (YBP ±1σ)	Calibrated Age Estimates (2σ)
UGA-13826*	Midden	20	TU 1-B	TU 1-B, Level 8	97.60–97.50	Base of Feature 1	3760 ± 70	-26.40 ‰	3740 ± 70	4350-4320 cal B.P. (p = 0.014) and 4300-3880 cal B.P. (p = 0.94)
Beta-207381	B	C-38	N1016 E1030	N1016.20 E1031.80	97.86	Below Feature 11	3750 ± 40	-24.9 ‰	3750 ± 40	4240-3980 cal B.P.
Beta-207379	A-NE	C-16	N1031 E1058	N1032.49 E1059.69	97.20	None	3740 ± 40	-19.4 ‰	3830 ± 40	4400-4100 cal B.P.
Beta-206132	B	C-94	N1014 E1038	N1015.58 E1038.10	97.94	Feature 37	3830 ± 40	-24.0 ‰	3850 ± 40	4410-4150 cal B.P.
Beta-206133	A-NW	C-101	N1023 E1042	N1023.94 E1042.71	97.50	Excavation Base Area A-NW	3930 ± 40	-25.2 ‰	3930 ± 40	4500-4480 cal B.P. and 4440-4250 cal B.P.
Beta-207386	A-SW	C-73	Feature 34-C	N1020.20 E1049.60	97.50	Direct Date Feature 34	4080 ± 40	-24.1 ‰	4090 ± 40	4810-4750 cal B.P., 4710-4500 cal B.P., and 4480-4440 cal B.P.
Beta-206116	A-NE	C-12	N1027 E1056	N1028.12 E1057.06	97.40	Feature 19 (Southern Portion)	4120 ± 40	-25.7 ‰	4110 ± 40	3720-3560 cal B.P.
Beta-206117	A-SW	C-13	N1021 E1044	Feature 16	97.65	Direct Date of Feature 16	4140 ± 40	-25.2 ‰	4140 ± 40	4830-4530 cal B.P.

Table 1. *(Continued)*

Lab No.	Area	SWCA Sample #	Unit	Provenience	Elevation (m)	Context and Associations	Measured Age (YBP ±1σ)	δ13C	Conventional Date (YBP ±1σ)	Calibrated Age Estimates (2σ)
Beta-207377	A-SW	C-13	N1021 E1044	N1021.94 E1045.01	97.65	Direct Date of Feature 16	4200 ± 40	-24.6 ‰	4210 ± 40	4850-4800 cal B.P. and 4770-4620 cal B.P.
Beta-206129	Midden	C-75	CT3, CS3	N1031.25 E1032.32	97.45	Feature 1 base	4220 ± 40	-25.7 ‰	4210 ± 40	4850-4800 cal B.P. and 4770-4620 cal B.P.
Beta-207390	A-NW	C-100	N1025 E1048	N1025.90 E1049.70	97.50	No Feature association. However, may provide Basal date for Area A-NW	4400 ± 40	-25.2 ‰	4400 ± 40	5220-5190 cal B.P. and 5060-4860 cal B.P.
Beta-206131	B	C-93	N1014 E1036	N1014.20 E1036.50	97.88	Feature 38	4560 ± 40	-27.0 ‰	4530 ± 40	5310-5040 cal B.P.
Beta-207380	A-NE	C-35	N1033 E1058	N1034.53 E1059.48	97.05	Feature 25 direct date. May be associated with Feature 5 from Testing Phase II	4540 ± 40	-24.4 ‰	4550 ± 40	5320-5050 cal B.P.
Beta-207389	B	C-91	N1014 E1036	N1015.19 E1036.51	97.91	Above Feature 38	4620 ± 40	-25.9 ‰	4610 ± 40	5460-5380 cal B.P. and 5340-5290 cal B.P.
UGA-13828*	Midden	23	TU 1-B	TU 1-B, Level 10	97.40–97.30	Below Feature 1	4670 ± 60	-25.30 ‰	4660 ± 60	5590-5280 cal B.P.
UGA-13827*	Midden	21	TU 1-B	TU 1-B, Level 9	97.50–97.40	Below or very base of Feature 1	4700 ± 60	-24.66 ‰	4710 ± 60	5590-5310 cal B.P.

Table 1. *(Continued)*

Lab No.	Area	SWCA Sample #	Unit	Provenience	Elevation (m)	Context and Associations	Measured Age (YBP ±1σ)	δ13C	Conventional Date (YBP ±1σ)	Calibrated Age Estimates (2σ)
UGA-13819*	Midden	1	TU 1-A	TU 1-A, Level 10	97.55–97.50	Upslope of and below Feature 1, between A and B horizons	4780 ± 70	-25.54 ‰	4770 ± 70	5620-5320 cal B.P.
Beta-206121	B	C-41	N1016 E1036	N1017.03 E1037.6	97.73–97.70	Excavation Base Area B	4930 ± 40	-24.8 ‰	4930 ± 40	5730-5600 cal B.P.
Beta-206124	A-SW	C-58	N1017 E1052	N1018.4 E1052.00	97.55–97.50	Feature 13	4950 ± 40	-23.6 ‰	4970 ± 40	5860-5830 cal B.P. and 5750-5610 cal B.P.
Beta-207385	A-SW	C-67	N1019 E1048	N1020.01 E1049.68	97.52	Direct Date Base of Unit or Bison Teeth?	4960 ± 40	-24.5 ‰	4970 ± 40	5860-5830 cal B.P. and 5750-5610 cal B.P.
Beta-206123	B	C-50	N1018 E1032	N1018.96 E1032.60	97.76	Feature 28	4980 ± 40	-25.0 ‰	4980 ± 40	5870-5820 cal B.P. and 5760-5610 cal B.P.
Beta-206128	A-SW	C-74	N1019 E1048	N1020.90 E1049.95	97.50	Feature 34-c	4990 ± 50	-25.2 ‰	4990 ± 50	5890-5610 cal B.P.
UGA-13823*	A-NW	8	TU 4-C	Level 3	97.43	Feature 2	5020 ± 70	-24.90 ‰	5020 ± 70	5920-5610 cal B.P.
UGA-13822*	A-NW	7	TU 4-C	Level 3	97.45	Feature 2	5060 ± 60	-25.93 ‰	5040 ± 60	5920-5650 cal B.P.

Table 1. *(Continued)*

Lab No.	Area	SWCA Sample #	Unit	Provenience	Elevation (m)	Context and Associations	Measured Age (YBP ±1σ)	δ13C	Conven-tional Date (YBP ±1σ)	Calibrated Age Estimates (2σ)
UGA-13821*	A-NW	6	TU 4-B	Level 4	97.41	South of Feature 2, probably associated	5190 ± 70	-25.01 ‰	5190 ± 70	6180-6130 cal B.P. [p = 0.08] and 6120-5740 cal B.P. [p = 0.88]
Beta-206119	A-NE	C-20	N1027 E1066-1068	N1028.70 E1067.65	97.2–97.1	Feature 22	5280 ± 50	-26.2 ‰	5260 ± 50	6180-5920 cal B.P.
Beta-207374*	Midden	2	BHT 1, TU 1-A	N38 E88	97.48	Upslope of and below Feature 1	5250 ± 40	-24.4 ‰	5260 ± 40	6270-5920 cal B.P.
UGA-13825*	A-NW	13	TU 4-C	Level 3	97.41	Feature 2	5260 ± 70	-25.04 ‰	5260 ± 70	6270-6240 cal B.P. (p = 0.02) and 6210-5900 cal B.P. (p = 0.94)
Beta-206125	A-SW	C-64	N1019 E1048	N1020.8 E1048.4	97.49	Bison Teeth	5330 ± 40	-25.4 ‰	5320 ± 40	6200-5990 cal B.P.
Beta-207378	A-NE	C-14	N1029 E1068	N1029.50 E1068.26	97.20	None	5360 ± 40	-25.3 ‰	5360 ± 40	6280-6000 cal B.P.
UGA-13824*	A-NW	10	TU 4-C	Level 3	97.45	Feature 2	5390 ± 60	-25.03 ‰	5390 ± 60	6300-5990 cal B.P.
Beta-207387	A-SW	C-77	N1021 E1046	N1022.38 E1047.43	97.47	10 cm Below Feature 16	5410 ± 40	-24.2 ‰	5420 ± 40	6290-6170 cal B.P.
Beta-206126	A-SW	C-68	N1019 E1044	N1020.90 E1044.55	97.45	Feature 33	5440 ± 40	-25.2 ‰	5440 ± 40	6300-6180 cal B.P.

Table 1. *(Continued)*

Lab No.	**Area**	**SWCA Sample #**	**Unit**	**Provenience**	**Elevation (m)**	**Context and Associations**	**Measured Age (YBP ±1σ)**	**$\delta^{13}C$**	**Conventional Date (YBP ±1σ)**	**Calibrated Age Estimates (2σ)**
UGA-13916*	A-NE	41	TU 3-A	Level 11	96.98	Feature 5	5460 ± 70	-23.61 ‰	5480 ± 70	6410-6170 cal B.P. (p = 0.88), 6150-6110 cal B.P. (p = 0.05), and 6080-6000 cal B.P. (p = 0.03)
Beta-207384	A-SW	C-63	N1019 E1044	N1020.85 E1044.20	97.55	Above Feature 33 (may be associated)	5570 ± 40	-25.1 ‰	5570 ± 40	6420-6290 cal B.P.
Beta-207375	Midden	C-2	BHT 18, CS1	NW Section	97.23	Below Feature 1 base and within yellowish-brown soil horizon	5740 ± 40 BP	22.4 ‰	5780 ± 40	6670-6470 cal B.P.
Beta-206122	A-NE	C-44	N1035 E1058	N1035.96 E 1058.47	96.97	Feature 26	6100 ± 40	-25.2 ‰	6100 ± 40	7150-7130 cal B.P. and 7020-6860 cal B.P.
Beta-207382	A-NE	C-40	N1029 E1056	N1029.20 E1056.15	96.94–96.89	Provides basal date for Area A-NE	6480 ± 40	-26.6 ‰	6450 ± 40	7430-7280 cal B.P.
Beta-206115	A-NE	C-11	N1027 E1060	N1027.80 E1060.43	96.97	Feature 14	6570 ± 50	-25.1 ‰	6570 ± 50	7570-7420 cal B.P.

* Sample from testing investigations. ** The reported result indicates an age of post 0 BP and has been reported as a % of the modern reference standard, indicating the material was living within the last 50 years. † Bulk matrix sample

Table 2. Radiocarbon Dates Used to Define OZs.

Lab No.	Area	Sample Type	Unit	Provenience	Elevation (m)	Context and Associations	Calibrated Age Estimate (2 sigma)
Beta-206114	A-NE	Wood Charcoal	Gradall Strip-ping	Within Feature 7	97.19	Feature 7	3720-3560 cal B.P.
Beta-207381	B	Wood Charcoal	N1016 E1030	N1016.20 E1031.80	97.86	Below Feature 11	4240-3980 cal B.P.
Beta-206132	B	Wood Charcoal	N1014 E1038	N1015.58 E1038.10	97.94	Feature 37	4410-4150 cal B.P.
Beta-207386	A-SW	Wood Charcoal	Feature 34-C	N1020.20 E1049.60	97.50	Direct Date Feature 34	4810-4750 cal B.P. and 4710-4500 cal B.P. and 4480-4440 cal B.P.
Beta-206116	A-NE	Wood Charcoal	N1027 E1056	N1028.12 E1057.06	97.40	Feature 19 (Southern Portion)	3720-3560 cal B.P.
Beta-206117	A-SW	Wood Charcoal	N1021 E1044	Feature 16	97.65	Direct Date of Feature 16	4830-4530 cal B.P.
Beta-207377	A-SW	Wood Charcoal	N1021 E1044	N1021.94 E1045.01	97.65	Direct Date of Feature 16	4850-4800 cal B.P. and 4770-4620 cal B.P.
Beta-206131	B	Wood Charcoal	N1014 E1036	N1014.20 E1036.50	97.88	Feature 38	5310-5040 cal B.P.
Beta-206124	A-SW	Wood Charcoal	N1017 E1052	N1018.4 E1052.00	97.55-97.50	Feature 13	5860-5830 cal B.P. and 5750-5610 cal B.P.
Beta-207385	A-SW	Wood Charcoal	N1019 E1048	N1020.01 E1049.68	97.52	Direct Date Base of Unit or Bison Teeth?	5860-5830 cal B.P. and 5750-5610 cal B.P.
Beta-206123	B	Wood Charcoal	N1018 E1032	N1018.96 E1032.60	97.76	Feature 28	5870-5820 cal B.P. and 5760-5610 cal B.P.
Beta-206128	A-SW	Wood Charcoal	N1019 E1048	N1020.90 E1049.95	97.50	Feature 34-c	5890-5610 cal B.P.
Beta-206119	A-NE	Wood Charcoal	N1027 E1066-1068	N1028.70 E1067.65	97.2-97.1	Feature 22	6180-5920 cal B.P.
Beta-206125	A-SW	Wood Charcoal	N1019 E1048	N1020.8 E1048.4	97.49	Bison Teeth	6200-5990 cal B.P.
Beta-206126	A-SW	Wood Charcoal	N1019 E1044	N1020.90 E1044.55	97.45	Feature 33	6300-6180 cal B.P.

Table 2. *(Continued)*

Lab No.	Area	Sample Type	Unit	Provenience	Elevation (m)	Context and Associations	Calibrated Age Estimate (2 sigma)
UGA-13916*	A-NE	Wood Charcoal	TU 3-A	Level 11	96.98	Feature 5	6410-6170 cal B.P. (p = 0.88) and 6150-6110 cal B.P. (p = 0.05) and 6080-6000 cal B.P. (p = 0.03)
Beta-207384	A-SW	Wood Charcoal	N1019 E1044	N1020.85 E1044.20	97.55	Above Feature 33 (may be associated)	6420-6290 cal B.P.
Beta-206122	A-NE	Wood Charcoal	N1035 E1058	N1035.96 E 1058.47	96.97	Feature 26	7150-7130 cal B.P. and 7020-6860 cal B.P.
Beta-206115	A-NE	Wood Charcoal	N1027 E1060	N1027.80 E1060.43	96.97	Feature 14	7570-7420 cal B.P.

* Sample from testing investigations.

Note: For the Beta samples, 2 sigma calibrations were made with the program INTCAL98 (Stuiver et al. 1998). For the UGA samples, atmospheric data are from Stuiver et al. (1998); 2 sigma calibrations were made with the program OxCal v. 3.5 (Bronk Ramsey 2000).

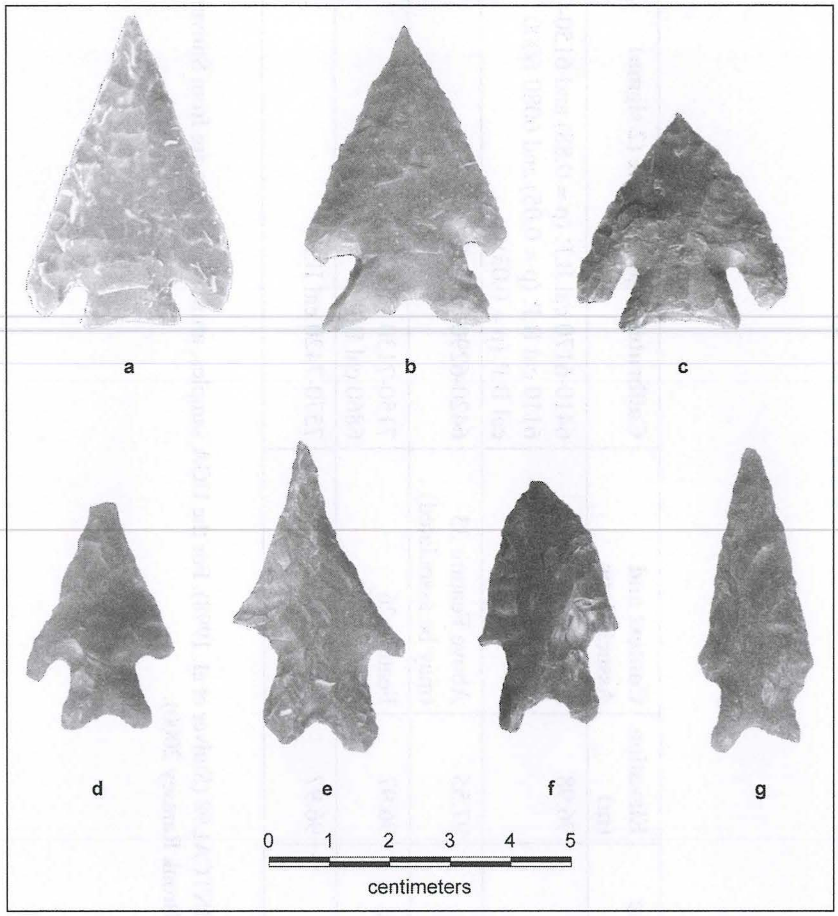

Figure 5. Representative examples of Early Archaic projectile points from the Gatlin site: a, Bandy; b-c, Martindale; d, Martindale, Narrow Stem; e, Baker; f-g, Gower.

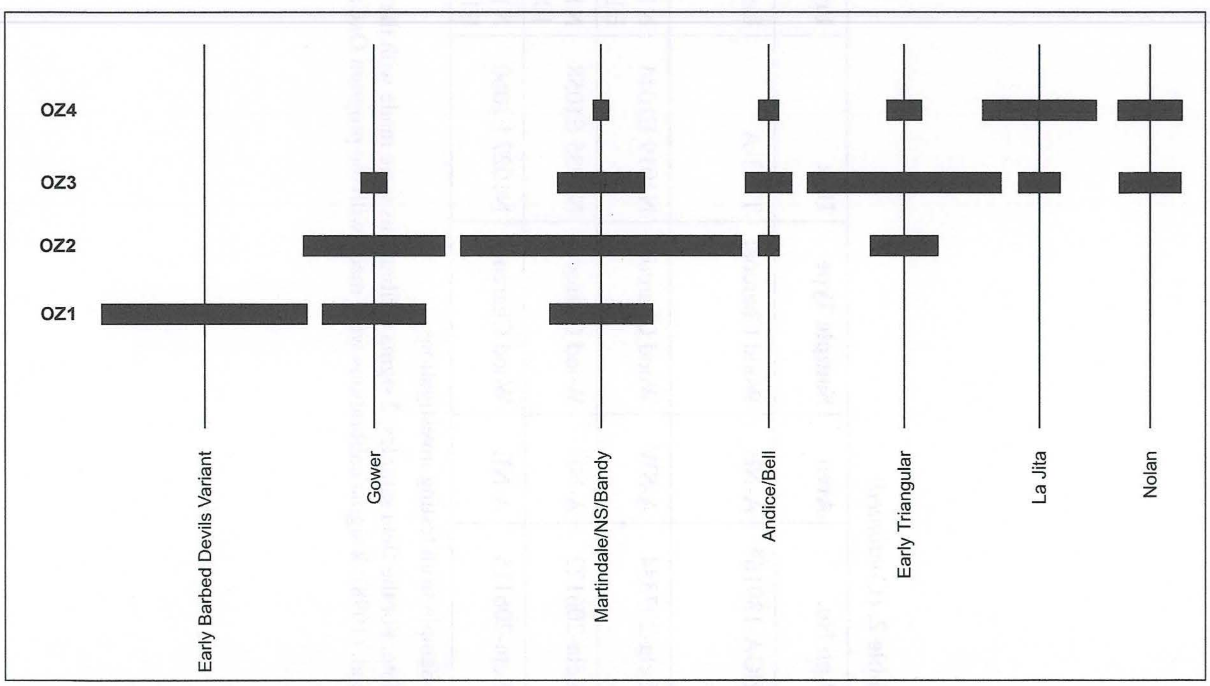

Figure 6. Seriation diagram of major projectile point types by Occupation Zone (OZ).

Early Triangular points account for 38 percent of the 101 typed points in the occupation zone. Late Middle Archaic points, such as La Jita (n=8) and Nolan (n=12), account for 20 percent of the points in the OZ 3 sample. The rest of the assemblage includes a variety of Late Archaic styles indicative of the compression or mixing of younger artifactual material from the overlying OZ 4.

As Figure 6, an admittedly very gross seriation diagram, shows, the temporal sequence of Early Archaic to late Middle Archaic point types at the Gatlin site is as follows, from earliest to latest: Early Barbed Devils Variant, Gower, Martindale/Bandy, Early Triangular, Andice/Bell, Nolan, and La Jita. This sequence fits well with the chronological orderings of points proposed by Johnson and Goode (1994:Figure 2) and Collins (2004:Figure 3.9a) for Central Texas, and appears to represent the entire sequence of projectile points typically expected for the time periods in question.

A PARTIAL CHRONOLOGY FOR THE SOUTHERN EDWARDS PLATEAU

The true contribution of the Gatlin site to the chronology of the southern Edwards Plateau is its suite of radiocarbon dates, which can be used to provide more refined temporal parameters for the Early Archaic and Middle Archaic sequences (Figure 8a-c, see also Table 1). As mentioned above, most of the sites used to define the archeological style intervals listed by Collins (2004:Figure 3.9a) lack radiocarbon dates. Figure 9 represents a proposed chronology for the region based on the calibrated Gatlin site radiocarbon assays and the seriation of projectile points shown in Figure 6. In constructing this chronology, we have selected samples with good associations between features, stratigraphy, and projectile points, and we have opted to present the chronology in calibrated dates to make it more

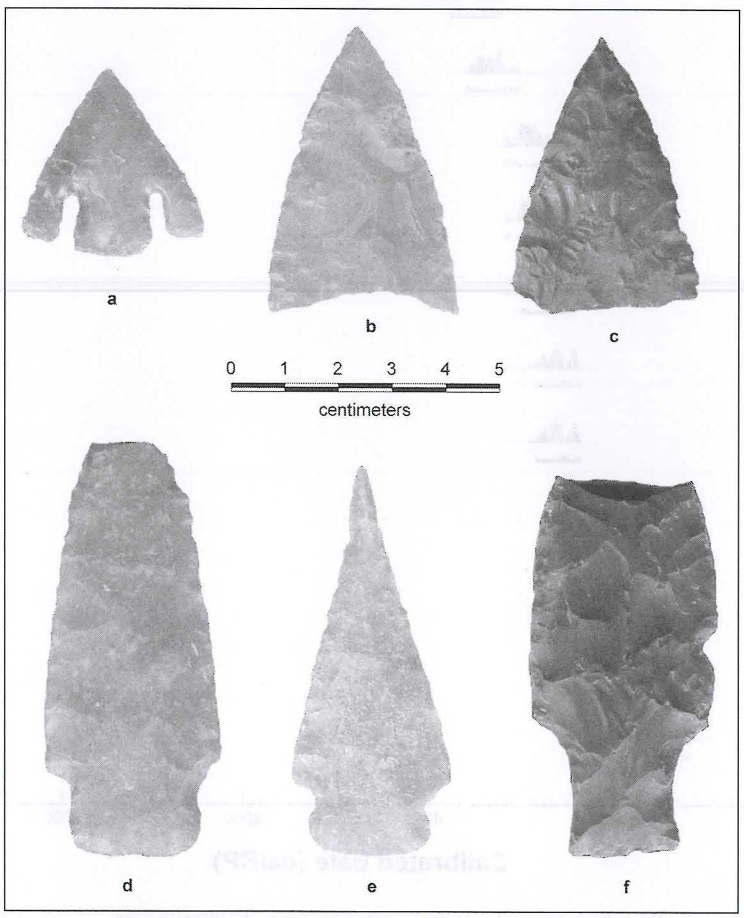

Figure 7. Representative examples of Middle Archaic projectile points from the Gatlin site: a, Bell; b-c, Early Triangular; d-e, La Jita; f, Nolan.

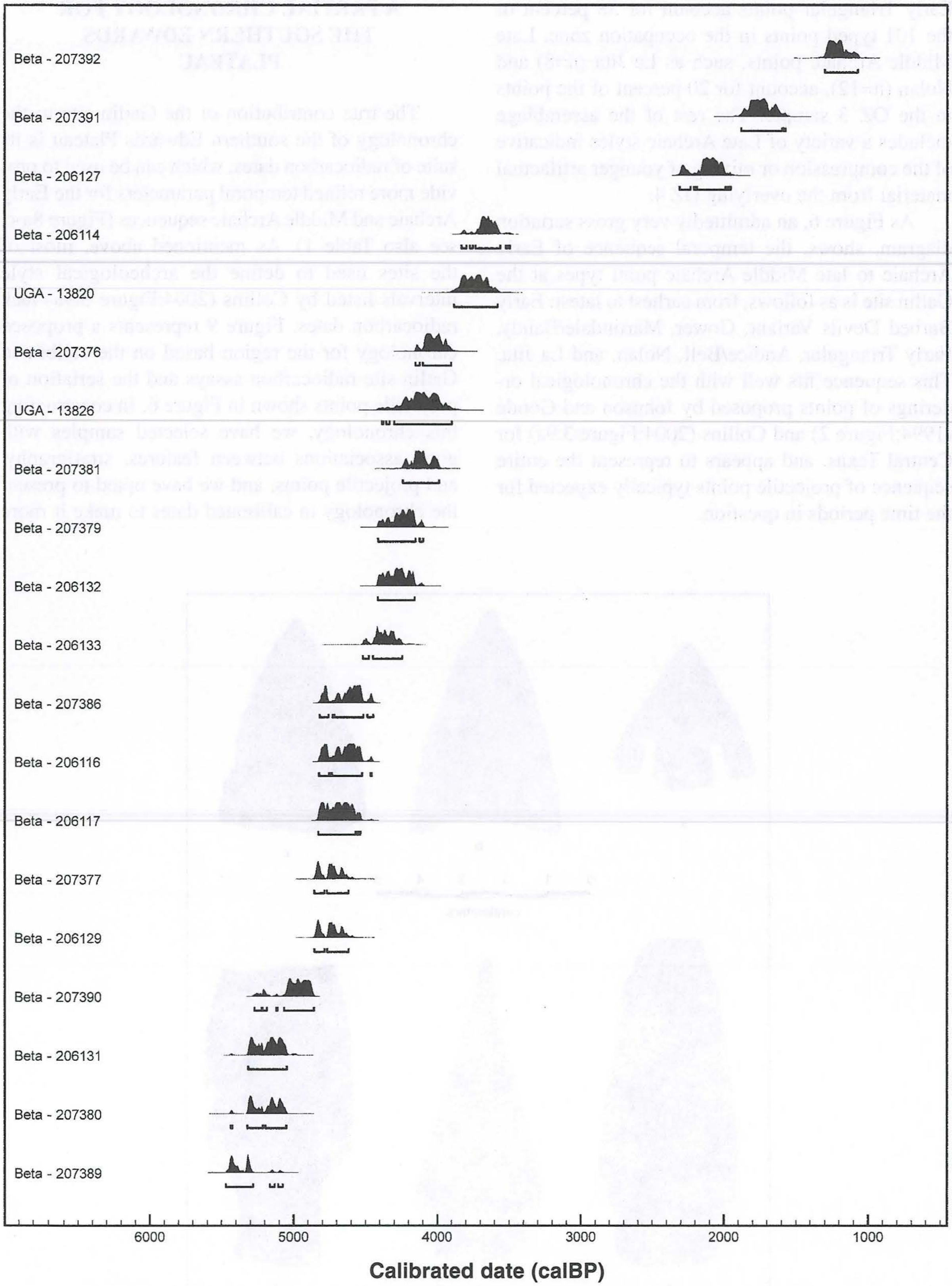

Figure 8a. OxCal 4.0 plot of all prehistoric radiocarbon samples from the Gatlin site.

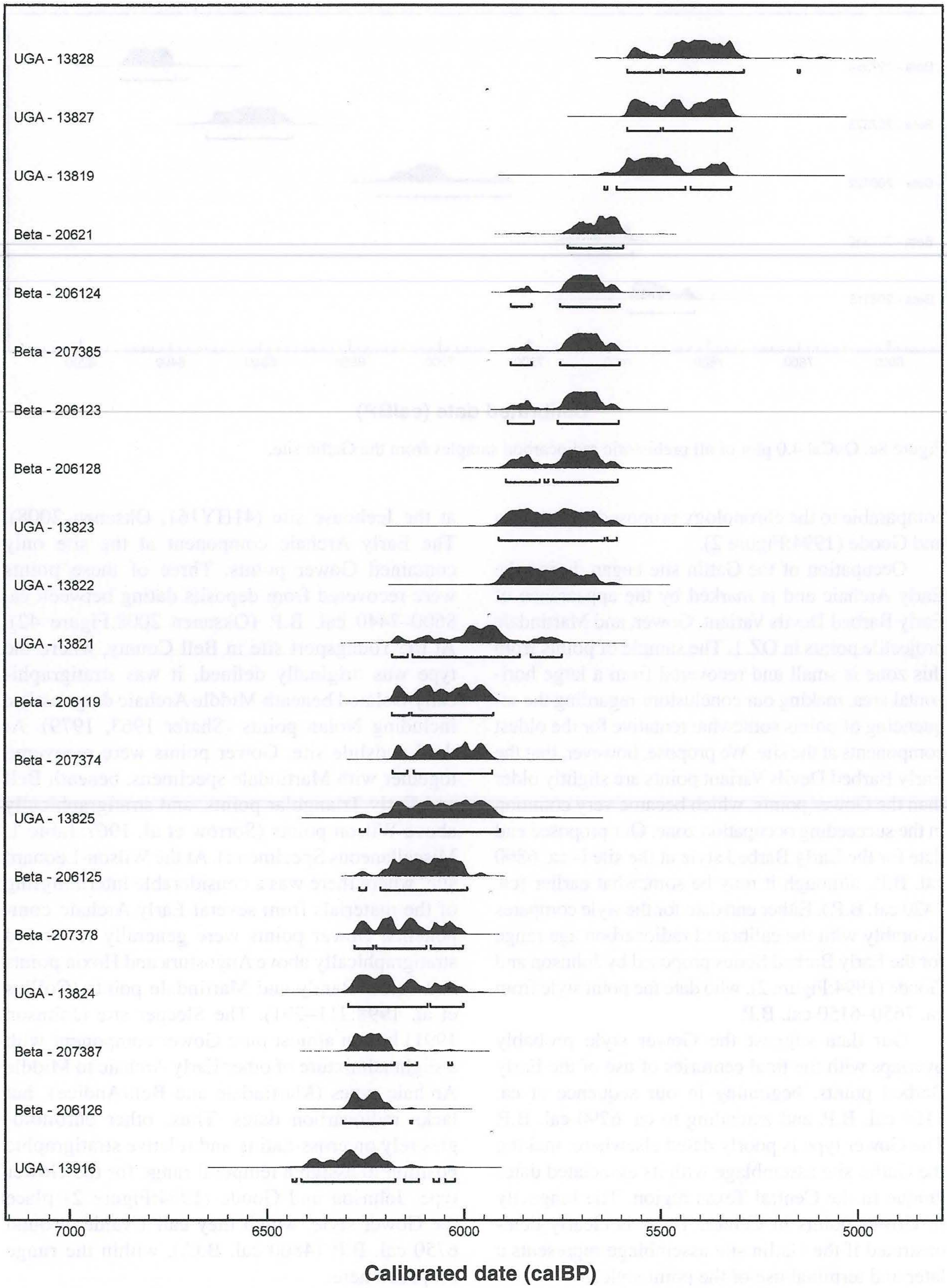

Figure 8b. OxCal 4.0 plot of all prehistoric radiocarbon samples from the Gatlin site.

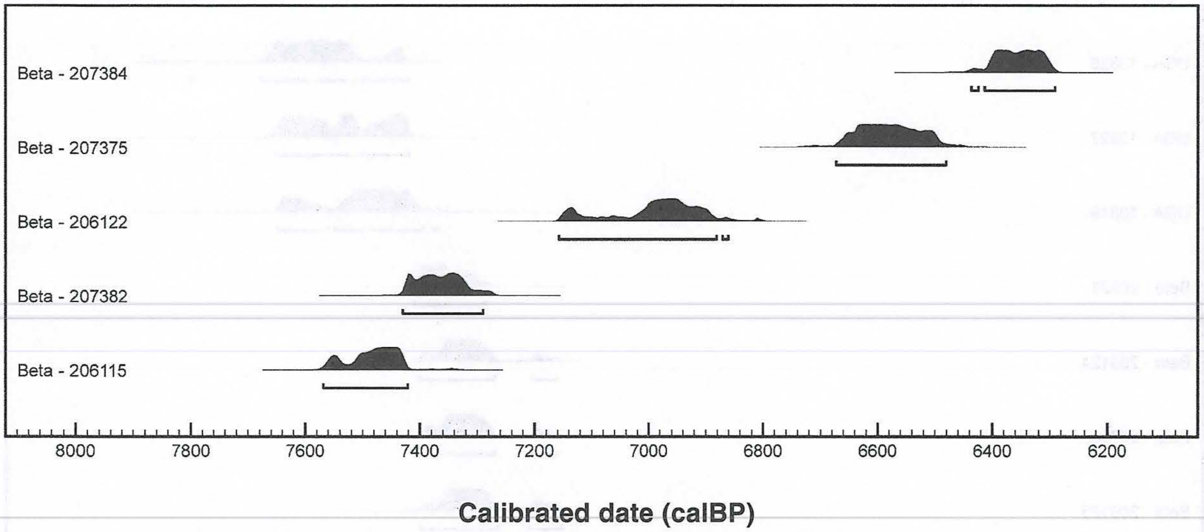

Figure 8c. OxCal 4.0 plot of all prehistoric radiocarbon samples from the Gatlin site.

comparable to the chronology proposed by Johnson and Goode (1994:Figure 2).

Occupation of the Gatlin site began during the Early Archaic and is marked by the appearance of Early Barbed Devils Variant, Gower, and Martindale projectile points in OZ 1. The sample of points from this zone is small and recovered from a large horizontal area, making our conclusions regarding the sequencing of points somewhat tentative for the oldest components at the site. We propose, however, that the Early Barbed Devils Variant points are slightly older than the Gower points, which became very common in the succeeding occupation zone. Our proposed end date for the Early Barbed style at the site is ca. 6860 cal. B.P., although it may be somewhat earlier (ca. 7420 cal. B.P.). Either end date for the style compares favorably with the calibrated radiocarbon age range for the Early Barbed Series proposed by Johnson and Goode (1994:Figure 2), who date the point style from ca. 7650–6150 cal. B.P.

Our data suggest the Gower style probably overlaps with the final centuries of use of the Early Barbed points, beginning in our sequence at ca. 7160 cal. B.P. and extending to ca. 6290 cal. B.P. The Gower type is poorly dated elsewhere, making the Gatlin site assemblage with its associated dates unique in the Central Texas region. The longevity of Gower points in Central Texas is clearly demonstrated if the Gatlin site assemblage represents a later and terminal use of the point style.

Currently, the best dated Gower assemblage is at the eastern edge of the Edwards Plateau, along the Balcones Escarpment in San Marcos, at the Icehouse site (41HY161, Oksanen 2008). The Early Archaic component at the site only contained Gower points. Three of these points were recovered from deposits dating between ca. 8600–7440 cal. B.P. (Oksanen 2008:Figure 42). At the Youngsport site in Bell County, where the type was originally defined, it was stratigraphically isolated beneath Middle Archaic diagnostics, including Nolan points (Shafer 1963, 1979). At the Landslide site, Gower points were recovered together with Martindale specimens, beneath Bell and Early Triangular points, and stratigraphically above Wilson points (Sorrow et al. 1967:Table 1, Miscellaneous Specimen f). At the Wilson-Leonard site, where there was a considerable intermingling of the materials from several Early Archaic components, Gower points were generally recovered stratigraphically above Angostura and Hoxie points and below Bandy and Martindale points (Collins et al. 1998:211–291). The Sleeper site (Johnson 1991) has an almost pure Gower component with a slight admixture of other Early Archaic to Middle Archaic types (Martindale and Bell/Andice), but lacks radiocarbon dates. Thus, other chronologies rely on cross-dating and relative stratigraphic position to assign a temporal range for the Gower type. Johnson and Goode (1994:Figure 2) place the Gower style, which they call Uvalde, around 6750 cal. B.P. (4800 cal. B.C.), within the range proposed here.

In teasing out our projectile point sequence for the oldest occupation, we relied on Johnson and Goode's (1994:22, 24) research that suggests

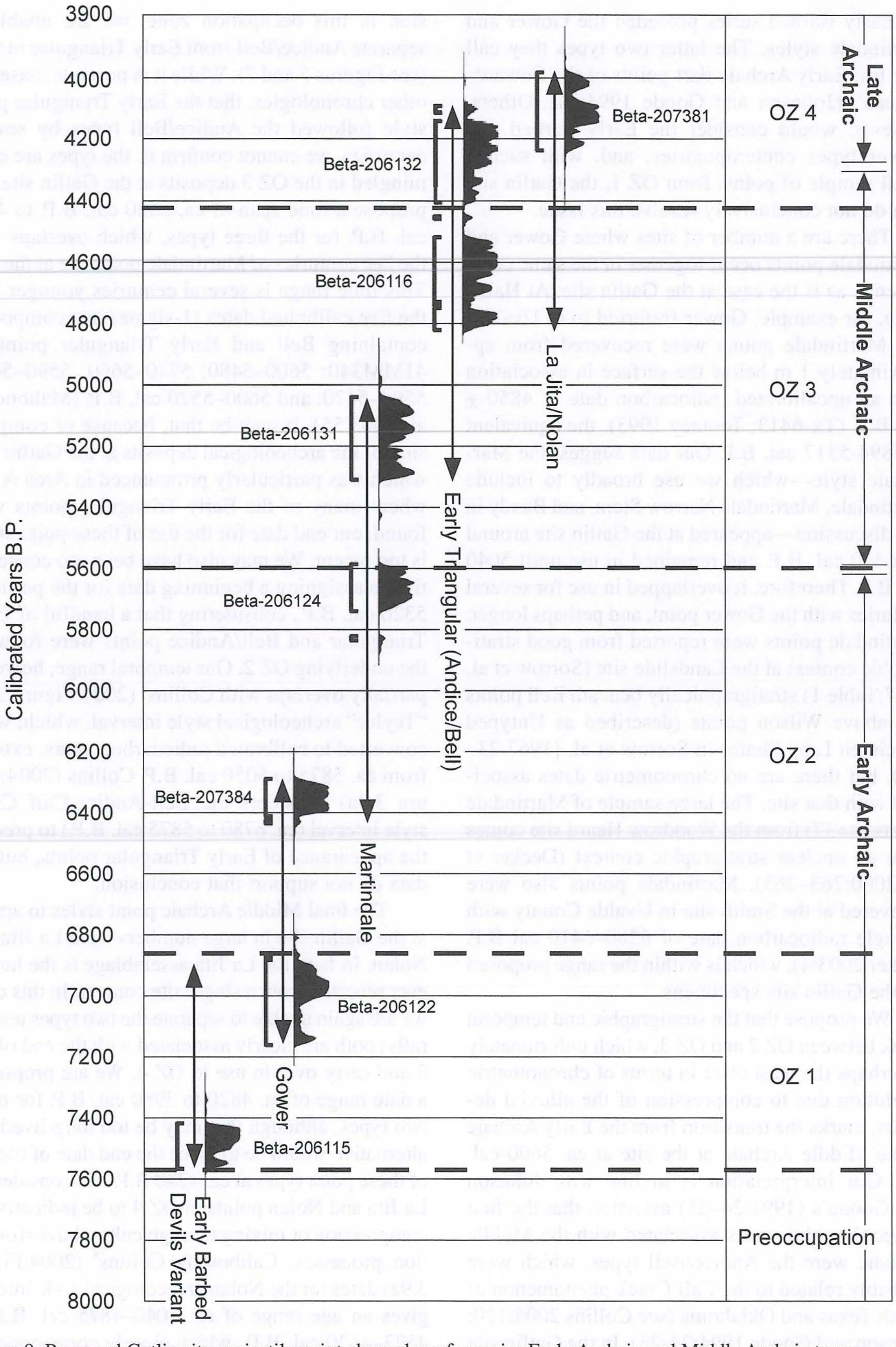

Figure 9. Proposed Gatlin site projectile point chronology for major Early Archaic and Middle Archaic types.

the Early Barbed series preceded the Gower and Martindale styles. The latter two types they call "the last Early Archaic dart points of the Edwards Plateau" (Johnson and Goode 1994:24). Others, however, would consider the Early Barbed and Gower types contemporaries, and, with such a small sample of points from OZ 1, the Gatlin site data do not conclusively resolve this issue.

There are a number of sites where Gower and Martindale points occur together in the same components, as is the case at the Gatlin site. At Hall's Cave, for example, Gower (referred to as Uvalde) and Martindale points were recovered from approximately 1 m below the surface in association with an uncalibrated radiocarbon date of 4850 ± 130 B.P. (Tx-6413; Toomey 1993), the equivalent of 5894-5317 cal. B.P. Our data suggest the Martindale style—which we use broadly to include Martindale, Martindale Narrow Stem, and Bandy in this discussion—appeared at the Gatlin site around ca. 6440 cal. B.P. and remained in use until 5040 cal. B.P. Therefore, it overlapped in use for several centuries with the Gower point, and perhaps longer. Martindale points were reported from good stratigraphic context at the Landslide site (Sorrow et al. 1967:Table 1) stratigraphically beneath Bell points and above Wilson points (described as Untyped Specimen L by Shafer in Sorrow et al. [1967:23–25]), but there are no chronometric dates associated with that site. The large sample of Martindale points (n=37) from the Woodrow Heard site comes from an unclear stratigraphic context (Decker et al. 2000:263–265). Martindale points also were recovered at the Smith site in Uvalde County with a single radiocarbon date of 6280–6410 cal B.P. (Baker 2003:4), which is within the range proposed for the Gatlin site specimens.

We propose that the stratigraphic and temporal break between OZ 2 and OZ 3, which unfortunately is perhaps the least clear in terms of chronometric resolution due to compression of the alluvial deposits, marks the transition from the Early Archaic to the Middle Archaic at the site at ca. 5600 cal. B.P. Our interpretation is in line with Johnson and Goode's (1994:24–25) assertion that the first projectile point styles associated with the Middle Archaic were the Andice/Bell types, which were probably related to the Calf Creek phenomenon of North Texas and Oklahoma (see Collins 2004:120; Johnson and Goode 1994:24-25). In the Gatlin site assemblage, due to the aforementioned compression in this occupation zone, we are unable to separate Andice/Bell from Early Triangular in time (see Figures 5 and 7). While it is possible, based on other chronologies, that the Early Triangular point style followed the Andice/Bell types by several centuries, we cannot confirm it; the types are commingled in the OZ 3 deposits at the Gatlin site. We propose a time span of ca. 5320 cal. B.P. to 4140 cal. B.P. for the three types, which overlaps with the last centuries of Martindale point use at the site. This time range is several centuries younger than the five calibrated dates (1-sigma) in a component containing Bell and Early Triangular points at 41MM340: 5600–5480, 5740–5660, 5590–5460, 5590–5470, and 5600–5520 cal. B.P. (Mahoney et al. 2003:55). It may be that, because of compression of the archeological deposits at the Gatlin site, which was particularly pronounced in Area A SW where many of the Early Triangular points were found, our end date for the use of these point styles is too recent. We may also have been too conservative in assigning a beginning date for the points of 5320 cal. B.P., considering that a handful of Early Triangular and Bell/Andice points were found in the underlying OZ 2. Our temporal range, however, partially overlaps with Collins' (2004:Figure 3.9a) "Taylor" archeological style interval, which, when converted to calibrated radiocarbon years, extends from ca. 5875 to 5050 cal. B.P. Collins (2004:Figure 3.9a) considers the Bell-Andice-Calf Creek style interval (ca. 6780 to 5875 cal. B.P.) to precede the appearance of Early Triangular points, but our data do not support that conclusion.

The final Middle Archaic point styles to appear at the Gatlin site in large numbers were La Jita and Nolan. In fact, the La Jita assemblage is the largest ever reported from a single site context. In this case, we are again unable to separate the two types temporally; both are clearly associated with the end of OZ 3 and carry over in use to OZ 4. We are proposing a date range of ca. 4820 to 3980 cal. B.P. for these two types, although that may be too long-lived. An alternative would be to place the end date of the use of these point types at ca. 4240 B.P. and consider the La Jita and Nolan points in OZ 4 to be indicative of compression or mixing through cultural transformation processes. Calibrating Collins' (2004:Figure 3.9a) dates for the Nolan archeological style interval gives an age range of ca. 5040–4875 cal. B.P. to 4523–4420 cal. B.P., which closely corresponds to the Gatlin site data.

CONTRIBUTIONS TO THE REGIONAL CHRONOLOGICAL DATABASE

The Gatlin site represents one of the largest Early-to-Middle Archaic artifact assemblages associated with radiocarbon dates from an excavated site in Central Texas. As such it is able to contribute significantly to the regional chronological database despite the compression of some of the sequence. In general, the Gatlin site chronology supports the relative sequence of point styles presented in both Collins (2004:Figure 3.9a) and Johnson and Goode (1994:Figure 2), but provides chronometric ages for the Gower, Martindale, Bell, Andice, Early Triangular, Nolan, and La Jita projectile point styles. Many of the sites originally used to establish the ages of most of the point types mentioned here were excavated prior to the widespread use of radiocarbon dating. There are no dates for sites, for example, from the contexts in question from the following sites used by Collins (2004:Fig. 3.9a) in his Central Texas chronology: the Sleeper (Johnson 1991), Youngsport (Shafer 1963), and Jetta Court (Wesolowsky et al. 1976) sites, high integrity "Early Split Stem" components; the Camp Pearl Wheat site (Collins et al. 1990), a high integrity Martindale-Gower component; the Landslide site (Sorrow et al. 1967), a moderate integrity Martindale-Gower component and high-integrity Bell-Andice-Calf Creek component; and the Wounded Eye site (Luke 1980), a moderate integrity Early Triangular (Taylor) component.

Based on the Gatlin site data, the Middle Archaic projectile point types begin to appear ca. 5600 cal. B.P. in southern Central Texas. Early Triangular points in great numbers, along with Bell and Andice points, show up at the Gatlin site around this date, which corresponds to Johnson's and Goode's (1994) end date for the Early Archaic. At the Gatlin site, the Middle Archaic styles fade from the record with the decrease in La Jita points, about the same time that the burned rock midden began to form, ca. 4400 cal. B.P. This corresponds well to the Middle Archaic ending dates proposed by Johnson and Goode (1994) and Collins (2004).

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Geochemical Evidence for a Mexican Source of Origin for an Obsidian Artifact from South Central Texas

Richard E. Hughes and Thomas R. Hester

ABSTRACT

Energy dispersive x-ray fluorescence (EDXRF) analysis was conducted on an obsidian biface fragment from the Mangold site (41ME132), located in south central Texas. Trace element data indicate that the specimen was manufactured from obsidian of the Ojozarco chemical type, located in west central Mexico. These data provide additional documentation for the importance of Mexican obsidians in Texas prehistoric archeological sites.

INTRODUCTION

For more than 30 years one of us (TRH) has obtained provenience and chemical data on obsidian artifacts recovered from Texas archeological sites (Hester et al. 1975, 1985, 1991a; Mitchell et al. 1980; Giauque et al. 1993). This collaborative project—the Texas Obsidian Project (TOP)—has as its primary goals the documentation of the use of different obsidian source materials, and the investigation of time and space continuity and variability in the use of these obsidians during different periods of time in Texas prehistory (Hester et al. 1983; Hester 1988, 2004:149-150). Obsidian artifacts analyzed by the TOP occur rarely in most parts of the state, and usually not more than a single specimen occurs at any one site. In recent years, Hester identified an obsidian artifact from the Mangold site (41ME132) and secured permission for trace element analysis to be performed. This article reports the results of non-destructive instrumental analysis of this specimen.

The late H.W. (Buddy) Mangold's excavations at the Mangold site in the 1990s yielded evidence of recurring occupations from 10,500 years ago until the early Historic era, likely the early 1700s. The early artifacts include projectile points of the Wilson, Golondrina, and Angostura types, dating (earliest to latest) 10,500 to 8,800 years ago. Large numbers of dart points representing the Archaic (8,500-1,300 years ago) cultures of the region include Calf Creek, Pedernales, Montell, and Darl, among others (Turner and Hester 1993). Late Prehistoric use of the site is reflected by arrow points and tools that date between 1300-300 years ago. At least two arrow points are the Guerrero type, typical of arrow points found in eighteenth century Spanish missions in southern Texas and northeastern Mexico (Hester 1989). Unfortunately the specimen we designate as TOP-209 was excavated from an area of the deposits containing no associated diagnostic artifacts and it is not typologically distinct, so its temporal affiliation is presently unknown.

THE SITE AND THE SPECIMEN

The obsidian artifact analyzed here is a biface tip recovered from excavation at the Buddy Mangold site (41ME132), located near Quihi in eastern Medina County, Texas (Figure 1). The specimen, designated as sample TOP-209, is approximately 20 mm long, 12.5 mm wide, and 4.0 mm thick, and appears to have an impact fracture on one side (Figure 2).

LABORATORY ANALYSIS

Non-destructive trace element analysis of the Mangold site specimen (sample TOP-209) was conducted by the senior author at Geochemical Research Laboratory (GRL) using a QuanX-EC™ (Thermo Electron Corporation) energy dispersive x-ray fluorescence (EDXRF) spectrometer equipped with a silver (Ag) x-ray tube, a 50 kV x-ray generator, digital pulse processor with automated

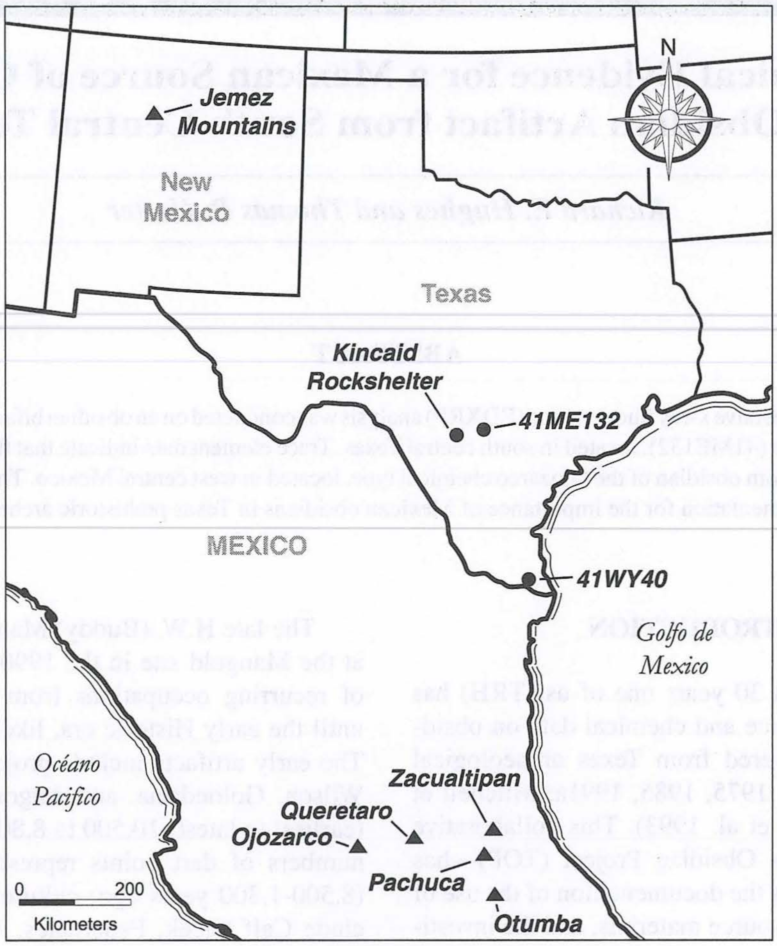

Figure 1. The study area, showing general location of archeological sites (black dots) and obsidian sources (black triangles) mentioned in the text.

Figure 2. Obsidian biface fragment from the Mangold site (41ME132). Length of the specimen is 20 mm.

energy calibration, and a Peltier cooled solid state detector with 145 eV resolution (FWHM) at 5.9 keV. The x-ray tube was operated at differing voltage and current settings to optimize excitation of the elements selected for analysis. In this case analyses were conducted for the elements rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), barium (Ba), titanium (Ti), manganese (Mn) and iron ($Fe_2O_3^t$) and to determine iron vs. manganese (Fe/Mn) ratios. The analyses were conducted at 120-600 deadtime-corrected seconds, with tube current scaled to the physical size of the specimen. Other details involving laboratory analysis protocol appear elsewhere (Hughes and Pavesic 2005); the interested reader should consult this article, and Hughes (1988a, 1994, 2005:249-250), for additional information on calibration and element-specific measurement resolution.

INTERLABORATORY COMPARISON ISSUES

Prior to evaluating the significance of the trace element composition data generated for specimen TOP-209 from the Mangold site, it was deemed important to assess the degree of concordance between the trace element abundance measurements generated at GRL and those reported for other artifacts and source samples analyzed as part of the TOP. For over three decades, the laboratory analyses of TOP specimens have been conducted at the Lawrence Berkeley Laboratory (LBL) using a combination of instrumental neutron activation analysis and x-ray fluorescence spectrometry (Giauque et al. 1993). There has been close agreement through the years between trace and selected minor element data generated at LBL and at GRL, but it seemed advisable at this time to conduct a more contemporary comparison using a specimen from the TOP (Table 1).

LBL data in Table 1 are from Asaro and Stross (1994) while GRL data are those generated on the same sample. As was the case in earlier LBL/GRL comparisons (Hughes 1988a:Table II; Brown et al. 2004:Table 1), the elements measured in common are in exceptional agreement, engendering confidence that the quantitative composition estimates generated at each laboratory can be directly compared.

LBL researchers devoted considerable attention to documenting analytical measurement precision (e.g. Stross et al. 1983; Giauque et al. 1993), so comparative data were generated for GRL measurements. Table 2 shows the results of the precision analyses for both the U.S. Geological Survey RGM-1 rock standard and archeological artifact TOP-209. Although one might have expected RGM-1 values to have lower values (i.e., better precision) than those generated for TOP-209 because they were generated on a uniformly flat pressed powder pellet, the data in Table 2 document that, despite less than optimal x-ray reflection geometry for the artifact (TOP-209), the precision determined for the pressed powder RGM-1 sample and TOP-209 are remarkably similar (see Hughes 1994:267). The principal differences between them (Sr in TOP-209 and Nb in RGM-1) are due largely to low concentrations (approaching detection limits) of these elements in the respective samples (Hughes 1993:205). When concentrations

Table 1. Comparison of Quantitative Composition Estimates for Sample TOP-164.

Cat. Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	$Fe_2O_3^t$	Fe/Mn	Obsidian Source (Chemical Type)
	Trace Element Concentrations											Ratio	
TOP-164 (LBL)	193 ±3	52 ±2	170 ±4	1 < 1	111 ±2	1160 ±16	58 ±3	< 22	nm	289 ±21	nm	nr	Ojozarco
TOP-164 (GRL)	nm	nm	173 ±4	7 ±3	114 ±3	1131 ±4	50 ±3	0 ±10	1139 ±21	279 ±10	2.26 ±.02	92	Ojozarco

All trace element values (except Fe/Mn ratios) in parts per million (ppm) or weight percent composition ($Fe_2O_3^t$); ± = estimate of x-ray counting uncertainty and regression fitting error at 120-360 seconds livetime; nm = not measured; nr = not reported.

Table 2. Measurement Precision for Trace and Selected Minor Elements Analyzed at Geochemical Research Laboratory (GRL).

Sample Number	Elements Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	$Fe_2O_3^t$
RGM-1	1.2	1.1	2.8	< 1	12.7	1.4	< 1	1.5	< 1
TOP-209	1.6	6.8	1.4	< 1	2.6	nr	< 1	1.3	< 1

Values in %, derived from ten analyses at 120-360 seconds livetime. Value not reported (nr) for Ba in TOP-209 because the concentration value exceeded (was lower than) detection limits.

significantly exceed detection limits (i.e., Sr in RGM-1 and Nb in TOP-209), precision is practically identical to other well-measured elements.

ARCHEOLOGICAL RESULTS

Trace and selected minor element data generated by EDXRF analysis for the obsidian biface fragment (TOP-209) recovered from the Mangold site appear in Table 3. The resulting elemental data were compared with values from in-house geologic obsidian samples and with published data on certain Mesoamerican and America Southwest volcanic glasses (e.g., Cobean et al. 1991; Glascock and Cobean 2002; Hughes 1988c; Macdonald et al. 1992; Nelson 1984; Shackley 1995, 2005; Stross et al. 1976, 1983).

Despite the number of different chemical varieties of obsidian in these areas, the trace element chemical composition of TOP-209 allowed us to eliminate many known sources and to focus only on those containing > 500 ppm Zr. Figure 3 illustrates this chemical comparison, plotting the Zr vs. Rb composition of archeologically significant obsidian sources from Mesoamerica against values

Table 3. Quantitative Composition Estimates for Sample TOP-209 from 41ME132, Texas.

Cat. Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	$Fe_2O_3^t$	Ratio Fe/Mn	Obsidian Source (Chemical Type)
			Trace Element Concentrations										
TOP-209	nm	nm	166	20	109	1102	45	0	1213	275	2.35	92	Ojozarco
			±4	±3	±3	±4	±3	±12	±21	±10	±.02		
U.S. Geological Survey Reference Standard													
RGM-1	nm	nm	148	104	25	224	10	811	1576	274	1.85	65	Glass Mtn., CA
(measured)			±4	±3	±3	±4	±3	±10	±16	±10	±.02		
RGM-1 (recommended)	32	15	149	108	25	219	9	807	1600	279	1.86	nr	Glass Mtn., CA

Values in parts per million (ppm) except total iron [in weight %] and Fe/Mn intensity ratios; ± = x-ray counting uncertainty and regression fitting error at 120-600 seconds livetime. nm= not measured. nr= not reported. Recommended value for RGM-1 from Govindaraju (1994).

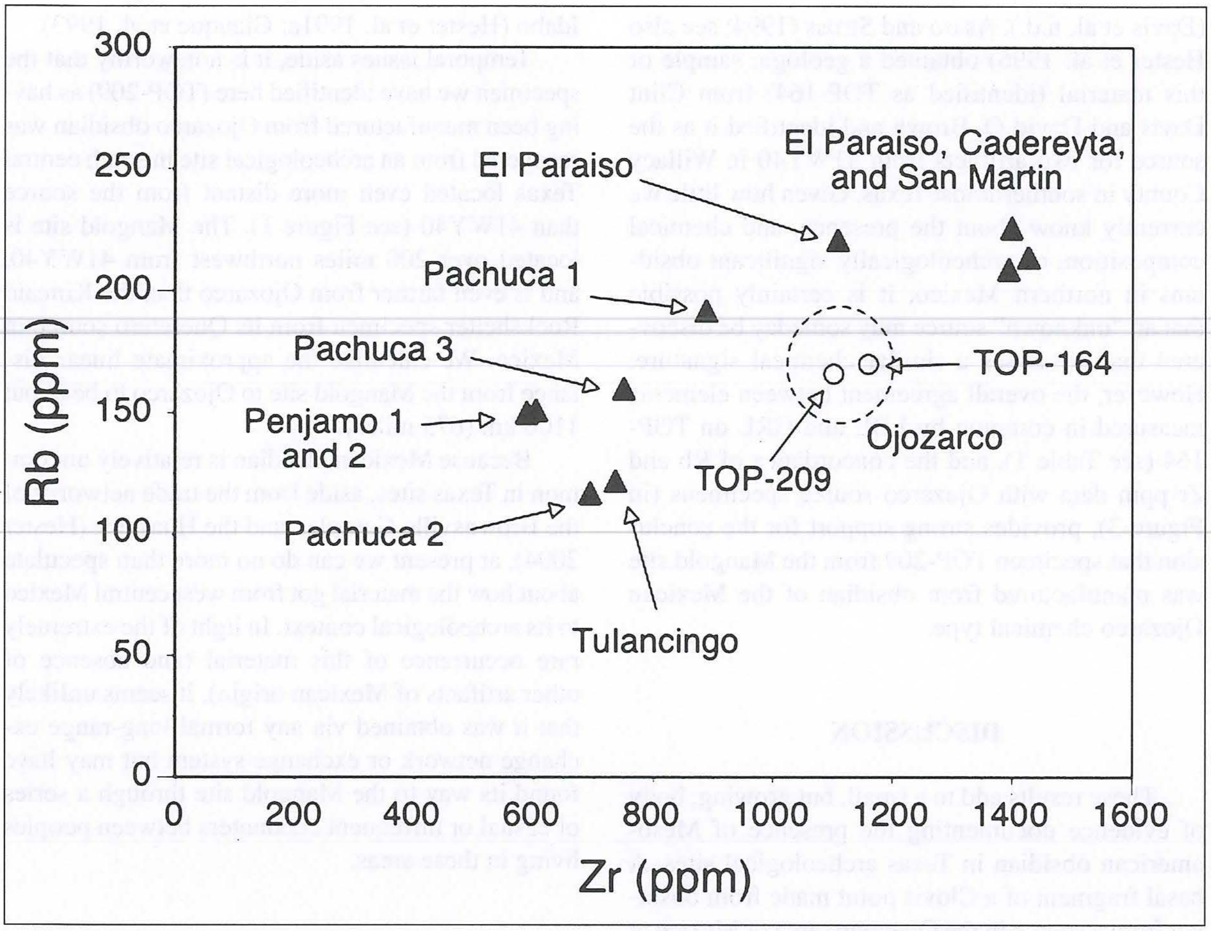

Figure 3. Rb vs. Zr composition for major Mesoamerican geologic obsidians (chemical types) with Zr composition > 500 ppm in relation to values for archeological samples TOP-164 and TOP-209, Texas. Filled triangles represent mean values for geologic obsidian source standards from El Paraiso, Pachuca 1-3, Penjamo 1 and 2, and Tulancingo (from Glascock and Cobean 2002:Tables A2.9, A2.12-A2.14, A2.18-A2.20); values for El Paraiso, Cadereyta, and San Martin from Hester et al. (1985:Table 1) and Asaro and Stross (1994). Open circles represent plots for archeological samples TOP-164 and TOP-209. Dashed line represents range measured for geologic samples from Ojozarco.

generated for archeological samples TOP-164 and TOP-209. Only two well-known obsidians from the American Southwest contained enough Zr to have been included on Figure 3. A peralkaline glass from Antelope Wells contains > 1200 ppm Zr, but its Rb composition (> 320 ppm; Hughes 1988c:Table 3; Shackley 1995:Table 1) would plot off the scatter diagram and is therefore much too great for it to have been the source of origin for TOP-209. The other Southwest source, San Francisco Peak (Jack 1971:Table I; Shackley 1995:Table 1), could have been included on this diagram, but its Rb/Zr values would appear just slightly above that for Tulancingo, thus eliminating this source, too, as a possible parent material for TOP-209. Some of the peralkaline obsidians from the Sierra La Primavera, Jalisco, Mexico (Mahood 1988:Table 1) contain Zr concentrations between 500-550 ppm (with one at 616 ppm), but all of these are too low to be correlated with TOP-209. Other newly reported northern Mexico sources—El (Lago) Barreal (Shackley 2005:Table A.11) and Los Jagueyes (Shackley 2005:Table A.16)—also are not close enough in Rb/Zr composition to have been sources for this archeological artifact.

However, as can be seen from this diagram (see Figure 3), the Rb/Zr ppm values for TOP-209 fall squarely within the range generated from a newly discovered obsidian source (chemical type; sensu Hughes 1998:104) named Ojozarco (variously rendered as Ojo Zarco or Ojos Arco) located northwest of Queretaro in Guanajuato, west central Mexico

(Davis et al. n.d.). Asaro and Stross (1994; see also Hester et al. 1996) obtained a geologic sample of this material (identified as TOP-164) from Clint Davis and David O. Brown and identified it as the source for two artifacts from 41WY40 in Willacy County in southernmost Texas. Given how little we currently know about the presence, and chemical composition, of archeologically significant obsidians in northern Mexico, it is certainly possible that an "unknown" source may someday be discovered that possesses a similar chemical signature. However, the overall agreement between elements measured in common by LBL and GRL on TOP-164 (see Table 1), and the concordance of Rb and Zr ppm data with Ojozarco source specimens (in Figure 3), provides strong support for the conclusion that specimen TOP-209 from the Mangold site was manufactured from obsidian of the Mexican Ojozarco chemical type.

DISCUSSION

These results add to a small, but growing, body of evidence documenting the presence of Mesoamerican obsidian in Texas archeological sites. A basal fragment of a Clovis point made from obsidian from a source in the Queretaro area of Mexico at Kincaid Rockshelter (Hester et al. 1985) indicates that the cultural connections between Texas and Mexico have significant time depth. In addition to TOP-209 and the Kincaid Clovis fragment there are several other Mexican sources identified in Texas obsidian artifacts, including Zacualtipan (Hester et al. 1992, 1999), Ojozarco (Hester et al. 1996), Sierra de las Navajas (Pachuca), and Otumba (Hester et al. 1996). Some of these sources are most common in the Rio Grande Delta, and are linked to the Brownsville Complex (Hester et al. 1999; Hester 2004).

Overall, however, relatively few of the artifacts subjected to trace element analysis by the TOP have been conclusively linked to Mexican volcanic glass sources. Results to date indicate that, even from earliest times (Johnson et al. 1985; Hester 1988; Hester et al. 2006), obsidian sources in the Jemez Mountains of New Mexico were most frequently used. Obsidian artifacts analyzed from later time periods in Texas (i.e., after A.D. 1000) show even more dramatic use of New Mexico obsidian source materials (Mitchell et al. 1980; Hughes 1988b; Hester et al. 1991b), as well as the Malad source in Idaho (Hester et al. 1991a; Giauque et al. 1993).

Temporal issues aside, it is noteworthy that the specimen we have identified here (TOP-209) as having been manufactured from Ojozarco obsidian was recovered from an archeological site in south central Texas located even more distant from the source than 41WY40 (see Figure 1). The Mangold site is located over 200 miles northwest from 41WY40, and is even farther from Ojozarco than the Kincaid Rockshelter specimen from its Queretaro source in Mexico. We calculate the approximate linear distance from the Mangold site to Ojozarco to be about 1100 km (675 miles).

Because Mexican obsidian is relatively uncommon in Texas sites, aside from the trade networks of the Brownsville Complex and the Huasteca (Hester 2004), at present we can do no more than speculate about how the material got from west central Mexico to its archeological context. In light of the extremely rare occurrence of this material (and absence of other artifacts of Mexican origin), it seems unlikely that it was obtained via any formal long-range exchange network or exchange system but may have found its way to the Mangold site through a series of casual or infrequent encounters between peoples living in these areas.

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Avian Procurement and Use by Middle Ceramic Period People on the Southern High Plains: A Design for Investigations

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ABSTRACT

The prehistoric exploitation of birds on the southern High Plains has been rarely considered by archeologists more interested in bison, deer, and antelope. However, more than 450 avian species presently visit the region and modern inventories suggests that migrating waterfowl using the Central North American flyways constitute between 4,070 and 9,000 metric tons of meat annually passing through the region. Historic changes suggest that many more migrating waterfowl passed through the area during the prehistoric and early historic periods. Birds clearly have a tremendous economic potential for prehistoric and historic people in the region. To better understand the behavior of avian resources and the character of possible prehistoric procurement tactics, I delineate the life cycle of waterfowl along with the ecological differences between playas and riverine habitats. The importance of birds is also demonstrated by summarizing their roles in Plains Indian beliefs, which mirrors their use on Historic Plains dress and implements. The roles of birds among Plains Indian beliefs expand insights of avian usage beyond subsistence contributions, and underscores the importance and efforts in pursuing small fowl with limited meat weight.

The archeological occurrence of bird remains is extracted from 17 faunal records of the more than 50 Middle Ceramic period sites excavated in the Texas and Oklahoma Panhandle. Between 38-45 avian groups or species have been identified from the Middle Ceramic period sites that have received detailed faunal studies. To date no procurement strategies or detailed technological studies have been advanced to explore where or how birds were obtained, and I consulted the ethnographic record of North American Indians to delineate a range of procurement strategies, methods, and tactics. Finally the archeological record of sites in and surrounding the Texas and Oklahoma Panhandle region were examined to establish what to look for, and where to look, on the landscape for evidence of avian procurement, to begin correcting simplistic perceptions about the rich cultural heritage of the Middle Ceramic period people in the region.

INTRODUCTION

Bison, deer, and antelope are commonly known to have provided the bulk of meat consumed by Plains Village people during the Late Prehistoric or Middle Ceramic period (A.D. 1200 to 1500) on the southern High Plains (Duffield 1970; DeMarcay 1986; Duncan 2006). Perhaps surprisingly, these studies of hamlet and village faunal remains indicate that a great diversity of birds also is represented, albeit in low frequencies. This article focuses on the procurement and potential use of birds by prehistoric (Middle Ceramic period), protohistoric (Late Ceramic period), and historic aboriginal people, and the ways archeologists can begin to recognize such activities. The article also serves as a research design to guide field investigations into the topic of prehistoric bird procurement. If we ignore the more ancillary aspects of prehistoric adaptive strategies, then we risk developing a shallow reconstruction of these societies, and our knowledge becomes a poor reflection of the subtle, yet rich complexities of ancient behaviors that undoubtedly once existed.

The life cycles of waterfowl and the relative habitat importance of playas and rivers are discussed as a background to understanding bird procurement, since waterfowl constitute nearly half of the avian species found in the archeological record on the southern High Plains. I then summarize the importance of birds in Plains Indian cosmology. The religious role of birds and their ethnographic uses provide a possible context for viewing how they may have been regarded by Middle Ceramic peoples on the southern High Plains. Next, I discuss the diversity of bird remains from a series of Middle Ceramic period sites in the Texas and Oklahoma panhandles. This is followed by speculations about various passive and active bird procurement strategies based on North American patterns. Finally, a series of expected artifacts and features useful for identifying bird procurement and their distribution on the southern High Plains landscape are presented as testable hypotheses of avian hunting behaviors. Wherever possible, archeological evidence from the region is used to support contentions for the feasibility of these methods. However, until archeologists search to confirm the expected evidence, the range of procurement practices will remain speculative.

BIRDS OF THE SOUTHERN HIGH PLAINS WITH SPECIAL REFERENCE TO WATERFOWL

Considerable numbers of diverse birds seasonally reside or pass through the southern Plains. The list of birds for the high and rolling plains of Texas include 450 species, of which only 85 are permanent residents. Another 25 species are infrequently reported, but may be permanent residents (Seyffert 2000, 2001). The other 340 to 365 bird species are seasonal visitors. Many are migratory birds that often spend summers in the northern Plains and Canada and winter in southern latitudes, including the Texas and Oklahoma panhandles. The "Central Flyway" through the Plains is a major north-south migration route for millions of waterfowl and other birds (Hawkins et al. 1984). The Plains is also the transitional boundary between eastern and western avian habitats, and some species from each area can be found on the southern Plains. The migrating birds range from ducks and geese to predatory hawks and eagles, to smaller game birds, and perching birds. Bird inventories on the southern Plains have identified 25 waterfowl species associated with playa lakes alone (Flowers 1996; Curtis and Beierman 1980).

Migratory waterfowl using the Central Flyway are represented by truly impressive numbers. Midwinter waterfowl inventories for the period from 1978-1987 average more than 5 million birds, with yearly variations ranging from slightly more than 3 million to slightly less than 9 million birds (Table 1). These recent historic seasonal numbers of waterfowl potentially offer between an estimated 4,071.5 to 8,996.6 metric tons (4,488 to 9,917 short tons) of meat. When the meat of other birds is added to that of waterfowl, it should be clear that birds constitute a tremendous subsistence resource available for taking. Although fluctuation in the recent counts of waterfowl is due to inventory procedures, some variation in bird abundance undoubtedly is due to habitat changes, natural predation and diseases, including avian flu, botulism, enteritis, and fowl cholera (Jensen and Williams 1964; Pederson et al. 1989). However, these counts in the millions of individuals also occurred long after the thinning of the flocks following the introduction of shotguns and other technological advances in bird-hunting strategies. It is probably safe to say that the number of birds was substantially higher in prehistoric times, when stone-age technologies were in use. Indeed, historic records indicate that the skies were once filled with "great clouds of ducks" and "the sound made by flushing immense flocks of birds was like thunder" (Linduska 1964:4). By 1950, wetlands and feeding habitat in the United States decreased from more than 127 million acres to less than 82 million acres. These conditions, along with the use of pesticides, diseases, and historic change in weaponry, are partly responsible for the historic decline in waterfowl numbers.

THE YEARLY CYCLE OF WATERFOWL

Before examining the archeological and ethnographic evidence for bird procurement practices and uses, the life cycle and behavior of migratory waterfowl are reviewed to provide insights into the potential tactics used by ancient hunters. Generalizations about migratory waterfowl over-simplify the situation, since not all species act exactly the same way or are on the same seasonal schedule. The following yearly cycle is based on the behaviors of mallards and Canada geese, since they occur in abundance in the region (Ducks Unlimited 2007; Goode 2007).

The southern latitudes, including the Texas-Oklahoma short grass Plains, are part of the dominant wintering and mating grounds for migrating mallards and geese, along with the Texas coastal plain wetlands, as well as Mexico, and stretching to South America. Ducks and geese have access to food reserves in the southern regions that are not available in ice-covered lakes and rivers of their dominant

Table 1. Counts and estimated live and meat weight for waterfowl from playa lakes during mid-winter inventories: Central Flyway, 1978 to 1987.

	Mean Count	Percent	Minimum Count	Maximum Count	Single live bird weight (ounces)	Total mean live weight (pounds)	Total mean meat weight (70% live weight in pounds)	Estimated mean short tons of annual available meat
Ducks								
Mallard	1,431,930	28.18	799,800	2,220,000	38.4	3,436,632.00	2,405,642.40	
Gadwall	155,860	3.07	101,000	258,200	35.2	342,892.00	240,024.40	
American widgeon	95,770	1.88	76,000	154,400	27.2	162,809.00	113,966.30	
Green-winged teal	482,731	9.5	195,000	1,201,000	12.8	386,184.80	270,329.36	
Blue-winged teal	4,380	0.09	1,000	13,800	14.4	3,942.00	2,759.40	
Northern shoveler	54,630	1.08	33,000	70,300	22.4	76,482.00	53,537.40	
Northern pintail	713,300	14.04	335,600	1,709,000	36.8	1,640,590.00	1,148,413.00	
Redhead	220,080	4.33	108,000	322,100	41.6	572,208.00	400,545.60	
Canvasback	37,700	0.74	16,000	82,200	44.8	105,560.00	73,892.00	
Lesser scaup	71,520	1.41	29,000	140,300	27.8	124,266.00	86,986.20	
Ring-necked	15,300	0.3	1,500	54,200	25.6	24,480.00	17,136.00	
Common goldeneye	16,030	0.32	9,100	33,000	32.9	32,961.69	23,073.18	
Bufflehead	6,220	0.12	3,300	8,000	16.0	6,220.00	4,354.00	
Ruddy	11,460	0.23	5,200	25,200	20.8	14,898.00	10,428.60	
Common/ redbreasted merganser	117,750	2.32	45,000	291,300	24.0	176,625.00	123,637.50	
Sum	3,434,661	67.59	1,758,500	6,583,000		7,106,750.49	4,974,725.34	2,487.36
Geese								
Canada goose	642,700	12.65	483,000	844,700	134.4	5,398,680.00	3,779,076.00	
White-fronted goose	127,830	2.52	69,000	194,500	96.0	766,980.00	536,886.00	
Snow goose	876,230	17.24	801,000	1,205,000	92.5	5,065,704.69	3,545,993.28	
Sum	1,646,760	32.41	1,353,000	2,244,200		11,231,364.69	7,861,955.28	3,930.98
Total Ducks and Geese	5,081,421	100	3,111,500	8,827,200		18,338,115.18	12,836,680.62	6,418.34

Sum of Ducks and Geese	Bird Count	Total live weight (pounds)	Total meat weight (pounds)	Short tons of meat
Minimum	3,111,500	12,822,540.63	8,975,778.44	4,487.89
Mean	5,081,421	18,338,115.18	12,836,680.62	6,418.34
Maximum	8,827,200	28,333,424.75	19,899,396.63	9,916.70

Yearly counts after Ringleman et al. (1987:Table 5); live weight uses Alsop (2002); meat weight based on Solomon et al. (2006).

nesting grounds further north. They spend most of the winter eating plants and invertebrates to build up fat reserves for the spring migration north, and for their breeding, nesting, and molting phases.

Most ducks select mates and form bonded pairs during the fall and winter, but they typically do not breed until the next late March or early April. Most breeding pairs form after the southward late summer to fall migration, but a few form before the birds reach the wintering region (Pederson et al. 1989:292). Among Canada geese that lost mates, pair bonds can form in a matter of hours after reaching the wintering site, but for younger birds, the courtship and bonding can take weeks to months, and in a few cases, the courtship persists all fall and winter. Studies have found that birds with mates tend to weigh more and are dominant over unpaired birds due to the tendency for waterfowl to select healthy mates. Also hens metabolically store reserve calcium in medullary tissue of the hollow bone cores for producing egg shells a few weeks before laying begins.[1]

Typically the hen of the pair bond selects the brooding site during the northward spring migration. Often the brooding site is her place of birth or a prior successful site for brood rearing. Occasionally bonded pairs nest and raise brood in the southern latitudes, but most nesting sites are in the northern Plains and Canada. Nests are built solely by the hen and are sited close to water, usually in areas hidden by shrubs, rushes, grass, or reeds, on the ground, but some nests occur in tree cavities several meters above ground. Female mallards typically lay four to 14 eggs, with an average of nine, and incubation period takes from 22 to 28 days. If a nest is destroyed before the eggs hatch, mallards may re-nest three or four times a season, but they only produce one brood a year (Goode 2007).

Upon hatching, the hen leads the brood to the feeding grounds near water. Her job is to keep the broodlings warm until they can regulate their own heat and to protect the young from such predators as turtles, skunks, coyotes, bob cats, weasels, raccoons, herons, and hawks. About 10 weeks after the ducklings hatch, they lose their soft down and begin to grow their adult feathers in late summer to fall.

Many kinds of ducks eat day and night. Primary foods include leaves, seeds, berries, bulrushes, wild rice, wheat, corn, primrose, willow, and seeds of elm, oak, and hackberry. They also eat many kinds of water-borne invertebrates and vertebrates, including worms, insects, crustaceans, tadpoles, frogs, mollusks, freshwater snails, fish, and fish eggs. The dappling ducks forage in shallow water, but they can also dive to deeper depths where they use their bills to efficiently filter lake-bottom mud to extract nutrients.

Shortly after the breeding season, mature mallards shed old, worn feathers and replace them with a less colorful new plumage. Males molt shortly after the females begin their egg incubation. Researchers disagree on whether males remain in the general nesting territories during molting or move to distinctly different molting sites away from the nesting areas. The latter researchers suggest that the segregation of the nesting and molting areas eases the nutritional competition between those molting male ducks, who are feeding to regrow feathers, from the hen-duckling groups. Hens molt later than males and after the ducklings are grown. Because each duck molts synchronously and loses and replaces all its feathers over a short span, the bird is rendered flightless for a few weeks. During this period, mature waterfowl are literally "sitting ducks" and are susceptible to predation. Often the molting season occurs in preparation for the fall migration southward. And the yearly cycle is repeated over again. Raptors and songbirds have different life cycles, behaviors, and migration patterns (Alsop 2002).

THE ECOLOGY OF RIVER AND PLAYA RESOURCES OF THE SOUTHERN PLAINS

For this discussion, the southern High Plains consists of the mid-continent short grass areas bounded on the north by the Arkansas River of south central Kansas-Colorado and the escarpments of the Llano Estacado on the south, east, and west in New Mexico, Texas, and Oklahoma. Rivers are relatively scarce in this area, with only the Cimarron, North Canadian (Beaver), Canadian, and Prairie Dog Town Fork of the Red River crossing the plains from west to east. The Cimarron and Canadian rivers drain snow melt from the Rocky Mountains in northern New Mexico, but the North Canadian and Red rivers do not. The North Canadian River forms a narrow valley fed by a series of widely spaced, very long tributaries. In contrast, the Canadian River has a series of closely spaced, relatively short (20 to 35 km long) lateral drainages, which essentially form a wide corridor of rolling land. The Red River resembles the North Canadian River in that it forms a relatively narrow river valley with few long tributaries. Erosion of the Red River along the eastern edge of the Llano forms the deeply incised Palo Duro Canyon. Most rivers and creeks are presently sand-choked, and the channels tend to be braided. Some creeks seasonally flow underground, providing little available surface water. Many of the lateral tributaries drain the Ogallala aquifer and provide more reliable surface water than the main river channels.

Much of the vast southern High Plains is crossed by a few narrow draws, but this physiographic region is not well-drained by creeks or rivers. Instead, this gently rolling landscape dips slightly towards the southeast and is dotted with thousands of closed drainage catchments called playa lakes (Figure 1). Estimates place the number of playa lakes in the southern Plains at about 25,390 for the 39 counties in the Texas panhandle, one county in Colorado, seven counties in Kansas, four counties in New Mexico, and three counties in the Oklahoma panhandle (Smith 2003:14-15). These playa lakes encompass some 410,994 acres, predominately on the Plains upland surfaces (Smith 2003:14-15). The existence of nearly 16,660 km^2 (6,408 mi^2) of non-riverine wetlands constitutes a tremendous resource used annually by migratory waterfowl.

The playas and rivers of the southern High Plains form an important series of wetlands for migrating waterfowl and other birds (Figure 2). But from an ecological and waterfowl subsistence perspective, playas and rivers are significantly different in two ways. First, the closed nature of playa basins means that fish are denied access.[2] Fish compete with waterfowl for consuming more than 25 orders and 110 genera of water-born and moisture-favoring invertebrate and insect species. These resources include a wide range of worms, crustaceans (shrimp, crayfish, ostracodes, etc.), and nymphs of dragonflies, mayflies, damselflies, and caddisflies, as well as various other kinds of insects and bugs (Smith 2003:Appendix). Without the competition of fish, playa lakes quickly become protein-rich reserves for waterfowl. Even during periodic droughts on the Plains when water flow occurs beneath the sand-choked riverbeds, plunge pools and other catchments retain sheltered habitat for fish and mussels. From these sources, rivers and creeks are quickly repopulated with fish when the wet seasons restore surface water flow, especially

Figure 1. General view of playa lakes on the High Plains (Courtesy of TPWD).

Figure 2. Ducks and geese wintering-over at Lake Armstrong compartment of Playa Lakes Wildlife Management Area, Castro County, Texas (Courtesy of TPWD).

after floods. However, recent studies suggest that invertebrates only constitute about 5 percent of modern waterfowl's diet; plants are more important. But the relative importance of invertebrates in the past is uncertain due to the historic dietary changes outlined below.

In addition to the rich and abundant diversity of invertebrates in playas, a concentric series of plant zones develop around playa basins and provide an abundance of seed species favored by waterfowl. The concentric habitats consist of the inner marsh zone, persistent emergents zone, outer marsh zone, transition zone, and the surrounding uplands (Smith 2003:64). Each zone is characterized by different degrees of water retention and supports various aquatic and semi-aquatic plants. Plant height decreases from the outer marsh zone, where cattails and reeds grow, to the uplands, which tend to be covered in short grasses. Some of the indigenous plants favored by waterfowl at playas include rice grass that flourishes in the outer marsh zone, and wheat grass, foxtail barley, and Virginia rye grass in the transition zone. Thus, invertebrate and plant food resources are factors that draw waterfowl to the playas.

A second contrast between playas and rivers is that rivers experience seasonal flooding that transports tree seeds and seedlings to form gallery forests. The woods along rivers are attractive nesting and perching sites for predatory raptors, and offer concealment for carnivores. Rivers and streams are relatively unsafe places for nesting ducks and geese, but they are welcome sanctuaries for perching birds (cardinals, kingfishers, orioles, thrushes, etc.). The absence of trees around playas allows waterfowl to monitor approaching predatory animals, including humans, much more easily than along the wooded river valleys. Most forms of migratory waterfowl have a well-developed calling system that alerts the community to potential dangers, and confounds skillful predators, including hunters. The concentration of predatory animals near rivers repels many migratory birds.

HISTORICAL CHANGES IN WATERFOWL OCCURRENCES

There has probably been little change in the occurrence of playas, except as related to climatic changes. Although some new sink holes break though the surface of the Llano Estacado, the number of playas probably has not changed significantly for thousands of years. Some biotic changes in playas have coincided with modern agricultural practices. Farmers sometimes dig deep slit trenches in playa bottoms to concentrate water in smaller areas, and seasonal playas have been plowed over so that domestic crops have replaced indigenous plant communities.

Evidence also suggests that A.D. 1200 to 1500 was a period of intensifying droughts on the southern Plains (Lintz 1986; Hall 1982, 1990). Interpolation of tree ring data on the Palmer Drought Severity Index for the Canadian River area in the Texas panhandle suggest that a prolonged, series of moderately intense droughts occurred ca. A.D. 1200 to 1300 and again between ca. A.D. 1315 and 1325; some climatic amelioration occurred during periods of ca. 1300 to 1315 and ca. 1325 to 1415, followed by a period of extremely intense droughts during the interval ca. A.D. 1415 to 1480 (NOAA/DESDIS North American Drought Variability 2008). With decreased rainfall, some smaller playas probably dried up on a seasonal or period-long basis. However, other large, deep playas, such as Lake Tahoka south of Lubbock, are substantial and probably remained a continuous water resource since the end of the Pleistocene.

Significant changes have likely occurred in the hydrology of the southern High Plains rivers. Water flow in the Canadian River was altered with the construction of Conchas Reservoir in the 1930s, and Ute and Sanford Reservoirs in the 1960s. The construction of Conchas Reservoir predates the government's maintenance of water flow records, so only anecdotal observations exist about flow conditions and flood events. Significant flooding is reported historically along the Canadian River. Following water flow regulation by up-stream reservoirs, the Canadian River is typically characterized as having a sand-choked, braided channel. The shallow conditions of the river were not attractive to various cranes, and perhaps other waterfowl. However, recently segments of the river have down cut enough to form central channels in the undersized floodplain. These shifts in the river conditions may have altered historic patterns of waterfowl use. Anecdotal reports suggest that mergansers and goldeneyes prefer to reside along the Canadian River more often than in the upland playas, so not all duck species prefer the playa settings (Bill Johnson, personal communication, 2007).

Other historic changes include alterations in waterfowl diet and changes in the occurrence of winter residency in the Panhandle. The flourishing of cattle feedlots has brought in stockpiles of feed corn that has become a favorite food of many kinds of waterfowl. In addition to the corn available in fields and at feed lots, hunters often use corn to draw waterfowl to hunting blinds. Corn is consumed by geese and select groups of dabbling ducks, including Mallards, Northern Pintails, American Widgeons, and Green-winged Teals. Recent studies of duck stomach contents from the southern High Plains indicate that some bird's diet during the winter hunting season consists of nearly 90 percent corn (Smith 2003:94). Other common dabblers, such as Blue-winged Teals, Gadwall, and Northern Shovelers, and many diving birds (including Ruddy Ducks, Scaups, Redheads, and Canvasbacks), do not participate in field feeding and likely consume less corn (Bill Johnson, personal communication 2007). For those that favor corn, it provides considerably more energy than native grains and is much more readily accessible. This ready source of food has allowed the birds to stay longer in the region during cold spells. Winter storms typically freeze rivers and playas and limit waterfowl access to food, which has historically driven flocks south to warmer climates. But with the availability of corn, different historical patterns have emerged. Anecdotal reports indicate that the food shift has allowed many waterfowl to remain throughout the winter; the constant movement of dense waterfowl has prevented some playas from freezing during short cold events, whereas adjacent playas without so many birds are frozen thick enough to support the weight of an adult person (Bill Johnson, personal communication, 2007). The waterfowl wintering-over that occurs in the Panhandle today may be unprecedented due to the ready availability of corn. Presumably, corn was grown prehistorically in insufficient quantities to be used as bird feed. Furthermore, the climatic conditions of the Middle Ceramic period were different from that historically recorded for the colder episodes of the "little Ice Age" climatic episode of ca. A.D. 1500 to 1800 (Fagan 2002; Grove 2004). The abundance and diversity of waterfowl in the High Plains region may have been different 1,000 years ago, but exactly how and why is not clear.

IMPORTANCE OF BIRDS TO PLAINS INDIANS

Most historic journals and ethnographies of Plains groups offer little information about the procurement, consumption, and use of birds. Compared to the protein provided by bison and other large game, birds are assumed to offer little nutritional value to a Plains Indian diet and hence have been largely overlooked (Wedel 1986:23-25). However, the seasonal availability of an estimated 4,071 to 8,996 metric tons of meat from recent waterfowl counts at playa lakes, along with additional meat provided by turkeys, prairie chickens, quail, etc., suggests that game birds could be considered an important resource. Many archeological assemblages report the occurrence of few bird bones, representing a range of species in small numbers in the Plains and adjacent areas (Drass 1997; DeMarcay 1986; Duffield 1970; Kalasz et al 2007; Meissner 2005). However, the diversity of bird remains used in historic Plains Indian ceremonial bundles, and attached to garments, and other artifacts strongly suggests that birds were sought with regularity. Waterfowl, chicken-like birds, and some perching birds were hunted for food, but many raptors were not preferred food due to religious or symbolic connotations (Grinnell 1972:256; Fletcher and La Flesche 1972:104-105). However, just as the sacred status of bison did not deter them from being a major food source, the sacredness of birds did not deter their use as food. Consumption may relate more to preferences, abundance, availability, and ease of capture than to strict cultural prohibition. In contrast to Grinnell (1972), birds, especially waterfowl, may have served a dual role in being spiritually revered, yet providing dietary diversity (O'Brien 2000).

Birds figure prominently in the religious views and cosmological beliefs of many Plains Indian societies (O'Brien 2000; Grinnell 1972). Many birds were imbued with symbolic meaning that was important to the community's spiritual health and survival. Religions among most historic Plains Indian groups are nature-oriented with a series of dualistic contrasts between the earth and sky, day and night, and summer and winter, etc. Stars and other celestial bodies were greatly revered as powerful beings that figured prominently in creation stories and annual ceremonial cycles for the renewal and continuity of life (Dorsey 1906; Del Chamberlain 1982). Most earth-bound plants and animals were viewed as being interconnected and containing various powers that could help people. So it is not the kind of animal or bird that was important, but rather the powers they were perceived to have access to that was important. Among some Plains Indian societies, particular kinds of rocks are regarded as "grandfathers" who could provide human guidance. This tenet is formed by the belief that rocks have been around since the beginning of creation and have seen and experienced everything throughout history (Murie 1989). Many plants and animals possessed powers due to certain behavioral traits or sacred colors represented by their leaf/wood, fur, or feather characteristics.

Often, birds (along with butterflies and dragon flies) were regarded as the intermediaries that transcended the boundaries between the people on earth and the celestial beings. Among the Pawnee, specific kinds of birds were representatives of a variety of entities, including the Supreme Being, a multitude of celestial beings, the sacred semi-cardinal directions, the chiefs of natural phenomena (day-night, earth-water, trees, and birds), representatives of animals, and personal guardians, protectors, and advisors to specific people (O'Brien 2000). In addition, other birds served specific roles as "errand-messengers" that relayed information between the Supreme and celestial beings above and humans below, including healers (shaman or medicine men) and elders (priests).[3] Sometimes, different kinds of birds worked in tandem to deliver messages or answer prayers between people and the heavenly beings. A few birds such as burrowing owls also bridged the domain between the surface of the earth and the subterranean world, although ants and other insects are often regarded as the more common messengers to the underground helpers (Quigg 1996:30-31).

The perpetuation and maintenance of the universe for some Plains Indian societies was based on a yearly ceremonial and ritual cycle tied to the powers held by the band, community/village, and society. Priests, shaman, medicine men or healers, and visionaries or elders were guided in decisions by natural cues, and even personal guidance powers obtained from individual prayers and vision quest experiences. Some powers were reinforced by tangible objects contained in sacred bundles that were retained by recognized members of societies on behalf of various bands and specific villages, or by personal amulets worn by individuals (Gilmore 1932; Uberlaker and Wedel 1975). The sacred bird objects contained in Pawnee medicine bundles and amulets, for example, include stuffed bird skins, feet, talons, wings, tail feathers, and other objects made from specific kinds of birds associated with spiritual connections to various celestial beings. Avian body parts also served as amulets for people seeking power and strength to make decisions, assess risks, and accomplish difficult tasks.

Ethnographic studies show that many Native people do not classify birds in the same manner as members of western societies. Some are grouped according to shared color schemes, such as the inclusion of robins and cardinals together as "red birds" (Moore 1986); others are grouped together based on flying or feeding patterns. Additional bird classifications were developed according to dualistic oppositions such as day vs. night creatures or flesh-eating birds (eagles, hawks, vultures, owls, ravens, crows, jays, etc.) vs. plant and insect-eating birds. The linkage of supernatural beings with directionality, color schemes, trees, and other animals is often hard to comprehend by people in cultures not versed in conceiving that natural objects have inherent or ascribed powers or of the relationship that natural objects have to the sacred color and animal symbolism of celestial beings. Such beliefs are not irrational but reflect consistency between the relationships of natural objects and their ascribed powers.

The following examples draw heavily from Pawnee myths and tales, which are appropriate for two reasons. First, the Pawnee (along with the Wichita, Kichai, and Arikara) are Plains Caddoan language-speakers, and some or part of the Plains Middle Ceramic groups were probably related to peoples speaking that family of languages (cf. Hughes 1968). Second, one of the origin stories told by the Pawnee stipulates that they lived in stone houses located to the southwest of their current residences in Nebraska (Grinnell 1893). Only the Early and Middle Ceramic period Plains people living in the Texas-Oklahoma panhandle and adjacent mesa and canyon lands of southeastern Colorado and northeastern New Mexico lived in stone masonry houses and retained a cord-marked ceramic continuity with the ancestral Pawnee.

The Pawnee believe that the Supreme Being, Tirawa (or Tirawahat, known as the expanse of the heavens who directs everything), classified the objects of the world and developed the underlying symbolic relationships among objects (O'Brien 2000:95; Weltfish 1977:64). Second tier celestial beings were Morning Star and Evening Star, followed by the Sun, Moon, and other stellar entities, including the four pillar stars (Parks 2001a:536; Del Chamberlain 1982). Tirawa assigned names to all objects, and many things carried symbolic connotations tied to the sacred four semi-cardinal directions and the colors black, red, yellow, and white that served as direct paths that Tirawa provided for humans to receive personal powers from the four pillar stars (Table 2).

Ornithological classification schemes based on mythological powers have also been ascribed to birds. For example, O'Brien (2000) believes that the Pawnee recognized four classes of birds: earth or ground-dwelling birds, sky birds, water birds, and tree birds. Ground-dwelling birds include the turkeys, grouse, prairie chickens, quail, burrowing owls, and varieties of song birds that typically nest on the ground (larks, warblers, sparrows, etc.). Sky birds consist of those species that soar very high, and include various raptors. This taxon encompasses two kinds of eagles, goshawks, six varieties of hawks, ospreys, falcons, turkey vultures, and the Great Blue Heron. Other sky birds that prefer evening or night activities include owls, nighthawks, and Whip-poor-wills. Water birds include a wide range of ducks, loons, geese, and swans. Tree birds reside in wooded areas near springs and along creeks and rivers; they include jays, woodpeckers, cardinals, purple martins, and wrens. The powers attributed to these birds have been compiled by O'Brien (2000) based on various Pawnee myths (Dorsey 1904, 1906; Fletcher 1904; Fletcher and Murie 1996; Jipson 1922; Murie 1989) and ethnographic sources (Grinnell 1893; Dunbar 1880). In some cases, O'Brien argues that a duality exists between day birds and night birds within the four primary classes. These birds and their inferred sacred attributes are summarized in Tables 3 and 4.

The inferred powers ascribed to various birds by O'Brien (2000) provide a context for interpreting the occurrence and use of plumes and other bird parts found on many kinds of garments and artifacts used by historic Plains Indians. In most cases, the use of feathers is not just decorative or for embellishment but instead carries great significance to those wearing or using the artifacts. In a few instances decorations may be indicated, as when cultural materialists claim that bird feather quills sewn onto clothing before 1850 were replaced by colored porcupine quills and later glass beads (Feder 1982:64). Perhaps the feathered quills added color to clothing as is suggested by rare examples of feathered capes in the Great Lakes region (Anderson 1985). These and other colorful decorations may also have had social significance.

The historic use of birds by Plains Indian groups is impressive (Table 5). Feathers are the most common part used on clothing (hats, caps,

Table 2. Correlation of Pawnee sacred directions, colors, celestial beings, and animals.

Second Tier Celestial Beings and Cardinal Directions

	West	North	East	South
Name of Celestial Being	Evening Star (Venus)	North Star (North Star)	Morning Star (Mars with Venus or Jupiter as alternatives)	Death Cyclone Star (South Star)
Primary Powers	Goddess of night/ darkness; female power; germination for renewal of corn and bison		God of sun, light, fire, and war. Fights Morning Star for start of each day	
Cardinal Direction Birds	Turkey	Crow	Hawk	Eagle
Cardinal Directional Birds from Mud Lodge Tales	Crane	Owl	Snipe	"Yellow wood-knocker" (Flicker)
Animal		Buffalo		

Correlation of Sacred Colors, Pillar Stars, Trees, and Animals to the Semi-Cardinal Directions

	Northwest	Northeast	Southeast	Southwest
Colors	Yellow	Black	Red	White
Pillar Stars (and modern correlates)	Yellow Star (Capella)	Big Black Meteoric Star (Vega or Cassiopeia)	Red Star (Antares)	White Star (Sirius)
Birds of Pillar Star Semi-cardinal directions	Swan (probably Whistling Swan)	Loon (or Blackbird)	"Gar-pike" (Probably Merganser)	Kingfisher (or swan)
Pillar Star Bird traits and Color Correlations	Water bird with yellow spot near eye	Diving bird, black color	Diving bird with gar-like serrated teeth and red bill and eyes	Diving bird with white-spotted blue colors
Weather Condition	Lightning	Thunder	Clouds	Wind
Animal	Mountain Lion	Beaver, Bear	Wolf	Wildcat
Tree	Cottonwood	Elm	Willow	Box Elder
Corn Varieties*	Yellow Corn	Black Corn	Red Corn	White Corn
Life Cycle- Season	Youth- Spring	Adult- Autumn	Youth- Summer	Old Age- Winter

Data derived from Weltfish (1977:112), O'Brien (2000), and Del Chamberlain (1982:97, 234).
*Pawnee grew four subspecies of corn (flint, flour, sweet, and pop) and perhaps 15 subvarieties; flour corn was classified as blue, speckled, white, yellow, and red (Parks 2001a:525).

capes, shirts, and leggings), offensive and defensive weapons (shields, coup sticks, lances, shields, and war bonnets[4]), amulets (necklaces and solitary feathers in hair), and ceremonial paraphernalia (medicine bundles, pipes, pipe bags, bison-horn headdresses, and dance bustles, etc.). Other exploited bird remains include stuffed bird skins used for personal amulets, status symbolism, and communal bundles. Most of these artifacts use perishable parts of birds (plumes and skins) which would be difficult to recover in most archeological situations. Bird bones are rarely fashioned into artifacts, although bird heads were symbolically attached to shields, wing bones are used as whistles and flutes, and talons are sometimes made into necklaces. Amulet and bundle artifacts may show so little modification

Table 3. Select cosmological powers ascribed to birds on the plains.

Bird Type	Powers	Symbolism and Artifacts	References
Day Birds			
Ground Birds			
Turkey	Possible bird symbol of Evening Star; protectors of children and the human race; very prodigious, caring birds with maternal associations.	Turkey feathers used to symbolize female in Hako Ceremony. Tail feathers used to fletch arrows.	O'Brien 2000: 97, 118
Prairie Chicken	Messenger bird—symbol for Mother-Corn, and in myths is associated with cosmically-important birds—eagles, hawks, crows, blackbirds, and magpies.	Feathered capes (Fox Tribe)	O'Brien 2000: 98; Anderson 1985
Meadowlark	Evening Star's errand bird conveying messages from the Four Old Men (Powers) of the West (under Evening Star's control) to humans.		O'Brien 2000: 97, 99
Horned Lark	Lark with horned pattern on side of head is the symbol for bison. It is believed to have granted power to humans to procure bison.		O'Brien 2000: 100
Swallows	Messenger bird to humans for the Four Old Men (Powers) of the West under Evening Star's control. Also some build mud nests resembling Pawnee domed earth lodges. Social birds that often nests near people.		O'Brien 2000: 100
Purple Martin	Associated with Morning Star sacrifice and prefers nesting near humans. They are very protective of nests and even drive away crows and hawks.		O'Brien 2000: 101
Blackbird	Associated with the creation of the Crow Lance Society and Children of Iruska (Contraries). Due to tendency to eat grain from dung, it may be a bison messenger-bird sent to help people locate bison.	Feathers of swans and blackbirds used on war lances; stuffed skins on headdresses	O'Brien 2000: 101; Gilbert et al. 1996:12.
Mockingbird	Extremely territorial and protective of area. Possible errand bird to diverse animals who communicates in many different languages. In mythology, they caused bison to live in herds.		O'Brien 2000: 102
Sky Birds (High-flying Birds)			
Unspecific Raptors	Respect and reverence paid to "war birds:" birds of prey and flesh-eating birds	Feathers on coup sticks and war shields	Grinnell 1972: Vol. 2:87; Curtis 1997: 134, 184, 240, 714
Eagles	Chief of the Day. Represent Tirawa's power and knowledge; wearers of eagle items are visionaries and know many things; important to Medicine Men. Eagles represents fire and are associated with the southern direction; high-flying birds who dive upon prey like lightning bolts; symbols of war and male gender. Eagle feathers protect wearer from bullets. Bald Eagles are regarded as old wise men with gray hair.	Skins, talons, feathers, claws, and wings are important ceremonial objects: bone whistles, wing fans, war bonnet, war shields; isolated feathers worn in hair (feather movement warnings of danger); dance bustles; lances	O'Brien 2000: 103; Grinnell 1972:105, 108-110; Weltfish 1977:283, 344; Newcomb 2001:561
Hawks, General	Symbolizes war and messenger for Morning Star, the warrior. Kills other birds in flight with their wings, analogous to killing with war clubs. Symbol of bravery.	Stuffed hawk cap worn by sacrifice victim in Morning Star ceremony. Hawk claws painted on warriors. Claw necklaces; stuffed bird skin on headdress and feathers on lances.	O'Brien 2000: 104; Grinnell 1972:124; Curtis 1997: 166
"Swift Hawk" (Cooper's or Sharp-shinned)	Works with "skull" and owl to deliver people's messages to Tirawa. Very aggressive and fast. Cooper's hawks have red eyes (symbolic color of Morning Star)	Stuffed bird skin on clothing.	O'Brien 2000: 104; Parks 2001a:526
Harrier (Marsh) Hawk and Kites	Probable "gray eagle" venerated as sacred. Possibly Tirawa's messenger bird.	Often stuffed skins in bundles; plumes of gray eagle and heron worn in hair	O'Brien 2000: 103, 105.

Table 3. *(Continued)*

Bird Type	Powers	Symbolism and Artifacts	References
Sparrow hawks	Protect people during battles due to swiftness	Stuffed skin used in Chaui medicine bundle	O'Brien 2000: 114; Grinnell 1972:108-110; Gilbert et al. 1996
Great Blue Heron	Possibly represents Tirawa. Associated with the sky by color and connected to both water and earth.	Feathers are worn	O'Brien 2000: 105-106
Buzzards	Represent errand people on the south side (and opposite magpie) of Waconda Spring Lodge. Eagle and Buzzard used by Tirawa to send orders to first High Priest.	Stuffed bird skin caps.	O'Brien 2000: 106; Curtis 1997:185
<u>Water Birds</u>			
Ducks, General	Chief of the Water. Contain great power because they migrate long distances at low elevations and know regional geography. They fly, walk, swim, and dive and have contacts with powers in many directions. Also associated with sacred springs and water.		O'Brien 2000: 107
Mallard	Important bird playing role in Hako or Calumet Ceremony.	Head and skin applied to two sacred wands in Hako ceremony	O'Brien 2000: 107
Merganser	Possible "gar-pike bird" representing the Southeast direction in the Evening Star bundle, and "Part of a Village" bundle ritual. Red bill and eyes are sacred color of the Southeast.		O'Brien 2000: 107
Kingfishers ("Fish Hawk")	Diving bird associated with underground animal lodges and water. Errand bird of all animals. Messenger of the Four Gods of the North. Used to represent Southwest direction in Evening Star Bundles. Allows wounds to heal or close quickly (just as water closes over diving bird).	Found in some sacred bundles. "War charm" of stuffed skin with eagle down; also skins used in war bonnets. Stuffed skin held by Elder in ceremony of Four Gods.	Grinnell 1972: 120, 122; O'Brien 2000: 106, 108
Loons	One of seven Chiefs of healers and knows their secrets because they fly close to heaven. Represents the Northeast direction in Evening Star Bundle.	Evening star bundle; also used as altars inside earth lodges.	O'Brien 2000: 106, 108
Cranes (Thunderbirds?)	One of four chiefs of Nahurac. Helps warriors scare enemy with whistle sounds. Whooping crane used in Young Dog Dance (warrior's dance).	Head attached to war shields. War whistles made from wing bones.	O'Brien 2000: 109; Gilbert et al. 1996:12; Grinnell 1972
Swans (Thunderbirds?)	Used by several bundle societies. Linked to the Thunderbird (loud call resembles thunderclaps that scare enemies and prevents their attack during storms). Possible errand birds for animals. High flying migratory bird that connects earth to sky.	Feathers of swans and blackbirds used on war lances. Swan down feathers on shirts and used to renew lances for the Thunderbird Lance Society	O'Brien 2000: 109; Parks 2001a:528
Geese	Flying geese wings make sound of drum. Linked to southern end of lodges, and provides medicine powers.		O'Brien 2000: 110
Snipe	Associated with cranes in possessing powers. Skin hung in east end of "first lodge;" cranes were hung in the west.		O'Brien 2000: 111
<u>Tree Birds</u>			
Blue Jays	Carrier of prayers and sacrifices to Tirawa. Blue feathers symbolize clear skies.	Skins tied to red (sun) pipe and black (moon) pipe. Worn by warriors to deliver prayers before battles.	O'Brien 2000: 111
Woodpeckers	"Chief of Trees" enjoys and symbolizes protection from Tirawa. Regarded as fearless because it lives in dead trees (regarded as lightning rods), and calls out during thunder storms. An interpreter of the Thunder Gods. A protector of life and can avert disasters. General talisman.	Feathers used on war clubs and hatchets. Woodpecker caps protected wearer	O'Brien 2000: 112; Grinnell 1972:108-110
Red-headed Woodpecker	Symbolizes scalped warrior and offers protection in battle		O'Brien 2000: 112
Northern Flicker	Sacred bird whose yellow feathers can kill. Behavior is impersonated by Medicine Men. Yellow is associated with the south side of the lodge.	Yellow feathers worn by members of secret society	O'Brien 2000: 112

Table 3. *(Continued)*

Bird Type	Powers	Symbolism and Artifacts	References
Wrens	Symbol of humility. Small but happy vocal bird who greets sunrise.		O'Brien 2000: 112-113
Magpies	Signal direction of approaching enemies. Also "errand-man" for all animals and represents the north side of the Waconda Spring Lodge. Very adaptable and mimics human voice, but they are rather destructive birds.	Stuffed magpie skin amulet charms	Grinnell 1972: 108-110, 124; O'Brien 2000: 106, 113
Crows	Crows and eagles are visionaries that help people find lost items, or people who have lost their way. They fly high and far and see and know many things. Prominently related to the Ghost dance and directionally related to the north (eagles are related to the south).	Feathers worn by seers and visionaries. Dance Bustles (with crow and eagle feathers); crow skins on dance apparel	O'Brien 2000: 103, 113; Newcomb 2001; Gilbert et al. 1996:12
Ravens	Follow war parties and attend to certain mysteries called Kaw-kah		O'Brien 2000: 114
Oriole	Builds distinctive sack-nests that are so strong that storms never blow them away and thus offers protection of the powers of Tirawa to children held above the nest in the Hako Ceremony.	Nest used in Hako Ceremony; stuff birds attached to lances.	O'Brien 2000: 114; Grinnell 1972:108-110
Cardinal	Redbird (along with robin?) associated with the sun. It cannot be killed and flies to the west into the sun. Either the sun's errand bird, or symbol for the sun.		O'Brien 2000: 114
Scissor-tailed Fly-catcher	Sacred bird due to unusual appearance and rarity in the region.	Stuffed skin used in Chaui medicine bundle; tail feathers used in fans.	O'Brien 2000: 114
Snowbird (Junco or Bunting?)	Power to thwart witches; protect people from witches.		O'Brien 2000: 115
<u>Night Birds</u>			
<u>Sky Birds</u>			
Owl, General	Leading medicine man among birds and Chief of the Night. Associated with Evening Star and the Four Powers of the West. A messenger who teaches people how to worship Tirawa. Linked to the "four powers that never sleep": Thunder, Lightning, Wind, and Clouds. Protects people at night.	Feathers and skins often worn by Healers and Elder priests. Part of apparel of the four Keepers of the Pillar Star bundles. Feathers on lances.	O'Brien 2000: 97, 115; Grinnell 1972: 81
Great Horned Owl, Screech Owls, and Long-eared Owl	All three owls have ear tuffs reminiscent of bison horns and provide powers to see at night. Screech owl is fearless defender of nests.		O'Brien 2000: 116-117
Prairie Owl	Provides powers to see at night. Associated with death and helped kin connect with deceased.	Feathered caps and feathers worn on arms	Grinnell 1972: Vol. 2:108-110; 155-157
Barn Owl	Speculated to be "Moon's Bird" based on the night activity and round white face. Exists in contrast to the "redbirds," which are the Sun's Bird.		O'Brien 2000: 120
<u>Water Birds</u>			
"Night Raven" (Crowned Night Heron or Green Heron)	Birds active around twilight. Possibly related to the powers contained by Blue Heron applied to duality of night or evening.		O'Brien 2000: 117
<u>Ground Birds</u>			
Nighthawk	Possibly evening or night equivalent of day hawks and eagles. Aggressive birds that attack humans. Steep dive on the wing makes booming sound that startles hunters and enemy.		O'Brien 2000: 117
<u>Other Birds</u>			
Quail	Social birds living in coveys that forage and roost; defends territories in fall and winter but breaks into nesting pairs in spring. Arguably symbols of the Pawnee people and "Chief of People."		O'Brien 2000: 118-119; O'Brien and Post 1988; Roper 1994

O'Brien's data synthesized from Dorsey (1904, 1906), Fletcher (1904), Jipson (1922), and Murie (1989).

Table 4. Synopsis of the role of birds in Pawnee beliefs.

Cosmic Beings and Entities	Symbolic Bird Representation	Errand Bird to Humans	Errand Bird to Medicine Men	Errand Bird to Elders/ Chiefs
Supreme Being				
Tirawa (Supreme Being)	Great Blue Heron	Marsh Hawk	Buzzard	Eagle
Atira (Tirawa's mate)	"Brown eagle" or Marsh Hawk			
Celestial Beings				
Morning Star (male power and warriors)	Hawks (e.g., Cooper or Sharp-shinned)	Purple Martin		
Evening Star (female power)	Turkey	Meadowlark		
Four Powers of the West associated with Evening Star)	Owls	Swallows		
Northwest Pillar Star	Whistling Swan			
Northeast Pillar Star	Loon			
Southwest Pillar Star	Kingfisher			
Southeast Pillar Star	Merganser			
Sun	Redbirds (Cardinal)			
Moon	Barn Owl			
Non-Celestial Beings				
Nahurac Chief	Sand-hill Crane			
Corn Mother	Prairie Chicken			
Sacred Semi-Cardinal Directions				
North	Crow or Owl			
South	Eagle or Flicker			
East (Morning Star)	Hawk or Snipes			
West (Evening Star)	Turkey or Crane			
Center direction	Unknown			
Chiefs of Natural Phenomena				
Chief of the Day	Eagle			
Chief of the Night	Owl			
Chief of the Earth	Swans			
Chief of the Water	Mallard Duck			
Chief of the Trees	Woodpecker			
Chief of Birds	Golden Eagle			
Representatives of Animals				
Pawnee People	Bob-white Quail	Blue Jay		
Bison	Horned Lark	Blackbird		
Thunderbird	Whooping Crane			
Human Guardians, Protectors, Advisors				
Human Guardians	Woodpecker			
Protector from witches	Junco or Bunting			
Bird of Healers	Loon			
Teacher of Humility	Wrens			

(after O'Brien 2000:119-121)

Table 5. Bird remains with select Plains ethnographic artifacts.

Artifact Type	Bird Parts	Species	Cultural Affiliation	References
Clothing				
Clothing decorations (moccasins, shirts, etc.)	Feather quillwork (predates porcupine quills use of ca. 1850s)	Unspecified	General Plains	Feder 1982:64
Feather cordage robes	Parts of feathers	Turkey	Basket-maker (Southwestern)	Olson 1968:135
Feathered capes	Feathers stitched to woven cape	Prairie Chicken, Peafowl, Guinea fowl, Peacock	Mesquakie (Fox) Illinois or Iowa Region	Anderson 1985
Bustles	Feathers	Eagle and Crow	Wichita	Newcomb 2001:561
Shirts	Feathers	Unspecified	General Plains	Feder 1982:64
Cloth shirts	Downy feathers	Swan	Pawnee	Parks 2001a:528
Leggings	Feathers	Unspecified	General Plains	Feder 1982:73
Medicinal				
Shaman's Headdress	Stuffed bird skin	Red-wing Blackbird	Piegan	Gilbert et al. 1996:12
Shaman's Headdress	Stuffed bird skin	Hawk	Crow (Apsaroke)	Curtis 1997:20, 166
Feather fan	Wing or feathers	Eagle	Most Plains groups	Curtis 1997:155, 722; Weltfish 1977:283, 344
Personal				
Amulets	Isolated Feather in hair	Unspecified Raptors	Most Plains groups	Curtis 1997:123.
Caps	Stuffed bird skin	Vulture	Crow (Apsaroke)	Curtis 1997:185
Amulets	Stuffed bird skin	Chickadee	Crow	Gilbert et al. 1996:12
Necklace	Talons/claws	Hawk and other raptors	Cheyenne, Unspecified Plains	Grinnell 1972:124; Kopper 1986:183
Religious or Ceremonial				
Wooden dance sticks	Feathers	Unspecified	Sioux	Feder 1982:51
Dance apparel	Bird skins	Crow	Assiniboin	Gilbert et al. 1996:12
Rawhide rattle	Feathers	Unspecified	Kiowa	Feder 1982:37
Buffalo skin cap	Downy feather attachments	Unspecified	Cheyenne-Arapahoe	Curtis 1997:273
Pipe stems (of wood)	Decorated with woodpecker beaks, and mallard duck necks and feathers	Unspecified	Unspecified Plains	Feder 1982:74

Table 5. *(Continued)*

Artifact Type	Bird Parts	Species	Cultural Affiliation	References
Medicine Bundles	Stuffed bird skin	Various, unspecified	Crow (Absoroka), Blackfeet, Arikara	Wildschut and Ewers 1959; Wissler 1912; Gilmore 1932
Medicine Bundles	Bird skins	Sparrow hawk	Omaha	Gilbert et al. 1996:12
Bison skull altar corner prayer sticks	Feathers on sticks	Unspecified	Teton Sioux or Assiniboin	Curtis 1997:123
Pipe bag	Feathers	Unspecified	Cheyenne-Arapahoe	Curtis 1997:245
Necklace	Feather down	Unspecified	Cheyenne-Arapahoe	Curtis 1997:254
Warfare				
War bonnet	Feathers	Eagle or Hawk	Most Plains groups	Feder 1982:73 Curtis 1997:125, 183, 211
War bonnet	Feathers on skull cap part	Kingfishers	Cheyenne	Grinnell 1972:120
War Party leader symbol	Stuffed bird skin	"Swift hawk"	Pawnee	Parks 2001a:528
Beaver fur cap (Chief Symbol)	Feathers (two)	Eagle	Chawi Band, Pawnee	Parks 2001a:530
Coup sticks	Feathers	Raptors	Most Plains groups	Feder 1982:64; Curtis 1997:134, 184, passim
Lances	Feathers	Owls, Hawks, Eagles	Cheyenne	Grinnell 1972:81
Lances	Stuffed bird skin	Orioles or Tanagers (red)	Cheyenne	Grinnell 1972:81
War shields	Feathers	Raptors	Mandan, Arikara, Cheyenne, Arapahoe	Curtis 1997:240, 714
War shields	Feathers or down and immature plumes	Unspecified	Sioux, Arikara, Arapahoe	Feder 1982:14, 25-26, 64
War shield	Preserved head	Crane	Crow (Absoroka)	Gilbert et al. 1996:12
War whistles	Wing bones	Sandhill Crane, Eagles	Cheyenne	Grinnell 1972:108-110
War clubs and hatchets	Feathers	Woodpeckers	Cheyenne	Grinnell 1972:108
War charm	Stuffed bird skin	Kingfishers	Cheyenne	Grinnell 1972:122
Arrows	Feather fletching	Unspecified	Most Plains groups	Curtis 1997:173, passim

that they would not be recognized as decorative items in prehistoric faunal assemblages.

AVIAN FAUNA FROM MIDDLE CERAMIC SITES IN THE TEXAS-OKLAHOMA PANHANDLES

The extension of ethnographic significance attributed to birds back into prehistoric times is not an easy or automatic connection. The transition of Middle Ceramic pedestrian nomads of the 13th century to Late Ceramic equestrian bison hunters of the 16th century brought a tremendous influx of new people from diverse backgrounds onto the Plains. The transformation in mobility, subsistence practices, and social organizations likely were accompanied by social changes and alterations in the structure of fundamental beliefs about the cosmos (Oliver 1962; Moore 1986; Roper 1994:75). Although religious beliefs tend to be more conservative than other societal aspects, alterations in the emphasis of symbolic and ceremonial order likely occurred to validate these social changes. Hence, there is no assurance that ethnographic records of bird significance and usage during the Historic and Late Ceramic periods necessarily provides analogs for the way Middle Ceramic period people felt about birds, even though there may have been a general continuity between Middle Ceramic period groups and Plains Caddoan-speaking groups, such as the Arikara, Pawnee, and Wichita (cf. Hughes 1968, 1974; Wedel 1979; Parks 2001b). But if beliefs changed in response to alterations in other aspects of a particular culture, it probably was not accompanied by wholesale replacement. The rate, extent, and degree of change in religious attitudes about birds are unknown. Nevertheless, an overview of bird use during the Historic and Late Ceramic periods provides a starting point for considering the possible context and occurrence of avian remains in Middle Ceramic period sites. With the possible exception of Lubbock Lake, which has yielded 34 avian species from Paleoindian contexts and nine bird species from Historic contexts, few faunal studies of southern High Plains sites have identified birds from sites pre-dating the past 2000 years (Johnson 1987:Table 7).

Fairly intensive archeological excavations over the past century have been reported at more than 50 Middle Ceramic period (A.D. 1200-1500) sites in the drainages of the Prairie Dog Town Fork of the Red River, the Canadian River of Texas, and the North Canadian or Beaver River in the Oklahoma Panhandle (Figure 3 and Table 6). Most sites are open stone slab and/or pit-house structures attributed to the Antelope Creek phase, the Odessa-Yates phase, or the Buried City Complex (Lintz 1986; Hughes 1991; Brosowske 2005). All of these excavated sites contain surface or pit structures, except the South Ridge site, which is possibly a short term open camp, and Canyon Country Club Cave, a rock shelter. The structures at all others conform to simple or complex forms of sub-homestead, homestead, or hamlet configurations with surface masonry structures (Lintz 1986) or pit houses (Brosowske 2005).

At most sites modified bone tools are described, but the scrap food bones are rarely identified. Yet the faunal remains from most sites represent the largest quantity of artifacts and consist primarily of systematically reduced small splinters from larger herbivores (bison, elk, deer, pronghorn, etc.) derived from the extraction of bone marrow and grease (DeMarcay 1986). More than half the excavated site faunal assemblages have received no formal examination whatsoever. Of those that have been studied, less than 10 percent of the bone refuse is identifiable to specific elements of identifiable animals. Rigorous and thorough attempts to analyze bone refuse from 17 sites have found smaller mammals, birds, amphibians, reptiles, and fish (Duffield 1970; DeMarcay 1986; Duncan 2006; Meissner 2005). These studies suggest that bird remains constitute less than 5 percent of identifiable bones in the faunal assemblages. In addition to the rigorous studies mentioned above, five bird species have been identified in limited studies of avian remains from the Stamper and Roy Smith sites in Oklahoma (Lintz 2003b; Duffield 1970:246).

As many as 45 bird taxa have been attributed to Middle Ceramic period sites in the Oklahoma and Texas Panhandle regions by Duffield (1970), DeMarcay (1986), Duncan (2006), and Meissner (2005). These birds are listed in Table 7 by common and up-dated scientific names (AOU 2007; Alsop 2002), live weights, and seasonal movements in Texas (Shackelford and Lockwood 2000). The list of birds from archeological sites in the study area describes 18 kinds of waterfowl (ducks, geese, swans, etc.; 40 percent of the 45 known taxa), four kinds of small game birds (doves and quail, etc; 8.9 percent), four kinds of shore birds (snipes, coots, etc.; 8.9 percent), 11 kinds of predatory birds (hawks, owls, crows, etc.; 24.4 percent), seven kinds of

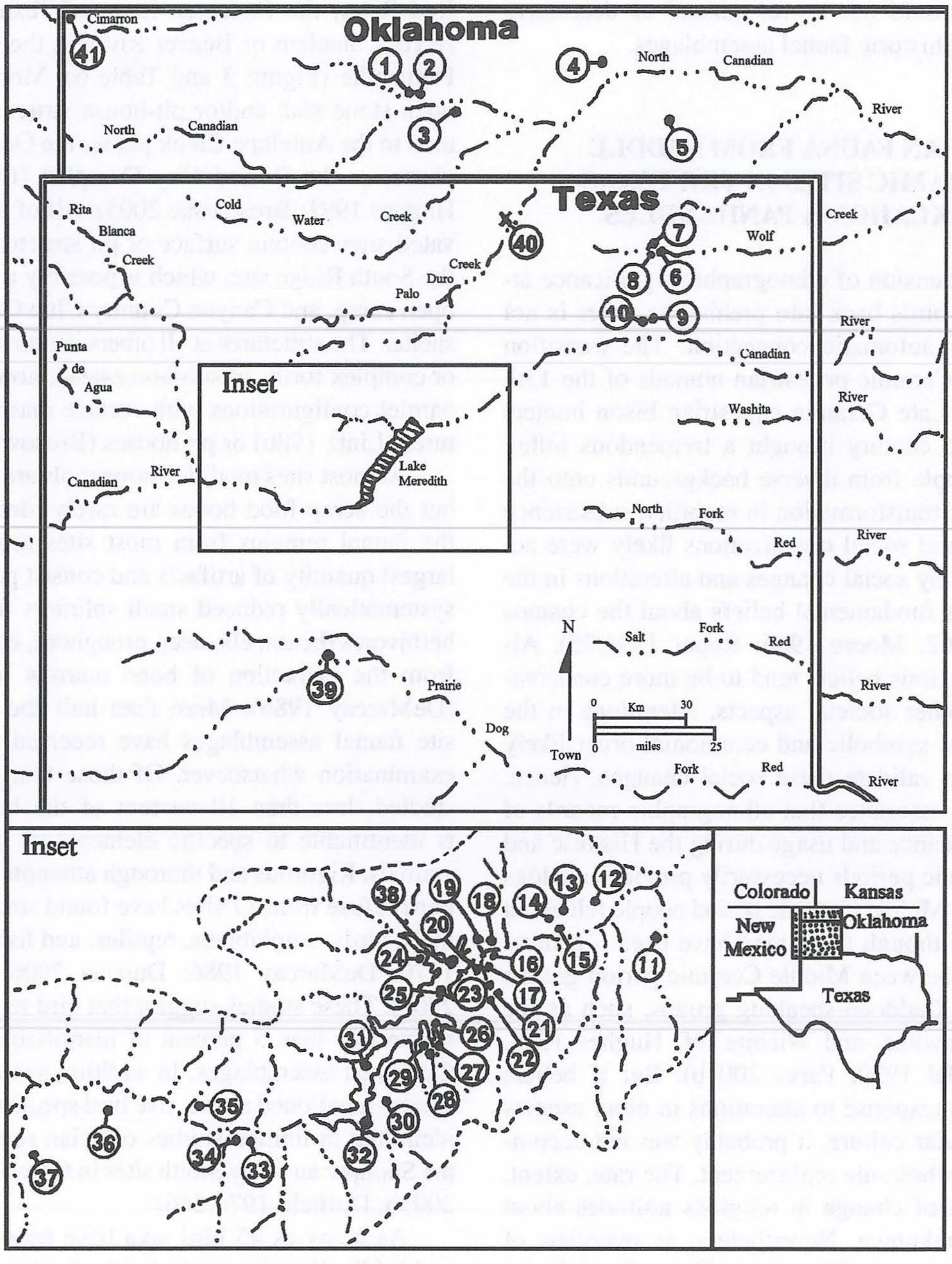

Figure 3. Map of Middle Ceramic sites with avian faunal remains (numbers reference sites in Table 6).

small perching or colorful birds (orioles, cardinals, kingfishers, etc.; 15.6 percent), and one category for unidentified bird remains (2.2 percent). In addition, fragmentary egg shells were recovered from prehistoric contexts at the Two Sisters site, but no attempts have been made to identify these egg shell fragments (Duncan 2006).

The variety of waterfowl, shore birds, game birds, and song/perching birds in the prehistoric assemblages are most likely subsistence-related game. But many ethnographic accounts of Plains Indian groups noted that they avoided consuming flesh-eating birds except in times of famine. The importance of hawks, eagles, owls, crows, and jays as well as some of the colorful feathers of many perching birds may lie in their symbolic significance if historic cosmological views can be extended back into prehistoric times.

Many of the identifiable bird remains were excavated from Canyon Country Club Cave, where

Table 6. Status of faunal and avian studies for Middle Ceramic period sites on the southern High Plains.

Map Ref.	Site name or number	Site type	Approx. area dug (m^2)	Dates dug	Faunal study type	Bird bones present?	Bird types identified?	Excavation reference	Faunal reference
Oklahoma Sites									
1	McGrath (34TX-31)	Homestead	90	1972	Cursory	None	No	Lintz 1976	Lintz 1976
2	Two Sisters (34TX-32)	Homestead	210.4	1972, 1973	Thorough	Many (101)	Yes	Duncan 2006	Duncan 2006
3	Stamper (34TX-1)	Hamlet	662	1932-1934	Anecdotal	Few (5)	Yes	Watson 1950; Lintz 2003a, 2003b, 2003c, 2004	Duffield 1970; Lintz 2003b
4	Roy Smith (34BV-14)	Hamlet	273.5	1965	Anecdotal	Few (3-5)	Yes	Schneider 1969	Duffield 1970; Lintz 2003b
5	Odessa Yates (34BV-100)	Hamlet	67	1998-2000	Thorough-big game only	Few (7)	No	Brosowske 2005	Brosowske 2005
			1,302.90	Approximate Total Area Dug (m^2) – Oklahoma Panhandle.					
Texas Sites: Buried City Complex									
6	Buried City (41OC1)	Hamlet	55	1907, 1917-1920, 1988	None	ND	No	Eyerly 1907, 1912; Moorehead 1931; Hughes 1991	None
7	Courson A (41OC26)	Homestead	62.8	1985, 1987, 1988	None	Few	No	Hughes 1991	None
7	Courson B (41OC27)	Homestead	142	1985, 1986, 1987, 1988	Cursory	Few	No	Hughes and Hughes-Jones 1987	Hughes and Hughes-Jones 1987
7	Courson C (41CO28)	Homestead	81	1987, 1988	None	Few	No	Hughes 1991	None
7	Courson D (41OC29)	Hamlet	114	1987, 1988	None	Few	No	Hughes 1991	None
8	Kit Courson Ruins (41OC43)	Homestead	124	1986-1988	None	Few	No	Hughes 1991	None
			578.8	Approximate Total Area Dug (m^2)—Buried City/ Wolf Creek Texas					
Texas Sites: Canadian River Valley									
9	Indian Springs Site (41RB81)	Homestead	112	2002-2007	None	ND	No	Cruse 2007	None
10	Hank Site (41RB109)	Homestead	36	2000-2001	None	ND	No	Boyd and Wilkens 2001; Boyd 2008	None
10	Three Toe Site (41RB110)	Homestead	6	2003-2006	None	ND	No	Boyd 2008	None
10	Whistling Squaw (41RB108)	Homestead	8	2000, 2004	None	ND	No	Boyd 2008	None
11	Jack Allen	Homestead	11.2	1969-1970	None	ND	No	Lintz 1986; Harrison n.d.;	None
12	Zollars Site	Sub-homestead	34.8	1980	None	ND	No	Smith and Smith 1982; Smith 1989	None

Table 6. *(Continued)*

Map Ref.	Site name or number	Site type	Approx. area dug (m^2)	Dates dug	Faunal study type	Bird bones present?	Bird types identified?	Excavation reference	Faunal reference
13	Tarbox Ruin (41HC2)	Hamlet	56.2	1929	None	ND	No	Holden 1929; Lintz 1986	None
14	Cottonwood Creek Ruin (41HC141)	Hamlet	33.5	1920, 1958	Cursory	Few (1?)	No	Holden 1929; Lintz 1997	Lintz 1997:65
15	Black Dog Village (41HC30)	Hamlet	180	1973	None	ND	No	Keller 1975	None
16	Pickett	Sub-homestead	26	1958	System-atic	None	No	Lintz 1986; Duffield 1970:	Duffield 1970:189
17	Sanford Ruin (41HC3)	Hamlet	80	1953	Systemat	None	No	Lintz 1986; Duffield 1970:	Duffield 1970:211
18	Spring Canyon (41HC20)	Homestead	81	1961-62	Thorough	Many (66)	Yes	Duffield 1964; Lintz 1986	Duffield 1970:180
19	Medford Ranch (41HC10)	Homestead	113	1961-62	Thorough	Few (1)	No	Duffield 1964; Lintz 1986	Duffield 1970:163
20	Roper (41HC6)	Sub-homestead	76	1957	System-atic	Few (2)	No	Lintz 1986, nd.	Duffield 1970:201
20	South Ridge Site (West end)	Campsite	50	1977-1978	Cursory	No	No	Etchieson 1979	Etchieson 1979
20	Conner Site (41HC7)	Sub-homestead	28	1961-62	Thorough	None	No	Duffield 1964; Lintz 1986	Duffield 1970:181
21	Antelope Creek 23 (41HC25)	Hamlet	45	1939	None	ND	No	Lintz 1986	None
22	Antelope Creek 24	Unknown	340	1939	Thorough	Rare (1)	Yes	Lintz 1986	Duffield 1970:147
22	Lookout Ruin	Hamlet	5.6	1931	None	ND	No	Lowrey 1932; Lintz 1986	None
23	Antelope Creek 22 (41HC23)	Hamlet	1,135.00	1920, 1930-32, 1938	Selective intense	Few (1)	Yes	Baker and Baker 2000; Lintz 1986	Duffield 1970:127
23	Antelope Creek 22A	Homestead	229	1939	Thorough	None	No	Baker and Baker 2000; Lintz 1986	Duffield 1970:139
24	Big Blue Ruins LMRA-145 (41MO35)	Hamlet	62+?	1969	Cursory	Maybe	No	Couzzourt and Schmidt-Couzzourt 1996:74	Couzzourt and Schmidt-Couzzourt 1996
24	Big Blue Ruins LMRA-146 (41MO36)	Homestead?	102	1969	Cursory	Maybe	No	Couzzourt and Schmidt-Couzzourt 1996:57	Couzzourt and Schmidt-Couzzourt 1996
24	Big Blue Ruins LMRA-147 (41MO37)	Hamlet	102	1969	Cursory	Maybe	No	Couzzourt and Schmidt-Couzzourt 1996:37	Couzzourt and Schmidt-Couzzourt 1996
25	Site 41MO7	Homestead	109	1963	None	ND	No	Green 1967, 1986	None
26	Turkey Creek (41PT8)	Sub-homestead	44	1963	None	ND	No	Green 1967, 1986	None
27	Alibates Ruin 28A	Hamlet	318	1940	None	ND	No	Lintz 1986	None
28	Alibates Ruin 30 (41PT31)	Hamlet	225	1940	None	ND	No	Lintz 1986	None

Table 6. *(Continued)*

Map Ref.	Site name or number	Site type	Approx. area dug (m^2)	Dates dug	Faunal study type	Bird bones present?	Bird types identified?	Excavation reference	Faunal reference
29	Alibates Ruin 28 (41PT11)	Hamlet	5,625.00	1932, 1938-1941	Selective intense	Many (34)	Yes	Baker and Baker 2000; Lintz 1986	Duffield 1970:100-102
30	Coetas Ruins (# 55)	Hamlet	225	1932-1934	None	ND	No	Studer 1934; Lintz 1986	None
31	Footprint (41PT25)	Hamlet	115	1964	None	ND	No	Green 1967, 1986	None
32	Chicken Creek	Sub-homestead	48	1982-1983	None	ND	No	Schmidt-Couzzourt 1983	None
33	41PT109 (1st season)	Homestead	11	2003	Thorough	Many (71)	Yes	Weinstein 2005	Meissner 2005
34	Marsh	Homestead	42.5	1967-1968	None	ND	No	Lintz 1986	None
35	Chimney Rock Ruins 51	Hamlet	533.4	1941	None	ND	No	Lintz 1986	None
35	Chimney Rock Ruins 51A	Hamlet	41	1941	None	ND	No	Lintz 1986	None
36	Saddleback Mesa (41OL1)	Hamlet	537.5	1930-1933	None	ND	No	Holden 1930, Haynes 1932; Wan 1986	None
37	Landergin Mesa (41OL2)	Hamlet	88.5	1981, 1984	Thorough	Many (11)	Yes	Lintz 1990, 2001	DeMarcay 1986
38	Arrowhead Peak (41HC19)	Hamlet	140	1963	None	ND	No	Green 1967, 1986	None
			10,993.20	**Approximate Total Area Dug (m^2)-- Canadian River, Texas**					
Texas-- Red River/Palo Duro Creek									
39	Canyon Country Club Cave	Cave	40.5	1956	Thorough	Many (21)	Yes	Hughes n.d.; Duffield 1970: Appendix D	Duffield 1970:Appendix D
			40.5	**Approximate Total Area Dug (m^2)-- Palo Duro Creek/ Prairie Dog Town Fork of Red River, Texas**					
Various Caves and Rock Shelters (Multi-component)									
40	41HF86 and 41HF124	Caves	NA	1991	Thorough	No	No	Quigg et al. 1993	Quigg et al. 1993.
41	Kenton Caves, 34CI50 and 6 other shelters	Caves	ND	1929-1934	None	Unknown	No	Renaud 1930; Lintz and Zabawa 1984; Lintz 1981	None

ND = no data; NA = not available

Table 7. Avian species, live weights, and home ranges of birds from Middle Ceramic sites on the southern High Plains (after Shackelford and Lockwood 2000; Bryan et. al. 2003).

		Common Name	Scientific Names (after Alsop 2002)	Live ozs.	Weight grams	Migratory	Resident w/ movement	Resident w/o move.	Breeding Species	Rare Breeding	Tropical Migrant	Temperate Migrant	Accidental Species
Aquatic Birds & Waterfowl (Order Anseriformes)													
1		Unspecified Waterfowl	(Order Anseriformes)			Yes							
		Geese and Swans (Order Anseriformes)											
2		Greater White-fronted goose	Anser albifrons	96.0	2721.6	Yes					X		
3		Canada Goose	Branta canadensis	134.4	3810.2	Yes						X	
4		Trumpeter swan (?)	Cygnus buccinator	401.6	11385.4	Yes							X
5	**	Tundra swan	Olor colmbianus	n.d.	n.d.	Unk.							
		Ducks (Order Anseriformes)											
6	*	Gadwall	Anas strepera	35.2	997.9	Yes							
7		American Widgeon	Anas americana	27.2	771.1	Yes				X	X		
8		Mallard	Anas platyrhynchos	38.4	1088.6	Yes	X		X		X		
9		Blue winged Teal	Anas discors	14.4	408.2	Yes	X			X	X		
10		Green-winged Teal	Anas crecca	12.8	362.9	Yes							
11		Northern Pintail	Anas acuta americana	36.8	1043.3	Yes	X			X	X		
12		Northern Shoveler	Anas clypeata	22.4	1270.1	Yes				X	X		
13		Canvasback	Aythya valisineria	44.8	1270.1	Yes					X		
14		Redhead	Aythya Americana	41.6	1179.4	Yes			X		X		
15		Ring-neck	Aythya collaris	25.6	725.8	Yes					X		
16		Bufflehead	Bucephala albeola	16.0	453.6	Yes						X	
17		Hooded Merganser	Lophodytes cucullatus	24.0	680.4	Yes				X	X		
18		Ruddy	Oxyura jamaicensis	20.8	589.7	Yes				X	X		
Shore and Wading Birds													
		Shore Birds (Order Charadriiformes)											
19		Long-billed Curlew	Numenius americanus	8.9	252.3	Yes	X			X	X		
20		Wilson's Snipe	Gallinago delicate	4.5	127.6	Yes					X		
21		American Woodcock	Scolopax minor	6.2	175.8	Yes				X		X	
		Rails and Coots (Order Gruiformes)											
22		American Coot	Fulica Americana	25.6	725.8	Yes	X		X		X		
Small Game Birds													
		Chicken-like birds--Grouse, Quail (Order Galliformes)				Yes							
23		Unid. Chicken-like bird	(Order Galliformes)	n.d.	n.d.	No							
24		Northern Bobwhite	Colinus virginianus	6.3	178.6	No		X	X				
25	**	Sharp-tailed Grouse	Typanuchus phasianellus	33.6	952.6	No							
		Pigeons and Doves (Order Columbiformes)											
26		Mourning Dove	Zenaidura macroura	4.3	121.9	Some	X		X		X		
Raptors and Raptor-like Birds													
		Hawkes, Eagles, Osprey (Order Falconiformes)				Yes							
27		Unspec. hawks, eagles, etc.	(Family Accipitridae)	n.d.	n.d.	Yes							
28	*	Bald Eagle	Halaieetus leucocephalus	145.6	4127.8	Yes	X?			X	X		
29		Red-tailed Hawk	Buteo jamaicensis	36.8	1043.3	Yes	X		X		X		
30	*	American Kestrel	Falco sparverius	3.9	110.6	Yes	X		X		X		
		Vultures, Herons & Storks (Order Ciconiiformes)				Yes							
31	*	Turkey Vulture	Cathartes aura	51.2	1451.5	Yes	X		X		X		
		Owls (Order Strigiformes)											
32		Great Horned Owl	Bubo virginianus	48.0	1360.8	No		X	X				
33	*	Short-eared owl	Asio flammeus	11.1	314.7	Some					X		
34	*	Burrowing Owl	Athene cunicularia	5.3	150.3	Some	X		X		X		

Table 7. *(Continued)*

	Common Name	Scientific Names (after Alsop 2002)	Live ozs.	Weight grams	Migratory	Resident w/ movement	Resident w/o move.	Breeding Species	Rare Breeding	Tropical Migrant	Temperate Migrant	Accidental Species
	Nighthawks (Order Caprimulgiformes)											
35	Common Nighthawk	Chordeiles minor	2.2	62.4	Yes			X		X		
	Crows, Ravens, and Jays (Family Corvidae).											
36	Unidentified Crow	Corvus (sp)	n.d.	n.d.	No							
37	Chihuahuan Raven	Corvus cryptoleucus	19.2	544.3	No		X	X				
Perching, Song and Colorful Birds												
38	Unspecified Perching Bird (Order Passerifromes)		n.d.	n.d.	Unk.							
	Kingfisher (Order Coraciiformes)											
39	Belted Kingfisher	Ceryle alcyon	5.2	147.4	SM	X		X		X		
	Woodpeckers, Flickers, Sapsuckers (Order Piciformes)											
40	Unidentified Woodpecker	(Order Piciformes)	n.d.	n.d.	Unk.							
	Thrushes and Robins (Family Turdidae)											
41	* American Robin	Turdus migratorius	2.7	76.5	Yes	X		X		X		
	Mockingbirds, Thrashers (Family Minidae)											
42	Brown Thrasher	Toxostoma rufum	2.4	68.0	Yes	X		X				
	Cardinals, Grosbecks, Buntings (Family Cardinalidae)											
43	Northern Cardinal	Cardinalis cardinalis	1.6	45.4	No	X		X				
	Meadowlarks, Blackbirds, Orioles (Family Icteridae)											
44	Baltimore Oriole (more likely Bullock's Oriole)	Icterus galbula (more likely Icterus bullockii)	1.2	34.0	Yes				X	X		
Unidentified Bird Group (Aves)												
45	Unidentified Bird	(Aves)	n.d.	n.d.	Unk.							

* Bird remains are not from Middle Ceramic period contexts.
** Birds not presently found in Texas
n.d.=no data; Unk.=Unknown

Duffield (1970:Appendix D) recognized 135 bone elements from 25 varieties of birds. Problems exist in using Duffield's temporal context of avian and other faunal remains from this site. Most bird remains (n=84; 62.2 percent) were from Stratum 4, which Duffield erroneously attributed to the Middle Ceramic period component. A series of radiocarbon dates obtained after Duffield completed his study demonstrated that the cave was used from the Archaic through historic periods and only Strata 2 and 3 have Middle Ceramic and Transitional Early to Middle Ceramic period affiliations, respectively (Table 8; Hughes n.d.:40; Bender et al. 1971:477-478). Less than 16.3 percent (n=22) of the bird elements from Canyon Country Club Cave are from these strata (Table 9). The radiocarbon dates indicate that the rich Stratum 4 assemblage predates the Middle Ceramic period materials.

When the avian remains from Stratum 4 and other non-Middle Ceramic period zones from Canyon Country Club Cave are removed from consideration, the diversity of birds from all sites drops from 45 to 38 varieties. The seven kinds of birds removed from the bird list consist of Gadwall and burrowing owls found in both Archaic and Early Ceramic period deposits (Strata 5 and 4, respectively); short-eared owl and bald eagle from Early Ceramic period deposits (Stratum 4); American Kestrel and turkey vulture from both Early Ceramic and Late Ceramic period deposits (Strata 4 and 1), and American robin from the historic "trash level" (Duffield 1970:Appendix D).

The distribution of the 38 identified kinds of avian remains from Middle Ceramic period sites with the greatest abundance and diversity of bird remains is presented in Table 10. The six intensively studied faunal assemblages with identified bird remains are from Alibates Ruin 28, Spring Canyon, Canyon Country Club Cave, Landergin Mesa, 41PT109, and Two Sisters (Duffield 1970; DeMarcay 1986; Duncan 2006; Meissner 2005). I have also included the specialized avian identifications from the Stamper and Roy Smith sites even though the overall faunal identifications are not as rigorous as the bone studies from the other sites (Lintz 2003c; Duffield 1970:246). Duffield (1970) recognized sparse bird remains at four other sites. Antelope Creek Ruin 22 had a single great-horned owl bone, and the same species is at Alibates Ruin 28. The bird remains from Antelope Creek 24 Ruin (n=1), Medford Ranch site (n=1), and the Roper

Table 8. Radiocarbon dates from Canyon Country Club Cave, Site A251, Randall County, Texas.

Level-Stratum	Unit	P-PHM Catalog No	Radiocarbon Lab No.	Uncorrected Age B.P.	Uncalibrated Age	One SD Tree Ring Calibration Age B.P.	Probability	Two SD Tree Ring Calibration Age B.P.	Probability	Comments
Late Ceramic period (Protohistoric)										
1	N1/W1	183	WIS 411	300 ± 50	A.D. 1650	434-352 333-298	0.714 0.286	482-282 168-155	0.983 0.017	Charcoal
1	N2/NS	312	WIS 410	400 ± 60	A.D. 1550	512-430 362-326	0.735 0.265	524-416 413-313	0.600 0.400	Charcoal
Middle Ceramic period (Late Prehistoric)										
2	N1/W1	196	WIS 403	670 ± 50	A.D. 1280	660-633 597-562	0.491 0.509	682-616 614-549	0.497 0.503	Charcoal
2	N1/NS	53	WIS 421	700 ± 60	A.D. 1250	687-635 596-563	0.645 0.355	730-618 611-552	0.660 0.340	Charcoal
Transitional or Mixed Early to Middle Ceramic period										
3	N1/W1	217	WIS 408	620 ± 45	A.D. 1330*	649-621 606-579 571-555	0.400 0.393 0.207	658-543	1.000	Charcoal Date near Level 2 Group
3	EW/N1	306	WIS 402	1260 ± 55	A.D. 690*	1266-1168 1159-1137 1107-1093	0.799 0.130 0.070	1287-1063	1.000	Charcoal Date near Level 4 Group
Early Ceramic period										
4	A25/w	394	WIS 394	Modern*						Bison Bone
4	N2/W1	395	WIS 414	1250 ± 60	A.D. 680	1261-1168 1160-1126 1108-1091	0.682 0.210 0.108	1289-1055 1026-1013	0.985 0.015	Charcoal
4	EW/W1	309	WIS 404	1650 ± 55	A.D. 300	1688-1673 1613-1510 1499-1485 1432-1422	0.073 0.793 0.067 0.051	1693-1648 1632-1412	0.114 0.886	Charcoal
Late Archaic period										
5	N2/E1	440	WIS 412	1050 ± 50	A.D. 900*	1049-1032 990-926	0.169 0.831	1064-906 861-829 811-794	0.941 0.036 0.023	Charcoal Date near Level 2-3 Group.
5	N1/W1	231	WIS 420	2100 ± 60	150 B.C.	2148-2135 2133-1992	0.066 0.929	2304-2238 2181-2165 2163-1924	0.101 0.021 0.867	Charcoal
5	EW/W1	311	WIS 430	2830 ± 60	880 B.C.	3057-3051 3020-3012 3001-2850	0.027 0.030 0.943	3138-3128 3104-3091 3079-2782	0.013 0.014 0.968	Charcoal

* Date rejected by Jack Hughes (n.d.) as being erroneous

Tree ring calibrations use Stuiver and Reimer (2000): Calib.rev 4.3

Table 9. Avian fauna identified from Canyon Country Club Cave (Duffield 1970: Appendix D).

Strata and Period / Common Name	Trash Stratum (Historic) NISP	Stratum 1 (Late Ceramic) NISP	Stratum 2 (Middle Ceramic) NISP	Strata 2-3 (Early Ceramic Transitional to Middle Ceramic) NISP	Stratum 3 (Transitional Early-Middle Ceramic) NISP	Stratum 4 (Early Ceramic) NISP	Stratum 5 (Archaic) NISP	Mixed Strata (Unknown) NISP	Total NISP
Aquatic Birds & Waterfowl									
Geese and Swans									
Unidentified Geese and Swans						4			4
Ducks		1	1	1	1	23	1	2	30
Gadwall						1		1	2
American Widgeon						1		1	2
Mallard						2			2
Blue winged Teal				2	2	2			6
Green-winged Teal				1	1	6			8
Northern Pintail						1			1
Northern Shoveler				2	1	3			6
Canvasback								1	1
Redhead				1		1			2
Ring-neck						2			2
Ruddy			2		1	3			6
Small Game Birds									
Pigeons and Doves									
Mourning Dove		1			2	3	1	2	9
Shore Birds									
American Woodcock					1				1
Rails and Coots									
American Coot				1		3	1		5
Predators and Raptors									
Hawks, Eagles, Osprey									
Bald Eagle						1			1
American Kestrel	1	1				4			6
Vultures, Herons, Storks									
Turkey Vulture	1	2				9			12
Owls									
Great Horned Owl	8							2	10
Short-eared Owl						1			1
Burrowing Owl						13	1		14
Crows, Ravens, and Jays									
Unidentified Crow or Raven					1	1			2
Perching, Song, Colorful Birds									
Mockingbirds, Thrashers									
Brown Thrasher					1				1
Thrushes and Robins									
American Robin	1								1
Unidentified Bird Group									
Unidentified Bird									
Total bird elements (NISP)	11	5	3	8	11	84	4	9	135
Percent NISP	4.18	9.62	3.75	2.42	3.59	2.75	1.79	5.33	3.01
Total Fauna NISP	263	52	80	330	306	3,056	224	169	4,480

Table 10. Diversity of bird remains identified from Middle Ceramic period sites.

	Oklahoma Sites						Texas Sites										
	Two Sisters Site	Duncan 2006:171	Stamper Site	Lintz 2003b	Roy Smith Site	Lintz 2003b	Alibates Ruin 28	Duffield 1970:100	Spring canyon	Duffield 1970:171	Landergin Mesa	DeMarcay 1986	41PT109 (first season)	Meissner 2005	Canyon Country Club Cave, Strata 2, 2-3, and 3	Duffield 1970: Appendix D	Total NISP
Common Name	A*	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Aquatic Birds and Waterfowl																	
1 Unspecified Waterfowl			1(b)	1					1	1	1	1	6	nd			9
Geese and Swans																	
2 Greater White-fronted goose							1	1									1
3 Canada Goose					1(b)	1	1	1									2
4 Trumpeter swan (?)			1(b)	1			1	1									2
5 Tundra (Whistling) swan																	
Ducks															3	nd	3
6 American Widgeon			1(b)	1													1
7 Mallard	1	1															1
8 Blue winged Teal							1	1							4	nd	5
9 Green-winged Teal					1(b)	1									2	nd	3
10 Northern Pintail					1(b)	1	1	1									2
11 Northern Shoveler							2	1							3	nd	5
12 Canvasback	3	1					2	2									5
13 Redhead	6	2					1	1							1	1	8
14 Ring-neck	1	1															1
15 Bufflehead	2	1															2
16 Hooded Merganser	1	1			1(a)	1											2
17 Ruddy															3	nd	3
Small Game Birds																	
Chicken-like birds--Grouse, Quail																	
18 Unidentified Chicken-like bird											1	1	1	1			2
19 Northern Bobwhite													1	1			1
20 Sharp-tailed Grouse							1	1									1
Pigeons and Doves																	
21 Mourning Dove															2	nd	2
Shore Birds																	
22 Long-billed Curlew	1	1															1
23 Wilson's Snipe	1	1															1
24 American Woodcock															1	1	1
Rails and Coots																	
25 American Coot															1	1	1
Predators and Raptors																	
Hawks, Eagles, Osprey																	
26 Unspecif. hawks, falcons etc.			1(a)	1							1	1					2
27 Red-tailed Hawk	2	1			1(b)	1	1	1									4

Table 10. *(Continued)*

	Oklahoma Sites						Texas Sites										
	Two Sisters Site	Duncan 2006:171	Stamper Site	Lintz 2003b	Roy Smith Site	Lintz 2003b	Alibates Ruin 28	Duffield 1970:100	Spring canyon	Duffield 1970:171	Landergin Mesa	DeMarcay 1986	41PT109 (first season)	Meissner 2005	Canyon Country Club Cave, Strata 2, 2-3, and 3	Duffield 1970: Appendix D	Total NISP
Common Name	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Owls																	
28 Unidentified													1	1			1
29 Great Horned							1	1									1
Nighthawks																	
30 Common Nighthawk	3	1															3
Crows, Ravens, and Jays																	
31 Unidentified Crow or Raven			1(a)	1			4	1	1 8	2							23
Perching, Song, and Colorful Birds																	
Kingfisher																	
32 Belted Kingfisher	1	1															1
Woodpeckers, Flickers, etc.																	
33 Unidentified Woodpecker											1	1					1
Perching Birds																	
34 Unspecified Perching Bird	1	1							1	1							2
Mockingbirds, Thrashers																	
35 Brown Thrasher															1		1
Cardinals, Grosbecks, Buntings																	
36 Northern Cardinal	1	1															1
Meadowlarks, Blackbirds, Orioles																	
37 Baltimore or Bullock's Oriole	1	1															1
Unidentified Bird Group																	
38 Unidentified Bird	76	nd	nd	nd	nd	nd	17	13	46	nd	9	7	62	nd	nd	nd	210
Total bird elements (NISP)	101		5		5		34		66		11		71		21		316
Percent NISP Target Sample	0.88		nd		nd		0.66		0.58		0.01		2.16		0.03		
Identifiable NISP Sample	11,534		nd		nd		3,772		1,353		Nd		796		nd		
Identifiable NISP Site Assemblage	22,965		nd		nd		3,772		1,353		Nd		796		nd		
Total Analytical NISP Sample	11,534		nd		nd		nd		nd		121,912		3,285		716		
Total Site NISP Assemblage	89,048		nd		nd		5,152		11,376		121,912		3,285		nd		

(a) Lintz (2003b)

(b) Duffield (1970)

*A/NISP= Number of Individual Specimens
B/MNI= Minimum Number of Individuals

site (n=2) are all elements from unidentified bird species. Bird remains were not reported from faunal assemblages at five other sites: Conner, Pickett, Sanford, Antelope Creek Ruin 22A, and the McGrath site (Duffield 1970; Lintz 1976).

Three of the eight sites with identified birds occur along the North Canadian or Beaver River in the Oklahoma Panhandle. The Two Sisters and Stamper sites are within a few kilometers of each other in the middle of Texas County, while Roy Smith is located along Sharps's Creek in western Beaver County. Four of the eight sites occur along the Canadian River in the Texas Panhandle; from east to west, they consist of the Spring Canyon site in southwestern Hutchinson County, Alibates Ruin 28 and 41PT109 in Potter County, and Landergin Mesa in eastern Oldham County. Canyon Country Club Cave is located along the Prairie Dog Town Fork of the Red River in Randall County, Texas.

The following trends in avifaunal distribution are tentatively identified among these sites, as reflected by the current study samples:

1. Geese and swans are present among the site assemblages in the Oklahoma Panhandle; they are only found at Alibates Ruin 28 among the Canadian River sites, but not in the Middle Ceramic period strata at Canyon Country Club Cave;
2. A great variety of ducks are associated with the Oklahoma Panhandle sites, Alibates Ruin 28, and the Canyon County Club Cave assemblages, but they are not identified at other sites along the Canadian River;
3. Small game birds were not found among the Oklahoma Panhandle site assemblages, but they were present at all Texas Panhandle sites except Spring Canyon;
4. Surprisingly, turkey remains have not been documented among any of the Middle Ceramic period site assemblages in the Oklahoma or Texas Panhandle. The reasons for their absence are unknown, but very intriguing due to the potential meat returns from hunting this bird;
5. Shore birds are present in the Two Sisters site and Canyon Country Club Cave faunal assemblages, but not in bone assemblages from sites along the Canadian River;
6. Predators and raptors are present in all sites with identifiable birds along the Beaver and Canadian rivers, but are not at the Canyon Country Club Cave along the Prairie Dog Town Fork of the Red River. If caves were nesting sites for raptors, then apparently few died inside the shelter; and
7. perching and colorful bird remains are present in small numbers at a few sites in all three river basins.

Upon considering the physiography and hydrology of the three river drainages, both the North Canadian/Beaver River and the Prairie Dog Town Fork of the Red River contrast with the Canadian by having few short lateral tributaries and narrow incised channels. Playa lakes are found much closer to the floodplains of these two rivers than they are to the Canadian, where lateral drainages create a rolling topography within a broad river valley. In addition, whereas the Canadian River in Texas drains the eastern slopes of the southern Rocky Mountains, neither the North Canadian/Beaver River nor the Prairie Dog Town Fork of the Red River taps the snowmelt from these mountains. If the scarcity of ducks and shore birds at sites along the Canadian River is a valid pattern, then it would seem that most duck procurement methods focused on playas rather than major river systems. The single exception is Alibates Ruin 28, which has evidence of duck procurement. However, this major village site had a substantially larger population and greater time-depth relative to other sites along the Canadian River, as well as more expansive excavations. Perhaps the larger population needed larger hunting catchments, including the upland playa resources, than the people living in smaller or less permanent communities in the Canadian River drainage.

In contrast, the frequent occurrence of small game bird remains from sites along the Canadian River may also be related to habitat differences. The rolling topography of the Canadian River and its numerous short lateral tributaries could have provided more wooded habitats than the narrow canyons of the other two rivers.

Due to the few detailed faunal studies, interpretations of bird procurement patterns by Middle Ceramic period people are tentative. The complete absence of turkey remains in the reported archeological assemblages is surprising since they are one of the meatier avian animals indigenous to the area. The live weight of adult turkeys averages 16.3 lb. (Alsop 2002:265). In the Southwestern Casas Grandes and the northern Arizona Puebloan regions, turkeys were domesticated and raised for meat; their feathers were also important in various Kachina apparel (McKusick 1986). However, these birds apparently had no such valued role to play in the High Plains region, although turkey remains are fairly ubiquitous in Washita River and Paoli phase sites of the Middle Ceramic period in central and western Oklahoma (Drass 1997:126-129). The size differences between waterfowl and perching birds indicate that birds may have been gathered for a variety of uses. Overall, prehistoric bird use may be largely invisible in the archeological record due to poor preservation conditions at open sites as well as the poor recovery of smaller remains and limited in-depth faunal analyses. The diversity of birds and their preferred habitats suggests that a range of procurement methods were likely used.

BIRD PROCUREMENT: A SUMMARY OF POSSIBLE PASSIVE AND ACTIVE STRATEGIES

Few archeological studies of prehistoric bird procurement patterns have been conducted and tangible evidence for such activities has not been rigorously sought or recognized. Birds were captured by a range of passive and active methods. The subsequent discussion offers ways to archeologically detect some of these prehistoric avian procurement methods.

Passive Bird Procurement Strategies

Passive methods utilized snares, traps, deadfalls, and nets, which were set and periodically checked for game. Simple loop snares were placed at gaps in low brush fences about 1 m tall and barriers built near trails, feeding areas, or springs (Barrett and Gifford 1933; Shaffer et al. 1996). These snares were effective for quail, grouse, and other ambulatory chicken-like ground birds, and possibly some types of ducks (Figure 4). A common type of bird snare involved a pair of crossed sticks positioned to open a cordage loop tied with a simple slip knot. One end of the cord was tied to a peg or twig to ensure that the bird and snare stayed put. As the bird passed through the barrier, it tripped the supporting sticks and the noose tightened around the prey's body or neck as it struggled to escape.

The "spring-pole noose snare" relied upon the tension of a bent branch for energy to quickly close when the trigger was touched. Typically four or more pegs ensured proper tension to barely hold open a slip noose that was fixed on the ground. These snares were placed along runs for quail and prairie chickens and on open ground for flickers and other feeding birds (Speck et al. 1946:6). The trigger mechanism was sometimes baited so that a slight bump on the trigger released the spring noose snare from the ground pegs. Some groups in the Great Basin placed the spring snare noose in a shallow pit to restrict access to the bait and prevent lateral escape options (Fowler 1989:59).

The Navajo developed a combination of the loop snare and spring pole snare for use in corn fields (Franciscan Fathers 1983:323). The main element was a sunflower stalk about 1 m long with a sharpened base driven into the ground. They would remove the pithy center of the upper part of the stalk, and polish the upper cut rim with a stone to smooth out burrs and rough spots. Small holes were cut about 7 cm and 50 cm below the top of the stalk. In the lower hole they inserted a greasewood twig approximately 15 to 20 cm long and bent it to serve as a tension spring device. Next, from long strands of hair, they made a very small loop on one end and tied a small cross twig just below the loop. The unlooped end of the hair was passed down the pithy center, through the upper hole, and tied to the end of the bent twig. The tension of the bent twig kept the hair noose open. The small loop and cross twig were supported by a reed placed across the top of the polished upper end of the stalk. Birds foraging in the garden were snared by the extended loop when the bird bumped the stalk, displacing the upper reed and loop. The tension of the twig pulled the hair thread tight against the side of the sunflower stalk, but the small cross stick kept the hair loop from passing through the upper hole.

In contrast to snares, a wide range of traps may have been used to capture one or more birds at a time. These traps were activated by either bait or bump mechanisms (Speck et al. 1946). A cage-fall bird trap used a basket or tied cribbed stick container propped open by "figure 4" trigger-support sticks. When the birds pulled on the bait or bumped the trigger, the support sticks collapsed and the basket or crib structure fell over the bird.

Another passive method involved the use of "mash traps" or deadfalls, where heavy logs or large rock were barely supported with a trigger mechanism consisting of sticks or rock cylinders balanced on other rocks or on the hard ground. Deadfalls were most commonly used for killing

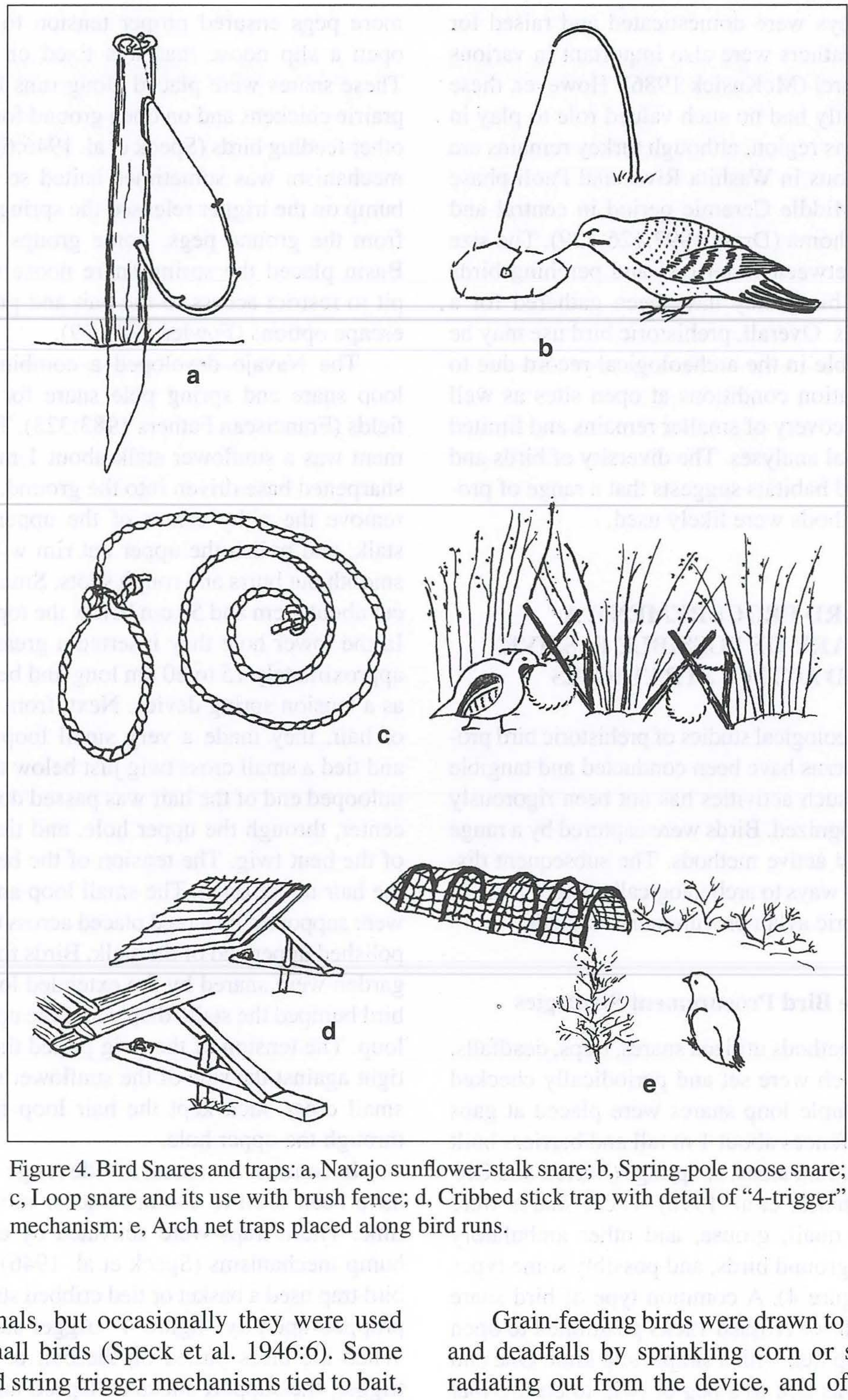

Figure 4. Bird Snares and traps: a, Navajo sunflower-stalk snare; b, Spring-pole noose snare; c, Loop snare and its use with brush fence; d, Cribbed stick trap with detail of "4-trigger" mechanism; e, Arch net traps placed along bird runs.

small mammals, but occasionally they were used to obtain small birds (Speck et al. 1946:6). Some deadfalls had string trigger mechanisms tied to bait, and others simply had pressure points that collapsed when bumped. Other forms had cords tied to the support element that were manually tripped when the bird entered the deadfall (Figure 5). When larger birds such as a turkey, swan, or duck bumped the trigger stick or rock support, the deadfall elements killed or pinned the bird.

Grain-feeding birds were drawn to snares, traps, and deadfalls by sprinkling corn or seed in lines radiating out from the device, and often a pile of food was placed inside the device to entice birds to enter. Other kinds of baits included the use of acorns or strips of meat. Passive devices were efficient, since one hunter could set scores of traps that were easily checked and maintained on a daily basis. Minimal hunting skills were needed and birds could be captured by relatively young children.

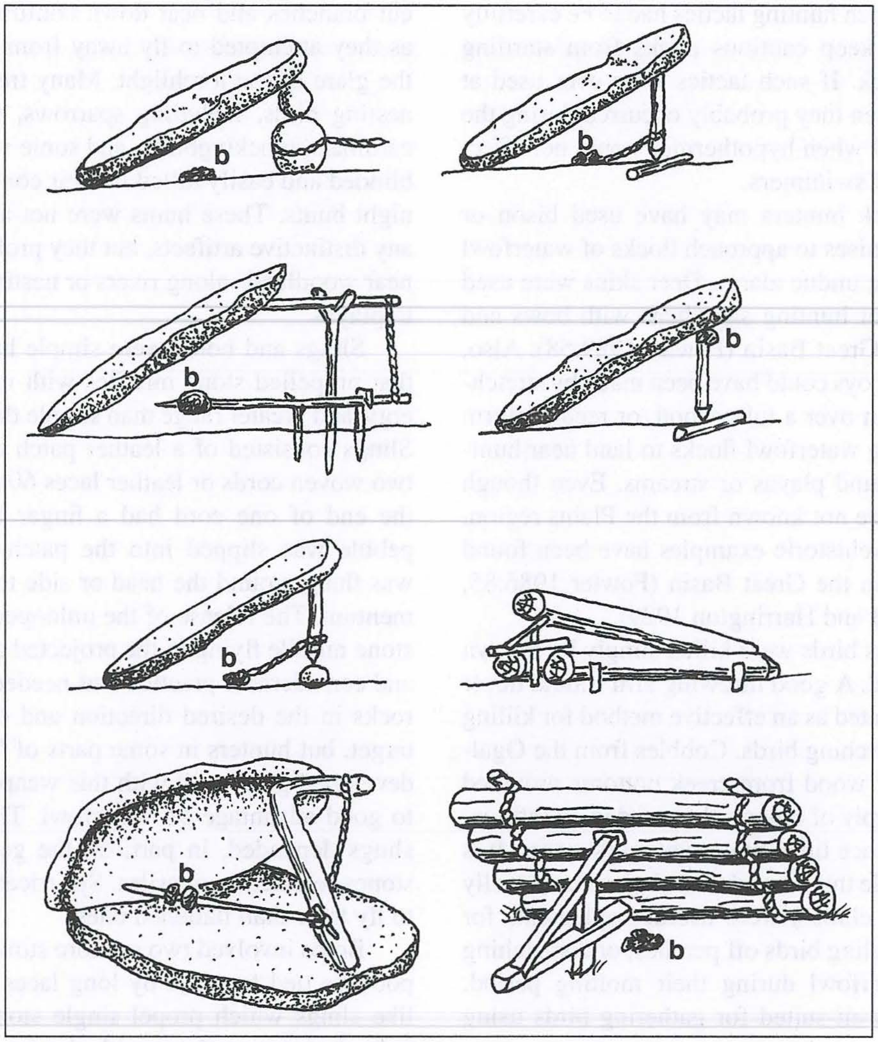

Figure 5. Bird deadfalls and gravity traps. Variations of trigger mechanisms used with rock and log dead falls. Note: "b" refers to location of bait.

Passive hunting devices along trap lines required daily monitoring and removal of prey, otherwise the game was lost to coyotes, foxes, raccoons, skunks, or raptors. In rare occasions, dry caves have preserved evidence of snares or trigger mechanisms (Setzler 1935; Lambert and Ambler 1965:36). In contrast, all evidence of their existence quickly disintegrated in open air settings.

Active Bird Procurement Strategies

Active hunting strategies required human participation in acquiring prey. Birds were more easily obtained on the ground, in water, or perched in trees than when they were in flight.

The simplest active procurement method involved gathering eggs and fledging birds from ground nests as an embedded resource collection with other hunting or gathering activities. Unless the activities occurred in established nesting grounds, such as those maintained by some waterfowl, nest discoveries were probably serendipitous, isolated events. Children and other family members needed no specialized equipment to climb trees and rocky outcrops to harvest immature birds from nesting and roosting sites.

Hunters sometimes disguised themselves with an imitation duck cap or tule reed cap and slipped into the lake from concealed blinds or reeds around the edge of playas. They slowly swam to the waterfowl quarry and pulled the birds underwater by their feet without means of other specialized equipment (Fowler 1986:87). Another version used cane breathing tubes to approach the birds from underwater. Such hunting tactics had to be carefully conducted to keep cautious ducks from startling the whole flock. If such tactics were ever used at playa lakes, then they probably occurred during the summer or fall when hypothermia would not affect the submerged swimmers.

Some duck hunters may have used bison or deer hide disguises to approach flocks of waterfowl without raising undue alarm. Deer skins were used as disguises for hunting sage hens with bows and arrows in the Great Basin (Fowler 1989:58). Also, bird mimic decoys could have been made by stretching a duck skin over a tule, wood, or reed preform to entice flying waterfowl flocks to land near hunting blinds around playas or streams. Even though duck decoys are not known from the Plains region, historic and prehistoric examples have been found around lakes in the Great Basin (Fowler 1986:85, 1989:54; Loud and Harrington 1929).

Sometimes birds were killed simply by thrown stones or wood. A good throwing arm should never be underestimated as an effective method for killing ground and perching birds. Cobbles from the Ogallala gravels or wood from creek bottoms provided an endless supply of objects that needed no fabrication, maintenance time, or energy investments. It is equally possible that curved throwing sticks (usually called "rabbit clubs") were useful implements for knocking fledgling birds off perches, or dispatching flightless waterfowl during their molting period. Children are well-suited for gathering birds using these methods.

Some forms of passive snares and traps were also manually tripped by cords tied to the support post and leading to hunting blinds that concealed children. When a number of birds entered the trap, a swift jerk on the cord collapsed the support stick on the gravity-fall trap.

Birds were lured towards hunters hiding in ambush by various calling methods. Often the calls were chirps made by voice, but sometimes calling sounds were enhanced by devices made from cane or wing bones (Speck 1946:13). The form and nature of these bird call devices are uncertain, so the artifacts are hard to recognize in prehistoric assemblages.

In the Southeastern United States, birds were reportedly hunted at night using a torch light and clubs (Hudson 1976:280; Speck 1946:13). Using a practice called "bird brushing," the Catawba held communal night hunts, especially in winter. In these events, a dozen or so people with torches in one hand and a branch in the other surrounded heaps of cut branches and beat down confused small birds as they attempted to fly away from their roosts in the glare of the torchlight. Many tree and ground-nesting birds, including sparrows, wrens, juncos, cardinals, mockingbirds, and some waterfowl were blinded and easily killed in their confusion in these night hunts. These hunts were not associated with any distinctive artifacts, but they probably occurred near woodlands along rivers or nesting locales next to playas.

Slings and bolos were simple hunting devices that propelled stone missiles with more force, energy, and greater range than simple throwing stones. Slings consisted of a leather patch or pocket with two woven cords or leather laces 60 to 90 cm long; the end of one cord had a finger loop. A single pebble was slipped into the patch and the sling was flung around the head or side to build up momentum. The release of the unlooped cord sent the stone missile flying in the projected arc. Some skill and considerable practice was needed to launch the rocks in the desired direction and distance of the target, but hunters in some parts of North America developed great skill with this weapon and used it to good advantage on waterfowl. The accuracy of slings depended, in part, on the geometry of the stones selected as missiles. Spherical stones tended to fly truer than flattened ones.

Bolos involved two or more stone-filled leather pouches tied together by long laces or cords. Unlike slings which propel single stones, the whole bolo device was flung with the intent of tripping fleeing animals, or in the case of birds, wrapping up their wings to prevent flight. Bolos required that the hunter be relatively close to their prey. Bolos are typically regarded as relics of Central and South American or Alaskan hunting technologies (Gilbert et al. 1996), but it remains undetermined whether or not this prehistoric technology was used on the southern Plains. Some of the notched pebbles found in Central Texas prehistoric archeological sites have been regarded as bolo stones (Weir 1979).

Cast nets were used to snag low-flying ducks and geese as they lifted off ponds and flew over blinds or thick reed cover (Gilbert et al. 1996). Cast nets required either supporting frames or stone weights along their edges to ensure that they opened properly. Some net weights were notched on opposite edges or ends for tying attachments to the net perimeter, and should be readily identifiable as artifacts. Notched and ground pebble net weights, including the "Waco sinkers" found in north central

Texas archeological sites are sometimes regarded as parts of fishing technologies, but their use for snagging birds and other game should not be discounted (Boyd and Shafer 1997:269). In this regard, it is interesting to note that notched Waco sinkers are typically recovered as upland isolates, as well as from sites on alluvial terraces and middens along gullies and creeks (Boyd and Shafer 1997:264).

The blow gun was a hunting implement possibly used for birds and other animals residing in the higher branches of trees. They were commonly used in woodlands and forests of the Southeastern United States and Central and South America (Hudson 1976:273). The weapons were made of hollow cane or reed tubes and a series of tight-fitting darts that were individually propelled by a strong puff of air. Blow guns were well adapted for killing squirrels and birds in the upper branches of trees at distances up to 20 m. But trees rarely occur on the southern Plains except along river valleys or the steep escarpment edges of the Llano Estacado, so the ancient use of blow guns on the Plains is unlikely.

Bows and arrows are mentioned most often as the preferred bird killing weapons in the Plains ethnographic literature. Bows were superior to atlatls (spear-throwers), bolos, slings, toss nets, and simple arm throwing, primarily because the arrows were launched with minimal body movement and propelled by relatively quiet energy transference that did not overly startle the prey. This probably allowed hunters multiple shots before the animals were aware of danger. Small animals and birds were wounded or killed from the arrow's impact, or the puncture and slicing of muscles by the sharp stone tip.

Poisons were sometimes employed with arrows to enhance their killing effectiveness on large mammals, but they were not needed for most birds and small game. Knobby wooden blunt tips or stunners instead of stone arrowheads were used to disable birds and other small game. Blunt tips were effective in hunting waterfowl on lakes, since the blunt-tipped arrows skipped along the surface of the pond and did not submerge (Fowler 1989:57).

Grinnell (1972:115-116) mentioned that birds were commonly used as targets to teach children the skills of stealth-stalking prey and shooting accuracy. Small birds, lizards, and bugs were critical practice targets for boys to become proficient hunters of larger game. Grinnell (1972:115-116) also mentioned that a Cheyenne child's hunting esteem was validated when the family processed and consumed even small avian prey as part of the family meal. Thus, even small birds may be considered to be subsistence game.

Mudhens (coots) were chased ashore during molting season, when they could not fly in the Great Basin, by either men on tule boats or people wading into the water (Fowler 1989:56). Tule boats were not used on the Plains, but the practice of driving molting waterfowl from small playa ponds is a distinct possibility. Women and children hid in the brush on shore and pounced on the birds, initially breaking their legs to cripple them. They returned to kill the birds after the drive was over.

The hunting methods described above do not employ structures that leave signatures on the archeological landscape. But several other bird hunting methods have some potential to be archeologically detectable under the right conditions. These include the use of brush hunting blinds, snare and net structures, drive lanes for molting waterfowl, and eagle or raptor trap pits.

Concealment blinds and disguises allowed hunters to approach game undetected, and by so doing, increased their chances of success. Blinds were placed next to watering and feeding areas or near established game trails. Some hunting blinds were made by tying together the tops of tall reeds, rushes, or willows to form a domed blind on the edges of playa lakes or river banks (Grinnell 1972:260-261). In the mesa and canyon lands of southeastern Colorado, small masonry features no more than 1-2 m in diameter placed along ridges or against cliff edges were regarded as hunting blind features (Nowak and Sparr 1989). Sometimes, hunters placed a small forked stick in the water next to a blind to draw perching birds, so that they could be shot at close range.

Other bird hunting features employed spaced post alignments. On windless days, Paiutes in the Great Basin used a complex series of hanging loop snares to capture ducks in shallow water (Fowler 1989:55). A series of notched sticks were driven into the bottom of a shallow pond that extended some 20-25 cm above the water. They were spaced 25-30 m apart over a distance of approximately 200 m. A cord was strung between the sticks, and at 1 m intervals a series of 10 cm diameter slip noose snares were suspended from the horizontal cord about 3 cm above the water level (Figure 6). Any duck that inadvertently put his head in a slip noose was caught in the ever-tightening snare. This complex snare system had to be continuously watched to prevent the ducks from tearing it apart.

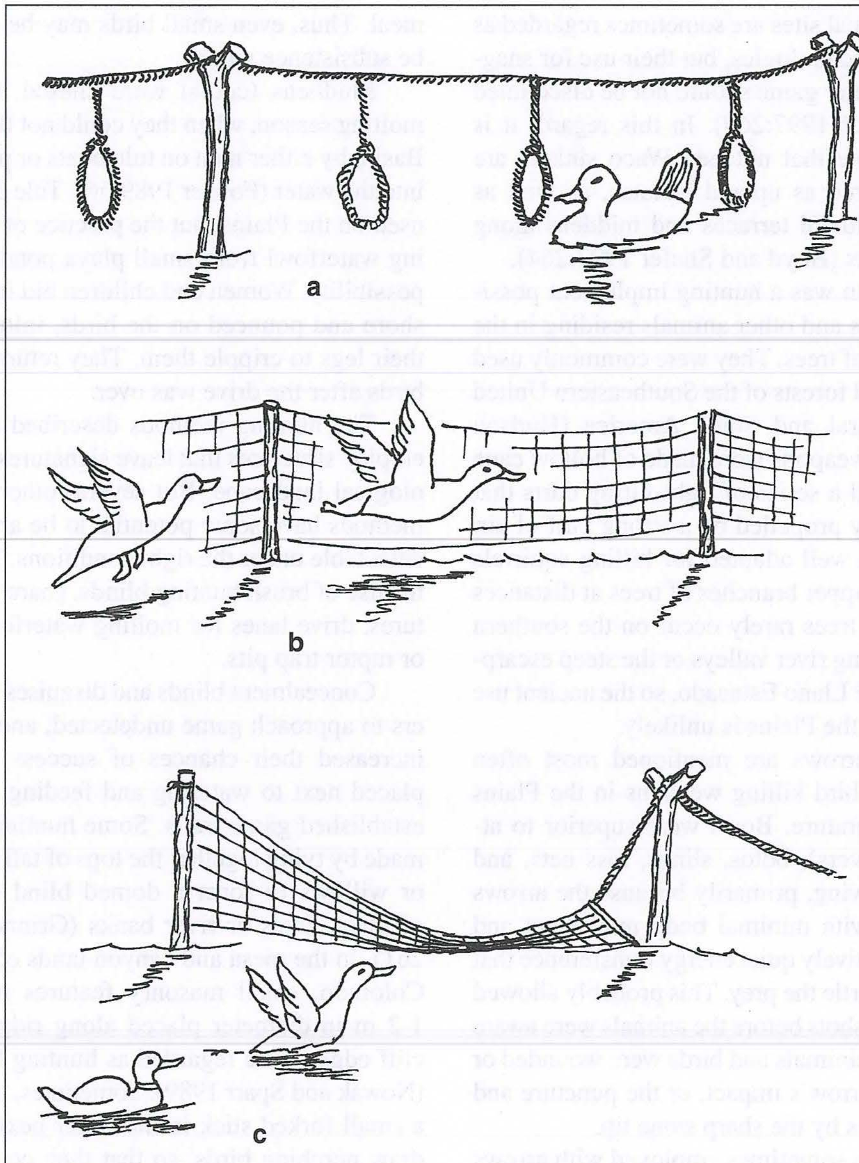

Figure 6. Waterfowl hunting features potentially used at playas: a, Hanging snares; b, Fixed net; c, Raised net.

In addition to the cast nets mentioned above, nets about 1.5 m wide were hung along spaced post alignments positioned at the margins of playas or other feeding areas. These nets were not usually tied to the posts, but the upper edges were draped on the posts about 1 m above the water. Usually the waterfowl quickly got accustomed to the hanging nets during the day, but on moonless nights the hunters returned to spook the feeding ducks by banging on sticks. Many fleeing ducks flew into the net, knocking it off the posts and causing it to fall on top of the frightened birds (Fowler 1989:56). A variation of this method used by California Indians was to have a slip net drooping between vertical poles strung along flight lines; the cord was pulled taut, and the net would be raised into the flight path when birds were taking off or landing (Barrett and Gifford 1933).

Another version adapted to ground birds involved securing a fine mesh net to a series of wooden arches spaced along a bird run. If runs were not evident, then some traps had drive wings of brush to concentrate and focus the bird's movements. The arched net was opened only at the entrance end. The trap was effective for catching coveys of quail, since they tended to scatter outward from the trail when startled, thereby becoming entangled in the net walls (Fowler 1989).

A similar drive lane feature was much larger and used for trapping ducks and waterfowl in shallow water, or in areas adjacent to ponds and nesting areas. Instead of the arched net, a woven wicker pen was the focal point of long drive lanes made of brush, nets, or posts. These features have considerable time depth in Europe and were used historically in eastern North America to trap molting waterfowl. Groups of hunters, sometimes assisted by dogs, would simply drive flightless birds toward two barrier wings of brush or nets. Their prey ultimately became concentrated in containment pens. Sometimes a third slack net alignment was raised behind the driven flocks to prevent their escape from the open air pen. The constructed wicker work tunnels were called "eende(n)kooi," by the Dutch, which is the entomology of the English word "decoy," namely a "a device intended to conceal or distract another activity" (Poodle History Project 2007). Only later was the decoy name applied to animal models and mimics as hunting decoys. The form of these bird trapping devices was similar, but smaller in scale, to the drive lanes used by Plains Indians to concentrate bison, deer, or antelope into traps. It is unclear if such bird drives were used prehistorically in North America or were introduced by Europeans. Modern wildlife managers still use this drive method and similar net apparatus to capture hundreds of waterfowl for banding purposes during single event episodes (Figure 7).

Eagle pit traps were dug in isolated hilltop or cliff-edge settings (Grinnell 1972:299-307; Mails 1970; Wilson 1928). Eagle traps constructed by Puebloan men into the volcanic tuff near escarpment edges on the Pajarito Plateau measured 2 x 1 m in size and 2 m deep, and occasionally had a single horizontal post placed near their base (Steen 1977:29-30). Eagle hunters covered themselves with grease to disguise their scent, and hid inside the pits beneath a brush or reed cover from dawn to dusk. A rabbit, bird, or bison hide was tied to the brush roof as bait. When the eagles swooped in for the kill, their talons would close on the bait and the men would reach up and safely grab the birds by

Figure 7. Waterfowl drive fences used in Saskatchewan for banding ducks during molting periods. This single event captured more than 1,100 mallards, plus many blue-winged and green-winged teal and gadwall (after Hawkins et al. 1984:288).

their legs and pull them into the pit structure. The pits were so small that the eagles' wings were ineffective as weapons. The eagles were either strangled with a cord or captured as pets to harvest feathers. In the latter case, their feet and wings were bound, and they were tied to the horizontal post. The reed covering was reset over the pit for additional eagle trapping activities. Sometimes several eagles were captured in a single day.

A different form of eagle or buzzard trap was an enclosure used by sheepherders in the Texas hill country. This ca. 6 m diameter circular and open-air enclosure was made by setting six wooden posts about 2 m above the ground and wrapping it with netting (Ben Banahan, personal communication, 2007). Raptors baited by a dead rabbit, small game, or piece of hide initially landed on the post before dropping into the enclosure. The fence was too high for large raptors to fly away from level ground. Such pen enclosures were often placed in remote sheep pastures, and human scent was masked by rubbing the posts with game, fruit, or other odorous vegetables. The historic sheepherder's trap is within the range of technology and materials to have been used by prehistoric people, but no examples are archeologically documented.

IDENTIFYING THE ARCHEOLOGICAL SIGNATURES OF AVIAN PROCUREMENT DEVICES

The recognition of avian procurement strategies must address what kinds of birds were potentially sought and utilized, the preferred bird habitats, and identifying the archeological evidence for procurement sites. Most birds provided small to moderate amounts of meat. For example, the live weights of ducks range from 0.45-1.28 kg; geese and swans weigh from 2.70-11.36 kg; owls and buzzards weigh about 1.42 kg; and eagles weigh nearly 4.26 kg (Alsop 2002). Except for the possible mass drives of fledglings and flightless birds during molting season, most birds were secured in small numbers and required no extensive butchering for their transport back to campsites and homesteads. Only in rare instances when large numbers of birds were captured (perhaps in various drive situations) should archeologists expect to find specialized bird butchering sites. These should be evident by large numbers of bones from a limited range of avian species. In most cases, bird procurement methods yielded few individuals, and therefore the remains should be limited to a few unmodified scrap bones at camp or habitation sites.

The archeological signatures of bird procurement by the various methods discussed in the previous section are provided in Table 11. Evidence for the use of passive traps and snares in the southern High Plains is not conclusive. Most of these remains are perishable and are probably not preserved in open sites. Indirect evidence of an elaborate cordage technology is provided by cordmarked and possibly fabric impressed pottery in Antelope Creek phase sites. But to date distinct impressions of nets have yet to be identified on Middle Ceramic period cordmarked pottery from the southern Plains. Furthermore, netting is not reported among the perishable artifact assemblage from the Kenton Caves at the far western end of the Oklahoma Panhandle (Lintz 1981; Lintz and Zabawa 1984) or among the shelters of the Chaquaqua Plateau of southeastern Colorado (Campbell 1969). However, Loendorf (personal communication, 2004) has argued that a distinctive rock art motif found at sites in southeastern Colorado is a symbolic representations of nets used for capturing deer and other large game. The context for these symbols at gaps in volcanic dikes and rock alignment drive lanes is intriguing, but the symbolism for nets is open to interpretation, especially since no fragments of nets have been found. If Loendorf is correct, then the concept of nets and drive lanes to divert game was used on the southern Plains, and may have been applied to driving molting waterfowl into pens or open net corrals.

Tangible evidence for wooden snare components has been tentatively identified at the Kenton Caves (Lintz 1981). Thus, components for snare and net capture are not beyond the technological skills of the Middle Ceramic people of the region. However, no snare features have yet been archeologically identified from open sites. Similarly, no evidence for the prehistoric use of poisons in the Panhandle region has been documented.

Many active bird procurement implements are archeologically unidentifiable, and others are typically associated with other kinds of animals. For example, most Antelope Creek village sites contain abundant small projectile points and arrow shaft abraders, so clearly a bow and arrow technology existed. A wooden bow was found in the Kenton Caves (Lintz 1981). Archeologists know that the side notched and unnotched forms of Washita and

Table 11. Expectations of recovering archeological evidence of bird hunting methods.

	Dry Cave (Chance Preservation)	Open Campsites	River Banks	Playa Basin and Edges	Hill Top or Mesa Edges
Evidence of birds	Bones, eggs, feathers, skins	Bone, eggs, burials	Bones	Bones	Features, bones?
Bird Procurement Methods					
Passive					
Loop snares	Cordage snares	Not Expected	Not Expected	Not Expected	Not Expected
Spring pole snares	Cordage snares	Not Expected	Not Expected	Not Expected	Not Expected
Cage or basket fall trap with trigger	Basket and Trigger parts	Not Expected	Not Expected	Not Expected	Not Expected
Cribbed stick trap with trigger	Crib cage, Trigger parts	Not Expected	Not Expected	Not Expected	Not Expected
Log deadfalls	Trigger parts	Not Expected	Not Expected	Not Expected	Not Expected
Stone slab deadfalls	Trigger parts	Not Expected	Not Expected	Not Expected	Not Expected
Active—No Features					
Gathering eggs and fledging birds	Egg shells, bones	Egg shells (rare), bones?	Not Expected	Not Expected	Not Expected
Swimming after waterfowl	Decoy or reed cap, breathing tube	Not Expected	Not Expected	Not Expected	Not Expected
Decoys and disguises	Waterfowl decoys, quadruped skins?	Not Expected	Not Expected	Not Expected	Not Expected
Bird call devices	Bone and reed call parts	Bone call	Not Expected	Not Expected	Not Expected
Throwing rocks/wood	Pebble anomalies	Pebble anomalies	Not Expected	Pebble anomalies?	Not Anticipated?
"Clubs" and "Rabbit Sticks"	Rabbit stick clubs	Not Expected	Not Expected	Not Expected	Not Expected
"Bird Brushing" with torches and stick "clubs"	Not Expected	Not Expected	Not Expected	Not Expected	Not Expected
Slings	Slings?, spherical stone clusters	Spherical stones	Not Anticipated	Spherical stones	Not Expected
Bolos	Bolo preserved	Pebble anomalies	Not Anticipated	Pebble anomalies	Not Expected
Blowguns	Darts, blowgun?	Not Expected	Not Expected	Not Expected	Not Expected
Cast nets	Nets, notched stone weights	Notched stone weights	Notched stone weights	Notched stone weights	Notched stone weights
Bow and stone-tipped arrows	Bows, arrows, fore shafts, arrowheads	Arrowheads	Arrowheads	Arrowheads	Arrowheads
Bow and wood blunt tipped arrows	Bows, arrows, fore shafts, blunt-heads	Not Expected	Not Expected	Not Expected	Not Expected

Table 11. *(Continued)*

	Dry Cave (Chance Preservation)	Open Campsites	River Banks	Playa Basin and Edges	Hill Top or Mesa Edges
Evidence of birds	Bones, eggs, feathers, skins	Bone, eggs, burials	Bones	Bones	Features, bones?
Bird Procurement Methods					
Active with Fixed Features					
Hunting blinds	Not Expected	Not Expected	Not Anticipated?	Not Anticipated?	Not Expected
Hung noose snares along post alignment	Noose snares attached to rope	Abundant bones, limited species	Post hole alignment	Post hole alignment	Not Expected
Fixed hung nets along post alignment	Nets, notched stone weights	Abundant bones, limited species	Post holes, notched stone weights	Post holes, notched stone weights	Not Expected
Draw nets along fence posts	Nets, notched stone weights	Abundant bones, limited species	Post holes, remote sensed alignment	Post holes, remote sensed alignment	Not Expected
Nets on arched frames	Nets, notched stone weights, arched frames	Abundant bones, limited species	Sediment alignment	Sediment alignments	Not Expected
Pedestrian Drives of molting waterfowl	Not Expected	Abundant bones, limited species	Not Anticipated?	Not Anticipated?	Not Expected
Drive Lanes for molting waterfowl	Not Expected	Abundant bones from limited species	Drive lane alignments; aerial and remote sensed	Drive lane alignments; aerial and remote sensed	Not Expected
Raptor Pit Concealment (Manual Snatch)	Not Expected	Not Expected	Not Expected	Not Expected	Small pits or structures
Raptor pen traps	Not Expected	Not Expected	Not Expected	Not Expected	Postholes in small circles

Fresno points (called "bird points" by many collectors), respectively, were used to hunt bison and other large terrestrial mammals. The ethnographic record indicates that stone and iron-tipped arrows were used in avian procurement, and it may have to be acknowledged that bird hunting occasionally used chipped stone projectile tips. Recovery of wooden blunt tips used to stun birds and small game are not documented from open sites on the southern High Plains, but examples have been found in the dry shelters at the Kenton Caves (Lintz 1981).

Some birds may have been dispatched by means of curved wooden throwing sticks. These so-called "rabbit sticks" were a common occurrence in the northern parts of the Southwest, and in the Lower Pecos region of Texas. The closest documented recovery of these throwing sticks in the southern Plains is from 34CI50, which is one of the Kenton Caves (Lintz 1981; Lintz and Zabawa 1984:169; Renaud 1930:125). The age of these hunting implements is usually ascribed to the Archaic or "Basket-Maker" period, which predates the Middle Ceramic period. However, due to the perishable nature of these kinds of artifacts, the persistence of these weapons is unknown. Curved throwing sticks would be ideal implements for knocking perched birds and those fledging or molting birds into drive nets, or for use during night hunts with torches.

No tangible evidence exists for the use of slings, cast nets, or bolos. Net and bolo weights might be recognized as artifacts by the presence of lateral notches on pebbles, but little if any cultural modification is expected for missile stones. The best evidence for these technologies may be the recovery of pebble weights or missiles from the fine sediments in the bottoms of playa lakes. Disparity in the size of pebble missiles in playa-bottom silt and clays would present a geomorphic enigma that could best be interpreted as the product of human transport or deposition. Occasional sites found next to playas recover geologically anomalously large unmodified rocks, but in lieu of tangible forms of modification, there has been some hesitance to attribute them to human activities, much less to specific bird procurement technologies (Johnson 1995:203). Insofar as many farmers have dug slit trenches in the bottom of playa lakes to concentrate water and increase the agricultural use of their lands, ample opportunities exist to search for geomorphically aberrant missile pebbles.

Archeological evidence for the use of bird nets and drive lanes is unknown for the southern High Plains. In light of the low number of bird bones and the great diversity of waterfowl species recovered from prehistoric villages, it is unlikely that drives were used for capturing large numbers of molting birds. Remnants of nets and drive lanes might be archeologically detectable as post hole alignments or as anomalous crop-marks in fields. Initially, ground penetrating radar or other remote sensing tools could be used to search for buried soil anomalies such as post holes. Then such anomalies could be ground-truthed by mechanically scraping various playa bed areas. Since much of the Plains area has been plowed and cultivated, these approaches should be tried in playa areas where little or no plowing has occurred. The playas located within a few kilometers of prehistoric villages should also be considered, especially for examining those deposits below the plow zone. If post hole alignments were to be found, then sediments corresponding to the original ground surface contact could be collected and dated using radiocarbon or optical stimulation lumination methods. Archeological studies around playa lakes and streams have relied on collector interviews and/or on conducting systematic pedestrian surveys to search for burned rock, chipped stone tools, or pottery (Bement and Brosowske 2001; Brosowske and Bement 1998; Hughes and Speer 1981; Johnson 1995; Largent 1995; Winchell and Largent 1994). Such methods are appropriate for finding campsites, but they are not appropriate for finding evidence of waterfowl procurement methods. Other approaches should be considered.

The final kind of specialized bird procurement site is the eagle trap. The only eagle remains reported so far from the southern High Plains are from Early Ceramic period contexts at Canyon Country Club Cave. Eagle trap features may be expected to occur in remote areas far from village and hamlet sites. The archeological expression of eagle traps on open plains expanses may be difficult to identify, and none are known on the southern High Plains. The small masonry "hunting blinds" placed along cliff edges in the mesa and canyon lands of southeastern Colorado may be prehistoric eagle traps (cf. Nowak and Spurr 1989). However, assigning a specific function to these kinds of features may be impossible to prove or disprove.

SUMMARY AND CONCLUSIONS

The foregoing summary has explored the issues of avian occurrence on the Southern High Plains and their use by historic ethnographic groups. The study suggests that birds served a vital role in Pawnee cosmology, and some oral texts hint that some portions of Pawnee bands may have once lived in the southern High Plains. The cosmological summary indicate that birds were both economically and symbolically important, as manifested in oral traditions and material culture. Although their subsistence role is easier to objectively evaluate, archeologists should be mindful that humans are symbolic beings and that many of the recovered archeological remains likely carry deep structural meanings, although these meanings are not easily discerned or proven.

The archeological faunal evidence from Middle Ceramic period sites on the southern High Plains indicates that a variety of birds were captured and used during a period from 500 to 800 years ago. A total of 38 of the 45 kinds of birds from archeological sites dating to the past two millennia are reflected in eight Middle Ceramic period faunal assemblages for the southern Plains. These represent about 10 percent of the bird species that visit the region today. The absence of turkey remains from these assemblages is intriguing due to the quantities of meat these Plains-adapted birds potentially would have provided.

In terms of diversity, waterfowl accounts for 40 percent of the species and raptors contribute another 24.4 percent. Orioles, robins, thrashers, and cardinals may have contributed a relatively small amount of meat, but their colored feathers or other parts may have been symbolically valued. Based on the ethnographic data, eagles, hawks, owls, and perhaps vultures and crows may have been taken for symbolic purposes related to achieving power. Thus, not all birds may have been taken strictly for their subsistence value.

The bird procurement methods developed by prehistoric people have rarely been considered. The diversity and habitat of birds found in the archeological assemblages suggest that several distinct methods would have been used. The preceding survey of avian procurement methods and the list of archeological correlates provide a guide for future research into exploring how birds were obtained.

Many procurement methods involved technologies that required only the most simple tool kits. Nonetheless, many of these simplified methods have the potential to leave tangible evidence from either perpetually dry or perpetually wet environments. Rock shelters provide the best chance for the dry environmental preservation of perishable artifacts. But, these sites are admittedly rare on the southern High Plains. Details of the Canyon Country Club Cave excavations have yet to be published, and despite the recognition of historic sheep dung and other humus layers, the manuscript examines only the standard lithic, ceramic, and faunal remains (Hughes n.d.). Analyses of the High Plains rock shelter assemblages from 41HF86 and 41HF124 at Palo Duro Reservoir did not produced perishable remains, and the specific sampling of perishable remains from 10 wood rat nests in the valley did not identify any wooden artifacts (Quigg et al. 1993:310-331, 351-352, and Appendix K). Although perishable funerary goods are found with historic or Late Ceramic period crevice burials, none of the remains have been interpreted as bird procurement artifacts (Shafer et al. 1994). Although not common, the Middle Ceramic people also occasionally placed their dead in rock crevices. To date, none have yielded perishable remains (Shaller et al. 1997). The most robust perishable assemblages reported to date are from the various Kenton Caves in the Mesa and Canyon land region at the western end of the Oklahoma panhandle (Renaud 1930; Lintz 1981; Lintz and Zabawa 1984). Although these sites were dug in the late 1920s and 1930s, large assemblages of perishable remains were saved. Although stratigraphic control was lacking in the recovery of the perishable items, their age could be readily obtained by accelerator mass spectrometer analysis. Using this method, small artifact pieces can be dated without destroying the entire specimen.

Few opportunities to recover perishable artifacts from saturated deposits are known to exist in the High Plains region. The lowering of the Ogallala aquifer by historic well irrigation has dried up many seeps and springs in the region. Most upland playas hold water only on a seasonal basis, and most are dry during moderate to severe droughts. A few locations along ancient draws (e.g., Lubbock Lake) or deep depressions (e.g., Lake Tahoka) have some potential to contain remnants of perishable artifacts, but few attempts have been made to search the saturation zones.

Open air site deposits are subjected to moisture fluctuations and should not be expected to preserve wood or feather artifacts. Few implements associated with avian procurement technology consist of nonperishable remains. Concrete evidence for identifying hunting technologies in open sites should therefore be hard to come by. Those few recoverable objects suitable for killing birds, including projectile points and sling rocks, are suited for a wide range of game or are observed in ambiguous functional contexts. Village sites commonly contain projectile point tips, but based on the abundance of the large game remains found at these sites, they are rarely thought to have played a role in bird procurement. However, the ethnographic literature often cites the bow and arrow as a preferred weapon for avian procurement.

Most bird procurement sites are located far from human habitation sites. The three most likely settings are the forested rivers and creek bottomlands, near playa lakes, and on remote hilltops. The archeological recovery of unusually large rock clasts in alluvial deposits cannot confidently be attributed to cultural behavior, since discrete flood events can occasionally transport and deposit widely spaced cobbles on to fine terrace sediments. The recognition of anomalously large rock clasts in playa bottom sediments, however, including walls of slit trenches cut by farmers, may be an excellent place to search for net weights, sling ammunition, and/or bolo stones, because high velocity alluvial processes do not naturally move large rocks in playa basins.

Some kinds of avian procurement methods may have left tangible feature evidence such as specialized constructed brush barrier walls, drive lanes, net alignments, fixed snare anchors, and/or pit traps. Aerial reconnaissance and photographic interpretation, coupled with remote sensing (ground penetrating radar or magnetic gradiometer) and mechanical stripping along the margins of playa basins, may be fruitful approaches for finding these features. Until field efforts attempt to confirm the potential evidence discussed above, the actual bird procurement practices used prehistorically must remain in the realm of speculation. Although archeologists have provided considerable information about prehistoric big game hunting, our understanding of the full range of hunting activities remains shallow, meager, and biased. The diversity of avian fauna in Middle Ceramic period sites on the southern High Plains suggests that these people had a much more robust range of subsistence and ceremonial activities than what is usually ascribed to Plains Villagers.

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END NOTES

1. The occurrence of stored calcium in the hollow bone cavities of female birds representing species with single yearly brooding events can be an important archeological indicator for interpreting the season of prehistoric site occupation.

2. Some playa lakes have been historically stocked with fish for private and public recreation, or mosquito control (Smith 2003:71-72). Local lore claims that fish eggs can be naturally introduced by birds, either from eggs attaching to bird's feet or eggs surviving the bird's digestion. However, the absence of fish in most playas suggests that this transmission mode is not a realistic option. Short of collapsing tornadoes and water spouts periodically dropping river fish into playas, the natural mechanism for moving live fish into closed drainage basins is limited.

3. The Native American view of birds serving as messengers between humans and celestial beings is analogous to many Christian's common acceptance in the existence of spirits, cherubs, and angels as personal winged messengers, guides, and protectors.

4. The Pawnee name for the traditional feathered war bonnet was an allegory of a comet, with its trailing tail (Weltfish 1977:377). Comets were Morning Star's projectiles and were related to him through the symbolism of fire, flint, and meteorites (Von Chamberlain 1982:142). The eagle and hawk plumage in war bonnet strengthens the symbolic connective and protective powers given to earth-bound mortals by various celestial beings.

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Stable Isotope Analysis of Diet of the Mexican War Dead from the Battle of Resaca de la Palma

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ABSTRACT

The battle of Resaca de la Palma was the second battle fought in the United States-Mexico War, near present day Brownsville, Texas, on May 9, 1846. U.S. troops were victorious, and hundreds of dead Mexican soldiers were buried in several mass graves. In 1967, one of these graves was excavated by archeologists at The University of Texas at Austin and was found to contain at least 30 young to middle-aged adults, including three or more females. In 1993, carbon and nitrogen stable isotope analyses were conducted on bone collagen and apatite samples from six adult individuals from Resaca de la Palma, including one definite male, and five of indeterminate sex. The mean carbon and nitrogen isotopes values are -10.9 ± 3.36‰ and 11.7 ± 1.45‰, respectively.

Overall, the $\delta^{13}C$ values of five individuals fall within the general range of maize-dependent populations. However, $\delta^{15}N$ values of some individuals are more enriched than those found in maize-dependent populations, suggesting freshwater or marine resources may have been part of the diet. In addition, values are not tightly clustered, but instead show dietary variability between individuals. The coastal component of the diet is most likely explained by the fact that soldiers may have been stationed at, or drafted from, coastal locations, which would have been closest to the battlefield site. The lack of clustering of values also suggests a diverse group of new soldiers reflecting the diverse isotopic signature of their home diets, and/or the presence of older soldiers with signatures of dietary variability inherent in a "soldier's" diet, since rations were not issued, and soldiers (or their *soldaderas*) had to get food for themselves.

INTRODUCTION

Several stable isotope studies (Huebner 1991, 1994; Huebner et al. 1996; Perttula 2001) have been published in Texas with regards to prehistoric burial sites in South Texas, since little archeological evidence is available to help narrow down possible dietary choices represented in the regional archeological record. In contrast, few if any stable isotope studies have been published of the historical war dead, possibly because historical documentation, particularly for the United States military, is exceptionally detailed. During the Mexican war, U.S. sergeants reported on the provisions given to soldiers, and soldiers would often write in diaries or letters about their rations, or lack thereof, and the large variety of foods they could purchase in Mexico (Bloom 1956). In contrast, similar documents for Mexican soldiers are hard to come by, possibly due to the differences in rationing of Mexican soldiers and the nature of the Mexican army in general (DePalo 1997).

Lacking sufficient documentary evidence, the stable isotope study of the Mexican war dead from the Battle of Resaca de la Palma presented here can suggest the nature of the adult diet consumed by Mexican soldiers. However, because of bone collagen turnover rates, it would take at least 10 years of eating a soldier's diet before isotope values would be dramatically affected (Libby et al. 1964). Since the length of service of the soldiers presented in this study is unknown, the isotope values of some soldiers may reflect their diets in service to a variable degree, while others represent diet from home lands prior to service. Specifically, results presented in this article may be indicative of dietary variability during the time of military service, or whether or not these individuals originally came from similar locations, assuming that diets from one particular location were not widely variable at that time. Thus, the stable isotope results from the Resaca de la Palma war dead provide a glimpse into the adult diet of the average Mexican soldier, both prior to and possibly during service.

HISTORICAL CONTEXT

The Battle of Resaca de la Palma was the second battle of the Mexican-American War, and took place near present day Brownsville, Texas, on May 9th, 1846. The U.S. was victorious, but prior to the battle and the war itself, the Texas-Mexican border from Matamoros to San Antonio was not free from strife. Ten years earlier, in 1836, Texas had not yet officially joined the United States. These rebellious Texans were already fighting against the Mexican army, as the Mexican government still considered most of Texas part of Mexico and wanted to enforce its laws. With the majority of its forces still in the core of Mexico, the Mexican expedition army of about 6,000 troops that campaigned into Texas was poorly equipped, undernourished, and exhausted from the long trek of 600 miles over rough terrain into South Texas (DePalo 1997). Nevertheless, the Mexican army's expedition into Texas ended in victory at the Alamo on March 6, 1836.

By 1846, Texas had joined the United States and the Mexican-American War had begun. At that time the Mexican Army had (on paper) 18,000 permanent troops, including 10,000 active militia, scattered about the country in regional garrisons (DePalo 1997). The average Mexican soldier was Indian or mestizo and could have come from anywhere in the country (Haecker and Mauck 1997). Indian soldiers were often unable to speak Spanish, and were largely unprepared for the sometimes freezing temperatures they would face in Texas (DePalo 1997; Haecker and Mauck 1997). If a soldier was a volunteer, length of service lasted eight years, while conscripts served 10 years (DePalo 1997). Soldiers to be drafted were chosen in a lottery at the end of October, and in April of 1846, men with no place of residence or employment were arrested, tried, and mustered into the army (DePalo 1997).

Services provided by the army to soldiers were inconsistent: pay was erratic, clothes and equipment were often lacking, and rations were not usually issued (DePalo 1997). The lack of government supply depots meant supplies were not readily available, and soldiers were forced to find or buy their own food. A soldier's wife or girlfriend, and in some cases her children, would often accompany him; she was referred to as a *soldadera*. *Soldaderas* were responsible for foraging, cooking, sewing, and the maintenance of equipment (DePalo 1997). The questionable dedication of drafted soldiers, combined with inconsistent services, led to a high desertion rate and an inadequately prepared army.

The overwhelming victory of the U.S. soldiers at the Battle of Resaca de la Palma in May 1846 resulted in the injury or death of hundreds of Mexican soldiers. U.S. military forces buried the nearly 200 Mexican War dead in mass graves, while 400 injured soldiers were left behind by the retreating Mexican forces that did not have sufficient transportation for them (DePalo 1997). A recent study of the paleopathology of the skeletal remains of 30 individuals from one of these mass graves revealed that several soldiers had healed injuries from past engagements (Baker et al. 2006). These soldiers also exhibited indications of arduous physical activity in their lower limbs, and nearly half had unhealed projectile or sharp-force trauma.

MATERIALS AND METHODS

Materials

A small portion of the battle site of Resaca de la Palma was excavated in 1967 by archeologists from The University of Texas at Austin. Excavation of one of the mass burials led to the recovery of the skeletal remains of 30 young to middle-aged adults, including three or more females. Samples were selected for stable isotope analysis by the late Jeff Huebner, who sent them to Krueger Enterprises, Inc. (now Geochron laboratories) in 1993. Stable carbon and nitrogen isotope analysis was conducted on six individuals from Resaca de la Palma. Table 1 lists the skeletal inventory information available for those samples from the Texas Archeological Research Laboratory (TARL) Osteological Database at The University of Texas at Austin. Unfortunately, an accession number was not listed for one of the samples (titled RES ?) and so inventory information for that individual is not available. Burial type, skeletal elements recorded, and state of preservation are also listed in Table 1. One individual was determined to be male, and five individuals were of indeterminate sex. This introduces the possibility that the stable isotope samples selected of individuals of unknown sex may be *soldaderas*.

As the sample was originally analyzed in 1993, and sample records are currently unavailable (although they may be in the future), the methods used for sample preparation and analysis are not known. However, methods used in later studies by Huebner, where analysis was performed at

Table 1. Skeletal Inventory Information for Resaca de la Palma Stable Isotope Samples, TARL Osteological Database.

Burial#	Burial Type	Sex	Cranial elements	Teeth	Long Bones	Vertebrae	Innominate	Preservation
RES 11	Single	Indet	X	X	X	X		FE
RES 31	Composite	?			X		X	FE
RES 16	Composite	?			X	X	X	WE
RES ?	?	?	?	?	?	?	?	?
RES 19	Composite	?			X		X	WE
RES 17	Single	Male	X			X	X	FG

Key: ?=information unavailable; X=skeletal element(s) present; FE=fragmentary, eroded; WE=whole, eroded; FG=fragmentary, good condition; Indet = indeterminate

Geochron laboratories (Huebner 1994), may be comparable. Stable isotope analysis by Geochron of bone collagen at the Mitchell Ridge site followed these methods: Bone samples were first cleaned manually, then in Alconox, and given an overnight bath in 1N acetic acid until reaction with carbonates ceased. Samples were then neutralized and crushed to a 1 mm powder and given an additional acid bath to ensure removal of carbonates. One gram of bone powder was demineralized in 1N HCL and the collagen separated by decantation and filtration. HCL was added and the mixture dissolved by boiling. The resulting liquid was filtered through fine fiberglass and filtrate evaporated and transferred to crucibles where it was dried in an oven to form a crystalline gelatin. 20 mg of bone gelatin and excess CuO were placed in a pyrex tube, evacuated, sealed, and held in an oven at 500º C overnight. Resulting CO_2, N_2, and H_2O were cryogenically separated into carbon and nitrogen gas for analysis. Analyses of gases for $\delta^{13}C$ and $\delta^{15}N$ were performed on a Micromass 903 triple collecting mass spectrometer. Results are expressed in ‰ as δ values where:

$$\delta^{13}C\ (‰) = \left[\frac{^{13}C/^{12}C\ \text{sample}}{^{13}C/^{12}C\ \text{standard}} - 1\right] \times 1000$$

$$\delta^{15}N(‰) = \left[\frac{^{15}N/^{14}N\ \text{sample}}{^{15}N/^{14}N\ \text{standard}} - 1\right] \times 1000$$

Stable Isotope Analysis

Isotopes are the atoms of an element which only differ in their number of neutrons. Because additional neutrons increase the mass of an atom, the carbon (^{12}C) atom is referred to as 'light,' while its isotope ^{13}C has an additional neutron, and is thus referred to as 'heavy.' Heavy isotopes react more slowly than light isotopes in chemical reactions (Katzenberg 2000). What results in the tissue of an organism is a ratio of heavy isotopes to light isotopes that is the result of the exclusion of some of the heavier isotopes in the organism's use of that element, called an isotope effect. Thus, the isotope effect results in different isotopic ratios in an organism's tissues which affects fractionation (Katzenberg 2000). Fractionation is defined as the difference in the ratio of heavy and light isotopes in an organism compared to the relative composition of a known standard (Katzenberg 2000). The standard for carbon is PeeDee Belemite (PDB), which is no longer naturally available, so vPDB or a synthetic of this standard is now used. For nitrogen, the standard is AIR, the atmospheric standard of nitrogen.

Terrestrial Carbon

Stable carbon isotope values are the expression of the use of carbon by an organism in its tissues, and these are dependent on where the carbon is derived, and in plants, the photosynthetic process. Terrestrial plants uptake carbon from the atmosphere (value of -7‰), and depending on the type of photosynthesis used, each type will affect fractionation differently (Katzenberg 2000). There are three different types of photosynthesis: C_3 pathway, C_4 pathway, and CAM (Crassulacean Acid Metabolism) pathway; each of the types of plants which use these types of photosynthesis (C_3 plants, C_4 plants, and CAM plants) will have different fractionation values. C_3 plants are the most depleted in ^{13}C (value -26‰), while C_4 plants are the most enriched (-12‰) (Katzenberg 2000). Major classes of plant foods are defined by the pathway they utilize. C_3 plants include temperate plant species such as trees, while C_4 plants include tropical grasses, such as maize, sorghum, millet, and sugar cane (Katzenberg 2000). Edible CAM plants in the South Texas region, many of which yield δC^{13} values in the C_4 plant range, include prickly pear and yucca (Huebner 1991).

Animals consume carbon when they consume plants, and depending on the pathway, the stable carbon isotope values of animals will differ. To measure carbon in animals, researchers can use collagen or carbonate (apatite). Collagen is the structural protein in bone, while carbonate is the mineral component. Collagen in bone can take 10-30 years to replace itself (turnover), and therefore it is a better estimate of lifetime diet (Libby et al. 1964). The effect of fractionation in the collagen of animals has been studied experimentally, and in general collagen is 5‰ more enriched in $\delta^{13}C$ than the diet food (Ambrose and Norr 1993; Tieszen and Fagre 1993). In addition, there are differences between collagen and carbonate with respect to the type of dietary information they provide. Experimental studies have shown that collagen reflects the carbon from protein in the diet, while apatite is a better reflection of carbon in the total diet (Ambrose and Norr 1993; Tieszen and Fagre 1993).

Freshwater and Marine Carbon

Freshwater aquatic plants have $\delta^{13}C$ values similar to terrestrial C_3 plants, but because the source of carbon for marine organisms is marine bicarbonate (value of 0‰) rather than atmospheric carbon, marine plants are 7‰ enriched in ^{13}C when compared to terrestrial plants. Thus, the values of C_3 plants and marine plants significantly differ, but ^{13}C values overlap between C_4/CAM plants, sea grasses, and marine algae. Only in terrestrial habitats dominated by C_3 plants can a marine component to the diet be distinguished using ^{13}C values alone (Pate 1994; Schoeninger and DeNiro 1984).

Terrestrial Nitrogen

In addition to stable carbon isotopes, stable nitrogen isotopes are also useful in establishing the character of the human or animal diet, particularly in determining the role of protein in the diet. Nitrogen is taken up by plants from organic matter in the soil, and plant values range between 3‰ and 6‰, with the exception of nitrogen-fixing plants like legumes that have values closer to the atmospheric standard (0‰). When animals eat the plants, they excrete light nitrogen isotopes, keeping proportionately more of the heavy isotopes in their tissues. Thus, nitrogen values reflect a trophic level effect, where nitrogen values become more enriched in ^{15}N as one moves up the food chain. Specifically, collagen is 3‰ more enriched in ^{15}N than the diet food (Katzenberg 2000).

Freshwater and Marine Nitrogen

^{15}N enriched nitrates and ammonia are present in freshwater and marine environments as atmospheric N_2 dissolves in water. In addition, in both freshwater and marine environments, an additional source of available nitrogen is available through nitrogen fixation by bacteria and blue-green algae. As a result of these differences, $\delta^{15}N$ values for aquatic organisms are more enriched than those of terrestrial organisms (Pate 1994). Since marine food chains are longer than terrestrial food chains, with more ^{15}N tropic enrichment steps, and marine plants and marine herbivores are usually minor portions of terrestrial animal diets, diets based primarily on marine foods or terrestrial foods should be distinguishable based on bone collagen $\delta^{15}N$ values (Pate 1994; Schoeninger and DeNiro 1984). Collagen $\delta^{15}N$ values for terrestrial mammals range from 1.9‰ to 10‰, while values for marine mammals range from 11.7‰ to 22.9‰ (Pate 1994; Schoeninger and DeNiro 1984).

RESULTS

Delta ^{13}C values for bone apatite and collagen, and $\delta^{15}N$ values for bone collagen, from the Resaca de la Palma burials are provided in Table 2. Individuals from Resaca de la Palma have collagen ^{13}C values that range between -7.4‰ to -16.1‰ with a mean of -10.9‰ and a standard deviation of 3.3‰. There is an 8.6‰ difference between the most enriched and the most depleted ^{13}C value in the sample. Apatite ^{13}C values range between -2.9‰ to -10.7‰ with a mean of -5.87‰ and a standard deviation of 2.9‰. Lastly, $\delta^{15}N$ values range between

Table 2. $\delta^{13}C$ and $\delta^{15}N$ values for Resaca de la Palma Individuals.

Sample	$\delta^{13}C$ Apatite	$\delta^{13}C$ Collagen	$\delta^{15}N$ Collagen
RES11	-10.7	-16.1	10.4
RES31	-7.1	-12.3	11.7
RES16	-6.7	-12.4	14.1
RES ?	-2.9	-7.4	10.1
RES19	-3.4	-7.5	11.8
RES17	-4.4	-9.7	12.5
MEAN	-5.87	-10.9	11.77
RANGE	-2.9 to -10.7	-7.4 to -16.1	10.1 to 14.1

10.1‰ to 14.1‰ with a mean of 11.77‰ and a standard deviation of 1.45‰.

Experimental studies suggest animals eating a monotonous diet should have $\delta^{13}C$ (and also $\delta^{15}N$) values that fall within 1‰ of each other (DeNiro and Schoeninger 1983). Thus, the difference in $\delta^{13}C$ values for collagen at 8.6‰ suggests that the diets of the individual Mexican soldiers in the Battle of Resaca de la Palma sample are highly variable. Even after removing the highest value of -16.1‰, the difference of 5‰ between the most enriched and the most depleted ^{13}C value suggests diets that are still quite variable in $\delta^{13}C$ when compared to a monotonous diet. The range of $\delta^{15}N$ values also suggests diets that were variable in $\delta^{15}N$. However, these values are more clustered relative to $\delta^{13}C$ values, and the difference between the most enriched and the most depleted $\delta^{15}N$ value is only 4‰ (see Table 2).

INTERPRETATION AND DISCUSSION

The results are presented in two figures, both bivariate plots based on data tables included here. Figure 1 plots $\delta^{13}C$ collagen along the X axis and $\delta^{13}C$ apatite along the Y axis, based on the results provided in Table 2. Figure 2 plots $\delta^{13}C$ collagen values along the X axis and $\delta^{15}N$ values along the Y axis based on data in Table 3.

Figure 1 compares the Resaca de la Palma sample to a predictive model that outlines a range of dietary groups developed by Krueger and Sullivan (1984), and later by Huebner (1991), based on collagen and apatite spacing. The $\delta^{13}C$ values show that the Resaca de la Palma individuals fall into four general dietary groups: one individual corresponds with the dietary group that has a C_3 plant and marine food diet, two lie in the overlap between a mixed maize diet or a C_4/CAM plant and C_3 meat diet, one individual corresponds with a mixed food diet of mainly maize, and two individuals correspond with a C_4 plant and C_4 meat diet.

Even though the collagen values show a range of variability spanning four different diet types, five of the six individuals have isotopic values indicative of a diet relying on C_4 plants rather than C_3 plants. These values are not unexpected given the importance of maize in the traditional Mexican diet, as well as its use historically in South Texas, such as at the San Juan Capistrano mission in San Antonio (Cargill and Hard 1999). However, two other sources may account for the high C_4 values.

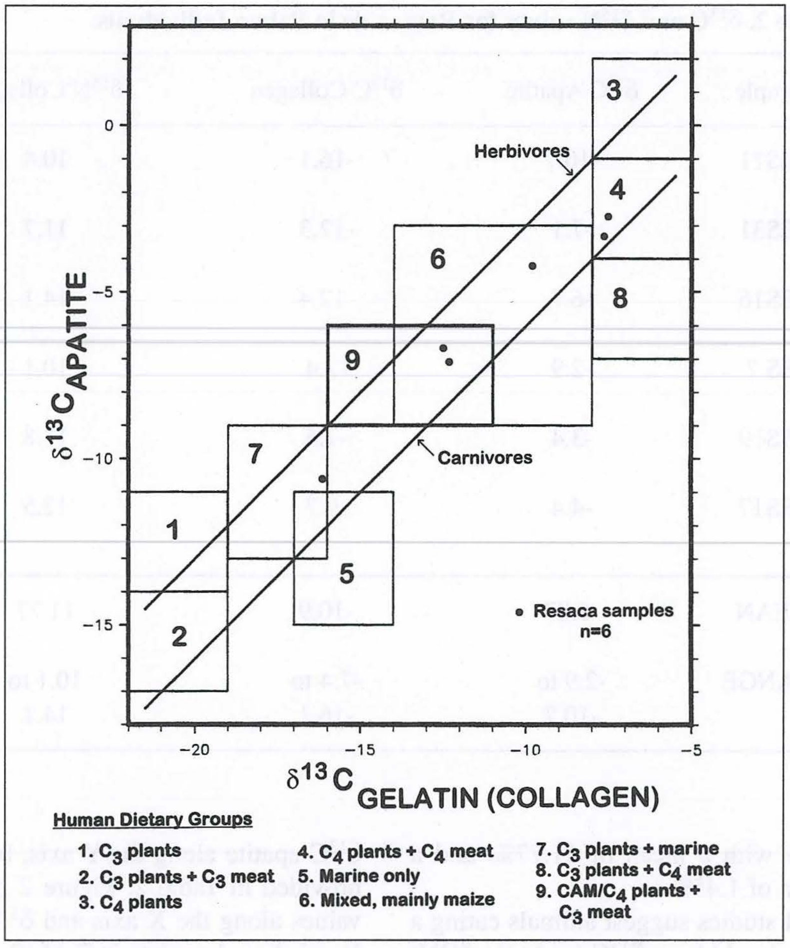

Figure 1. $\delta^{13}C$ isotopic signatures from the Resaca de la Palma sample, compared with the model diets from Krueger and Sullivan (1984) and Huebner (1991).

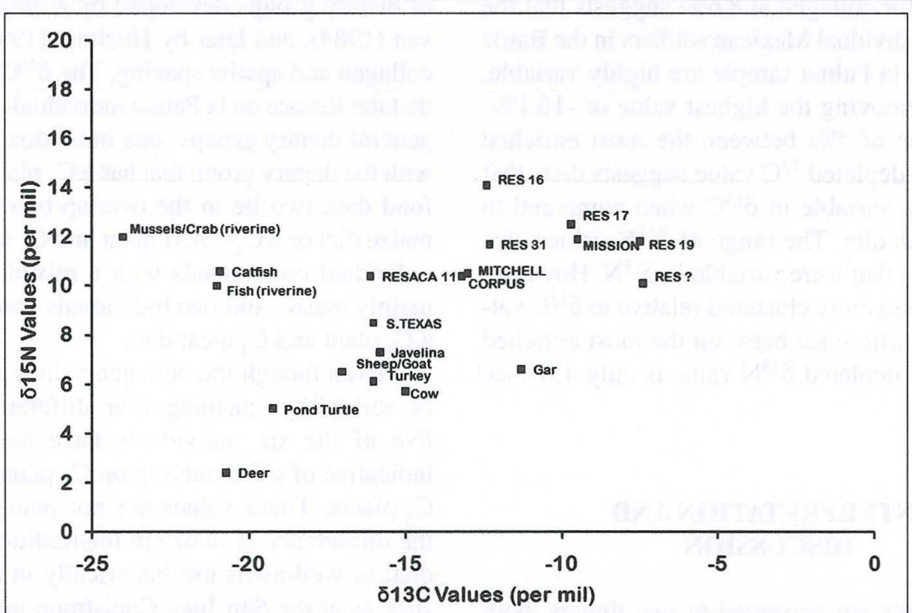

Figure 2.Collagen $\delta^{13}C$ and $\delta^{15}N$ values for Resaca de la Palma individuals, selected sites, and fauna.

Table 3. $\delta^{13}C$ and $\delta^{15}N$ Values for Selected Prehistoric and Historic sites, as well as for Fauna.

	$\delta^{13}C$ collagen	$\delta^{15}N$ collagen	Reference
Prehistoric Humans			
Corpus Christi (Coastal), mean value	-13	10.5	Huebner 1994
South Texas (Inland)	-16	8.5	Huebner et al. 1996
Mitchell Ridge (Coastal), mean value	-13.2	10.4	Huebner 1994
Historic Humans			
San Juan Capistrano mission, mean value	-9.5	11.9	Cargill and Hard 1999
Resaca de la Palma, mean value	-10.9	11.8	This study
Fauna			
Mussels/Crab (Riverine)	-24	12	Huebner 1994
Fish (Riverine)	-21	10	Huebner 1994
Gar	-11.3	6.6	Huebner 1994
Deer	-20.7	2.4	Huebner 1994
Fauna (historic)			
Cow	-15	5.7	Cargill and Hard 1999
Javelina	-15.8	7.3	Cargill and Hard 1999
Catfish	-20.9	10.6	Cargill and Hard 1999
Pond Turtle	-19.2	5	Cargill and Hard 1999
Turkey	-16	6.1	Cargill and Hard 1999
Sheep/Goat	-17	6.5	Cargill and Hard 1999
	$\delta^{13}C$ muscle	**$\delta^{15}N$ muscle**	
Marine Fish (Sea Grass)	-8.7	8.3	Huebner 1994
Marine Fish (Open water)	-15.7	13.3	Huebner 1994

Plants common to Texas and Mexico such as yucca and prickly pear have a CAM isotopic signature in the same range as C_4 plants (Huebner 1991). These plants may also have been part of the diet, depending on cultural preferences, or especially if food supplies were not available and foraging became a necessity. Furthermore, sea grasses and marine algae also have isotopic values that fall into the range of C_4 plants, and if marine organisms eating such plants were consumed, these values would be passed along to the Resaca de la Palma individuals. It is difficult to distinguish the types of animals that would have been consumed by these individuals using $\delta^{13}C$ values alone. While deer are known to eat C_3 plants and have produced values consistent with C_3 consumers (Land et al. 1980; Huebner 1994), the types of plants eaten by other animals, especially domesticated animals for which food is supplemented by humans, can vary, leading to a range of different values.

Figure 2 compares the Resaca de la Palma samples (see Table 2) to sample values from selected prehistoric and historic sites in Texas, as well as to faunal collagen samples (see Table 3). The only samples not plotted from Table 3 are the marine fish, since these are meat values, and Figure 2 only includes collagen values. The values for marine fish in Table 3 are more enriched than their collagen values would be due to fractionation; experimental studies indicate that muscle (meat) $\delta^{13}C$ values are approximately 2.25‰ more enriched than collagen (Tieszen and Fagre 1993). Figure 3 demonstrates that the Resaca de la Palma samples are most similar to the mean sample value from the San Juan Capistrano mission (discussed in detail below), but are also similar to coastal Texas prehistoric samples.

As suggested by the values in Figure 1, $\delta^{13}C$ values in Figure 3 indicate a greater proportion of C_4 plants in the diet than C_3 plants. However, if the elevated C_4 signature was the result of maize consumption alone, the $\delta^{15}N$ values would be expected to fall near the range of about 8 to 9‰ reported for maize agriculturalists (Schoeninger and DeNiro 1984). Instead, $\delta^{15}N$ values for four of the Resaca individuals (RES31, RES16, RES19, and RES17) deviate from the high end of the maize agriculturalist range by 2.7‰ to 5.1‰, suggesting consumption of proteins greater than those provided by maize alone. The $\delta^{15}N$ values for cow, pond turtle, sheep/goat, and turkey, sampled by Cargill and Hard (1999) at Mission San Juan Capistrano, are all too low to account for the $\delta^{15}N$ values of the Resaca de la Palma individuals, once the trophic effect of 3‰ is taken into account (Table 4). However, values for javelina, catfish, riverine fish, riverine mussel/crab, and marine fish in open water have sufficiently high $\delta^{15}N$ values to account for the Resaca de la Palma sample values. Interestingly enough, the $\delta^{15}N$ values for RES31, RES16, RES19, and RES17 fall within the range for marine mammals (11.7‰ to 22.9‰, Schoeninger and DeNiro 1984). Thus, $\delta^{15}N$ values suggest a strong marine or freshwater component to the diet of at least four of the Resaca de la Palma individuals.

Comparative Sample: Mission San Juan Capistrano

Cargill and Hard (1999) reported that the stable isotope values at Mission San Juan Capistrano were typical of maize-dependent populations. In support of these results, historical records also indicated that maize was an important component of the diet. However, archeological evidence of beef consumption at the site did not correspond with the isotopic evidence. Instead, the stable isotope values indicated that individuals that died and were buried at the mission were consuming freshwater or near-shore marine resources. Cargill and Hard (1999)

Table 4. $\delta^{15}N$ Collagen Values Adjusted to Account for Trophic Level Effect.

Fauna	$\delta^{15}N$ collagen	Adjusted $\delta^{15}N$ (+3‰)
Mussels/Crab (Riverine)	12	15
Fish (Riverine)	10	13
Gar	6.6	9.6
Deer	2.4	5.4
Cow	5.7	8.7
Javelina	7.3	10.3
Catfish	10.6	13.6
Pond Turtle	5	8
Turkey	6.1	9.1
Sheep/Goat	6.5	9.5
$\delta^{15}N$ muscle*		
Marine Fish (Sea Grass)	8.3	9.05
Marine Fish (Open water)	13.3	14.05

*Values were first converted into collagen values (-2.25‰ to account for enrichment of muscle relative to collagen), then adjusted for trophic effect.

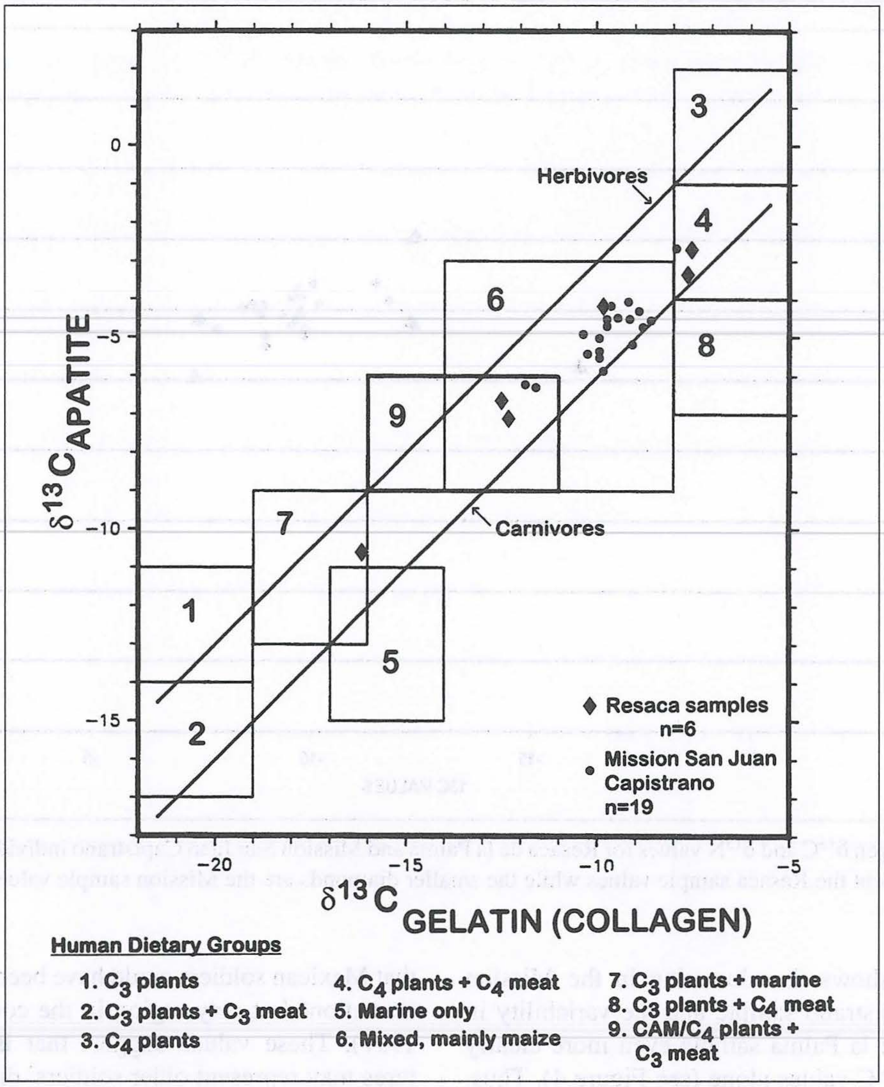

Figure 3. $\delta^{13}C$ isotopic signatures from the Resaca de la Palma sample and the Mission San Juan Capistrano sample, adapted from Krueger and Sullivan (1984) and Huebner (1991). The large diamonds are the Resaca sample values while the smaller dots are the Mission sample values.

concluded that the isotopic signatures of the mission inhabitants reflected the diets of their native homes, rather than the mission diet of maize and beef. Since the sample mean reported for Mission San Juan Capistrano is so similar to that of the individuals at Resaca de la Palma, a more in-depth comparison of the values at these two sites is presented here.

Mission San Juan Capistrano dates to the 18th century, and is located in San Antonio. Thus, the comparison of these two sample sets is relevant, as foods available both historically and in the general region are comparable. At San Juan Capistrano, stable carbon (both collagen and apatite) and nitrogen samples of 19 individuals were analyzed. These values were plotted along with the Resaca de la Palma values in Figures 3 and 4. These figures suggest that while diets overall were similar for these two groups of individuals, the diets of the Resaca de la Palma individuals were far more variable, while the Mission San Juan Capistrano values are more clustered. The majority of the Mission San Juan Capistrano values fall within the mixed maize dietary group (see Figure 3), and none indicate a significant C_3 component in the diet, while one of the Resaca individuals does fall in the C_3 plant consumer dietary group. Without $\delta^{15}N$ values, however, Figure 3 does not represent the entirety of the dietary differences between these two samples. Plotting both $\delta^{13}C$ and

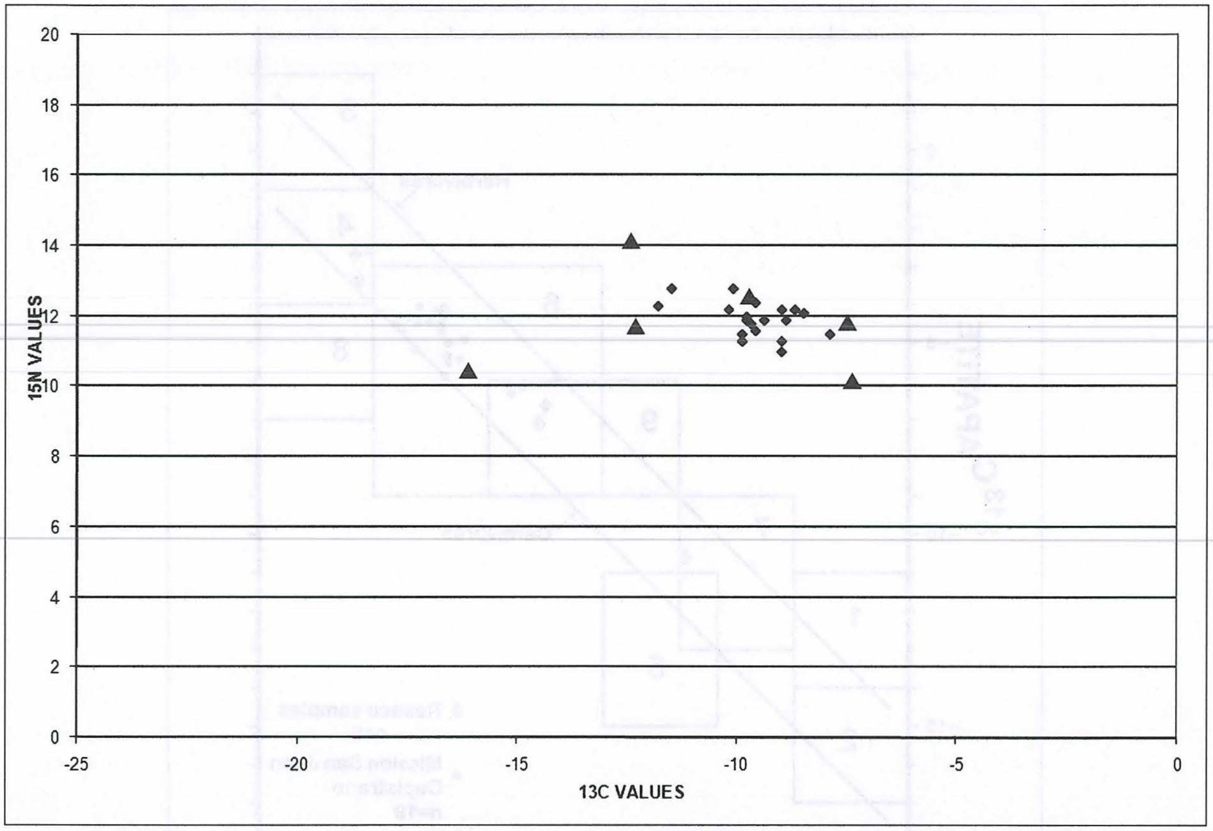

Figure 4. Collagen $\delta^{13}C$ and $\delta^{15}N$ values for Resaca de la Palma and Mission San Juan Capistrano individuals. The larger triangles represent the Resaca sample values while the smaller diamonds are the Mission sample values.

$\delta^{15}N$ values shows the clustering in the Mission San Juan Capistrano sample and the variability in the Resaca de la Palma sample even more clearly than using $\delta^{13}C$ values alone (see Figure 4). Thus, the stable isotope values for the Resaca de la Palma individuals, especially when compared with the Mission San Juan Capistrano values, indicate dietary variability between these individuals.

CONCLUSIONS

The $\delta^{13}C$ values of five individuals from the Resaca de la Palma battlefield fall within the general range of maize-dependent populations. $\delta^{15}N$ values suggest that freshwater or marine resources may have been part of the diet of at least four individuals, and terrestrial fauna were almost certainly part of the diet for all individuals. In addition, the isotopic values are not tightly clustered, but instead show dietary variability between individuals. The fact that individuals from Resaca de la Palma show such dietary variability is probably due to the fact that Mexican soldiers could have been drafted from, or stationed at, any region in the country (DePalo 1997). These values suggest that isotopic signatures may represent older soldiers' diets in military service, newer soldiers' homeland diets, or a mix of both; all should be characterized by high levels of variability. Since older soldiers in service were not relying on a standard diet of government-issued rations, variability as a result of the movements of the soldier into different regions and whatever foodstuffs were available would have been great, especially during the time surrounding the Mexican-American war, where troops would have been moving about the Texas-Mexican border (DePalo 1997). Diets of newer soldiers would have been variable as well, considering that new soldiers may well have been conscripts, volunteers, or unwilling draftees or vagrants, with dietary differences as a result of their region of origin as well as their cultural preferences (mestizo or Indian).

Unfortunately, stable carbon and nitrogen values alone cannot satisfactorily distinguish new soldiers from old, or those that might have hailed from similar or different home lands. One avenue of research that would help to distinguish the geographic origin of the Resaca de la Palma soldiers is stable oxygen isotopes. The oxygen isotope signature in the tissues of an animal will reflect the signature of its water source, and depending on climate and rainfall patterns, different geographic regions have characteristically different oxygen isotope values (Katzenberg 2000). For example, White et al. (2002) use oxygen isotopes to determine the geographic identity of sacrificial victims at the Feathered Serpent pyramid at the site of Teotihuacan in Mexico. Both tooth enamel and bone collagen oxygen isotope values are used to reflect residence in childhood and adulthood.

Since tooth enamel is formed during childhood, while bone values reflect long-term diet, oxygen isotopes can provide information on the geographic identity of individuals both as children and adults. White et al.'s (2002) results indicated that some individuals were "born and raised" in the area, while others were immigrants from foreign locations who had lived in the area for their adult life, while others still were recent immigrants. In addition, an important part of the study was the use of a geographic baseline to determine local oxygen isotope values, and in this case a contemporaneous archeological skeletal sample was taken in Teotihuacan to reflect the local oxygen isotopic value, and other average values were available for other relevant locations in the area to determine local or foreign residence. A similar study could conceivably be undertaken using the Resaca de la Palma samples. In that case, oxygen isotope sample values for different regions in Mexico and Texas would also be needed to establish geographic baselines to interpret the results.

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Caddo Ceramic and Lithic Artifacts from the Washington Square Mound Site (41NA49) in Nacogdoches County, Texas: 1985 Texas Archeological Field School Investigations

Timothy K. Perttula, with the contributions of Bo Nelson and Mark Walters

INTRODUCTION

In 1985, the Texas Archeological Society (TAS) held their annual Field School at the Washington Square Mound Site (41NA49) in Nacogdoches, Texas. The site is a regionally significant multiple mound center built and occupied by the prehistoric ancestors of the Caddo Nation of Oklahoma between ca. A.D. 1250-1425. It is also a formally designated State Archeological Landmark, and the artifacts recovered from the site during the Field School are considered to be held-in-trust collections under the Antiquities Code of Texas. These artifacts are curated at Stephen F. Austin State University (SFA) in Nacogdoches.

The Principal Investigator for the TAS Field School at Washington Square Mound was Dr. James E. Corbin of SFA. Corbin and Hart (1998) summarized the overall results of the archeological investigations at the site, including the 1985 TAS work—amidst a summary of the work done there by SFA since the late 1970s during various university field schools and other investigations (see Corbin 1980, 1982a, 1982b, 1983, 1984, 1985a, 1985b; Corbin et al. 1984; Hart 1980, 1982; Kisling 1983). The ceramics and other artifacts recovered from the site during the course of the TAS Field School were not analyzed or reported as part of the Corbin and Hart (1998:76) article, although they had mentioned that this work was intended, and they remained unanalyzed and unreported more than 22 years later. In late 2007, the TAS agreed to a proposal I submitted to the Board of Directors to complete the analysis of the recovered prehistoric artifacts from the 1985 TAS Field School, synthesize the archeological findings gained from the study of the artifacts and what they may tell about the history of Caddo use of the mound center, and compile an inventory of the recovered prehistoric artifacts.

HISTORY OF THE ARCHEOLOGICAL INVESTIGATIONS

The Washington Square Mound site is an important prehistoric Caddo multiple mound center in East Texas. The site, most of which is on property owned by the Nacogdoches Independent School District, is located on an upland interfluve (310 feet amsl) between Banita Creek on the west and La Nana Creek on the east (Figure 1). Both creeks are

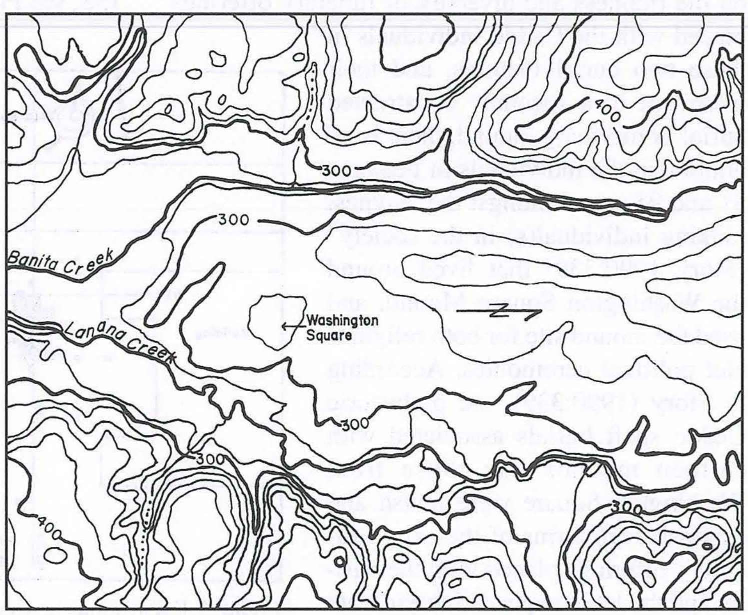


Figure 1. The general setting of the Washington Square Mound site between Banita and La Nana creeks (from Corbin and Hart 1998:Figure 3). Reproduced with the permission of the Texas Archeological Society.

tributaries to the Angelina River. This part of East Texas is within the Pineywoods vegetational region (Diggs et al. 2006:Figure 41).

The site appears to have primarily been occupied by ancestors of the modern-day Caddo Indian peoples between ca. A.D. 1250-1425 (Corbin and Hart 1998:Table 4; Perttula et al. 2008). Based on a pooled sample of calibrated radiocarbon dates from a number of features, Corbin and Hart (1998:74) suggest that the primary occupation at Washington Square Mound dates to cal. AD 1268-1302, but this calibrated age range is unrealistically narrow given the character of the pooled samples (Corbin and Hart 1998:Table 4).[1]

During this occupation, the Caddo erected at least three mounds, the University Mound or Mounds 1/2, Mound 3, and Mound 4 or the Reavely-House Mound (Corbin and Hart 1998:Figure 4). Mound 1/2 in Area C of the site was constructed by the Caddo over an important building (Corbin and Hart 1998:71), as was apparently also the case for Mound 3, the largest of the known mounds at Washington Square (Corbin and Hart 1998:55). Mound 4, the Reavely-House Mound, is a Caddo burial mound with at least six known burial pits, based on archeological investigations by SFA in 1979 and 1981.

In the course of that work in the Reavely-House Mound, initially designed "to obtain a stratigraphic profile of the mound" (Corbin and Hart 1998:67), two shaft burial features were identified and excavated in the mound: Feature 31 and Feature 95. Based on the richness and diversity of funerary offerings placed with the Caddo individuals in these two burial features, and their interment in a specially constructed burial or mortuary mound, there is no doubt that the individuals in Features 31 and 95 were amongst the "highest ranking individual(s) in the society" (Story 1990:339) that lived around the Washington Square Mound, and used the mound site for both religious and political ceremonies. According to Story (1990:339), the prehistoric Caddo shaft burials associated with earthen mounds like those from Washington Square were lavish and expensive (in terms of the exotic funerary offerings placed with the burials and the labor expended to excavate the shaft burial as well as construct the mortuary mound). They also had "the distinction of being placed in a relatively large and deep pit dug into, or capped by, a mound...these burials were embellished by numerous offerings, many of materials indicating the existence of long distance trade networks possibly controlled by elites."

In addition to the SFA investigations in Mounds 1/2 and Mound 4, significant amounts of excavations have been conducted in areas between the mounds that must have been the scene of important political and religious rituals as well as community feasts. The majority of that work has been completed in Area A, midway between Mounds 1/2 and Mound 4 (Figure 2), and Area B about 70 m to the south. Corbin (1984) had previously noted that this area, specifically south of N235 and east of W110 in Area A on the site grid (see Figure 2), had well-preserved archeological deposits with concentrations of artifacts (especially ceramic sherds) and pit features. The 1985 TAS excavations, consisting of 101 m^2 of hand-excavated units (Corbin and Hart 1998:60), were confined to Area A (Figure 3a).

Corbin and Hart (1998:60-68) have noted that non-mound features on the Washington Square Mound site consist of post holes, charcoal-filled or smudge pits (filled with charred plant remains, including wood charcoal, pine cones, and corn cobs), larger pits (including Feature 115, Figure 3b) with charred plant remains (corn, beans, and nutshell), sherds, and other artifacts, and four distinctive shallow sherd-filled pits (Features 45, 120, 134, and 138, see Figure 3b) with sherds from many vessels

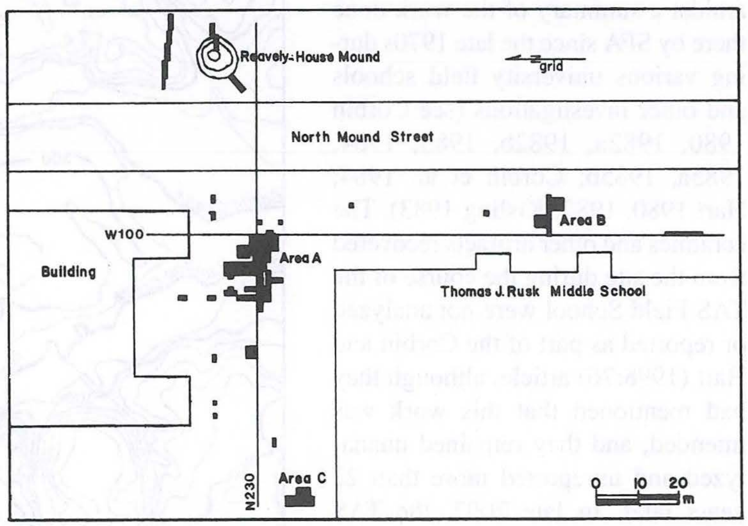


Figure 2. Excavations in Areas A, B, and C (Mounds 1/2) at the Washington Square Mound site (from Corbin and Hart 1998:Figure 14) prior to the TAS Field School in 1985. Reproduced with the permission of the Texas Archeological Society.

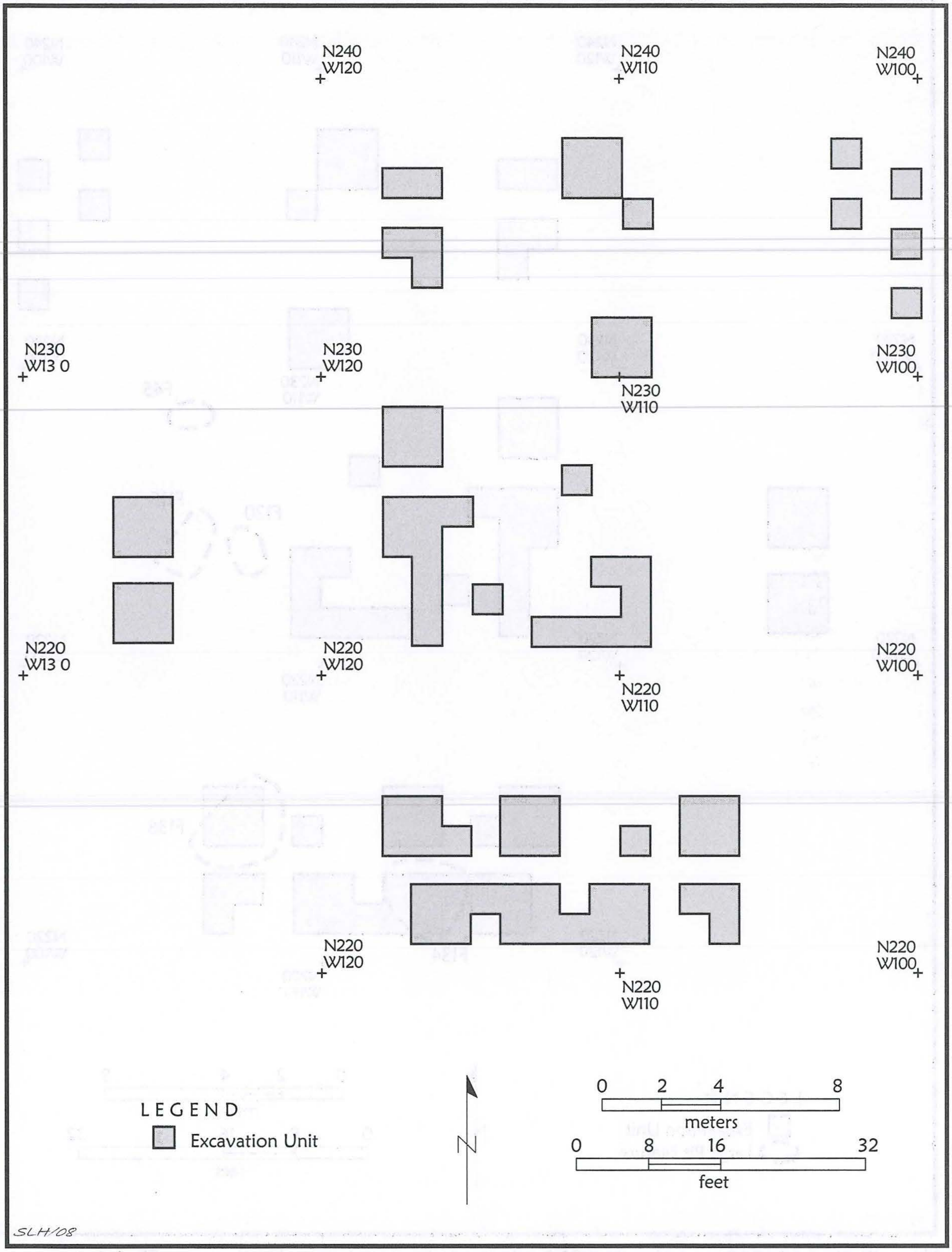


Figure 3a. Plan of the TAS excavations in 1985: hand-excavated units.

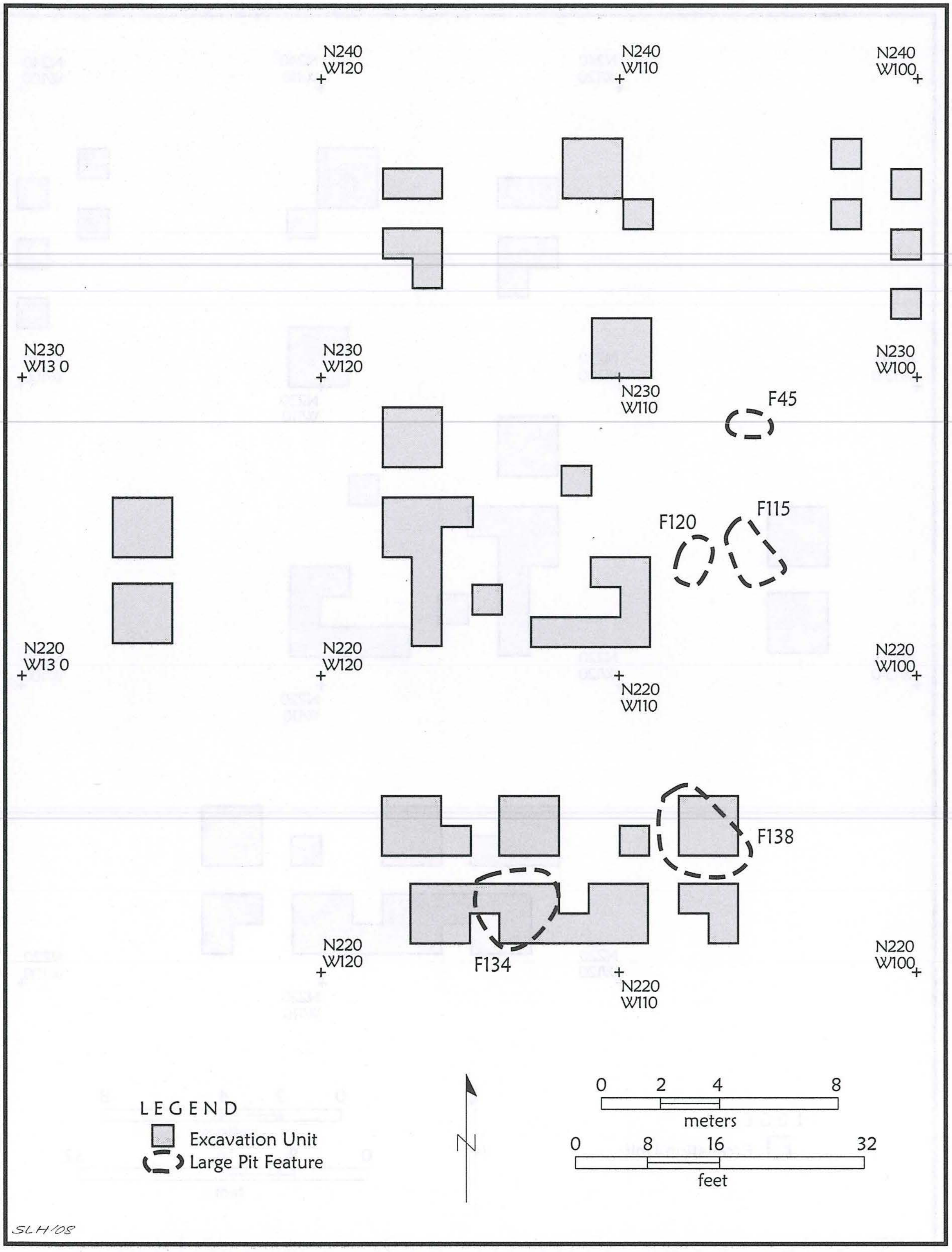


Figure 3b. Plan of the TAS excavations in 1985: hand-excavated units and selected large ceramic-filled pits.

represented in each pit (Corbin and Hart 1998:64). Three of these pits cover at least 2 m^2 in area (see Corbin and Hart 1998:Figures 23 and 24).

GOALS AND OBJECTIVES OF THE ARTIFACT ANALYSIS

The goals and objectives of the analysis of the recovered prehistoric artifacts from the Washington Square Mound site include (1) completing the analysis and write-up of the artifacts from the 1985 TAS excavations employing methods of analysis current in East Texas Caddo ceramic and lithic studies (see Perttula 2008a, 2008b; Shafer 2007); (2) integrate the write-up of the analysis of the artifacts into an overall synthesis of the archeological findings from the 1985 TAS Field School based on the recovered artifacts; (3) prepare a final inventory of the 1985 prehistoric artifact collections, with separate inventories for the lithic and ceramic remains; and (4) deliver the final inventory and completed manuscript to the TAS for publication in either the *Bulletin of the Texas Archeological Society*, a special publication of the Texas Archeological Society, or a joint publication of the Texas Archeological Society and Stephen F. Austin State University.

CERAMIC VESSEL SHERDS

Not including the 2715 sherdlets (i.e., sherds less than 1.5 cm in length and width), there are 3405 plain and decorated sherds in the collections from the 1985 TAS Field School at the Washington Square Mound site (Table 1; see also Appendix 1 and 2, on file with the TAS and Stephen F. Austin State University). The majority of the recovered sherds are from two clusters in the southern part of Area A that are associated with a number of large pit features (Figure 4a, see also Figure 3b).

Including a few sherds from unknown contexts in the Area A excavations, the ceramic sherd assemblage comprises 1461 plain sherds (43%) and 1944 decorated sherds (57%). Earlier excavations in non-mound areas at the site recovered 6084 sherds, of which 46% were plain and the remainder had a decorated exterior surface (Hart 1982).

The plain/decorated sherd ratio (P/DR) of the 1985 TAS collection from the Washington Square Mound site is 0.75; in the 1979-1981 collections (Hart 1982), the P/DR is 0.87. The P/DR ratios from the two collections are not significantly different, thus suggesting that there is an homogeneous Caddo ceramic assemblage at the site where much of the vessel surface of now fragmented pots had been covered with some sort of decoration, most commonly by the brushing of exterior rim and body surfaces.

Decorated Sherds

The decorated sherds from the Washington Square Mound site are readily separated into utility wares or fine wares, following the distinctions discussed by Schambach and Miller (1984) at the Cedar Grove site in the Great Bend area in southwestern Arkansas. These distinctions in the kinds of ceramic vessels manufactured and used by the Caddo at the site include apparent differences in temper, surface treatment, vessel forms, and decorative methods.

Utility Ware Sherds

Utility wares generally are jars and simple bowls used for the cooking and storage of foods, have a coarse temper, and lack burnishing, polishing, or slipping on interior and exterior vessel sherd surfaces. Such vessel sherds are decorated with brushing, incising, punctations (tool, cane, or fingernail), and appliqued elements, either by themselves or in combination with one or more of these decorative methods (see Rogers and Perttula 2004; Perttula et al. 1995; Schambach and Miller 1984; Suhm et al. 1954; Suhm and Jelks 1962). Fine wares, on the other hand, consist exclusively of engraved and engraved-punctated vessel sherds from carinated bowls, some simple bowls, and bottles. The fine ware vessels and vessel sherds more frequently are smoothed, burnished, and/or polished on the exterior vessel surface, have a finely crushed temper, and were used for the serving of food stuffs and liquids.

Utility wares comprise 93.7% of the decorated sherds from the Washington Square site (Table 2). Engraved fine wares are correspondingly rare, only accounting for 6.3% of the 1985 decorated sherd assemblage. In the larger assemblage studied by Hart (1982) from the site, fine ware sherds comprise only 9.3% of the decorated sherds (n=3261).

On the basis of the rim sherds, the utility wares account for 92.1% of the decorated sherds from the site (Table 2). The principal utility wares—solely on the proportion of rim sherds—include sherds from incised (27.1% of the utility ware rims), punctated (23.8%), brushed (21.2%), brushed-punctated

Table 1. Provenience of plain and decorated sherds from the Washington Square Mound site, 1985 TAS excavations.

Unit (N-W coordinates)	Decorated sherd	Plain sherd	N
210-110	10	28	38
211-106	4	19	23
211-109	182	161	343
211-110	12	5	17
211-111	5	2	7
211-112	52	20	72
211-113	53	23	76
211-115	70	40	110
211-116	75	28	103
212-106	38	39	77
212-107	88	61	149
212-109	33	18	51
212-110	46	32	78
212-112	46	33	79
212-113	26	35	61
212-114	56	37	93
212-115	58	30	88
212-116	55	46	101
214-106	117	85	202
214107	124	108	232
214-109	5	–	5
214-112	29	23	52
214-113	24	35	59
214-115	28	22	50
214-116	43	31	74
215-106	57	25	82
215-107	14	32	46
215-112	20	16	36
215-113	24	21	45
215-116	27	15	42
221-109	68	66	134
221-110	35	29	64
221-111	17	10	27
221-112	1	3	4
221-116	45	44	89
221-125	4	1	5
221-126	6	3	9
222-109	30	29	59
222-111	-	11	11
222-114	10	2	12
222-125	2	2	4
222-126	5	5	10
223-109	14	5	19
223-110	3	3	6
223-116	3		3

Table 1. *(Continued)*

Unit (N-W coordinates)	Decorated sherd	Plain sherd	N
224-116	14	9	23
224-117	11	5	16
224-125	7	1	8
224-126	9	2	11
225-116	9	6	15
225-117	3	3	6
225-125	7	4	11
225-126	15	13	28
227-116	3	4	7
227-117	10	3	13
228-116	6	3	9
228-117	8	3	11
230-109	6	26	32
230-110	10	9	19
231-109	5	3	8
231-110	2	7	9
233-116	4	3	7
233-117	1	1	2
234-100	7	5	12
234-116	3	2	5
234-117	–	1	1
234-125	1	–	1
235-102	1	–	1
235-109	2	3	5
236-100	–	3	3
236-110	3	8	11
236-116	17	6	23
236-117	1	2	3
237-110	4	12	16
237-111	15	19	34

(15.9%), and incised-punctated (11.3%) vessels. Those utility ware decorative method categories without rim sherds are likely from the bodies of jars with one of the five aforementioned rim decorative treatments.

Incised

The incised rim and body sherds from the Washington Square Mound site are dominated by simple straight or geometric decorative elements, including horizontal, opposed, diagonal, and cross-hatched incised lines on jars (Table 3 and Figures 5 and 6). Only 4% of the incised sherds—including 7% of the rims—have curvilinear lines as the decorative element (Figure 7e). The highest densities of incised sherds occur in three small clusters in the southern part of Area A, including Features 134 and 138 (see Figure 4b).

The most common decorative elements on the rims are sets of diagonal lines (see Figure 6b-c) or horizontal lines (see Figure 6e), probably from Dunkin Incised and Davis Incised vessels; these comprise 61% of the incised rims (see Table 3). Opposed (see Figures 6a and 7c) and cross-hatched (see Figures 5a, 6d, and 7d) incised elements from Dunkin Incised and Maydelle Incised vessels account for another 24% of the rims.

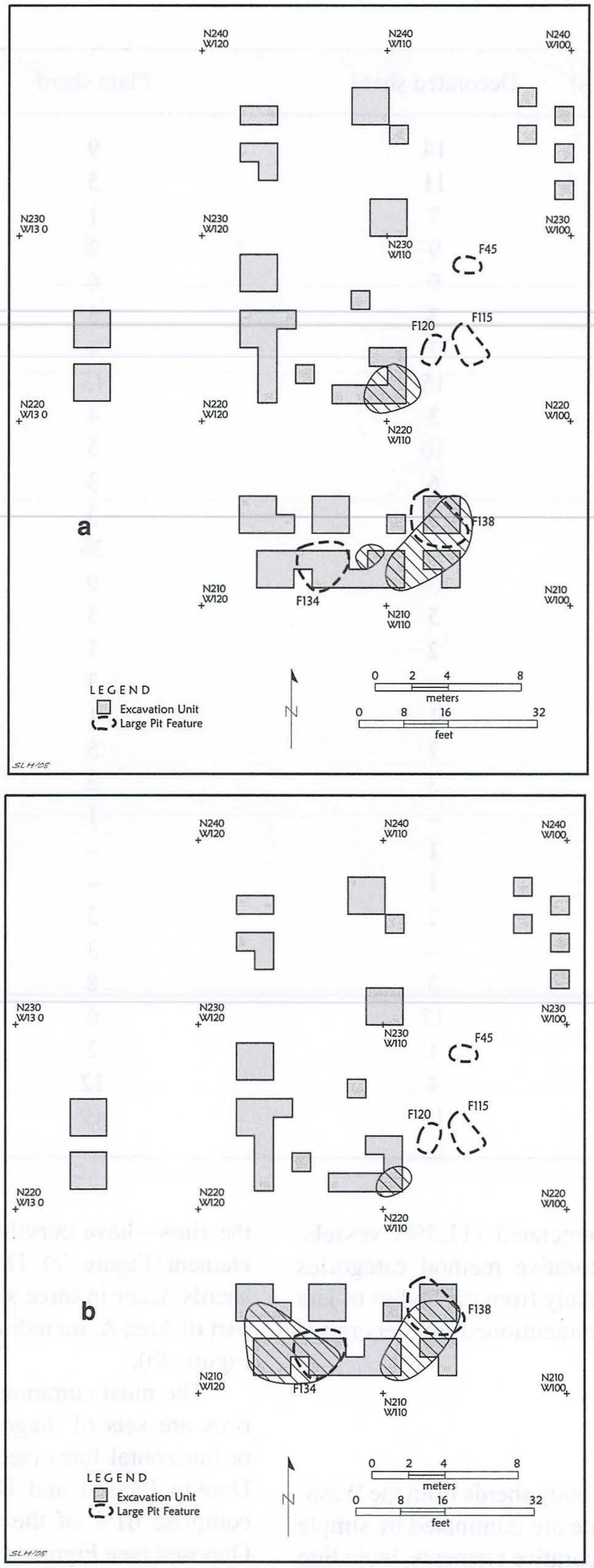


Figure 4. Distribution of ceramic artifacts in the TAS-excavated portions of Area A at the Washington Square Mound site, with the hatched areas representing the areas with the highest densities of artifacts for that particular category of artifacts; a, total sherds; b, incised sherds.

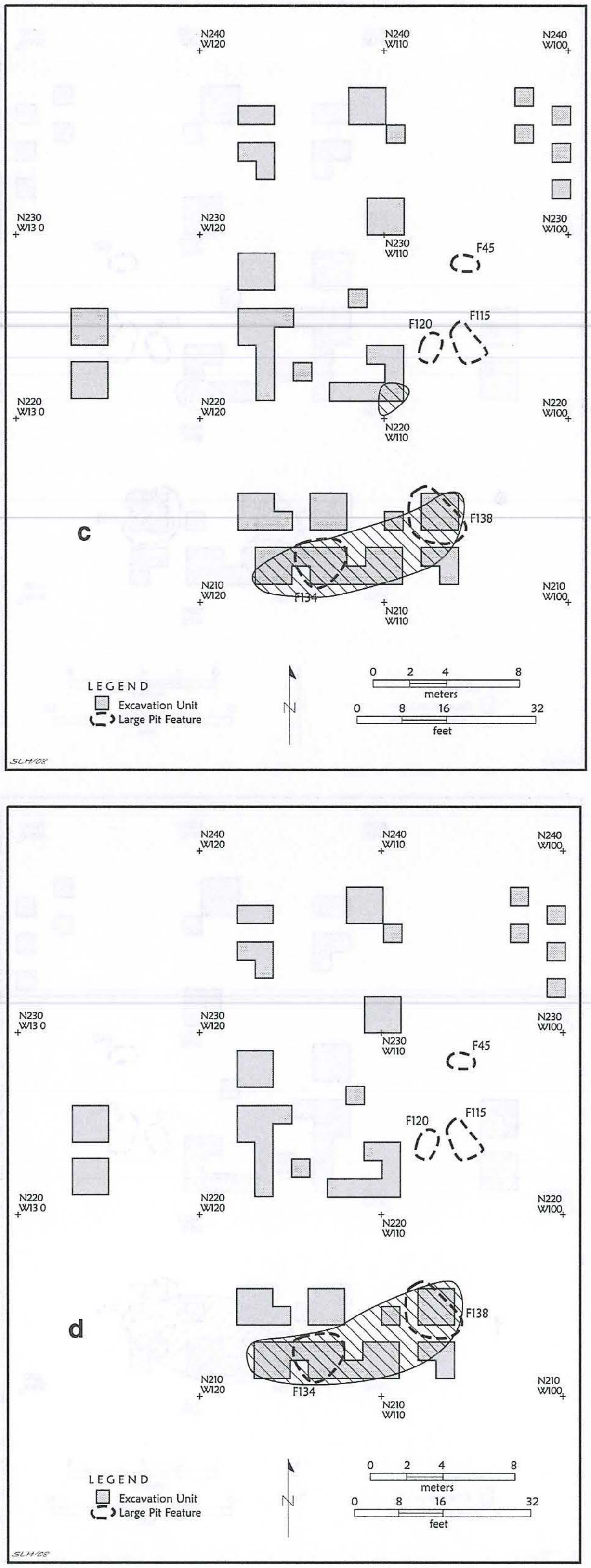
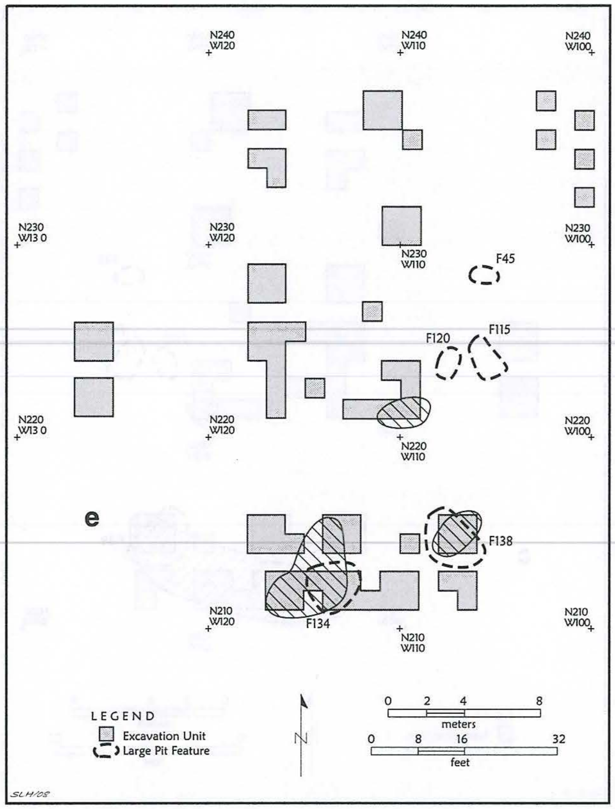


Figure 4. Distribution of ceramic artifacts in the TAS-excavated portions of Area A at the Washington Square Mound site, with the hatched areas representing the areas with the highest densities of artifacts for that particular category of artifacts; c, punctated sherds; d, brushed sherds.



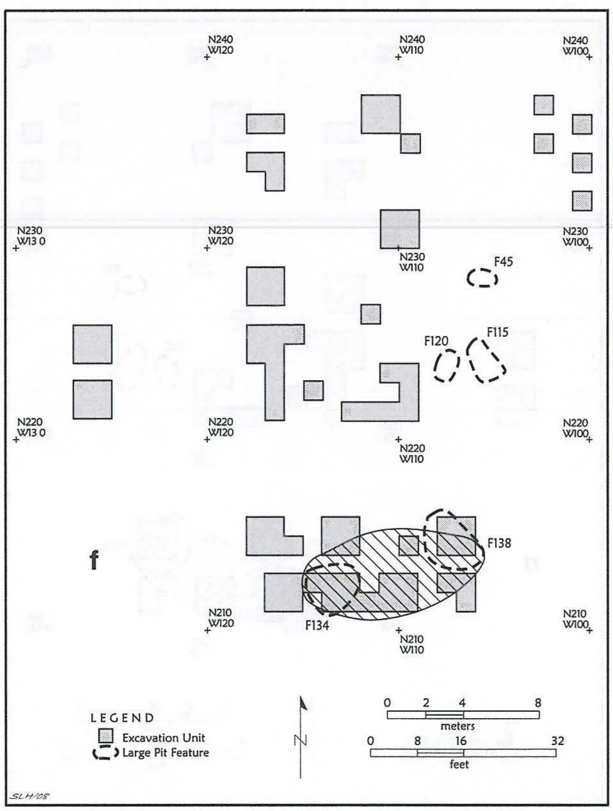


Figure 4. Distribution of ceramic artifacts in the TAS-excavated portions of Area A at the Washington Square Mound site, with the hatched areas representing the areas with the highest densities of artifacts for that particular category of artifacts; e, brushed-punctated sherds; f, incised-punctated sherds.

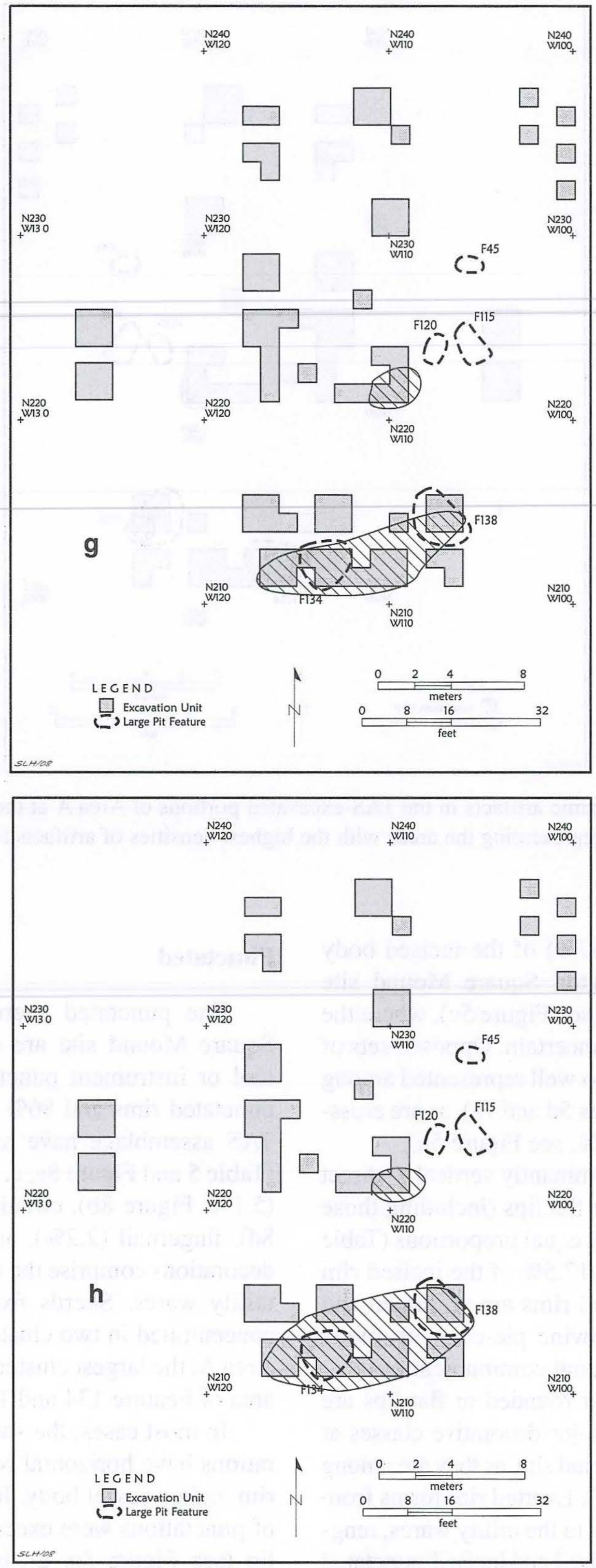


Figure 4. Distribution of ceramic artifacts in the TAS-excavated portions of Area A at the Washington Square Mound site, with the hatched areas representing the areas with the highest densities of artifacts for that particular category of artifacts; g, engraved sherds; h, plain sherds.

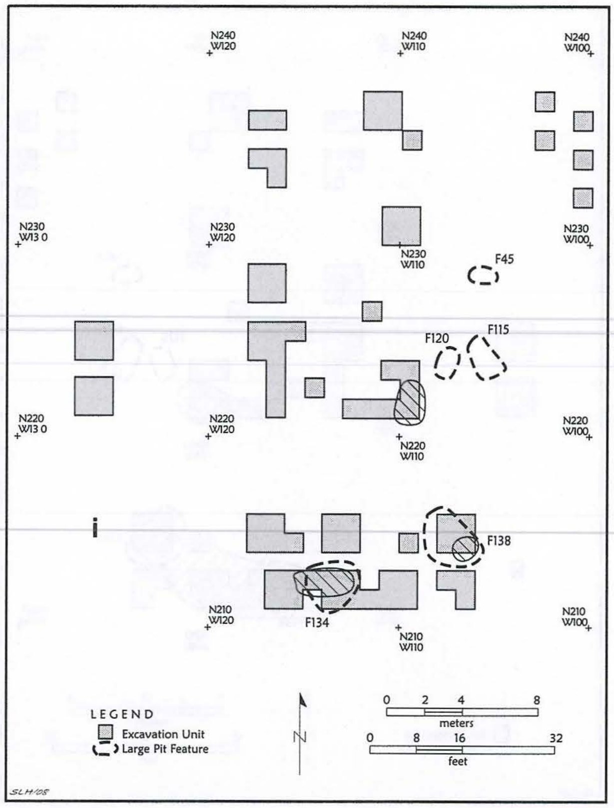


Figure 4. Distribution of ceramic artifacts in the TAS-excavated portions of Area A at the Washington Square Mound site, with the hatched areas representing the areas with the highest densities of artifacts for that particular category of artifacts; i, pipe sherds.

A large proportion (47%) of the incised body sherds from the Washington Square Mound site have sets of parallel lines (see Figure 5c), where the orientation of the lines is uncertain. Opposed sets of incised lines (21%) are also well represented among the body sherds (see Figures 5d and 7a), as are cross-hatched incised lines (8.8%, see Figure 5b).

Incised rims are predominantly vertical or direct in profile, with rounded or flat lips (including those with exterior folded lips) in equal proportions (Table 4); everted rims comprise 17.5% of the incised rim sample. Two of the incised rims are scalloped and one has a distinctive Redwine pie-crust lip mode (Mark Walters, 2008 personal communication).

Direct rims with either rounded or flat lips are prevalent in each of the major decorative classes at the Washington Square Mound site, as they are among the plain wares (see below). Everted rim forms from jars, however, are restricted to the utility wares, ranging from 14-17% in the incised and incised-punctated vessel sherds to 33-69% in the punctated and brushed-punctated rim sherds (see Table 4). The engraved serving vessels have direct rims.

Punctated

The punctated sherds from the Washington Square Mound site are dominated by the use of tool or instrument punctates. Almost 78% of the punctated rims and 86% of the body sherds in the TAS assemblage have tool punctated decorations (Table 5 and Figure 8a, c, e). Linear (6.2%), circular (5.1%, Figure 8b), circular and tool (0.6%, Figure 8d), fingernail (2.2%), and cane (1.7%) punctated decorations comprise the remainder of the punctated utility wares. Sherds from punctated vessels are concentrated in two clusters in the southern part of Area A, the largest cluster being associated with the area of Feature 134 and 138 (see Figure 4c).

In most cases, the sherds with punctated decorations have horizontal rows of punctations on the rim and/or vessel body. In a few cases (8%), a row of punctations were executed along the edge of the lip (see Figure 8a, e), but generally, punctations on the rim began under the lip and then were well spaced on the rim, ending at the rim-body juncture of the vessel. About 10% of the punctated sherds do

Table 2. Decorative methods represented in the 1985 sherd assemblage from the Washington Square Mound site.

Decorative Method	Rim	Body	N
Utility ware			
Brushed	32	1037	1069
Incised	41	215	256
Punctated	36	142	178
Brushed-Punctated	24	82	106
Incised-Punctated	17	65	82
Brushed-Incised	–	68	68
Brushed-Appliqued	–	31	31
Brushed-Incised-Punctated	1	7	8
Pinched	–	10	10
Brushed-Punctated-Appliqued	–	5	5
Appliqued	–	7	7
Incised-Appliqued	–	2	2
Subtotal	151	1671	1822
Fine ware			
Engraved	12	107	119
Engraved-Punctated	1	2	3
Subtotal	13	109	122
Totals	164	1780	1944

Table 3. Incised decorative elements.

Decorative element	Rim	Body	N
Cross-hatched lines	4	19	23
Opposed lines	6	46	52
Parallel lines	–	101	101
Vertical lines	1	2	3
Horizontal and vertical lines	2	1	3
Horizontal lines	11	1	12
Diagonal lines	14	–	14
Diagonal and cross-hatched lines	–	1	1
Single straight line	–	37	37
Curvilinear lines	2	7	9
Concentric lines	1	–	1
Totals	41	215	256

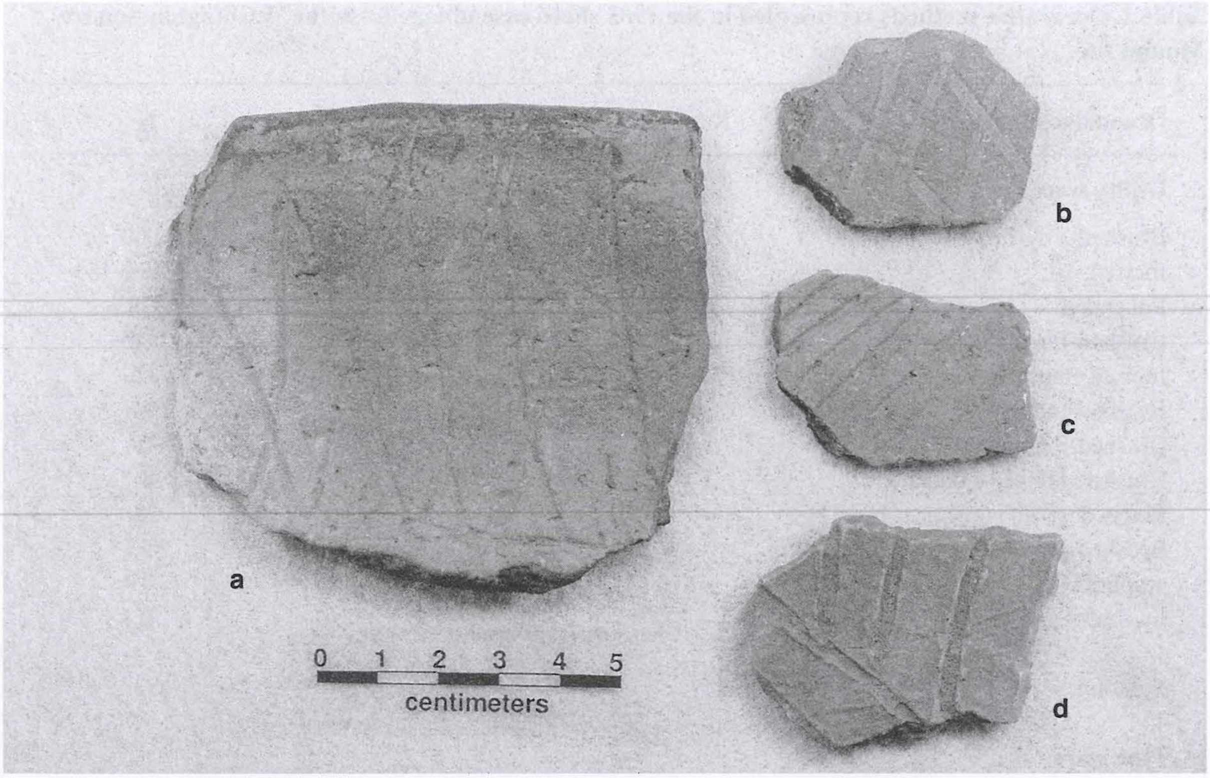


Figure 5. Incised rim and body sherds: a-b, cross-hatched; c, parallel; d, opposed. Provenience: a, N212 W114, level 2; b, N230 W110, level 1; c, N211 W109, level 1; d, N212 W107, fill.

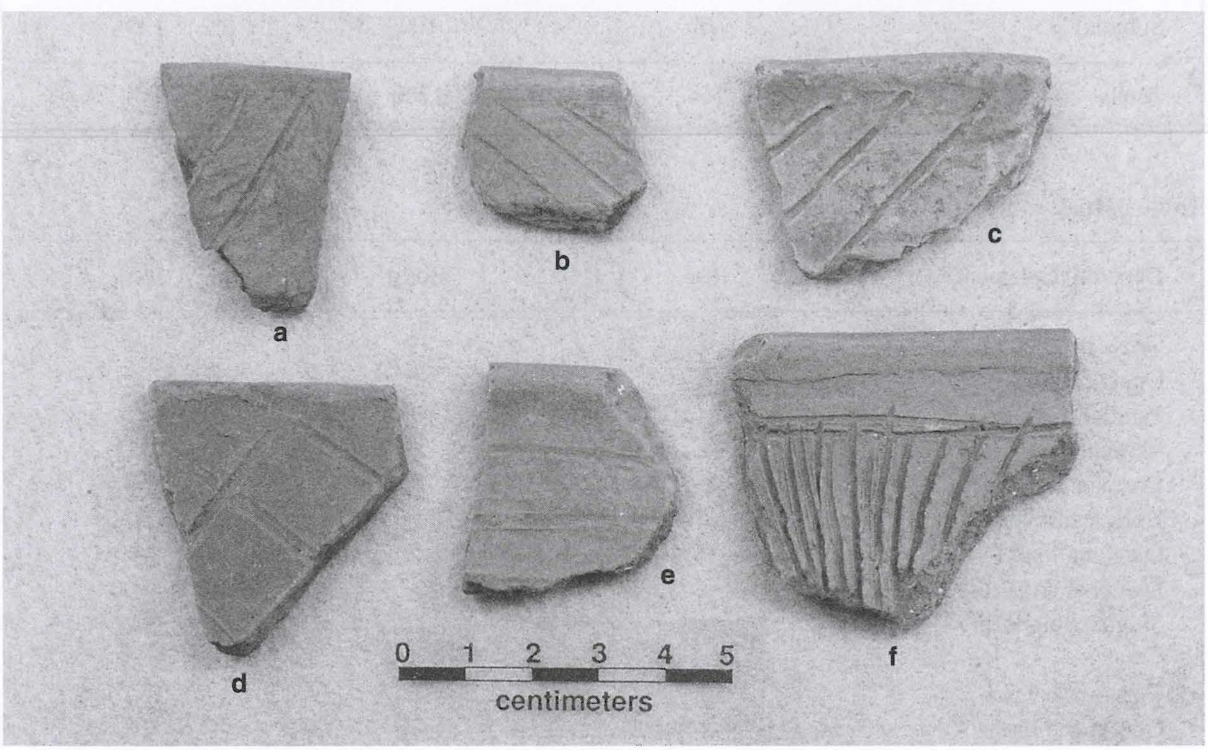


Figure 6. Incised rim sherds: a, opposed; b-c, diagonal; d, cross-hatched; e, horizontal; f, horizontal and vertical. Provenience: a, N212 W107, level 1; b, N227 W117, level 2; c, general; d, N211 W115, level 3; e, N211 W113, level 2; f, unknown (Lot 1556).

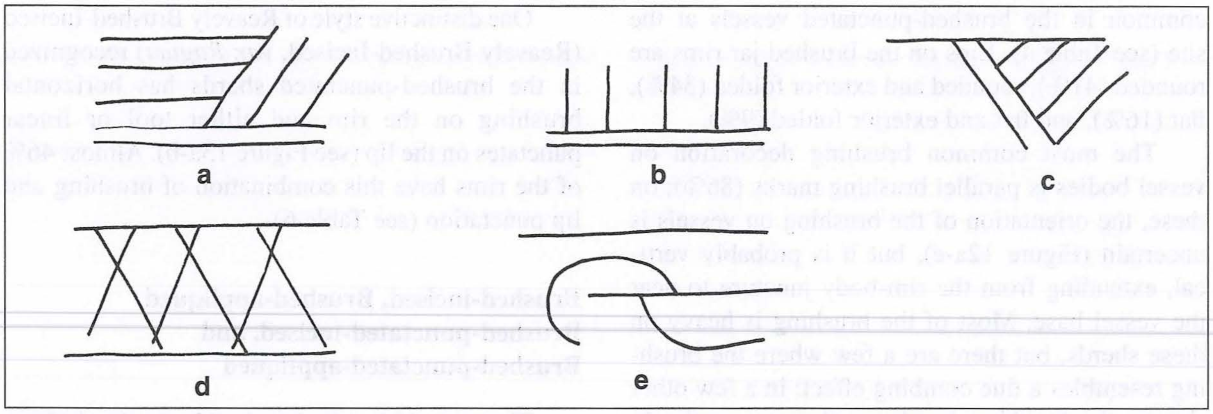


Figure 7. Incised decorative elements: a, c, opposed lines; b, horizontal and vertical lines; d, cross-hatched rim; e, curvilinear lines on a pie crust rim. Provenience: a, N224 W117, level 2; b-c, N211 W109, level 3; d, N212 W114; e, unknown (Lot 1458).

not have horizontal rows, including punctations in panels or zones (n=2) or in curvilinear, triangular, vertical, or diagonal rows (n=15, see Figures 8c-e and 9a-c).

Pinched

Nine of the 10 Killough Pinched sherds are body sherds with two or more pinched ridges. On four of the sherds, their curvature suggests that the pinched ridges are in vertical rows; the other five have two or more straight and parallel ridges. The other Killough Pinched sherd is part of a pedestal leg (see below).

Brushed sherds

Jars decorated solely with brushing are abundant at the Washington Square Mound site, especially in the southern part of the Area A excavations (see Figure 4d). On the rims of these vessels, most have only horizontal brushing marks (78%, Figure 10a), but there are also rims with horizontal and opposed (3%, Figure 11b), diagonal (6%, Figure 11a), vertical (3%), opposed (3%), and overlapping (3%) brushing marks. The rims are primarily direct or vertical in profile (90%), with only a small number of everted rim jars; everted rim cooking jars are apparently a more common rim treatments in certain post-A.D. 1400 utility wares in East Texas, although they are

Table 4. Rim and lip forms for major decorative classes.

Rim and lip form	Incised	Punctated	Incised-Punctated	Brushed-Punctated	Engraved
Direct rim	33	16	12	5	10
Everted rim	7	8	2	11	–
Subtotal, rim profile	40	24	14	16	10
Rounded lip	16	25	8	15	7
Rounded, exterior folded lip	3	4	3	4	1
Rounded, scalloped	2	–	–	–	–
Rounded, thickened	–	–	2	3	–
Flat lip	12	6	3	1	2
Flat, exterior folded lip	7	–	1	–	–
Pie crust mode	1	–	–	–	–
Subtotal, lip treatment	41	35	17	23	10

common in the brushed-punctated vessels at the site (see Table 4). Lips on the brushed jar rims are rounded (41%), rounded and exterior folded (34%), flat (16%), and flat and exterior folded (9%).

The most common brushing decoration on vessel bodies is parallel brushing marks (86%); on these, the orientation of the brushing on vessels is uncertain (Figure 12a-e), but it is probably vertical, extending from the rim-body juncture to near the vessel base. Most of the brushing is heavy on these sherds, but there are a few where the brushing resembles a fine combing effect; in a few other sherds, the brushing has been almost completely smoothed over to finish the vessel surface treatment. Other brushed body decorations on body sherds have overlapping (11%), opposed (2%), vertical (<1%), horizontal (<1%), and curvilinear (<1%) marks.

Brushed-Punctated

The brushed-punctated rim and body sherds are from Reavely Brushed-Incised jars (see Hart 1982:64-65), a common utility ware at the Washington Square Mound site (Table 6). The principal attributes of the brushed-punctated sherds are that they are usually (a) horizontally brushed on the rim and brushed vertically on the vessel body, and (b) there are rows of tool punctates on the rim, beginning under the lip and ending at the rim-body juncture, as well as rows of punctates on the body; punctates on the body are most commonly oriented vertically (Figures 13 and 14m), but horizontal and vertical rows are also noted (Figure 14l). The brushed-punctated sherds occur in three small clusters in the southern part of Area A; two of the clusters are associated with large pit features (see Figure 4e).

About 96% of the brushed-punctated rim sherds have horizontal brushing marks (see Table 6); the one exception has diagonal brushing (see Figure 14j). The brushed-punctated body sherds primarily have parallel brushing marks (82%); the brushing is likely vertical in orientation. Other brushing styles on the body sherds include diagonal (3.7%), horizontal (3.7%), opposed (4.9%), and overlapping (4.9%) (see Table 6).

Approximately 75% of the brushed-punctated sherds from the Washington Square Mound site have tool punctations on the rim and/or the body (see Table 6). The remainder have linear (14%, a distinctive form of tool punctate, see Figure 13e), fingernail (9.4%), and circular (1.9%) punctates.

One distinctive style of Reavely Brushed-Incised (Reavely Brushed-Incised, *var. Raguet*) recognized in the brushed-punctated sherds has horizontal brushing on the rim and either tool or linear punctates on the lip (see Figure 13a-b). Almost 46% of the rims have this combination of brushing and lip punctation (see Table 6).

Brushed-incised, Brushed-appliqued, Brushed-punctated-incised, and Brushed-punctated-appliqued

There are 68 brushed-incised body sherds from Reavely Brushed-Incised vessels in the TAS collections from the Washington Square Mound site (see Table 2). Approximately 53% have parallel brushed and parallel incised line decorations. Another 13% have parallel brushing marks with straight incised lines that cut through the brushing (see Figure 10d). A similar number of sherds have parallel brushing with either diagonal (n=4), cross-hatched (n=1), opposed (n=2), or curvilinear (n=1) incised lines that cut through the brushing (see Figure 14f). One other sherd has a zone or panel filled with a parallel brushed-incised decoration.

Approximately 10% of the brushed-incised sherds have opposed brushed-incised decorative combinations. Four sherds have opposed brushed-incised lines (see Figure 14a); the other three have opposed incised lines (probably on a jar rim) bordered by either horizontal (see Figure 14e), overlapping, or parallel brushed zones. The remaining brushed-incised sherds include two with overlapping brushing—either within an incised panel or with straight incised lines cutting across the brushed marks—a third sherd with curvilinear brushed-incised lines, a fourth sherd with horizontal brushing and diagonal incised lines (see Figure 14c), and a last example with parallel and overlapping brushed marks and parallel incised lines.

The brushed-appliqued sherds are from Reavely Brushed-Incised jars. Most (71%) of them have parallel brushing marks and parallel rows of appliqued fillets (Figure 15a; see also Figures 9b and 10b). Three others of the same kind have clear vertical brushing marks and adjacent vertical appliqued fillets. Approximately 16% have parallel brushing marks and an opposed appliqued fillet, and one body sherd has parallel brushing marks with both parallel and curvilinear appliqued fillets (Figure 15c; see also Figure 14h).

The one brushed-punctated-incised rim (direct

Table 5. Punctated decorative elements.

Decorative element	Rim	Body	N
Vertical tool punctated rows	1	–	1
Horizontal-diagonal tool punctated rows	1	–	1
Diagonal tool punctated rows	1	–	1
Tool punctated row under lip	9	–	9
Tool punctates under lip and on rim	4	–	4
Tool punctates on lip	2	–	2
Tool punctated rows	10	91	101
Small tool punctates in panel or zone	–	1	1
Triangular-shaped tool punctated zone	–	1	1
Curvilinear tool punctated rows	–	1	1
Tool punctates, random	–	5	5
Single tool punctate	–	23	23
Subtotal	28	122	150
Fingernail punctated rows	–	3	3
Single fingernail punctate	–	1	1
Subtotal	–	4	4
Linear punctates on lip	1	–	1
Linear punctated row under lip	1	–	1
Vertical linear punctated rows	1	–	1
Linear punctated row	–	6	6
Horizontal and diagonal linear punctated rows	–	1	1
Linear punctates, random	–	1	1
Subtotal	3	8	11
Large circular punctated rows	2	3	5
Circular and tool punctates in linear, curvilinear and triangular rows	1	–	1
Circular punctated row under lip	1	–	1
Small circular punctated row under lip	1	–	1
Small circular punctated row	–	2	2
Subtotal	5	5	10
Cane punctates, random	–	2	2
Cane punctated rows	–	1	1
Subtotal	–	3	3
Totals	36	142	178

with a rounded lip) has horizontal brushed-incised marks on the rim with a row of tool punctates under the lip. The brushed-punctated-incised body sherds have various combinations of brushing marks and incised lines running in different or common directions, with rows of tool punctates pushed through or between (see Figure 14k) either the brushing or the incised lines (Table 7).

The brushed-punctated-appliqued sherds have appliqued fillets that run either in parallel or opposed

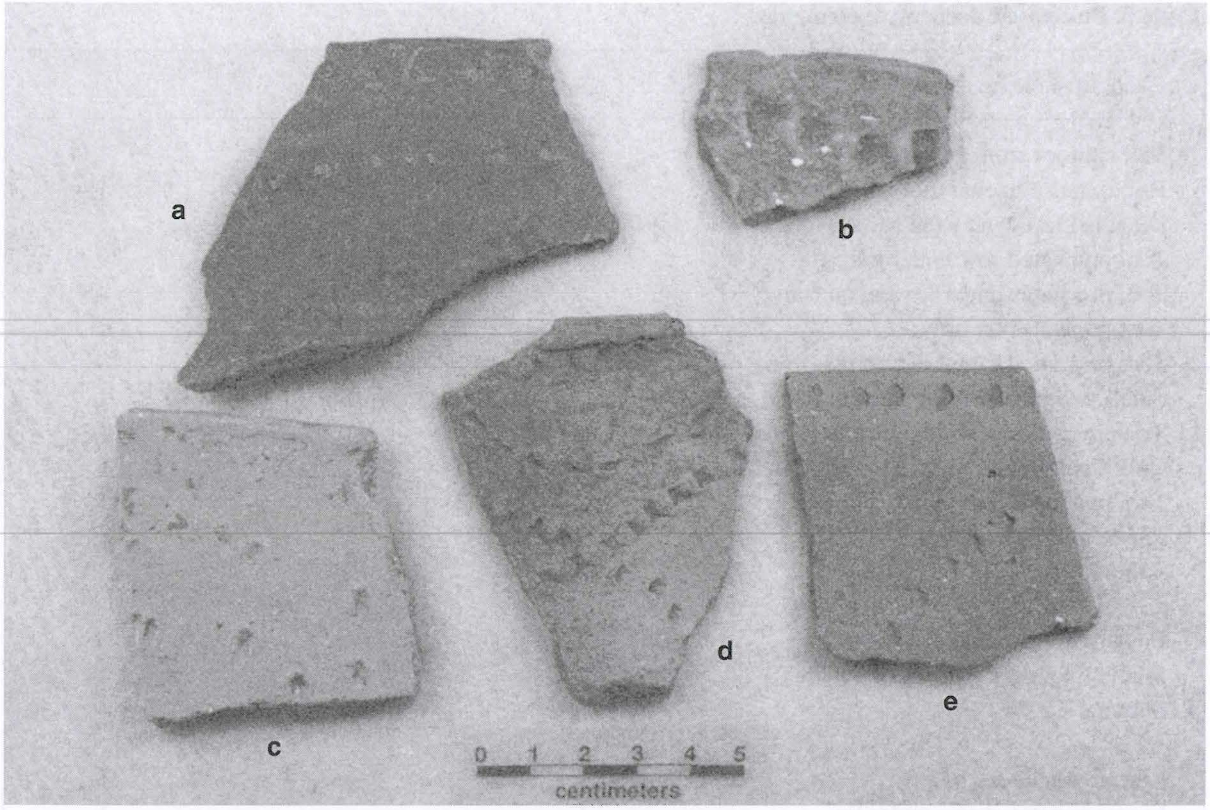


Figure 8. Punctated sherds from the Washington Square Mound site: a, c, e, tool punctated; b, large circular punctated; d, circular and tool punctated. Provenience: a, N212 W107, level 1; b, N211 W116, level 2; c, N214 W106, unknown level; d, N211 W100 or W109, fill; e, N214 W113, level 2.

directions to zones of brushing. In three of the five body sherds, a row of tool or linear punctations have been pushed through the brushing (usually running the same direction as the appliqued fillet, see Figure 14d, i), a fourth has parallel and opposed brushed zones on either side of a straight appliqued fillet and a row of punctates (see Figure 14n), while the remaining sherd has a row of linear punctations between zones of parallel brushing and a single straight appliqued fillet (see Figures 14g and 15b).

Incised-Punctated

The principal decorative elements in the incised-punctated utility wares from the Washington Square Mound site include sets of incised triangles (defined by diagonal or opposed diagonal lines on the rim) filled with tool punctations (Table 8 and Figure 16; see also Figure 10c). These decorations are a common feature of both Canton Incised (Suhm and Jelks 1962:Plate 12d, h) and Maydelle Incised (Suhm and Jelks 1962:Plate 52e) types. The highest densities of the incised-punctated sherds are found in close association with Features 134 and 138 (see Figure 4f).

About 53% of the incised-punctated rims have incised triangles filled with tool or circular punctates (see Figures 9h-i, k, n and 16a, e). Others have a row of tool punctations under the vessel lip as well as diagonal (n=2), horizontal (n=3), and curvilinear (n=1, see Figure 9f, j) incised lines on the rim (see Table 8). One other rim has a circular incised element filled with tool punctations. Regardless of the specific decorative element, tool punctates were the preferred stylistic choice (90%), with lesser frequencies of circular (7%), fingernail (1%), and linear (1%) punctates.

The prevalence of triangular incised-punctate-filled elements is also apparent in the body sherds (see Table 8). Other decorative elements include rectangular (see Figure 9e) and circular panels filled with punctations (see Figure 16b-d), circular and curvilinear zones filled with punctates (see Figure 9m), and various forms of punctates placed between incised lines (see Figure 9d, l, o), or in rows below (and likely at the rim-body juncture) vertical and diagonal incised lines (see Figure 9g).

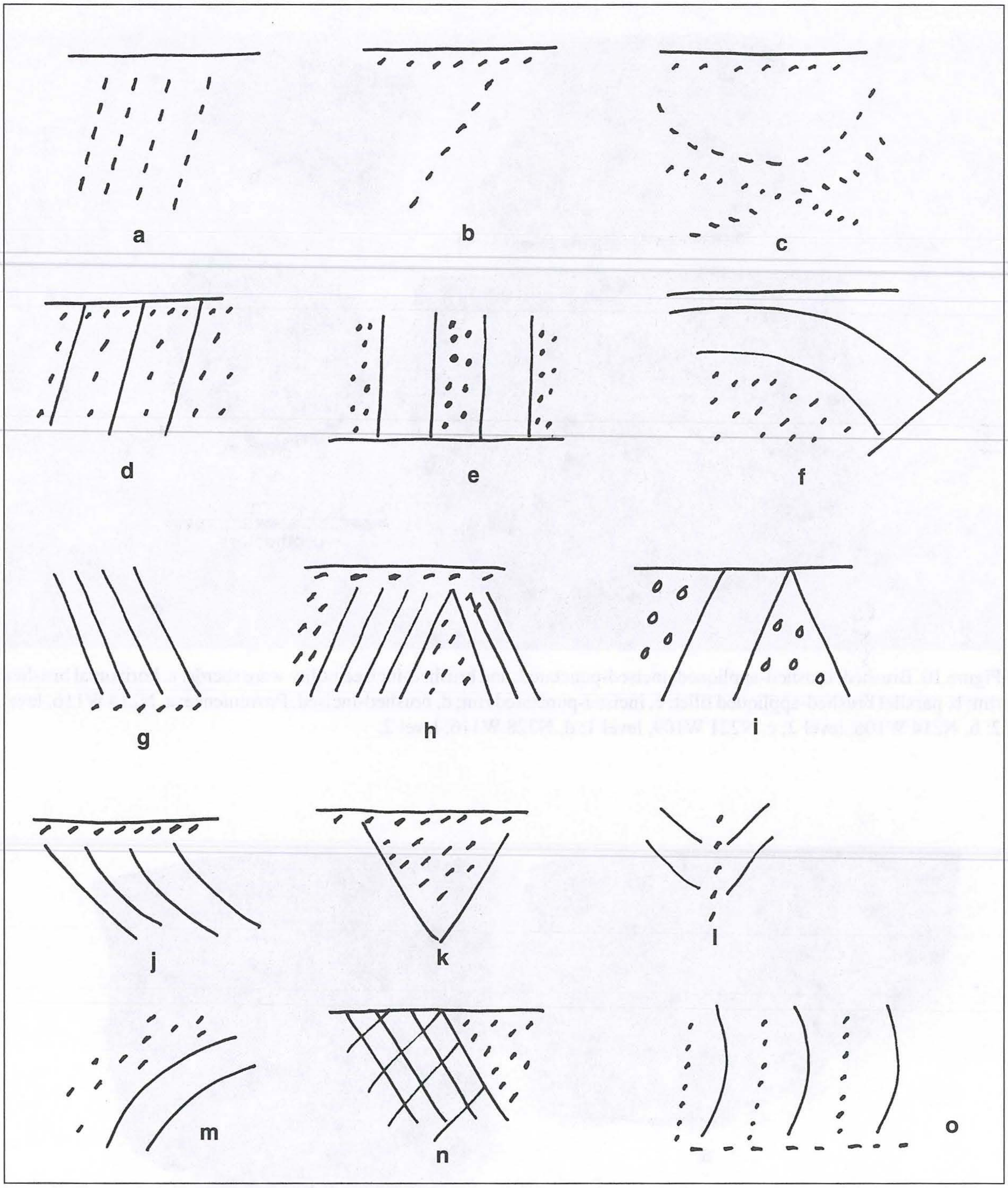


Figure 9. Selected punctated and incised-punctated decorative elements: a-c, punctated rims; d, f, h-k, n-o, incised-punctated rims; e, g, l-m, incised-punctated body sherds. Provenience: a, N230 W109, level 1; b, N214 W113, level 2; c, N211 W100 or W109, fill; d, N215 W106, level 1; e, h, N221 W109, level 1; f, N211 W112, level 2; g, N214 W106, level 3; i, N227 W117, level 1; j, N211 W109, level 2; k, N214 W116, level 2; l, N212 W113, level 1; m, N212 W114, level 2; n, N211 W106, level 1; o, N211 W109, level 1.

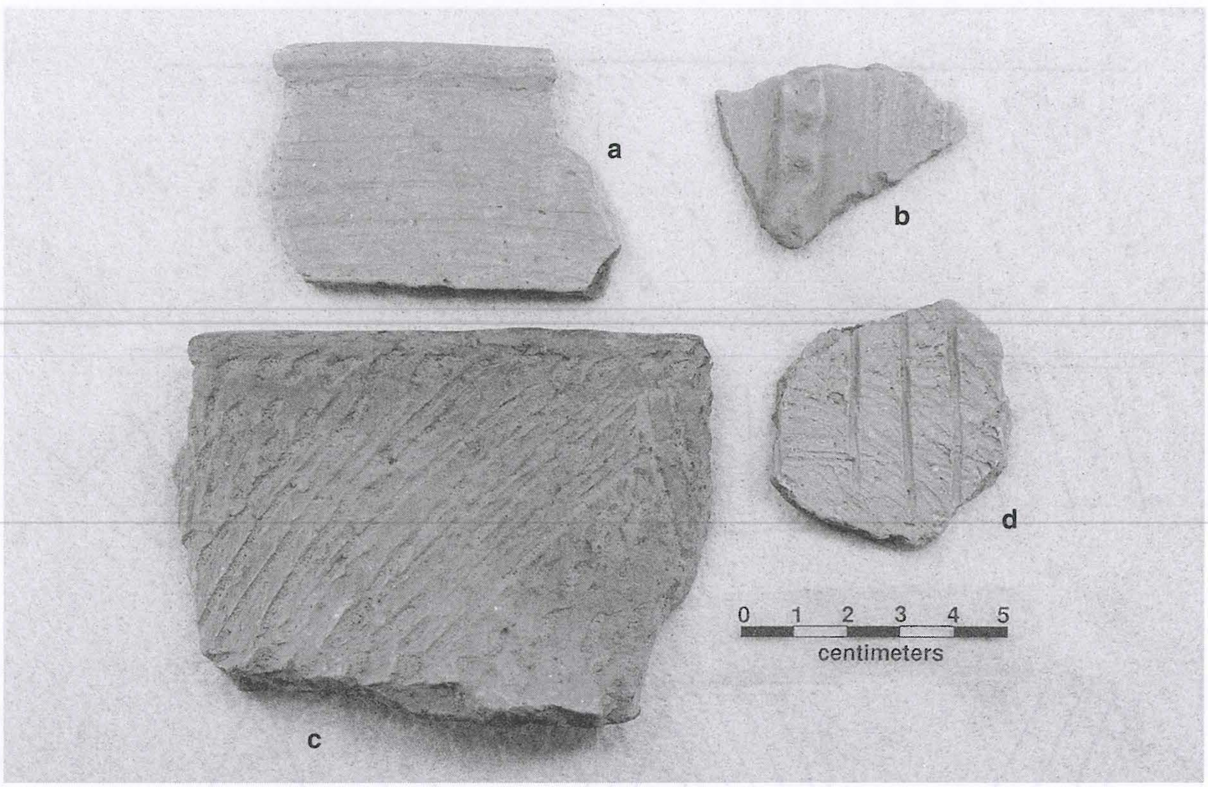


Figure 10. Brushed, brushed-appliqued, incised-punctated, and brushed-incised utility ware sherds: a, horizontal brushed rim; b, parallel brushed-appliqued fillet; c, incised-punctated rim; d, brushed-incised. Provenience: a, N214 W116, level 2; b, N214 W106, level 2; c, N221 W109, level 1; d, N228 W116, level 2.

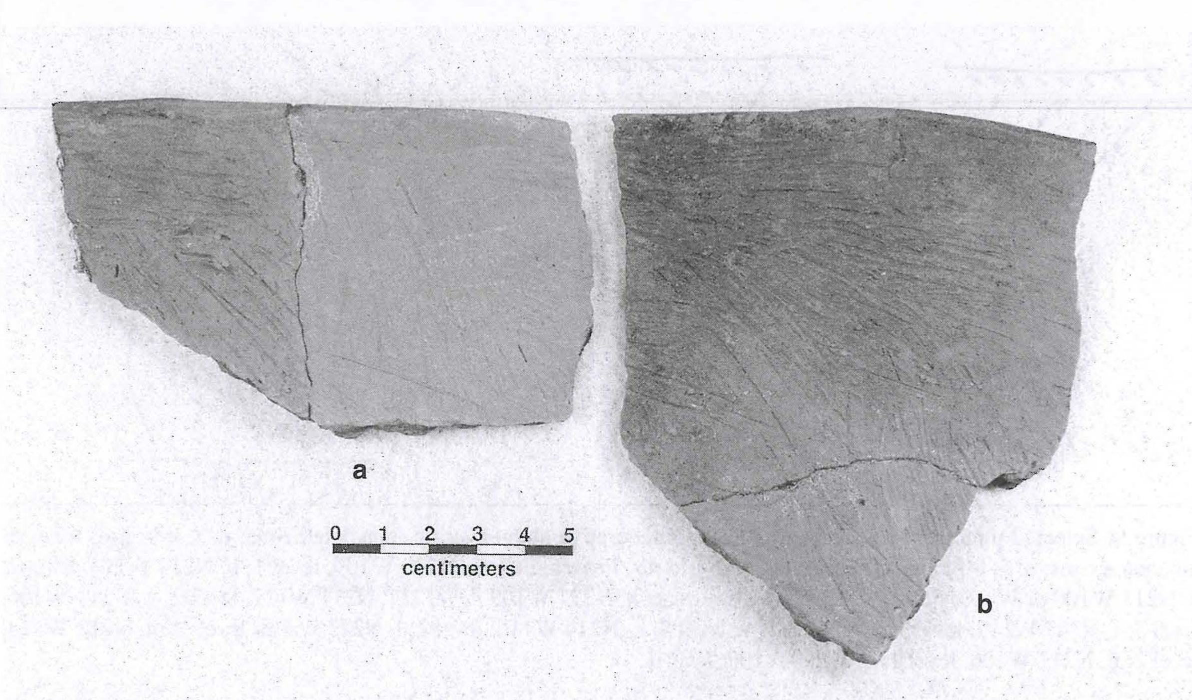


Figure 11. Brushed rims: a, diagonal; b, horizontal and opposed. Provenience: a, N211 W112, level 2; b, unknown (Lot 1564).

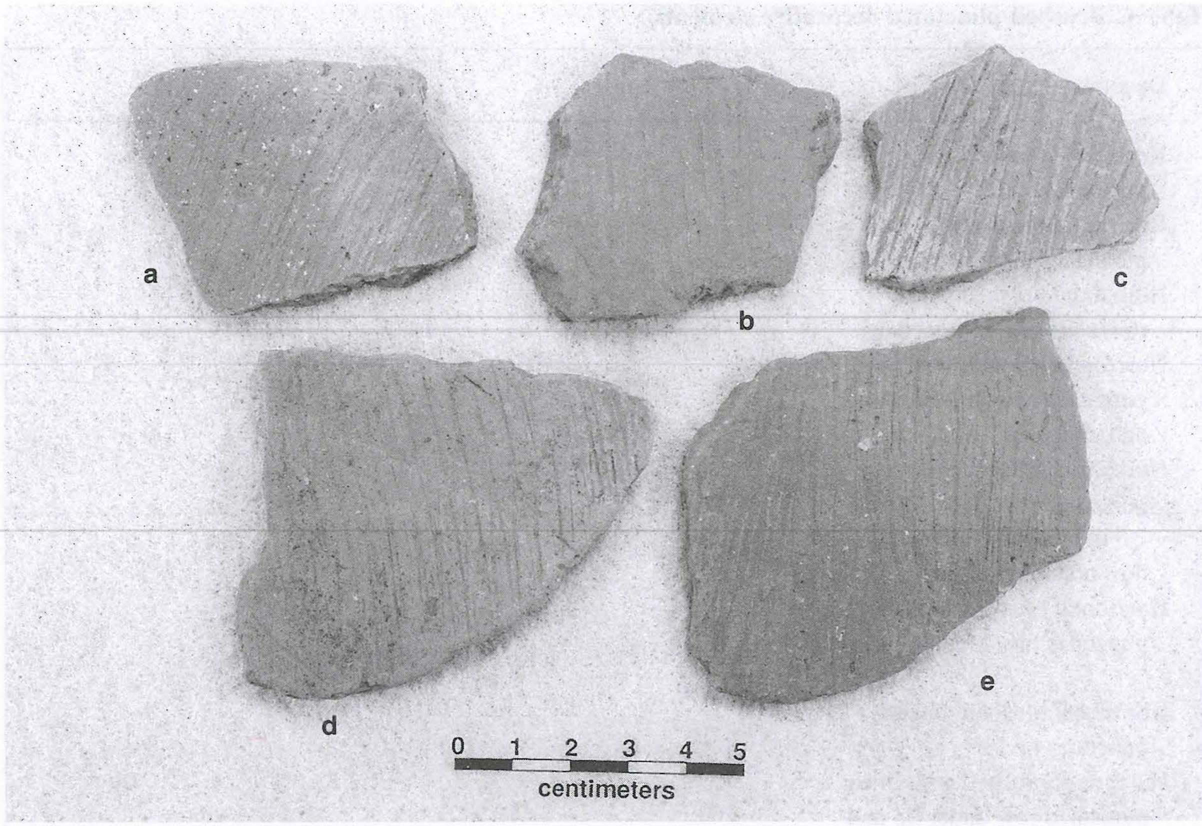


Figure 12. Parallel brushed body sherds. Provenience: a, N211 W109, level 1; b, N214 W116, level 2; c, N211 W112, level 2; d-e, N211 W112, level 3.

Appliqued and Incised-appliqued

Six of the seven appliqued body sherds have fillets, either a single straight fillet (n=5) or opposed fillets (n=1). The straight fillets likely are oriented vertically on the body of Reavely Brushed-Incised jars (Hart 1982:Figure 3-9), dividing the jar body surface into panels that are either left undecorated or are filled with brushing marks. The opposed fillets are part of a more complex appliqued decorative element. The last appliqued sherd consists of a single large appliqued node.

Two incised-appliqued body sherds are also from Reavely Brushed-Incised jars. These sherds have parallel and closely-spaced incised lines (i.e., simulating a brushed decoration?) divided by parallel appliqued fillets.

Fine Ware Sherds

Fine ware engraved and engraved-punctated sherds from the 1985 TAS excavations at the Washington Square mound site represent 7.9% of the rims and 6.1% of the body sherds from the decorated sherd assemblage (see Table 2). Like the decorated utility wares, the engraved sherds are concentrated in several clusters in the southern part of Area A, particularly in spatial association with Features 134 and 138 (see Figure 4g).

These fine wares are principally from carinated bowls and compound bowls, and only 10% of these sherds are from bottles. Rims are direct or vertical in orientation (see Table 4), with rounded (70%), rounded and exterior folded (20%), or flat (10%) lips.

Engraved

The engraved rims in the Washington Square Mound sherd collections from the 1985 TAS Field School have simple straight or geometric decorative elements, including sets of horizontal lines (n=5), horizontal and diagonal lines (n=1), horizontal and vertical lines (n=1), diagonal (n=3), and diagonal opposed lines (n=1) (Table 9). One other rim has a single horizontal line under the lip and a circular element, probably part of a scroll motif on a

Table 6. Brushed-punctated decorative elements.

Decorative element	Rim	Body	N
Horizontal brushed, tool punctates on lip*	7	–	7
Horizontal brushed and tool punctated row under lip	5	–	5
Horizontal brushed below row/zone of tool punctates	–	2	2
Horizontal brushed with tool punctated row thru brushing and under lip	2	–	2
Horizontal brushed with tool punctated row under lip and 2nd row of punctates thru brushing on rim	1	–	1
Horizontal brushed with tool punctates thru brushing	–	1	1
Horizontal brushed, linear punctates on lip*	4	–	4
Horizontal brushed with linear punctated row under lip and above brushing	3	–	3
Horizontal brushed with circular punctated row thru brushing	1	–	1
Diagonal brushed, tool punctates on lip and fingernail punctates on panel between brushing	1		1
Diagonal brushed with tool punctated row above/framing brushing	–	3	3
Vertical brushed with tool punctated row thru brushing	–	1	1
Opposed brushed with tool punctated row thru brushing	–	2	2
Opposed brushed with opposed row of tool punctates	–	1	1
Opposed brushed with fingernail punctates thru brushing	–	1	1
Overlapping brushed with tool punctated row thru brushing	–	3	3
Overlapping brushed with fingernail punctated row thru brushing	–	1	1

Table 6. *(Continued)*

Decorative element	Rim	Body	N
Parallel brushed with linear punctated row thru brushing	–	6	6
Parallel brushed above linear punctated row	–	1	1
Parallel brushed on either side of a row of linear punctates	–	1	1
Parallel brushed with tool punctated row thru brushing	–	34	34
Parallel brushed with random tool punctates thru brushing	–	2	2
Parallel brushed framed by tool punctated row	–	11	11
Parallel brushed between two tool punctated rows	–	2	2
Parallel brushed with parallel and opposed tool punctated rows	–	1	1
Parallel brushed with tool punctates in panel	–	1	1
Parallel brushed with fingernail punctated row thru brushing	–	6	6
Parallel brushed framed by fingernail punctated zone	–	1	1
Parallel brushed with circular punctates thru brushing	–	1	1
Totals	24	82	106

*Reavely Brushed-Incised, *var. Raguet*

Nacogdoches Engraved vessel (Hart 1982:Figure 3-4). The simplicity of the decorative elements on the small sample of rims, and the very diverse character of the engraved elements on the body sherds (Table 9)—especially the hatched and cross-hatched zones on many of them (Figures 17b-d, 18a, d, and 19a-c, h, j), which are likely from scroll fill elements on Nacogdoches Engraved vessels (see Hart 1982:Figure 3-4)—suggest that many of the engraved sherds are from compound bowls or shouldered bowls with two panels of engraved decorations on the rims, the lower panel having the more complex engraved decoration.

The most distinctive of the engraved decorative elements in the fine wares, as previously mentioned, are the various hatched and cross-hatched elements from Nacogdoches Engraved vessels. As defined by Hart (1982:46-47), these vessels are defined by scroll and circle elements and several distinctive scroll fill elements, including hatched triangles, narrow curvilinear cross-hatched zones, and circles with central dots (see Figure 19b).

There are also at least three engraved sherds from Washington Square Paneled vessels (see Table 9 and Figures 17a and 19c, i). These sherds are from vessels with "a rectangular panel with straight or convex

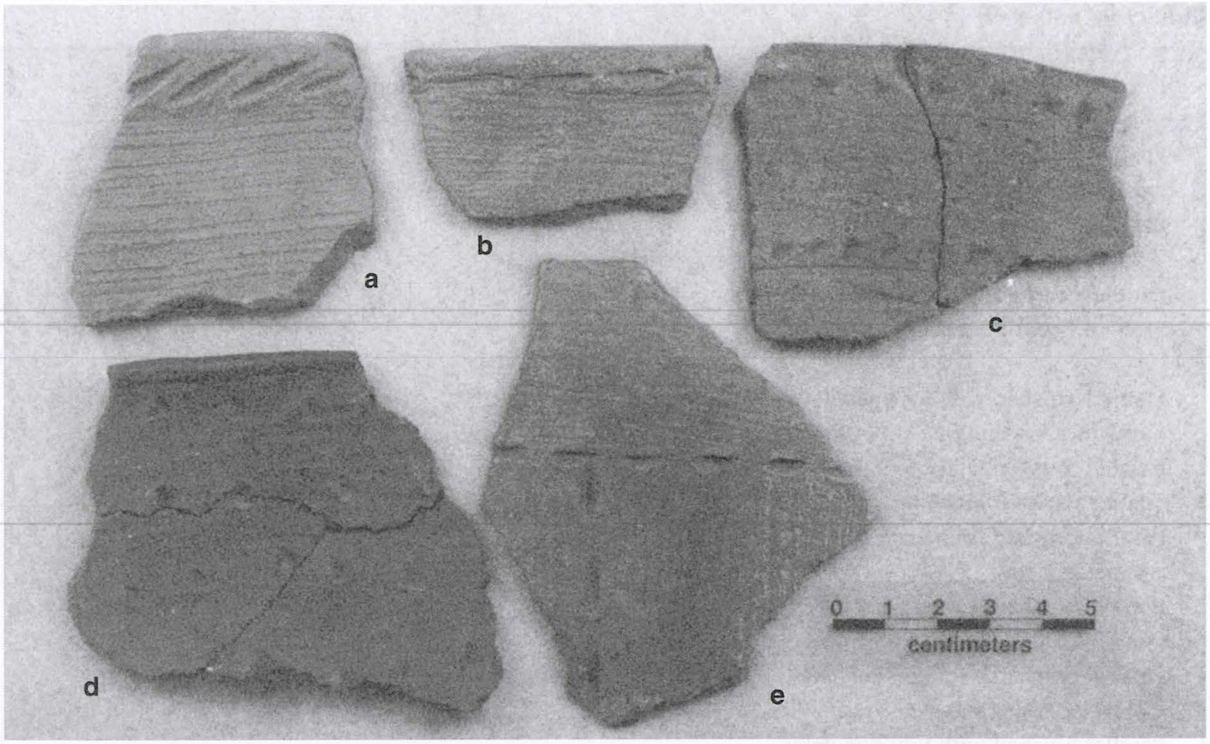


Figure 13. Brushed-punctated rim and body sherds: a-b, horizontal brushed and linear punctates on the lip (Reavely Brushed-Incised, *var. Raguet*); c-d, horizontal brushed and tool punctated rows; e, opposed brushed with opposed rows of tool punctates. Provenience: a, e, N221 W109, lv. 1; b, N225 W116, lv. 2; c, N211 W109, lv. 1; d, N211 W115, lv. 3.

sides," with the space between the "sides of adjacent rectangles is filled with either punctations or diagonal incised or engraved lines" (Hart 1982:71). Within each of the rectangles is a single horizontal line, in this case an engraved line, that bisects the central part of the rectangular panel (see Figure 19i).

The engraved bottle sherds from the site have curvilinear lines on the bottle bodies (see Table 9); several of these have a red clay pigment rubbed in the engraved lines. Additionally, there are hatched triangles and narrow hatched zones (see Figure 19e, m), cross-hatched circles (see Figure 19l), and cross-hatched triangles and zones creating negative rectangles (see Figure 19f). These are sherds from Nacogdoches Engraved bottles (see Hart 1982:Figures 3-7c-d and 3-8a-b).

There are a few sherds in the general collections from the Washington Square Mound site that testify to a limited post-A.D. 1650 Caddo use of the site, or at least the limited parts of the site that have been investigated to date. These include four sherds of Patton Engraved (Hart 1982:94), Taylor Engraved (see Figure 18b), and Natchitoches Engraved (see Figure 18c).

Engraved-punctated

The one distinctive engraved-punctated rim sherd (direct with a rounded and exterior folded lip) has widely-spaced horizontal engraved lines on the rim as well as a row of linear punctates just below the lip (see Figure 17e). The two body sherds are from Washington Square Paneled carinated bowls (see Hart 1982:71-72). They have parts of engraved rectangular panels with a single row of small punctations along one of the panel edges.

Plain Sherds

The plain sherds from the 1985 TAS excavations at the Washington Square Mound include 54 rims (Figure 20a-g), 60 base sherds, and 1347 body sherds. Given that 24.7% of all the rims (n=218) from these excavations are plain—and plain rims are the single most common kind in the assemblage of any of the wares—it is clear that plain wares were also a significant component of the Caddo ceramics made and used at the site. The highest densities of plain sherds are in the same parts of Area A as the utility ware and fine ware sherds (see Figure 4h).

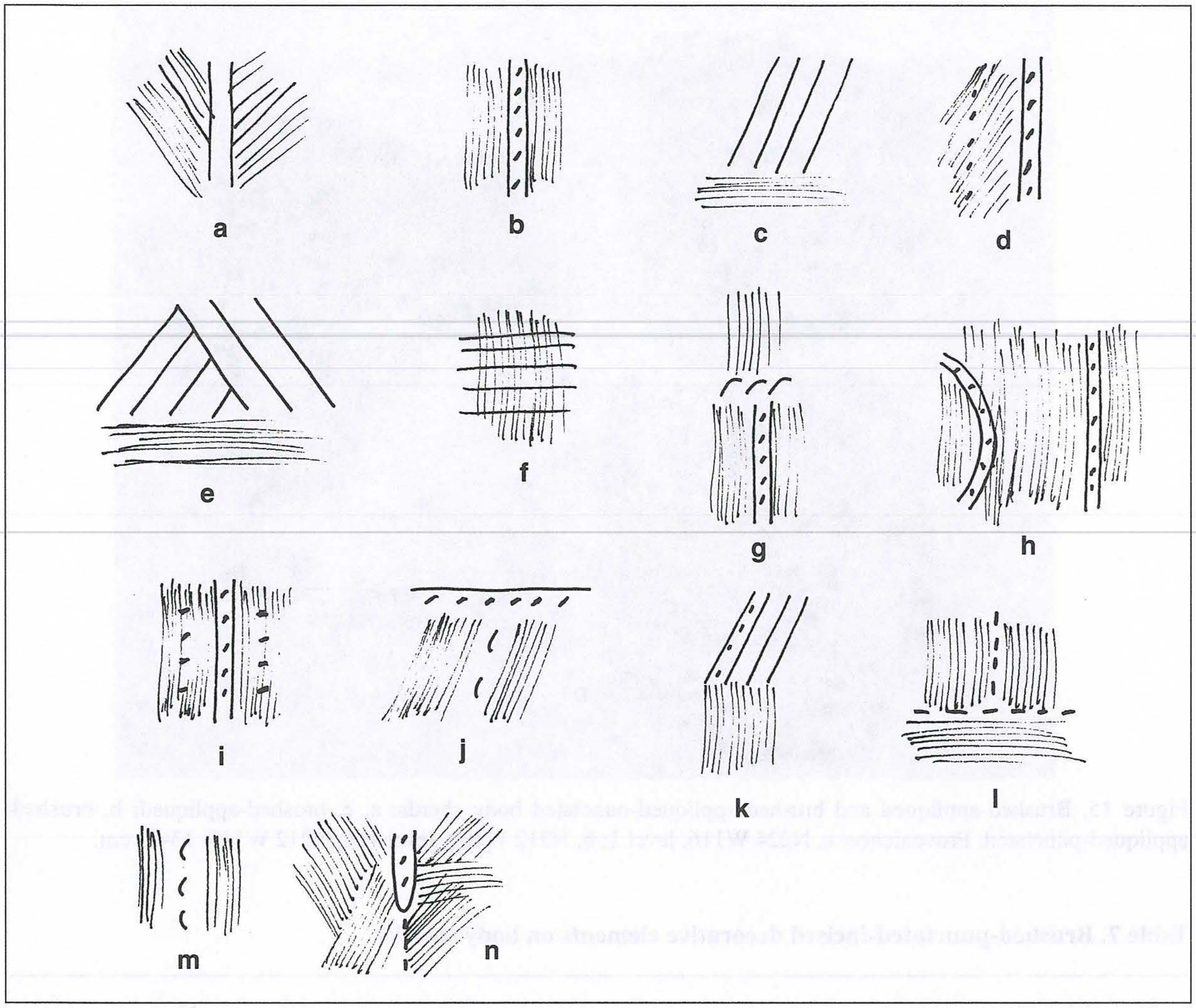


Figure 14. Selected brushed-incised, brushed-appliqued, brushed-punctated-appliqued, brushed-punctated, and brushed-punctated-incised decorative elements: a, c, e-f, brushed-incised; b, h, brushed-appliqued; d, g, i, n, brushed-punctated-appliqued; j, l-m, brushed-punctated; k, brushed-punctated-incised. Provenience: a, unknown (Lot 1458); b-c, N211 W115, level 3; d, N214 W107, level 2; e-f, N212 W112, level 1; g, n, N212 W109, level 1; h, N212 W115, 13-23 cm; i, N221 W126, level 1; j, N215 W106, level 1; k, N212 W113, level 3; l, N221 W109, level 1; m, N225 W125, level 3.

More than 91% of the plain rims have a direct or vertical profile; these are likely from bowls and carinated bowls. Another 6%, probably jars, have an everted profile, and 2%, shallow bowls, have an inverted rim profile. The lips on these rims are typically rounded (n=26) or rounded and exterior folded (n=10). Another 22% (n=12) have flat lips. One carinated bowl rim sherd has a sprocket-shaped rim and lip (an unusual and rare rim and lip treatment in East Texas, Mark Walters, 2008 personal communication), and another has a peaked rim. Three rims are interior beveled at the lip, and the remaining rim has a flat but exterior thickened lip.

CERAMIC MANUFACTURE AND USE OF DIFFERENT TEMPERS

The widespread use of burned bone as a temper is a notable technological feature of the Caddo ceramics made and used by the vast majority of the Caddo groups that lived in the Angelina, Attoyac, and middle Sabine River (i.e., Toledo Bend Reservoir area) basins (Perttula 2008a). The ceramics made and used at the Washington Square Mound site are part of this Middle, Late, and Historic Caddo ceramic tradition.

The Feature 31 and Feature 95 vessels from the

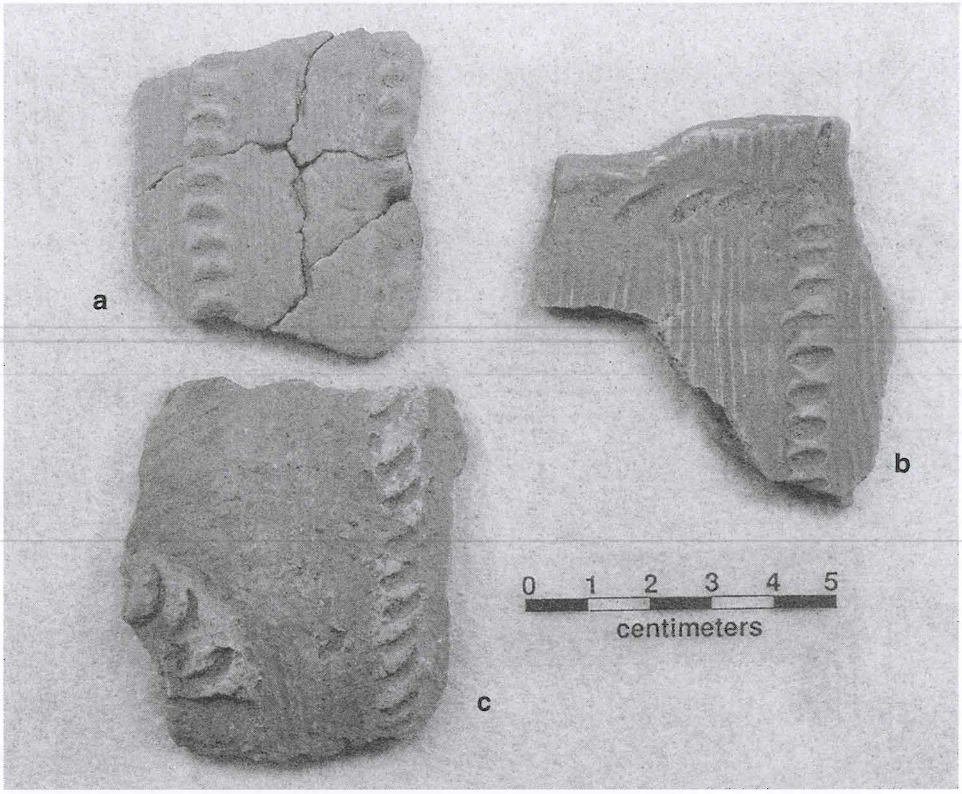


Figure 15. Brushed-appliqued and brushed-appliqued-punctated body sherds: a, c, brushed-appliqued; b, brushed-appliqued-punctated. Provenience: a, N224 W116, level 1; b, N212 W109, level 1; c, N212 W115, 13-23 cm.

Table 7. Brushed-punctated-incised decorative elements on body sherds.

Decorative element	No.
parallel brushed-parallel incised lines; tool punctates through brushing	1
parallel brushing-opposed incised lines; tool punctates through brushing	1
parallel brushed-straight incised line thru brushing; tool punctated rows through the brushing	1
overlapping brushed, with parallel incised lines overlying brushing; tool punctates pushed through brushing	1
opposed brushed-incised lines above tool punctated row	1
opposed brushed-zigzag incised lines thru brushing; tool punctated row pushed through the brushing	1
diagonal incised lines above vertical brushing; tool punctates through incised lines	1

Washington Square Mound site are primarily tempered with grog or crushed sherds, but frequently with other inclusions (Table 10), including crushed and burned bone, hematite, or charred organic remains (Perttula et al. 2008). Vessels tempered only with grog are slightly more common in Feature 31, while vessels tempered only with bone are more prevalent in Feature 95. In general, bone and hematite were more commonly added as aplastics to the Washington Square Mound vessels interred with the

Table 8. Incised-punctated decorative elements.

Decorative element	Rim	Body	N
Opposed diagonal lines and triangular-filled tool punctated zones; row of tool punctates under lip	2	–	2
Opposed diagonal lines and triangular-filled tool punctated zones	–	6	6
Opposed diagonal lines and triangular-filled circular punctated zones	1	–	1
Opposed diagonal lines opposite vertical tool punctated row	–	2	2
Triangle incised zone filled with tool punctates	–	5	5
Diagonal lines and tool punctated row under lip	2	–	2
Diagonal lines forming triangles filled with tool punctates	5	–	5
Diagonal lines and circular punctates between lines	1	–	1
Diagonal lines above tool punctated row	–	7	7
Vertical lines above tool punctated row	–	1	1
Horizontal lines and tool punctated row under lip	3	–	3
Parallel lines between zones of circular punctates	–	1	1
Parallel lines framing circular punctated row	–	1	1
Parallel lines framing tool punctated zones/rows	–	4	4
Parallel lines intersected by row of tool punctates	–	1	1
Parallel lines with tool punctated row between lines	–	1	1
Straight line framing tool punctated area/rows	–	23	23
Straight line framing fingernail punctated area/row	–	1	1

Table 8. *(Continued)*

Decorative element	Rim	Body	N
Cross-hatched lines and tool punctated-filled triangles	1	–	1
Rectangular panel filled with tool punctates	–	3	3
Rectangular panels filled with circular punctates	–	1	1
Curvilinear line and tool punctated row under lip	1	–	1
Curvilinear lines and circular-filled tool punctated zone	1	–	1
Curvilinear line and curvilinear tool punctate-filled zone	–	2	2
Curvilinear lines and horizontal and vertical tool punctates between and below incised lines	–	1	1
Curvilinear panel filled with tool punctates	–	2	2
Circular incised zone filled with tool punctates	–	2	2
Circular incised zone filled with linear punctates	–	1	1
Totals	17	65	82

two Caddo people in Feature 95 (Table 10).

Less than 10% of these vessels have a sandy paste, and less than 7% have charred organics present in the paste. Caddo vessels with sandy pastes tend to be utility wares used in every-day cooking and heating tasks, and thus the low frequency of sandy paste wares here is evidence of the fact that fine wares were preferentially and more commonly placed in the two burial features compared to jars. The low occurrence of charred organics in the paste of the Washington Square Mound vessels suggests that these vessels were well and evenly fired, and fired for a sufficient duration that any organics included in the paste were completely combusted.

The sherd assemblages from vessels used in non-mortuary contexts at the Washington Square Mound site indicate that grog was also the preferred temper for vessel manufacture (Hart 1982:Table 4-4). Sherds tempered simply with grog account for 50.6% of the large sample (over 6000 sherds) analyzed by Hart (1982) from non-burial contexts, roughly comparable to the 37.5-46.7% in the feature burials. In the 1985 TAS ceramic assemblage, 26% of the sherds have bone temper inclusions, either as the sole temper or in combination with other aplastics. The utility wares, dominated by coarse tempers, in the latter assemblage have the highest proportion of bone temper (30%), with lesser amounts of burned bone found in the plain wares (22.3%) and fine wares (19.9%).

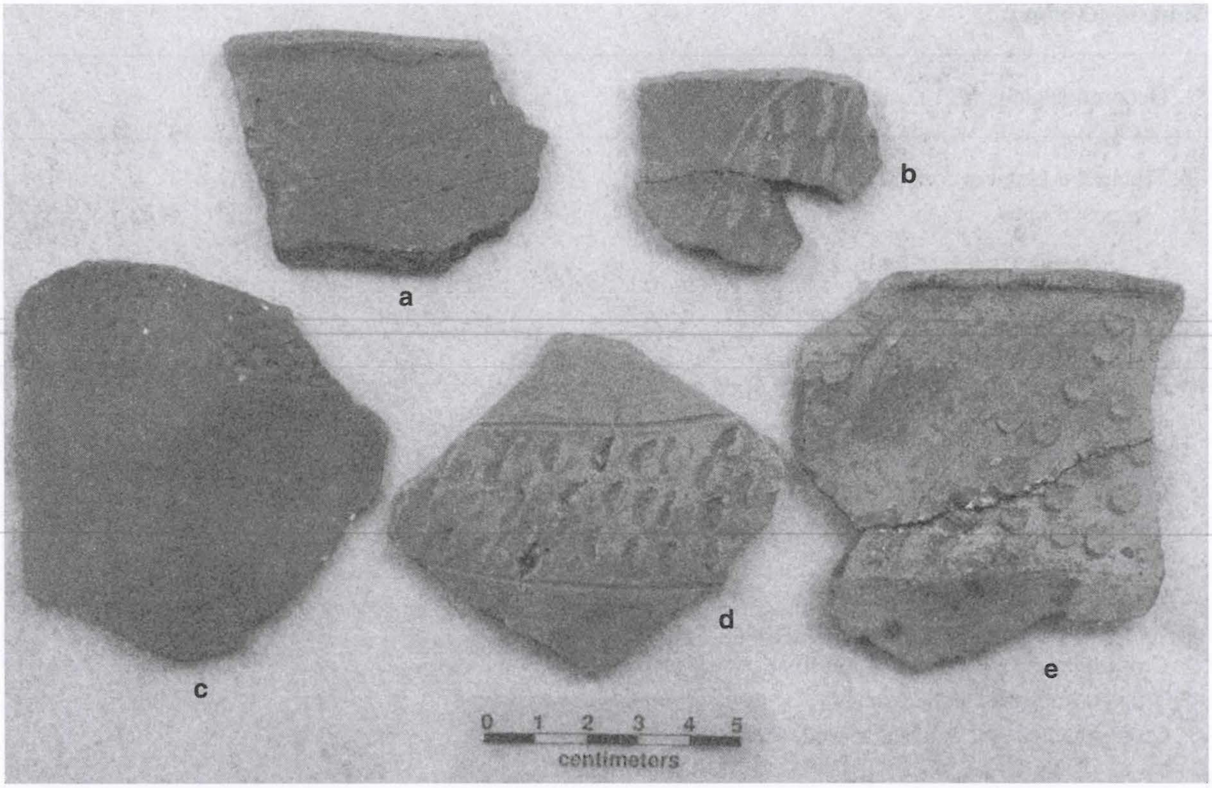


Figure 16. Incised-punctated rim and body sherds: a, e, incised triangles filled with tool punctations; b-c, panels filled with punctations; d, curvilinear panel filled with tool punctations. Provenience: a, N225 W126, level 2; b, N236 W116, levels 3 and 4; c, N221 W109, level 1; d, N221 W116, level 2; e, N227 W117, level 1.

Table 9. Engraved decorative elements.

Decorative element	Rim	Body	N
Horizontal engraved line under lip	3	–	3
Horizontal engraved lines	2	2	4
Horizontal engraved line under lip and circular element on rim	1	–	1
Horizontal line and cross-hatched hour glass column*	–	1	1
Horizontal and diagonal engraved lines	1	–	1
Horizontal, diagonal, and curvilinear lines	–	2	2
Horizontal and vertical engraved lines within panel	1	–	1
Diagonal engraved lines	2	1	3
Broad diagonal engraved lines	1	–	1
Diagonal opposed engraved lines	1	–	1

Table 9. *(Continued)*

Decorative element	Rim	Body	N
Triangular element formed by diagonal opposed lines	–	5	5
Vertical lines, closely-spaced	–	1	1
Cross-hatched curvilinear zone	–	2	2
Cross-hatched curvilinear zone with circle and central dot	–	1	1
Cross-hatched zone	–	2	2
Cross-hatched zone and negative ovals	–	1	1
Curvilinear cross-hatched zone and negative oval with straight line in oval*	–	2	2
Cross-hatched hour glass column	–	1	1
Cross-hatched circle and curvilinear lines	–	1	1
Cross-hatched zone and parallel lines	–	2	2
Triangular cross-hatched zones	–	1	1
Cross-hatched and hatched triangle element	–	1	1
Hatched curvilinear zone	–	5	5
Hatched circle and curvilinear lines	–	2	2
Hatched triangle	–	10	10
Hatched triangle and curvilinear lines	–	1	1
Rectangular hatched area and circle element	–	1	1
Hatched panel	–	2	2
Parallel lines	–	18	18
Parallel and curvilinear lines	–	1	1
Opposed lines	–	12	12
Opposed and curvilinear lines	–	1	1
Curvilinear lines (Bottles)	–	12	12
Meandering line	–	2	2
Single straight line	–	14	14
Totals	12	107	119

*Washington Square Paneled

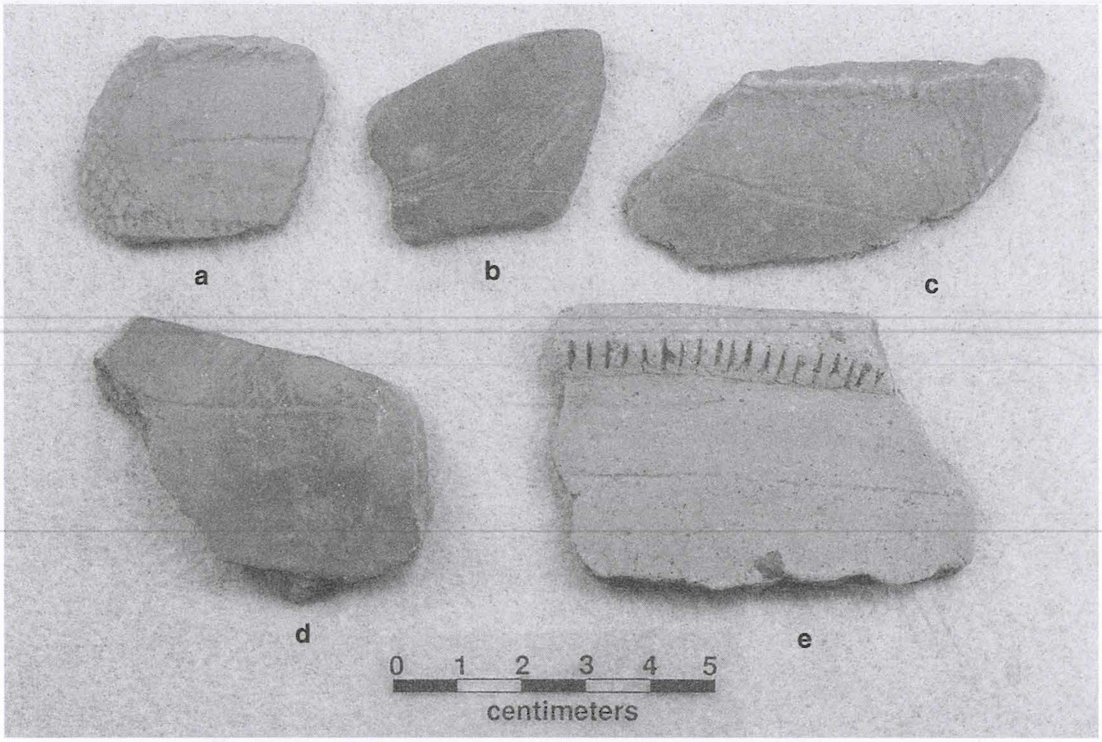


Figure 17. Engraved body sherds and engraved-punctated rim: a-d, engraved; e, engraved-punctated rim. Provenience: a, N211 W115, level 3; b, N225 W126, level 1; c, N211 W109, level 2; d, N221 W109, level 3; e, unknown (Lot 1556).

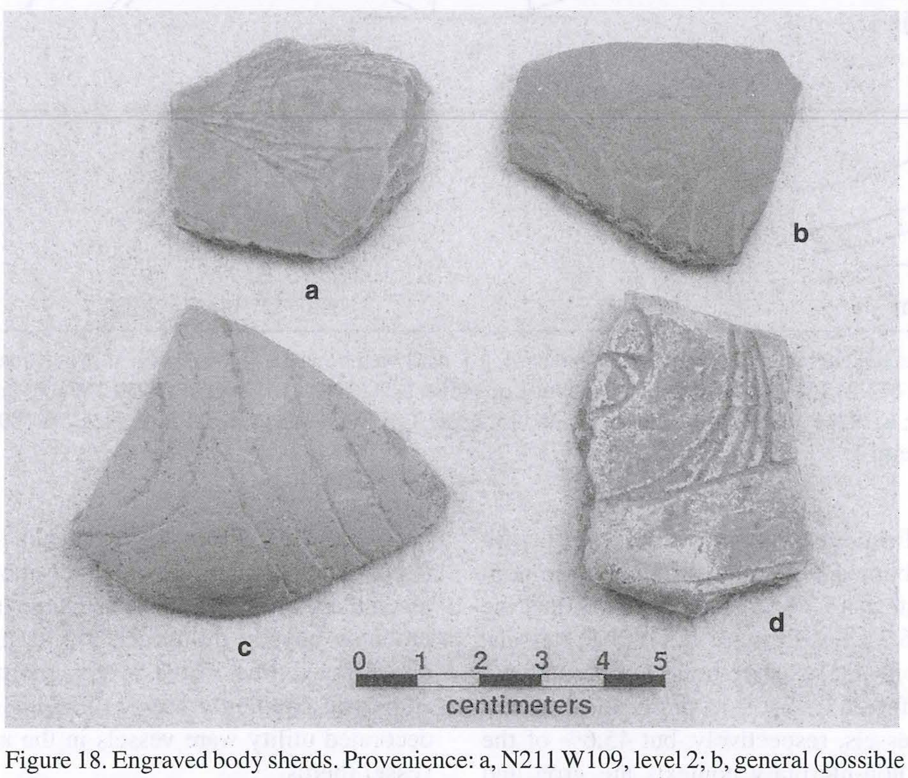


Figure 18. Engraved body sherds. Provenience: a, N211 W109, level 2; b, general (possible Taylor Engraved); c, general (possible Natchitoches Engraved); d, N214 W116, level 1.

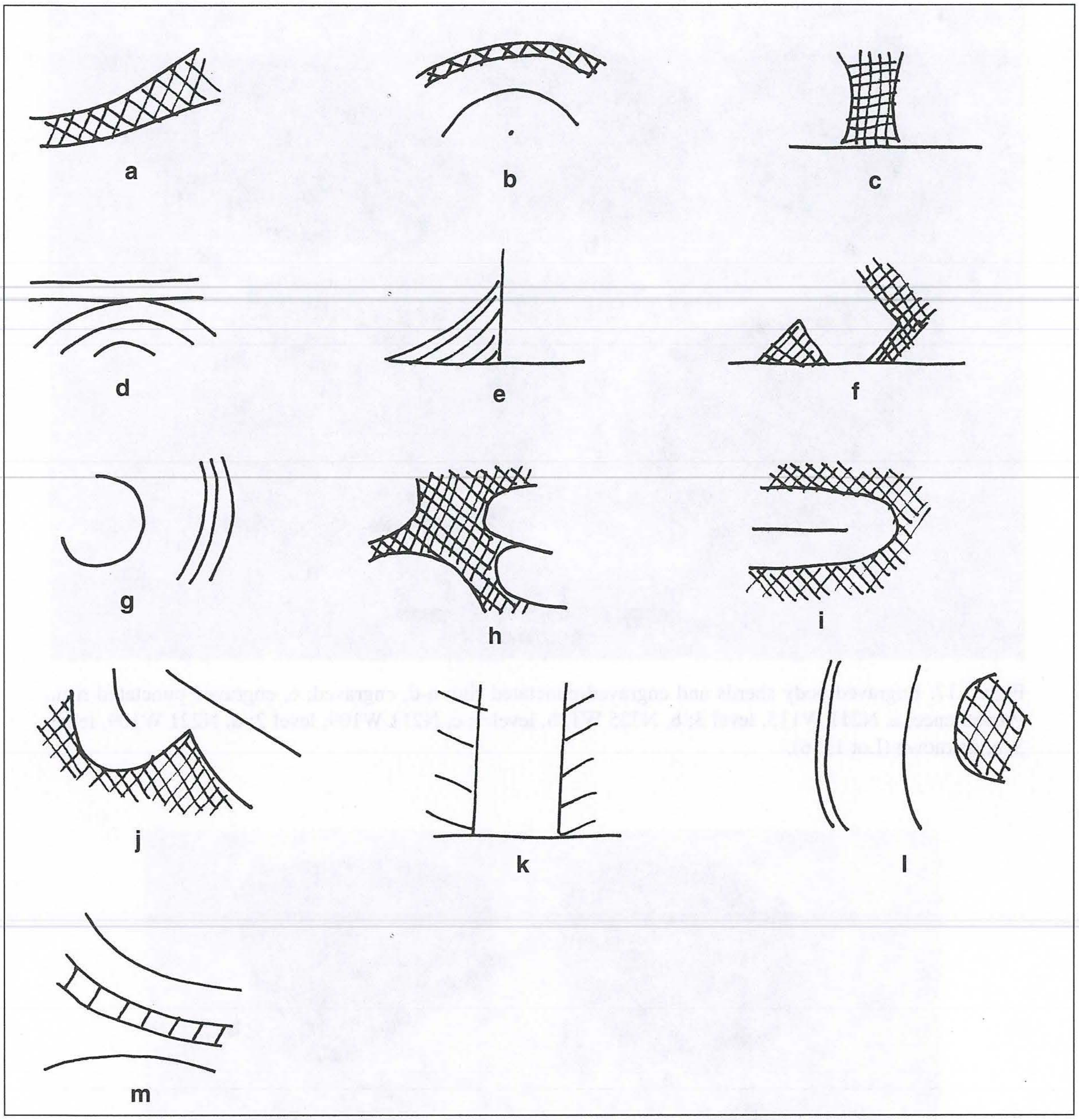


Figure 19. Selected engraved decorative elements: a-d, g-j, carinated bowls; e-f, k-m, bottles. Provenience: a, c, N212 W114, level 3; b, N212 W114, level 2; d, unknown (Lot 1458); e, N221 W116, level 2; f, N212 W107, level 2; g, N211 W113, level 2; h, N211 W109, level 2; i, N211 W115, level 3; j, N224 W117, level 2; k, N211 W109, level 1; l-m, N215 W107, level 1.

Sherds from vessels tempered solely with crushed and burned bone are less common in non-mortuary contexts (3.7%) than they are in either the Feature 31 (6.7%) or Feature 95 (12.5%) vessels, however. Conversely, grog-bone-tempered vessels account for 26.7-28.1% of the Feature 31 and Feature 95 vessels, respectively, but 45.6% of the sherds from non-mortuary contexts are grog and bone-tempered. From these data, it is reasonable to conclude that mortuary and non-mortuary vessel assemblages were not made and tempered the same, probably heavily influenced by the high numbers of engraved fine wares in the mortuary vessels and correspondingly higher amounts of plain and decorated utility ware vessels in the non-mortuary vessel sherds.

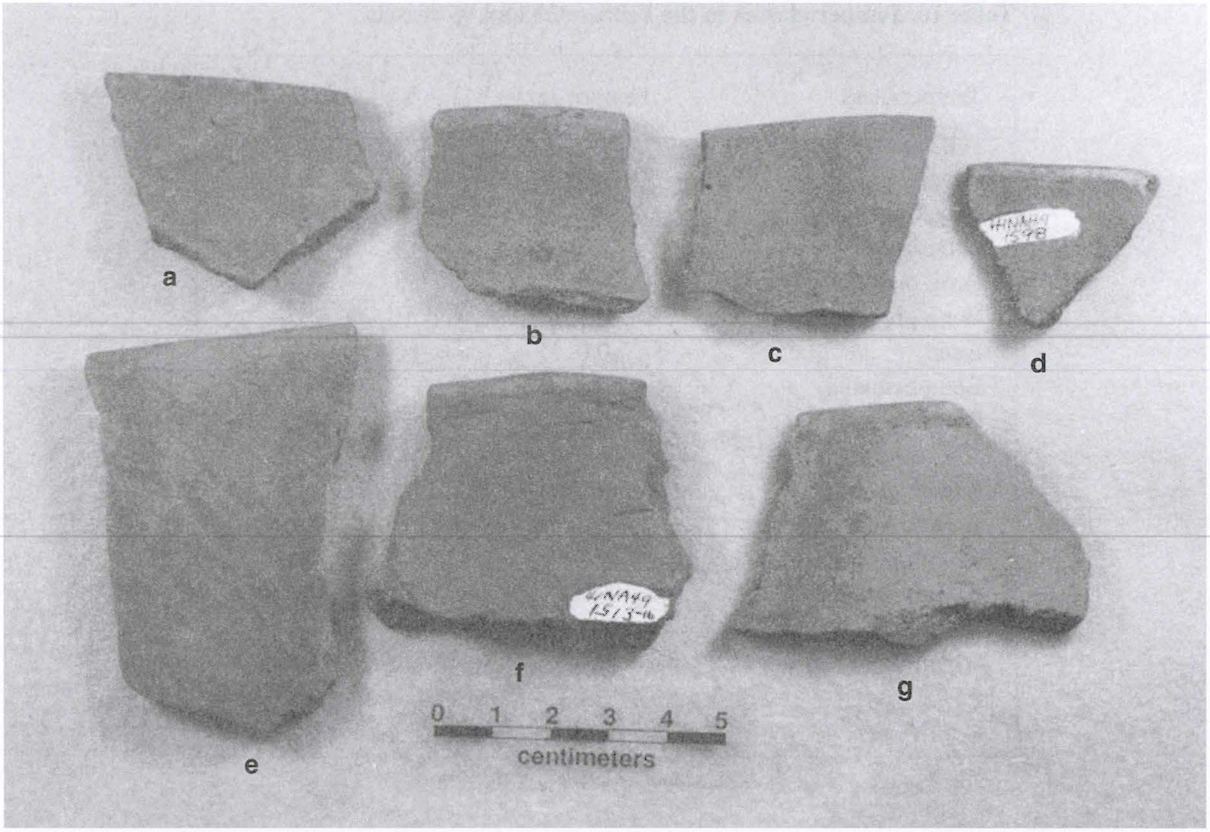


Figure 20. Plain rims from the Washington Square Mound site. Provenience: a, N212 W109, level 1; b, N214 W112, level 3; c, general site area; d, N212 W112, level 3; e, N227 W116, level 2; f, N211 W116, level 2; g, N215 W112, level 1.

ASSEMBLAGE COMPARISONS

Compositional differences in the Washington Square Mound site ceramics are also evident in the comparison of the proportions of different kinds of decorated fine wares and utility wares in both the funerary vessels and non-mortuary vessel sherds (Table 11). As Table 11 illustrates very well, engraved fine wares are almost seven times more prevalent in mortuary contexts (55.8%) than they are in non-mortuary contexts (8.3%) at the site, and clearly these fine wares were deliberately selected by the Caddo as a funerary accompaniment more often than any other kind of ceramic vessel. The engraved designs on these vessels likely had very specific social and ritual meanings to the Caddo lineages the deceased belonged to, as well as to the larger community that used the Washington Square Mound site for civic and ceremonial purposes, and thus it was appropriate that these fine wares were placed with the dead to use on their journey to the House of the Dead.

Decorated utility wares, especially those with brushing (either as the sole decorative treatment or in combination with other decorative methods), are three times more common in non-mortuary contexts than they are as funerary offerings. In fact, almost 63% of all the decorated sherds from non-mortuary contexts have brushing (see Table 11). Incised, punctated, pinched, and appliqued sherds and vessels are roughly equivalent in frequency between mortuary and non-mortuary contexts, although incised vessel sherds are more common in the latter and incised-punctated vessels are more abundant in the former archeological contexts (see Table 11).

In summary, then, vessels in mortuary contexts at the Washington Square Mound site are predominantly engraved, brushed-punctated, and incised-punctated (see Table 11), accounting for more than 80% of the decorated vessels. In vessel sherds from non-mortuary contexts, the principal decorative methods are brushed, incised-punctated, and punctated on utility wares; these account for almost 79% of the decorated sherds. Engraved fine wares were not commonly used or broken in non-mortuary contexts.

Table 10. Temper classes in the Feature 31 and 95 vessels.

Temper class	Feature 31	Feature 95
Grog	46.7*	37.5
Grog-hematite	20.0	18.8
Grog-bone	20.0	12.5
Grog-organics	0.0	3.1
Bone-grog-hematite	6.7	15.6
Bone	0.0	9.4
Bone-hematite	0.0	3.1
Bone-organics	6.7	0.0
% with grog	86.7	87.5
% with bone	33.4	40.6
% with hematite	26.7	37.5
% with organics	6.7	3.1
% with sandy paste	6.7	9.4
Total vessels	15	32

*percentage

In addition to the differences already noted in vessel composition, proportion of fine wares, utility wares, and plain wares, as well as choices in temper selection, we know that utility and fine ware vessels from the site were fired in different ways (Table 12). This is based on the detailed analysis of whole vessels from two mortuary features (Perttula et al. 2008). In the case of the Feature 31 vessels, 50% were fired in a high oxygen environment as compared to only 10.3% of the Feature 95 vessels. Almost 90% of the Feature 95 vessels were fired in a low oxygen or reducing environment (probably smothered in the coals), and most of these were subsequently removed from the fire to cool, leaving a thin oxidized layer along either interior and/or exterior vessel surfaces.

The meaning of these vessel firing differences between vessel offerings placed in the two mortuary features is presently uncertain. Possibilities that may account for these differences include (a) temporal or social changes in the technology of firing; (b) preferences in the hardness and color of vessels of different sizes, functions, and decorative style; (c) a greater learned or developed ability to control the firing temperature and the duration of firing by individual potters, or even (d) personal, familial, or community-wide choices that dictated how fine wares, utility wares, and plain wares needed to be fired. Certainly also influencing the differences in vessel firing detected between the two mortuary features were decisions made by the living descendants of the deceased about what kinds of pottery vessels were appropriate to place as funerary offerings in the mortuary features, and what pottery vessels were available for mortuary use.

CERAMIC PIPES

A total of seven pipe sherds were recovered from the 1985 TAS excavations in Area A (Table 13) at the Washington Square Mound site. These were found in the same part of Area A as the plain, utility, and fine ware ceramic sherds (see Figure 4i).

Four of the pipe sherds are definitely from elbow pipes (Figure 21b, d), one clearly of the L-shaped form (Figure 21c), which is the earliest known form of Caddo elbow pipe made in East Texas (cf. Rogers and Perttula 2004); one other pipe sherd is a large pipe bowl, probably also from an elbow pipe (Figure 21e). One of the elbow pipe sherds has an engraved line that encircles the base

Table 11. Decorated fine wares and utility wares in funerary vessels and non-mortuary vessel sherds from the Washington Square Mound site.

Wares	sherds from non-mortuary contexts*	mortuary contexts
Fine wares		
Engraved	8.2**	51.2
Engraved-punctated	0.1	2.3
Engraved-rocker stamped	0.0	2.3
Sub-total	8.3	55.8
Utility wares		
Brushed	54.7	0.0
Brushed-incised-punctated	0.2	2.3***
Brushed-incised	3.7	0.0
Brushed-punctated-appliqued	0.1	4.7
Brushed-punctated	3.6	14.0
Brushed-appliqued	0.6	0.0
Sub-total	62.9	21.0
Pinched	0.6	0.0
Incised	14.1	2.3
Incised-punctated	4.0	11.6
Punctated	9.9	9.3
Appliqued	0.3	0.0
Incised-appliqued	0.1	0.0
Sub-total	29.0	23.2
Total	5194 sherds	43 decorated vessels

*from Hart (1982) and this article
**percentage
***brushed-incised-appliqued-punctated (Reavely Brushed-Incised)

of the bowl (Figure 21b). Later elbow pipe forms in the Neches-Angelina River basin (Perttula 2008b) commonly have engraved lines on them, either encircling the rim of the bowl and/or the stem as well as the bowl base.

MISCELLANEOUS CERAMIC ARTIFACTS

Although included in the discussion above of the decorated utility wares, there is one sherd in the assemblage with horizontal rows of pinching that is worthy of further mention. This particular sherd is a portion of a pedestal leg from either a 3- or 4-legged Killough Pinched jar (Figure 22; see also Suhm and Jelks 1962:Plate 46a-c).

CHIPPED STONE TOOLS AND DEBRIS

The chipped stone tools and debris from the Washington Square Mound site TAS excavations

Table 12. Firing conditions observed in the Feature 31 and 95 vessels.

Firing conditions*	Feature 31	Feature 95
Oxidizing environment	20.0**	3.4
Incompletely oxidized	30.0	6.9
Reducing environment	10.0	13.8
Fired in a reducing environment, cooled in the open air	40.0	75.9
Total vessels	10	29

*follows Teltser (1993:Figure 2a-h)
**percentage

include eight arrow points, three scrapers, 17 flake tools, one chipped gouge, 122 pieces of lithic debris, and nine discarded cores (Appendix 3, on file with the TAS and Stephen F. Austin State University). The chipped stone artifacts are found in low numbers throughout the Area A excavations. Tools and Perdiz arrow points are more widely distributed across the excavations (Figure 23a-b) than are the ceramic vessels (see Figure 4), as are cores (Figure 23c) and lithic debris (Figure 23d). This suggests that multiple and spatially dispersed knapping events and tool use/discard areas are represented in the archeological deposits, or that multiple knappers and/or tool users have contributed to the dispersion of chipped stone tools and debris in this part of the mound center.

Arrow points

All eight arrow points from Area A are likely finely-made contracting stem Perdiz style specimens with finely serrated blades and downward-pointing barbs (Table 14 and Figure 24); these are concentrated in the southern part of Area A. Similar contracting stem arrow points have been recovered from Middle Caddo period sites in the Sabine and Neches-Angelina river basins in East Texas (see Rogers and Perttula 2004; Shafer 2007), as well as in Late Caddo contexts throughout the region.

Six of the eight arrow points are made from either gray (n=5) or reddish-brown (n=1) chert, with the other two made from a fine-grained quartzite. Based on the prevalence of cortex-covered pieces of gray chert in the lithic debris (see below) from Washington Square, but the overall dearth of lithic debris from this site, it is likely that the five arrow points of this material were made locally, although not in Area A. The two quartzite Perdiz points (see Figure 24a, g) and the one unidentified point made of a reddish-brown chert (see Figure 24c) appear to have been made from non-local lithic raw material sources, or obtained from some other Caddo groups outside of the Angelina River basin.

Scrapers

Three scraping tools with steep and well-defined working edges were found in the southern part of the Area A excavations (Table 15). All three side scrapers (Figure 25b-c) are on fine-grained chert raw materials, including dark gray (n=2) and light gray (n=1) colors. Two of the three scrapers are broken, but the area of use on each tool ranged between at least 13 mm to 72 mm in length along one side of the tool.

Flake tools

The flake tools from Area A at the Washington Square Mound site have use-worn and/or marginal retouching areas (ranging from 4.5-31 mm in length) along one or multiple edges of finely-grained

Table 13. Ceramic Pipes.

Provenience	Sherd type	Comments
212-112, lv. 2	pipe bowl	L-shaped elbow pipe with D-FL rim/lip; 32.0 mm exterior orifice diameter; 15.0 mm interior orifice diameter; 10.6 mm thick at lip; stem height is 57.0+ mm
212-114, lv. 1	pipe bowl	elbow pipe; 4.6 mm thick; single engraved line encircles the bowl base
214-106, lv. 1	pipe bowl	D-FL rim/lip, with an exterior thickened rim
214-106, lv. 1	pipe stem	elbow pipe; no apparent temper; ext. orifice diameter is 36.5 mm; interior stem diameter is 16.0 mm; stem length is 22.9+ mm; no apparent temper; stem narrows in the direction of the bowl
221-109, lv. 3	pipe stem	long-stemmed pipe; exterior stem diameter, 12.4 mm; interior stem diameter, 5.2 mm
221-109, lv. 3	pipe stem	elbow pipe; thick and flat lip; 10.3 mm thick; 5.7-9.7 mm stem diameter in cross-section (interior-exterior)
222-109, lv. 1	pipe bowl or stem	bone-tempered; 6.3 mm thick

D-FL=direct rim and a flat lip

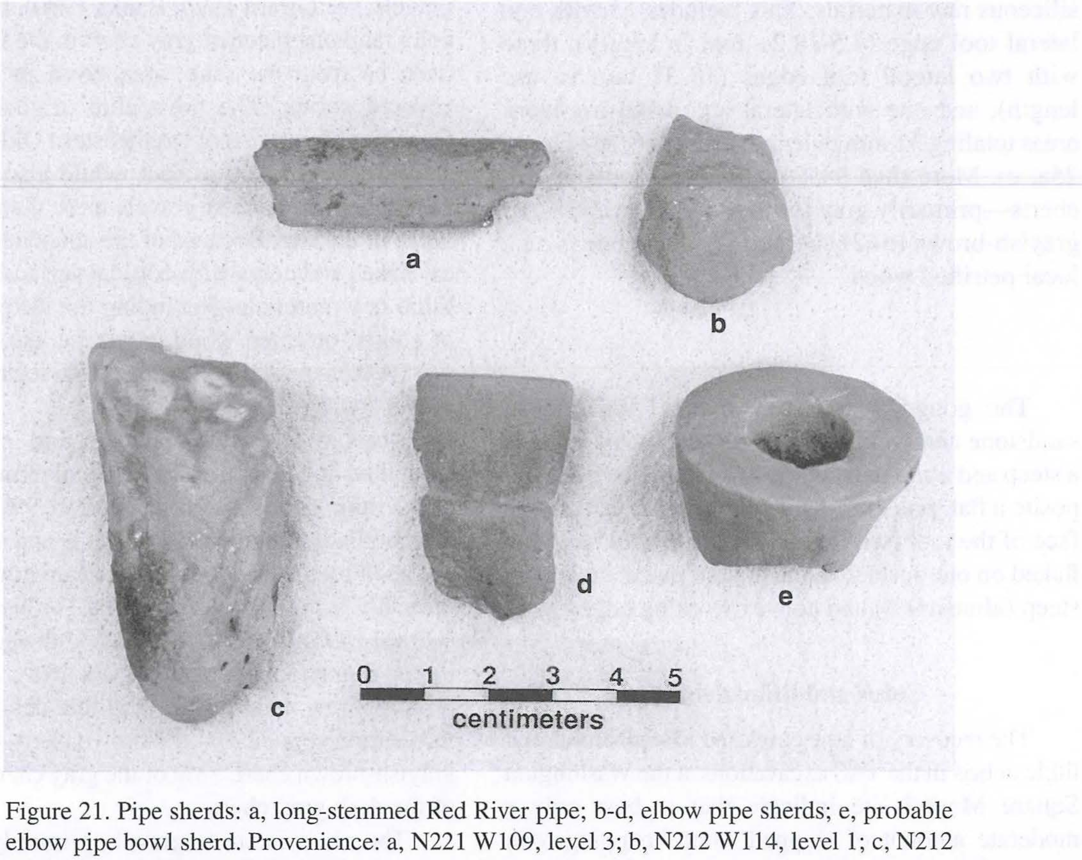


Figure 21. Pipe sherds: a, long-stemmed Red River pipe; b-d, elbow pipe sherds; e, probable elbow pipe bowl sherd. Provenience: a, N221 W109, level 3; b, N212 W114, level 1; c, N212 W112, level 2; d-e, N214 W106, level 1.

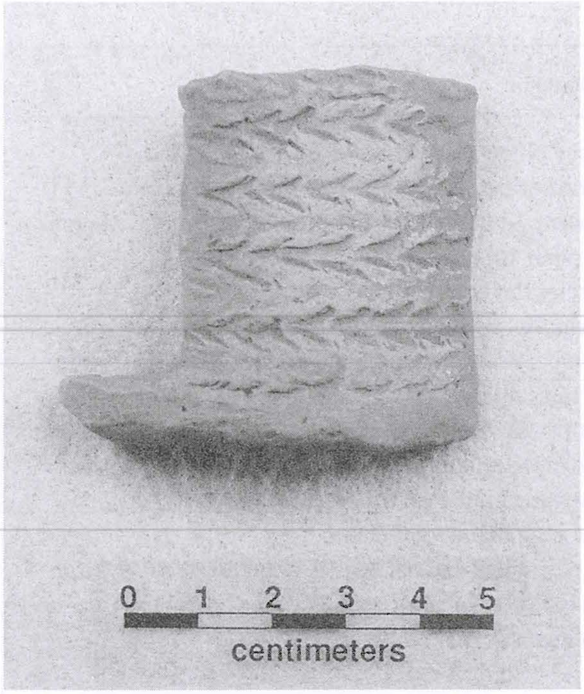


Figure 22. Killough Pinched pedestal leg. Provenience: N211 W112, level 3.

siliceous raw materials. This includes 13 with one lateral tool edge (4.5-18.2+ mm in length), three with two lateral tool edges (18-37 mm in use length), and one with lateral and distal use-worn areas totaling 31 mm in length (Table 16; see Figure 25a, e). More than 94% of the flake tools are on cherts—primarily gray (n=9), dark gray (n=2), and grayish-brown (n=2) chert colors—and one is on a local petrified wood.

Gouge

The gouge, made from a local ferruginous sandstone and probably used for woodworking, has a steep and unifacially chipped and utilized edge opposite a flat, polished planar surface that covers one face of the tool (see Figure 25d). The tool has been flaked on one surface of the tabular piece, creating a steep (almost 90^0) and convex working edge.

Cores and lithic debris

The recovery of nine cores and a small amount of lithic debris in the TAS excavations at the Washington Square Mound site indicate that at best only a moderate amount of chipped stone knapping took place during the Caddo use of Area A (see Figure 23c-d). Eight of the nine cores are on chert; the ninth is a core fragment of a local hematite (Table 17). Most of the cores were only minimally reduced—including tested pebbles (n=4) and single platform (n=2) cores—and only one brown chert pebble core was reduced to the point of exhaustion (i.e., no more flakes could be reasonably removed from the piece).

The 122 pieces of lithic debris from Area A at the Washington Square Mound site are dominated by cherts (93.5%), with only a limited use of other raw materials, among them hematite (0.8%), quartzite (0.8%), novaculite (1.6%), petrified wood (2.5%), Catahoula Sandstone (0.8%), and chalcedony (0.8%). The most common chert in the lithic debris is gray in color, often translucent (n=50, 41.0%), dark gray (n=17, 13.9%), grayish-brown (n=15, 12.3%), brown (n=11, 9.2%), brownish-gray (n=4, 3.3%), yellowish-gray (n=4, 3.3%), yellow (n=2, 1.6%), dark brown (n=2, 1.6%), dark grayish-brown (n=2, 1.6%), light gray (n=2, 1.6%), yellowish-red (n=1, 0.8%), red (n=1, 0.8%), white (n=1, 0.8%), and grayish-white (n=1, 0.8%).

The dark gray chert pieces are likely from a Central Texas source (although such material is available in closer Trinity River and Neches River gravels, see Girard 1995; Banks 1990), based on its color, and one piece of gray chert in the lithic debris must be from the same area given its limestone-covered cortex. The novaculite originated in the Ouachita Mountains of southeastern Oklahoma and southwestern Arkansas, but would also have been available in Red River gravels more than 150 miles north of the site. Because of the abundance of cortical flakes and cores with cortical surfaces, the other lithic raw materials—including the different colors of cherts, petrified wood, quartzite, etc.—found at Area A were probably obtained from regional stream gravel sources.

Most of the lithic debris and cores have smoothed and stream-rolled cortical remnants (61% of the lithic debris is cortical, and 91.9% of that has a smoothed stream-rolled cortex), and these were gathered by the Caddo from a stream gravel source, probably from either the Angelina or Neches rivers (Girard 1995:68-69) to the south and west of Washington Square, about a day's walk away. Among the principal raw materials in the lithic debris, cortical flakes represent 82% of the brown chert, 67% of the grayish-brown chert, 58% of the gray chert, and 42% of the dark gray chert.

The chert in these gravels primarily occur as pebbles, and bipolar flakes are relatively common

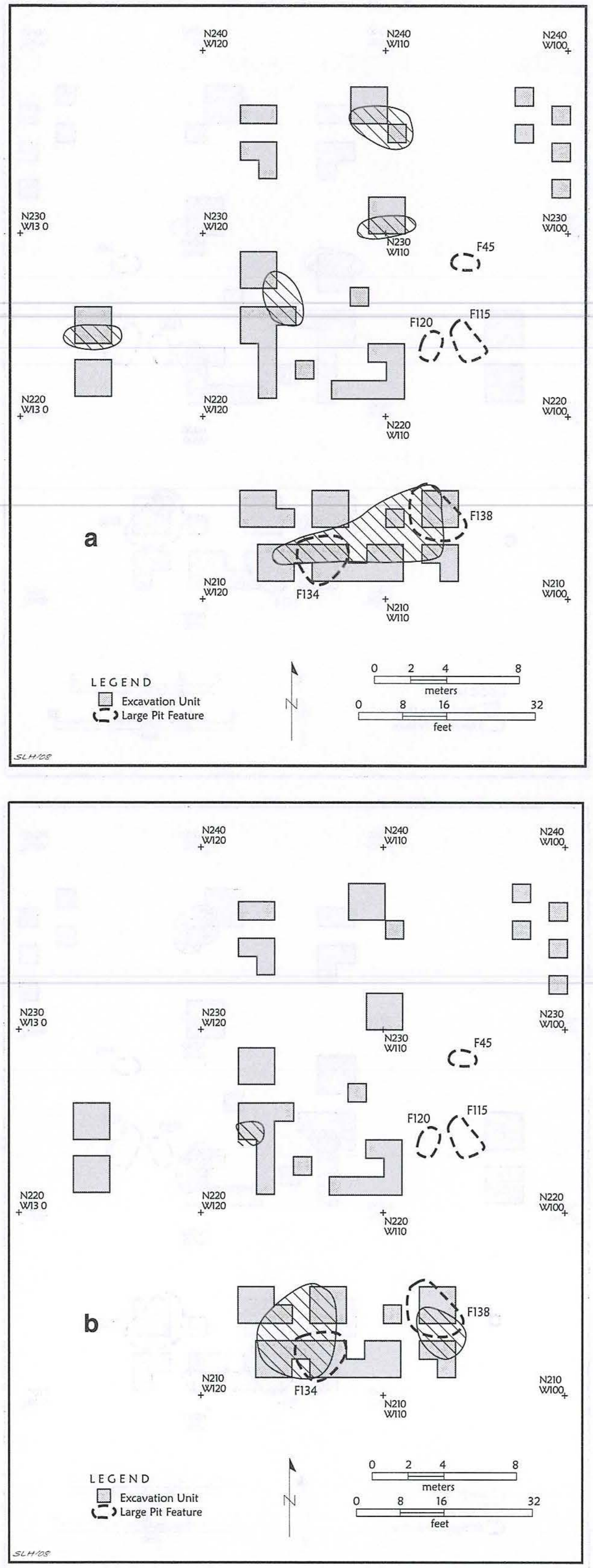


Figure 23. Distribution of lithic artifacts in the TAS-excavated portions of Area A; a, stone tools; b, Perdiz arrow points.

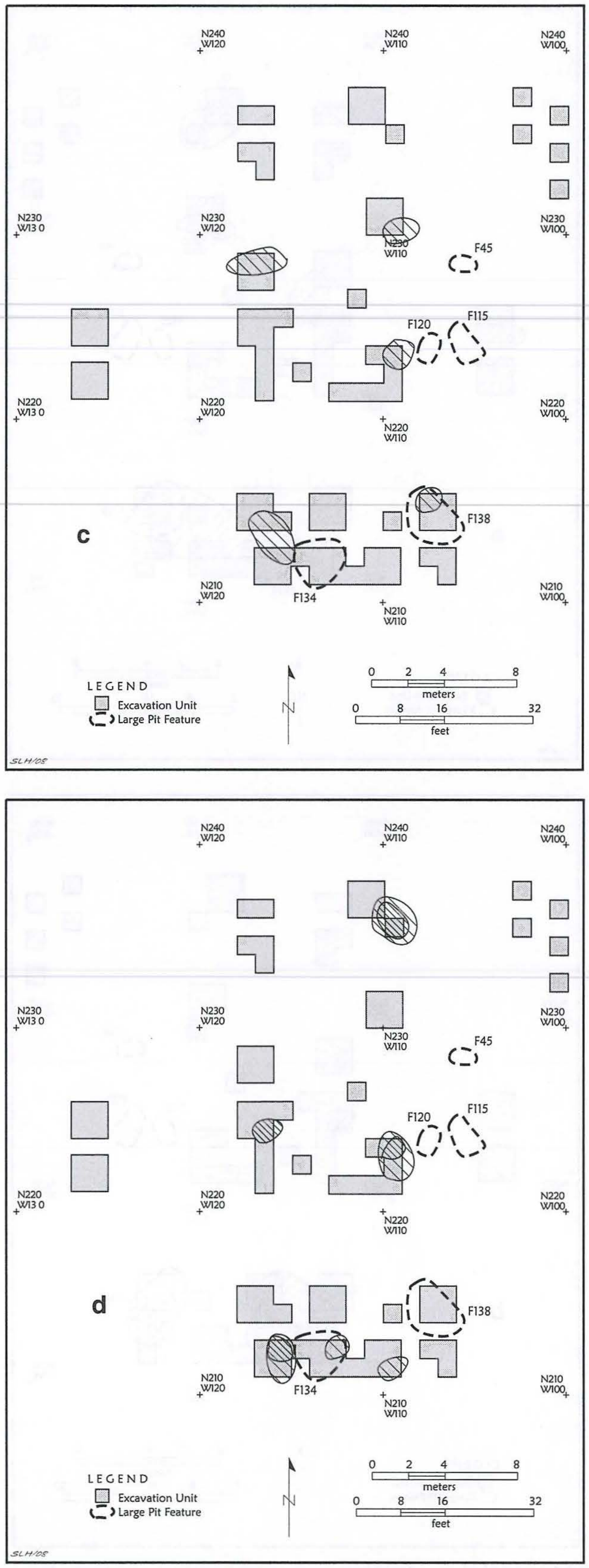


Figure 23. Distribution of lithic artifacts in the TAS-excavated portions of Area A; c, cores; d, lithic debris.

Table 14. Arrow points.

Provenience	Type	Raw Material	L*	W	Th	SW	RS/S	Comments
211-113, lv. 1	?	reddish-brown chert	–	13.0	3.1	3.4	–/+	downward barbs
211-115, lv. 1/ 214-115, lv. 2?**	Perdiz	gray chert	11.0	10.1	4.0	4.6	+/-	outward barbs
212-106, lv. 2	Perdiz	gray chert	47.4	18.9	3.0	5.4	+/+	downward barbs
212-116, lv. 3	Perdiz	gray chert	23.0	16.6	3.0	3.8	–/+	downward barbs
215-107, lv. 3	Perdiz	quartzite	–	10.9	2.7	3.7	–/+	downward barbs
215-113, lv. 1	Perdiz	gray chert	30.5	15.7	3.6	4.7	–/+	downward barbs
224-117, lv. 1	Perdiz	gray chert	–	13.9	3.6	4.2	–/+	downward barbs
224-117, lv. 1	Perdiz	quartzite	27.0	11.3	2.8	3.2	–/+	downward barbs

L=length (in mm); W=width (in mm); Th=thickness (in mm); SW=stem width; RS/S=resharpened/serrated; +=present; -=absent; **the lot no. label on the artifact is ambiguous, and may be either Lot 1490 or Lot 1491

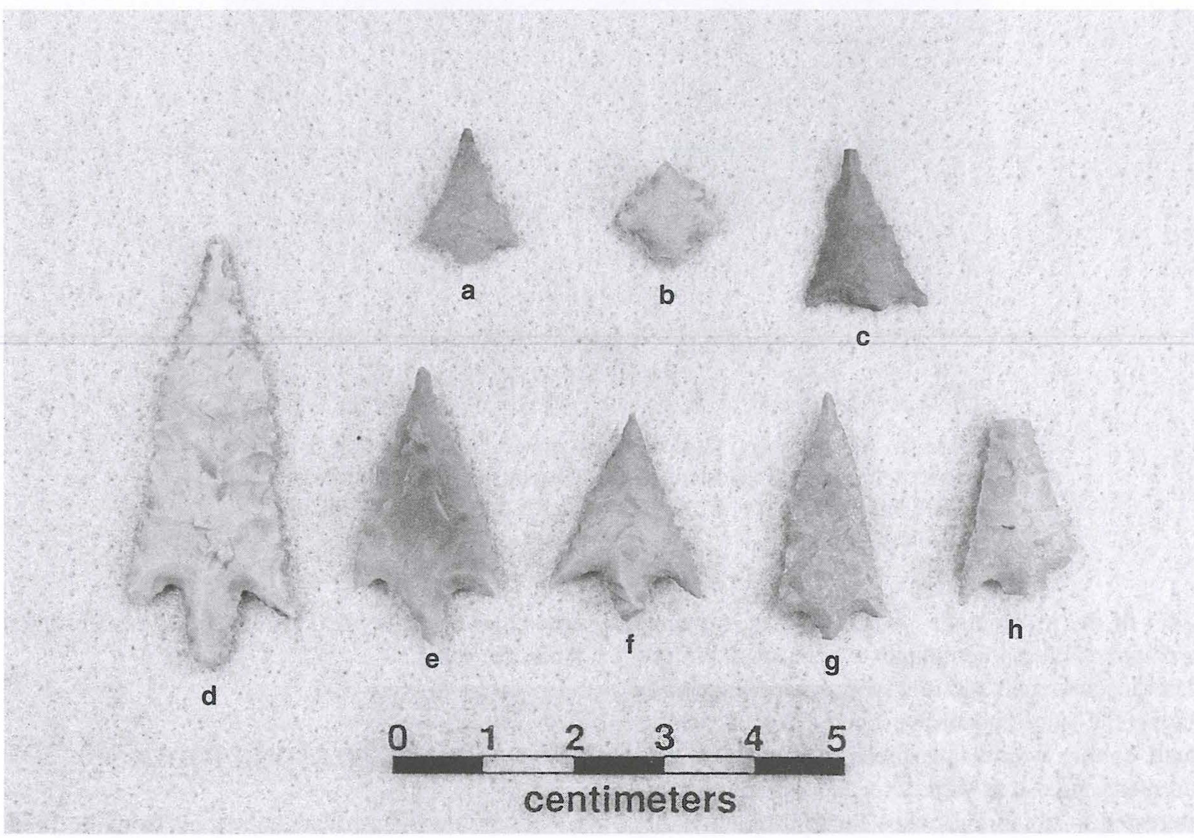


Figure 24. Arrow points from the Washington Square Mound site: a-b, d-h, Perdiz; c, unidentified. Provenience: a, N215 W107, level 3; b, N211 W115, level 1 or N214 W115, level 2; c, N211 W113, level 1; d, N212 W106, level 2; e, N215 W113, fill; f, N212 W116, 33-43 cm; g-h, N224 W117, level 1.

Table 15. Scraping tools.

Provenience	Raw Material	Utilized Length (mm)	Tool Type
212-110, lv. 1	dark gray chert	41.0+	side scraper
212-110, lv. 2	dark gray chert	13.0+	side scraper
214-107, lv. 4	light gray chert	72.0	side scraper

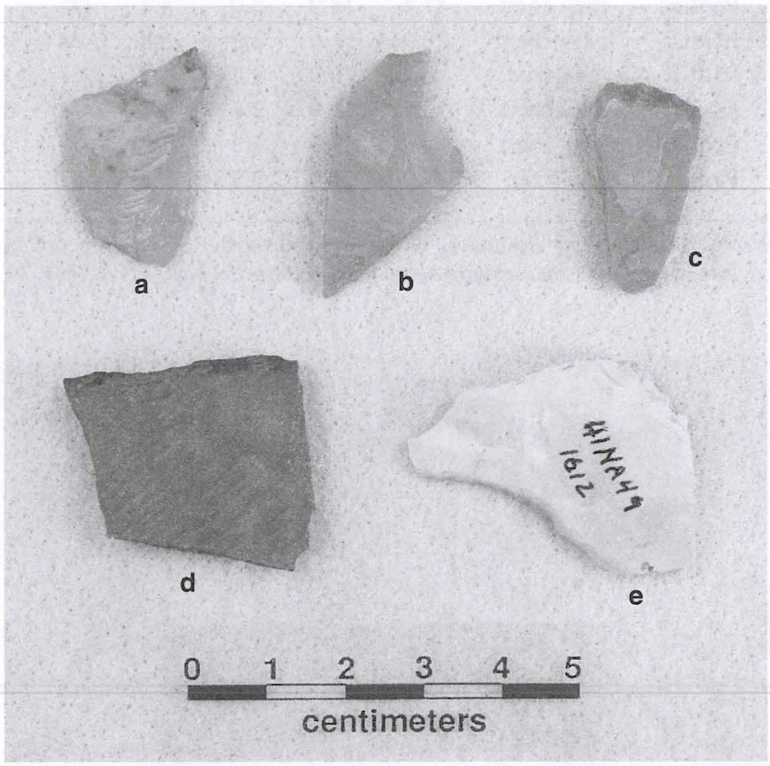


Figure 25. Side scrapers, flake tool, and gouge: a, e, flake tool; b-c, side scraper; d, ferruginous sandstone gouge. Provenience: a, general site context; b, N212 W110, level 1; c, N212 W110, level 2; d, N214 W109, fill; e, N214 W107, level 4.

(n=7) in the assemblage, which is to be expected in chipped lithic assemblages where available raw materials are small and relatively scarce, especially among the gray and brown cherts. An occasional small cobble would have been available for procurement and use as well. As Caddo knappers were interested in obtaining flakes for tool manufacture (including flakes for arrow points, other formal tools, as well as expedient flake tools), rather than by the direct reduction of cores, the limited knapping carried out in Area A of the site was for the purpose of obtaining a small stockpile of usable flakes for future tool manufacture, or for the testing of small cores that could be further reduced to obtain other flakes for tools.

GROUND STONE TOOLS

There are four ground stone tools from the 1985 TAS excavations. Three of the four ground stone tools are made from ferruginous sandstone, while the other is on hematite. Both materials are available locally (cf. Girard 1995). One of the ferruginous sandstone tools (N225 W116, level 1) is a fragment of a grinding slab, another of the same material is a mano

Table 16. Flake tools.

Provenience	Raw Material	Utilized Length (mm)	Tool Type
212-112, lv. 2	reddish-gray-brown chert	8.5	unilateral
212-112, lv. 2	gray chert	31.0	unilateral and distal
212-115, lv. 1	grayish-brown chert	4.5	unilateral
212-115, lv. 1	petrified wood	11.0	unilateral
212-115, lv. 1	gray chert	11.0+	unilateral
214-107, lv. 4	yellowish-white chert	37.0	bilateral
223-116, lv. 2	dark gray chert	7.5+	unilateral
224-126, lv. 1	gray chert	18.2+	unilateral
227-116, lv. 2	gray chert	9.0+	unilateral
230-109, lv. 1	yellowish-gray chert	7.0+	unilateral
230-110, lv. 1	gray chert	8.0	unilateral
235-109, lv. 1	gray chert	18.0	bilateral
235-109, lv. 1	gray chert	8.5	unilateral
236-110, lv. 1	dark gray chert	11.0+	unilateral
236-110, lv. 2	grayish-brown chert	8.0	unilateral
Lot 1458*	gray chert	18.0	bilateral
Lot 1458*	gray chert	12.0+	unilateral

*Not listed in the artifact catalog, specimen inventory, on file at Stephen F. Austin State University

Table 17. Cores.

Provenience	Raw Material	Core Type
212-115, lv. 1	yellowish-brown chert	single platform
212-115, lv. 1	brown chert	exhausted core
214-116, lv. 2	hematite	multiple platform core fragment
215-107, lv. 1	brown chert	tested pebble
215-107, lv. 1	light gray chert	tested pebble
223-109, lv. 1	gray chert	core fragment
223-109, lv. 1	dark grayish-brown chert	single platform
228-116, lv. ?*	reddish-gray chert	tested pebble
228-117, lv. 1	red chert	tested pebble

*the artifact catalog, specimen inventory, does not list the level for this lot no.

and bi-pitted stone (N224 W125, level 3), while the third such tool is a pitted stone with one pit (N236 W111, level 2). The hematite ground stone tool is a fragmentary bi-pitted stone (N215 W107, level 2).

FIRE-CRACKED ROCK

The small lithic assemblage from the Washington Square Mound site includes three pieces of fire-cracked rock (N225 E126) and a single unmodified piece of Catahoula sandstone (N211 E106).

SUMMARY

The Washington Square Mound site (41NA49), in the modern city of Nacogdoches, Texas, in the East Texas Pineywoods, is an important prehistoric multiple mound center constructed and used by the Caddo peoples between ca. A.D. 1250-1425, during the Middle Caddo period. In 1985, the Texas Archeological Society (TAS) held their annual summer field school at the site, under the direction of Dr. James E. Corbin of Stephen F. Austin State University. Although the general findings of the field school were summarized by Corbin and Hart (1998), the large assemblage of recovered artifacts (primarily Caddo ceramic vessel sherds) had not been analyzed and a report prepared on these material culture remains. As part of the concerted effort by the TAS to see that the results and archeological findings of past field schools are fully published (cf. Perttula 2008c), the TAS supported my proposal to complete the analysis of the recovered artifacts and prepare a report on the archeological significance of the ceramic and lithic artifacts found in the excavations.

The 1985 TAS Field School excavations were concentrated in non-mound archeological deposits not far to the east of Mound 1/2 and between that mound and the Reavely-House Mound (Mound 4), thus placed betwixt the sacred and civic parts of the mound center (see Figure 2). Mound 1/2 had been built over an important public structure "constructed on the leveled surface of a low, natural sandy rise" (Corbin and Hart 1998:71). The Reavely-House Mound is a burial mound that contains the graves of at least six members of the Caddo elite that lived and died in the Washington Square Mound community.

In the non-mound areas at Washington Square examined during several seasons of excavations—including that of the TAS Field School—clear evidence for on-site permanent Caddo habitation has yet to be identified. Instead, an assortment of pits and post holes have been documented (Corbin and Hart 1998:60-67). Certainly the most interesting of these non-mound features are several large sherd-filled pits (see Figure 3b) in the southern part of the excavations. These pits and the sherds they contain from many different vessels—especially cooking jars (see Figure 4a) but also including a modicum of fine ware serving vessels--may represent the deposits from public feasting activities led by the Caddo elite who used the Washington Square Mound site as a civic and ceremonial center. The remains of important public feasting events have been encountered at a number of mound centers in the eastern United States (e.g., Dietler and Hayden 2001; Pauketat et al. 2002) as well as the Early Caddo mound center at the Crenshaw site (Scott and Jackson 1998).

Not including a few charred plant remains and animal bones (not analyzed as part of my proposal), or the several thousand ceramic sherdlets, a total of 3580 prehistoric ceramic artifacts have been recovered in the Area A excavations at the Washington Square Mound site by the 1985 TAS Field School. As with many East Texas Caddo sites, this artifact assemblage from the Washington Square Mound site is dominated by sherds (95.1%) from broken ceramic cooking, serving, and storage vessels, with only a few ceramic pipe sherds (0.2%), and a small assortment of chipped stone (n=29, 0.8%) and ground stone (n=4, 0.1%) tools (particularly flake tools and Perdiz arrow points), the debris and cores from chipped stone tool manufacture (n=131, 3.7%), and a few pieces of fire-cracked rock and Catahoula Sandstone (n=4, 0.1%).

Based on the rim sherds, the ceramic sherd collection from the 1985 TAS Field School excavations at the Washington Square Mound site represent the fragments from at least 200 vessels used and discarded in Area A. About 25% of these vessels are from plain wares (typically bowls and carinated bowls), another 6% are fine ware carinated bowls and bottles decorated with engraved designs, and the remainder (69%) are from decorated utility ware jars (including at least one vessel with a pedestal base). The diversity of decorative motifs and elements in both the fine wares and utility wares is considerable, but defined types recognized in the decorated sherds includes Nacogdoches Engraved and Washington Square Paneled types in the fine wares, as well as a few sherds of the Historic Caddo type Patton Engraved, and Dunkin Incised, Davis Incised, Maydelle or Canton Incised, Killough Pinched, and Reavely Brushed-Incised types in the utility wares; there are also vessels that apparently have brushing (Bullard Brushed?) or punctations on both the rim and body surfaces. The same range of ceramic types are present in the Area A sherd assemblage studied by Hart (1982) and the mortuary vessels from the Reavely-House Mound, except in the case of the latter, engraved fine wares were obviously the preferred burial good (see Hart 1982; Perttula et al. 2008), well out of proportion to their use in more mundane non-mound contexts at the site.

Our consideration of the Caddo ceramic technology and decorative styles documented at the Washington Square Mound site suggests that the closest affiliations (although not necessarily that close stylistically speaking) of the Caddo groups that lived there from the 13th century A.D. onward are with other Caddo sites and communities not far to the northeast, east, and southeast in the Angelina and Attoyac river basins (Perttula 2008a:Figure 12-3). The Washington Square Mound site lies near the center of this ceramic tradition. This same broad area of East Texas was occupied in historic times by numerous Caddo groups that were affiliated with the Hasinai Caddo (cf. Swanton 1942), including the Nasoni, Nadaco, Hainai, and Nacogdoche. The prehistoric Caddo settlers and mound builders at Washington Square shared a common ceramic heritage with other prehistoric and historic Caddo groups living in this part of East Texas.

Some of these other Caddo sites include several 13th to 15th century Caddo settlements at Lake Naconiche on Naconiche Creek (a tributary to Attoyac Bayou, see Perttula 2008a), Middle and Late Caddo sites at Lake Sam Rayburn (Jelks 1965), and contemporaneous sites at Toledo Bend Reservoir (Woodall 1969). In each of these areas where archeological investigations have been undertaken, brushed pottery is an important decorative component in the utility wares after ca. A.D. 1250, and the proportion of brushed pottery appears to increase through time. Caddo sites in these areas also have high proportions of burned bone used as temper. North of the Sabine River, by contrast, grog was the preferred temper for vessel manufacture by Caddo potters between ca. A.D. 1300-1700.

Kelley (2005:61-66) has proposed a simple but effective way of determining cultural and ceramic stylistic affiliations between contemporaneous Caddo groups in East Texas and northwestern Louisiana. He made comparisons using a series of general decorative classes (i.e., brushed, ridged, incised, engraved, punctated, appliqued, and red-slipped) to "see how much variability occurs in assemblages from nearby regions." His examination of Belcher and Titus phase sites from different parts of the region (well north and east of Washington Square), the Burnitt site in the Sabine River uplands in northwestern Louisiana, and sites at Toledo Bend Reservoir along the Sabine River showed "very little variation within each region and significant differences between the regions." These similarities and differences lie at the heart of any conclusions about the cultural and ceramic affiliations of local Caddo groups.

I extend these comparisons by utilizing the ceramic decorative data compiled by Kelley (2005:Table 6-3) and adding to it decorative class information from other Middle and Late Caddo sites in this part of East Texas with well-studied ceramic assemblages. This includes sites at Lake Naconiche as well as decorative class data from the Tyson site in the Attoyac basin (Middlebrook 1994), and contemporaneous Caddo sites at Lake Sam Rayburn and Toledo Bend Reservoir (Table 18).

What these data first show are the existence between the 13th and early 15th centuries A.D. of some sort of a ceramic stylistic relationship between the Washington Square Mound site and contemporaneous Caddo sites at Lake Naconiche (on Naconiche Creek, about 20 km to the north) as well as the Caddo occupation at the Tyson site, located in the uplands on the east side of the Attoyac Bayou, not many miles to the east (see Table 18). These sites have considerable amounts of brushed, incised, and punctated utility wares (82-84% of all the decorated sherds)—as does Washington Square (89%)—but proportionally more engraved fine wares (13-20% for the former and 8% for the latter). More importantly, Nacogdoches Engraved and Washington Square Paneled sherds and/or vessels have been recovered from the Washington Square Mound site, the Lake Naconiche sites (Perttula 2008a), as well as at the Tyson site (Tom Middlebrook, 2008 personal communication), but not from any of the other sites listed in Table 18.

The Walter Bell site at Lake Sam Rayburn, some miles southeast of Washington Square, is also broadly stylistically similar in several respects: proportions of brushed, punctated, and engraved wares, although the former site has considerably

Table 18. Ceramic decorative classes from selected East Texas and northwestern Louisiana sites.

Decorative Class	Titus	Belcher	Burnitt	Goode	Walter Bell	Tyson	Lake Naconiche	Washington Square
Brushed	50*	14	40	42	47	38	45	61
Ridged	–	55	35	10	–	–	–	–
Incised	15	15	12	10	40	20	18	18
Engraved	20	15	12	35	4	20	13	8
Punctated	10	1	2	2	8	24	21	10
Appliqued	2	–	2	–	–	–	2	1
Red-slipped	2	–	–	–	–	–	Trace	–
Total decorated sherds	7407	10,103	1473	3645	4452	1862	3160	5194

*percentage; Belcher phase sites: Belcher, McLelland; Titus phase sites: Pilgrim's Pride, Sam Roberts, Ear Spool, Turtle Pond; Burnitt (Kelley 2005); Walter Bell (Jelks 1965); Goode (Woodall 1969); Tyson (Middlebrook 1994); Lake Naconiche, including Tallow Grove, Beech Ridge, and Foggy Fork sites (Perttula 2008a); Washington Square Mound (this study; Hart 1982)

more incised utility wares (40%, see Table 18) than does the Washington Square ceramic assemblage (18%). The absence of Nacogdoches Engraved or Washington Square Paneled sherds from the site suggests that there are not close—by comparison with the Tyson and Lake Naconiche Caddo sites—stylistic affiliations between the Caddo peoples living in the Lake Sam Rayburn area and the Washington Square Mound site.

Finally, ridged pottery is an important utility ware restricted to Caddo sites along the Red River affiliated with the Belcher phase and in sites in the middle Sabine River basin (see Table 18); no ridged pottery has been documented at the Washington Square Mound, Tyson, or Lake Naconiche sites. Consequently, these Belcher phase and middle Sabine River Caddo sites are somewhat farther removed stylistically from the Washington Square Mound site within this part of East Texas, particularly contemporaneous sites in the Attoyac and Angelina river basins in Nacogdoches and Shelby counties, Texas.

With a broader and regional archeological perspective on East Texas Caddo native history, the Washington Square Mound site appears to have been established, and began to flourish, about the time (around ca. A.D. 1250) that an earlier multiple mound Caddo civic and ceremonial center—the George C. Davis site (41CE19) (Story 1997, 1998, 2000)—was losing power and social authority among East Texas Caddo groups (Story 1997:64). Washington Square was situated about 60 km to the east of the Neches River and the George C. Davis site at the advantageous nexus of north-south (later known as the Caddo trace) and east-west (later known as the Camino Real de los Tejas) aboriginal trails that bisected Caddo ancestral lands. It seems likely that the Caddo community that built and used the Washington Square Mound site achieved preeminence at the expense of the long-lasting polity (400 years) on the Neches River. The George C. Davis site was eventually abandoned by the early 14th century A.D. (Story 2000). The Washington Square Mound site continued to function as an important Caddo civic and ceremonial center for at least 4-6 more generations, before it also was abandoned in the first part of the 15th century A.D. This abandonment may be part and parcel of a larger regional abandonment at that time of Caddo populations in broad parts of the upper Angelina and middle part of the Sabine river basins in East Texas (Perttula and Rogers 2007:91-92).

ENDNOTES

1. Of the seven radiocarbon dates used by Corbin and Hart (1998:Table 4), one had a very large standard

deviation (± 200 years, Tx-3945), and another (Tx-4872) dated a mixture of charred plant remains with very different rates of isotopic fractionation (i.e., wood, hardwood nuts, and corn), rendering the resulting dates suspect. These two radiocarbon samples at 2 sigma (AD 881-1478 and AD 1004-1322, respectively) barely fall within the calibrated age range of the pooled sample cited by Corbin and Hart (1998), but primarily date well before cal AD 1268-1302. A third sample (Tx-4873) at 2 sigma has a calibrated age range of AD 1153-1285, again indicating a date that primarily predates the pooled sample calibrated age range. I have not included these samples in my consideration of the estimated age of the Washington Square Mound site. Rather, I rely on four radiocarbon samples from Features 8, 9, 18, and 75 that have small standard deviations, include charred plant remains with similar isotopic fractionation properties, and are internally temporally consistent once they have been calibrated. Furthermore, for temporal comparisons I draw upon a large suite of calibrated radiocarbon dates from sites at Lake Naconiche with stylistically similar ceramic assemblages (Perttula 2008a) as well as the extensive prehistoric Caddo radiocarbon data base (Perttula 1998).

The 2 sigma calibrated age range of the radiocarbon samples from Features 8, 9, 18, and 75 at Washington Square are AD 1238-1434, AD 1217-1403, AD 1278-1436, and AD 1280-1427, respectively (Corbin and Hart 1998:Table 4). The mean calibrated age range of these four dates is AD 1253-1425.

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Investigations at the Gene and Ruth Ann Stallings Ranch Site (41LR297)

Jim Bruseth, Jeff Durst, Richard Proctor, Larry Banks, Gary Sykes, and Bill Pierson

ABSTRACT

During 2003 and 2004 the Texas Historical Commission conducted preliminary archeological investigations at the Stallings Ranch site in Lamar County, Texas. A magnetometer survey of the site showed promising evidence of habitation features, and with the help of several members of the Valley of the Caddo Archeological Society, exploratory excavations were conducted at the site in 2004. Testing recovered artifacts suggestive of a late Fourche Maline occupation dating to ca. A.D. 700-800, along with tentative evidence for structural remains.

INTRODUCTION

This article summaries magnetometer survey and archeological testing conducted during 2003 and 2004 at the Gene and Ruth Ann Stallings site (41LR297; also known as Stallings Ranch) on a ranch in Lamar County, Texas, owned by Gene Stallings of Paris, Texas (Figure 1). Fieldwork was conducted by members of the Valley of the Caddo Archeological Society (VOCAS), with Jim Bruseth, Jeff Durst, and Bill Pierson of the Texas Historical Commission (THC), and independent archeologist Larry Banks. Additional assistance was provided by archeological stewards Lee Green, Jim Blanton, Glynn Osburn, and Laurie Moseley. Richard Proctor provided logistical and moral support for all aspects of the project. Participants included approximately 30 members of the society, as well as others who were not members. The daily crew, including supervisory staff, numbered between 20 and 40. Ruth Ann and Gene Stallings, owners of the ranch, were extremely gracious in allowing the field investigations of the site, and their support is greatly appreciated.

The Stallings Ranch site encompasses 600-plus acres located within the northwestern-most headwaters of the Pine Creek drainage basin in Lamar County, Texas. The headwaters creek system on the Stallings Ranch is not named on any area maps, including the U.S.G.S. Slate Shoals 7.5 minute quad sheet.

The soils of the site proper are from the Annona-Freestone-Woodtell series (Ressel 1979), which consists of brown to dark grayish-brown, slightly acidic surface soils (about 10 cm thick) overlying about 23 cm of light yellowish-brown, medium-acidic fine sandy loam. Between

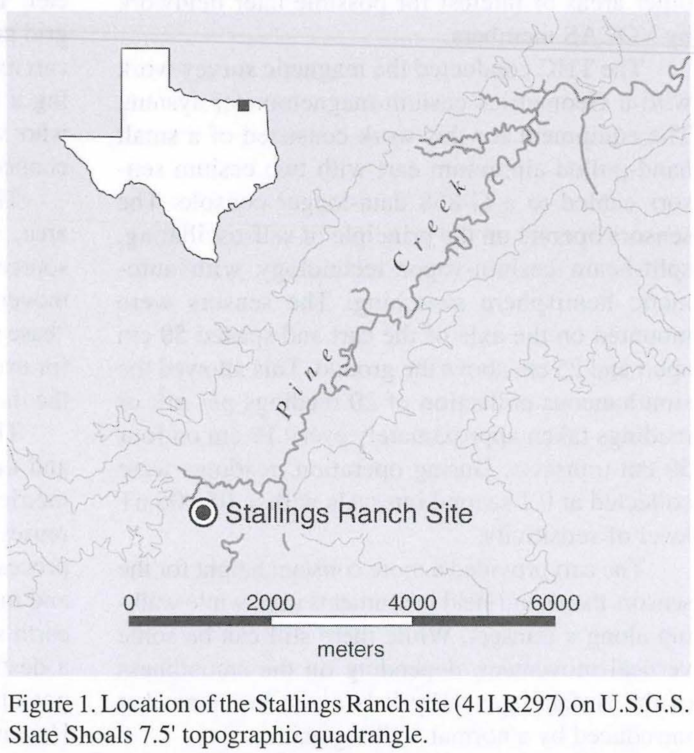

Figure 1. Location of the Stallings Ranch site (41LR297) on U.S.G.S. Slate Shoals 7.5' topographic quadrangle.

approximately 40 and 60 cm below the surface (bs), the soil (A-horizon) is a yellowish-brown, strongly acidic, loam that has strong brown mottles. At depths of about 60 cm to 1 m bs, the soil B-horizon is a light gray, very strongly acidic clay loam that has dark red and yellowish-brown mottles. Generally at a depth greater than 1 m, the soil (C-horizon) is a light brownish-gray, medium-acidic, clay that has olive yellow, yellowish-brown, and dark red mottles. This lowermost "soil" is actually heavily weathered upper exposures of the Bonham Clay geological formation (Ressel 1979).

On the basis of the work reported in the article and through the great generosity and cooperation of the Stallings family, the site was investigated by the Texas Archeological Society as part of the society's annual field school. This effort took place during June of 2005 and 2006 and the results will be reported on separately.

MAGNETOMETER SURVEY

The first fieldwork undertaken at the site consisted of a magnetometer survey conducted on December 18, 2003, by Jim Bruseth and Bill Pierson of the THC. This work was assisted by VOCAS members. The purpose was to identify areas of the site that might contain features and other areas of interest for possible later fieldwork by VOCAS members.

The THC conducted the magnetic survey work with a Geometrics cesium-magnetometer system. The equipment for this work consisted of a small hand-pulled aluminum cart with two cesium sensors cabled to a G-858 data-logger console. The sensors operate on the principle of self-oscillating, split-beam cesium-vapor technology with automatic hemisphere switching. The sensors were mounted on the axle of the cart and spaced 50 cm apart and 25 cm above the ground. This allowed the simultaneous collection of 20 readings per m^2, or readings taken approximately every 10 cm on four 50 cm transects. During operation, readings were collected at 0.1 second intervals with a .05–.06 nT level of sensitivity.

The cart provided a more constant height for the sensors than hand-held instruments used while walking along a transect. While there still can be some vertical movement, depending on the smoothness of the surface, generally it is much less than that introduced by a normal walking gait.

A base-station magnetometer was used to correct for diurnal magnetic fluctuations and sun-induced magnetic storm activity, which affect the earth's magnetic field. The base-station magnetometer consisted of a single cesium sensor on a 1 m-long pole, held upright above the ground by a tripod, and connected to a data-logging console. The collection rate was set to a 0.2-second interval and showed a sensitivity of as much as .03 nT.

The methodology for conducting the survey was quite simple. The area to be surveyed was laid out into a north-south and east-west grid of 10 m quadrants, and the overall grid size was entered into the console attached to the cart. Magnetic data were then collected by pulling the cart along the north axis of the grid, collecting two 50 cm transects of data simultaneously. The readings were stored in a data-logging console set to the "survey" mode. Although both unidirectional and bidirectional (zigzag) survey methods were possible, the bidirectional method was found to be the most efficient, since the operator did not have to walk back to the beginning of each survey line to start the next line. Survey rates of up to 8 ha per day have been achieved employing this methodology.

Plastic traffic cones were placed at 10 m intervals along the survey transects to serve as fiducial marks, or known points on the grid entered into the data logger to track the position of the magnetometer. To record when the sensors crossed a known grid point, a small plastic flapper was placed on the cart axle to flap when it encountered a cone, providing a visual and auditory marker for the operator, who would register the point on a pickle switch connected to the console.

The base station was placed away from the site area, where it would not be affected by intrusive sources of magnetism such as passing cars or the movements of people. The console was set to the "base station" mode and continuously collected data for eventual downloading and diurnal correction of the moving sensors' data.

The data collected by the mobile magnetometer and the base station were downloaded using Geometrics Magmap 2000, Version 4. This program retrieves the data from the consoles and allows processing to remove dropouts, adjust value spikes, and make corrections for diurnal fluctuations in the earth's magnetic field. The program also contains a destripping algorithm to remove heading errors potentially introduced with bidirectional surveys. However, extensive experimentation has showed that this algorithm could introduce subtle changes to data values, especially for linear anomalies that trended along the orientation of the survey transects, adversely affecting the interpretability of the data. Consequently, destripping was not routinely employed in the data processing in order to preserve data integrity.

After processing in Magmap 2000, the magnetic data were exported into Surfer©, Version 8 for contouring into two-dimensional spatial maps. A Kriging gridding algorithm was employed and the final maps produced using the Shaded Relief Map option. This map option was used instead of line-contour or color maps, since the human eye can more easily observe subtle changes in shades of gray than multitudes of contour lines or highly varying colors.

The result of the magnetic survey is presented in Figure 2a. The gradations in grayscale show fluctuations in magnetism of the soils due to inherent magnetic susceptibility, iron objects deposited onto the site, and, quite possibly, cultural features related to prehistoric occupation. The strongly contrasting black and white anomalies almost certainly are small dipoles associated with ferrous objects that have been dropped on the site during the Historic period. Other than these recent anomalies, there is an overall trend for smaller-scale anomalies to be clustered into five areas, each corresponding to small topographic knolls present at the site (Figure 3). These are likely related to cultural activities that were concentrated on the topographic knolls. Also, an old road, today not visible, is observable on the map as two narrow and parallel lines running from the northwest (grid N180/E222) to the southeast (N100/E260). Since this road consists of two parallel lines, it reflects modern wheeled vehicles.

Perhaps the most intriguing aspect of the magnetic map is the hint of circular structure patterns. Figure 2b shows an area that has a circular pattern that is reminiscent of the outline from a prehistoric structure. The outline would represent the wall of the structure where posts were set into the ground. While the outline shown in Figure 2b is the most apparent pattern, others, including partial arcs, are also apparent.

ARCHEOLOGICAL TESTING

From March 25 through March 28, 2004, four days were spent testing the Stallings Ranch site. The research goals of the fieldwork were to investigate the anomalies found on a magnetometer map of the site and to collect a sample of artifacts to culturally identify and determine the age of the site. Three areas were investigated during the test excavation. One was an area on the magnetometer map in the central part of the site where a prehistoric structure may have been present, based on a faint circular outline on the magnetic map (see Figure 2b). Excavation was planned to look for post holes associated with a structure.

Another area investigated was located in the northeastern part of the site, where a knoll is sufficiently high in elevation to suggest that it might be a man-made mound. The prehistoric Caddo of East Texas sometimes built earthen mounds, often to cover burned structures. To investigate this as an explanation for the rise, two units were excavated to look for evidence of culturally-filled soil and for a possible burned structure at the bottom of the mound. Two backhoe trenches were also dug to investigate the mound. Finally, several units were excavated across the site to obtain a sample of artifacts to better understand when the site was occupied and by what cultural group or groups.

The principal methodology employed during the March 2004 fieldwork was hand excavation of 1 x 1 m squares to investigate different areas of the site. All 1 x 1 m units were excavated in 10 cm levels with all soil screened through 1/4-inch mesh. All artifacts were bagged by provenience for later analysis. The units were taken down to Levels 4, 5, or 6 (40, 50, or 60 cm bs, respectively), depending on where the soil color changed sufficiently to allow features to be seen, and at the depth at which artifact frequencies declined significantly. The upper 40 to 60 cm of soil (the A-horizon) was very disturbed by bioturbation, and numerous krotovina were observable, suggesting that artifact movement has been commonplace.

Units were excavated singly or in groups of two or more, depending on the goal for each unit. Several single units were systematically placed around a possible structure location shown on the magnetometer map (see Figures 2b and 3). These units were placed to obtain a sample of artifacts to assess the site's age. Other units were combined to form 2 x 2 m or larger groupings of units to investigate features, mostly possible post holes.

The results of the fieldwork at the Stallings Ranch site were very productive in addressing the research goals. Two block excavations were opened

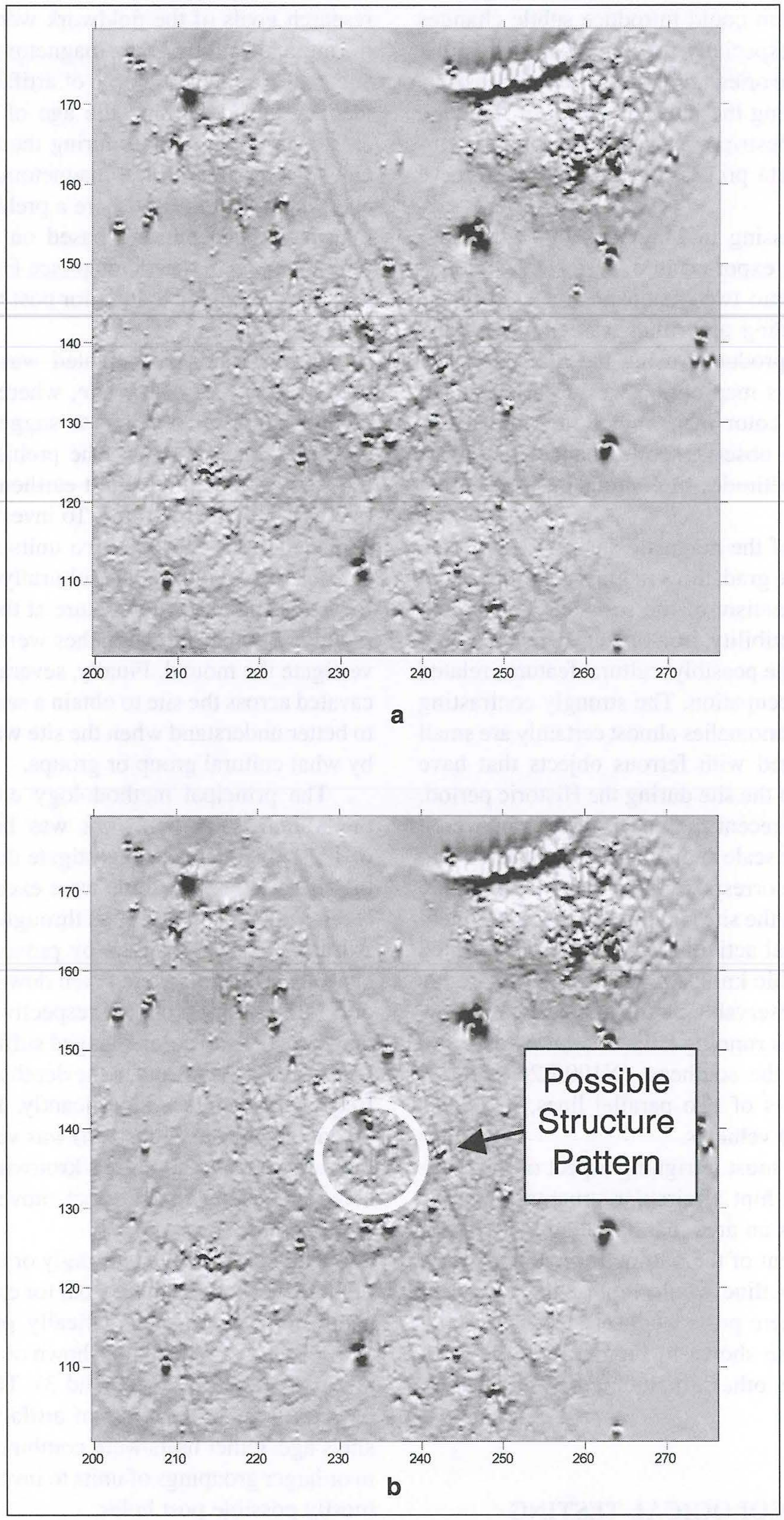

Figure 2. Magnetometer maps of (a) the Stallings Ranch and (b) possible structure location. Note that the grid is in meters, and see Figure 3 for orientation of the survey area on the site map.

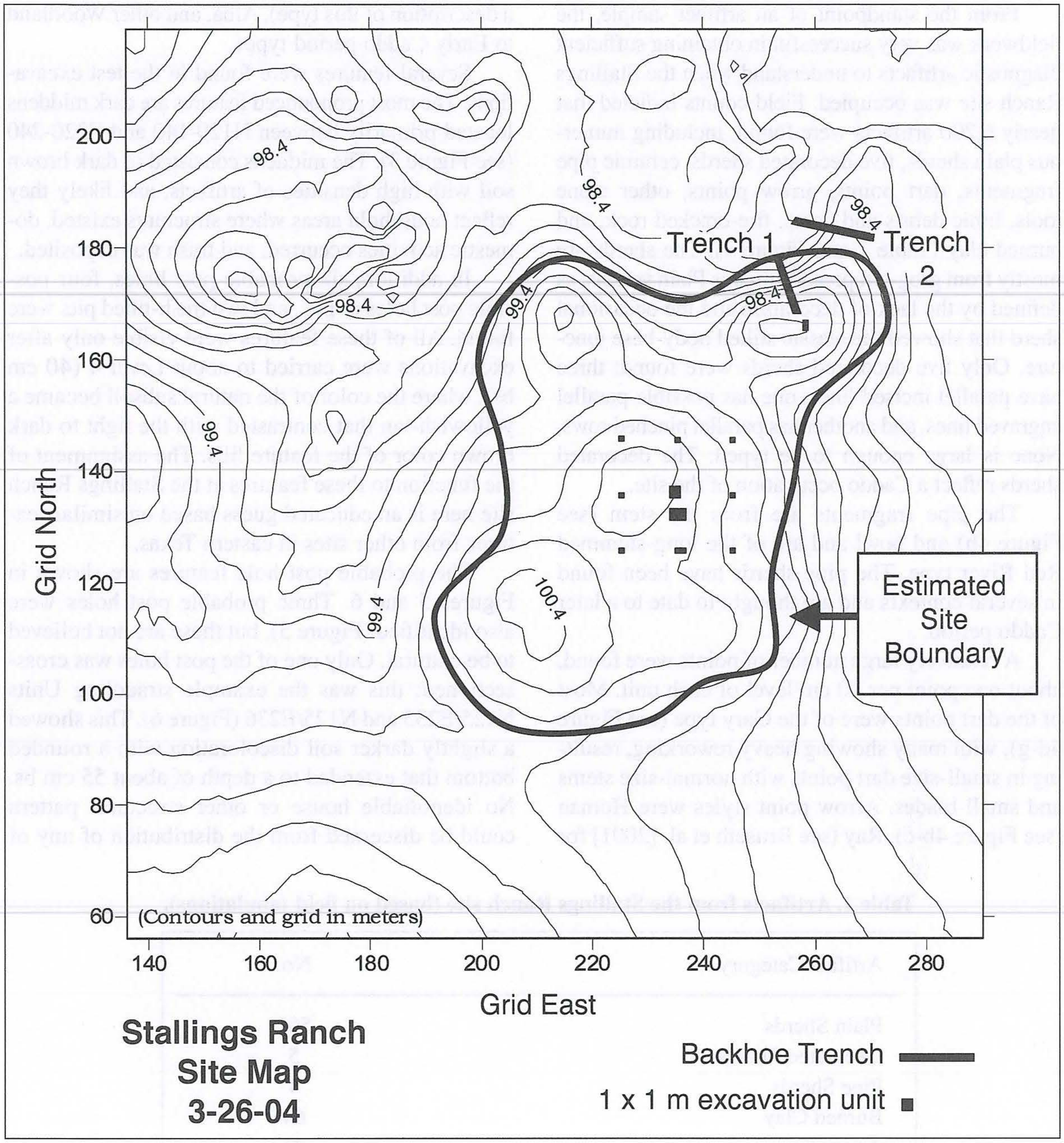

Figure 3. Site map (grid north is also magnetic north).

to investigate a possible house location identified on the magnetometer map (see Figures 2b and 3). The blocks were expanded to include 13 m^2, and several post holes were found (described below).

The northeastern rise, originally thought to be a possible man-made mound, was found to be a natural rise on which prehistoric occupation had occurred. This was borne out by two 1 x 1 m units excavated in the top of the rise that showed midden soil with large quantities of artifacts to a depth of 60 cm bs. Below this, the soil lightened to a light tan color and artifact density dropped off. Two backhoe trenches (labeled Trenches 1 and 2 in Figure 3) were excavated to further investigate the mound. The backhoe trenches showed a normal, well-developed soil profile for the area with a sandy A-horizon and a sandy loam B-horizon. The evidence from both the hand-dug units and the mechanically excavated trenches shows clearly that the mound is not man-made.

From the standpoint of an artifact sample, the fieldwork was very successful in obtaining sufficient diagnostic artifacts to understand when the Stallings Ranch site was occupied. Field counts indicted that nearly 6,200 artifacts were found, including numerous plain sherds, five decorated sherds, ceramic pipe fragments, dart points, arrow points, other stone tools, lithic debris and cores, fire-cracked rock, and burned clay (Table 1 and Figure 4). The sherds are mostly from grog-tempered Williams Plain vessels, as defined by the lack of decoration and the occasional sherd that showed the classic stilted body-base juncture. Only five decorated sherds were found; three have parallel incised lines, one has possible parallel engraved lines, and another has parallel pinched rows. None is large enough to be typed. The decorated sherds reflect a Caddo occupation of the site.

The pipe fragments are from the stem (see Figure 4h) and bowl and are of the long-stemmed Red River type. The pipe sherds have been found in several contexts and are thought to date to a later Caddo period.

A relatively large number of points were found, about one point per 10 cm level of each unit. Most of the dart points were of the Gary type (see Figure 4d-g), with many showing heavy reworking, resulting in small-size dart points with normal-size stems and small blades. Arrow point styles were Homan (see Figure 4b-c), Ray (see Bruseth et al. [2001] for a description of this type), Alba, and other Woodland to Early Caddo period types.

Several features were found in the test excavations. The most pronounced features are dark middens located primarily between N120-140 and E220-240 (see Figure 3). The middens consisted of dark brown soil with high densities of artifacts, and likely they reflect household areas where structures existed, domestic activities occurred, and trash was deposited.

In addition, six probable post holes, four possible post holes or pits, and two trash-filled pits were found. All of these features were visible only after excavations were carried to about Level 4 (40 cm bs), where the color of the natural subsoil became a yellowish-tan that contrasted with the light to dark brown color of the feature fills. The assignment of the function to these features at the Stallings Ranch site here is an educated guess based on similar features from other sites in eastern Texas.

The probable post hole features are shown in Figures 5 and 6. Three probable post holes were also identified (Figure 5), but these are not believed to be cultural. Only one of the post holes was cross-sectioned; this was the example straddling Units N125/E235 and N125/E236 (Figure 6). This showed a slightly darker soil discoloration with a rounded bottom that extended to a depth of about 55 cm bs. No identifiable house or other structural pattern could be discerned from the distribution of any of

Table 1. Artifacts from the Stallings Ranch site (based on field tabulations).

Artifact Category	No.
Plain Sherds	501
Decorated Sherds	5
Pipe Sherds	4
Burned Clay	64
Arrow Points	24
Dart Points	36
Bifaces	3
Drills	3
Lithic Debris	3,604
Cores	6
Mano	1
Fire-Cracked Rock	1,838
Bone and teeth	94
Mud Dauber Nests	2
Total Artifacts	6,185

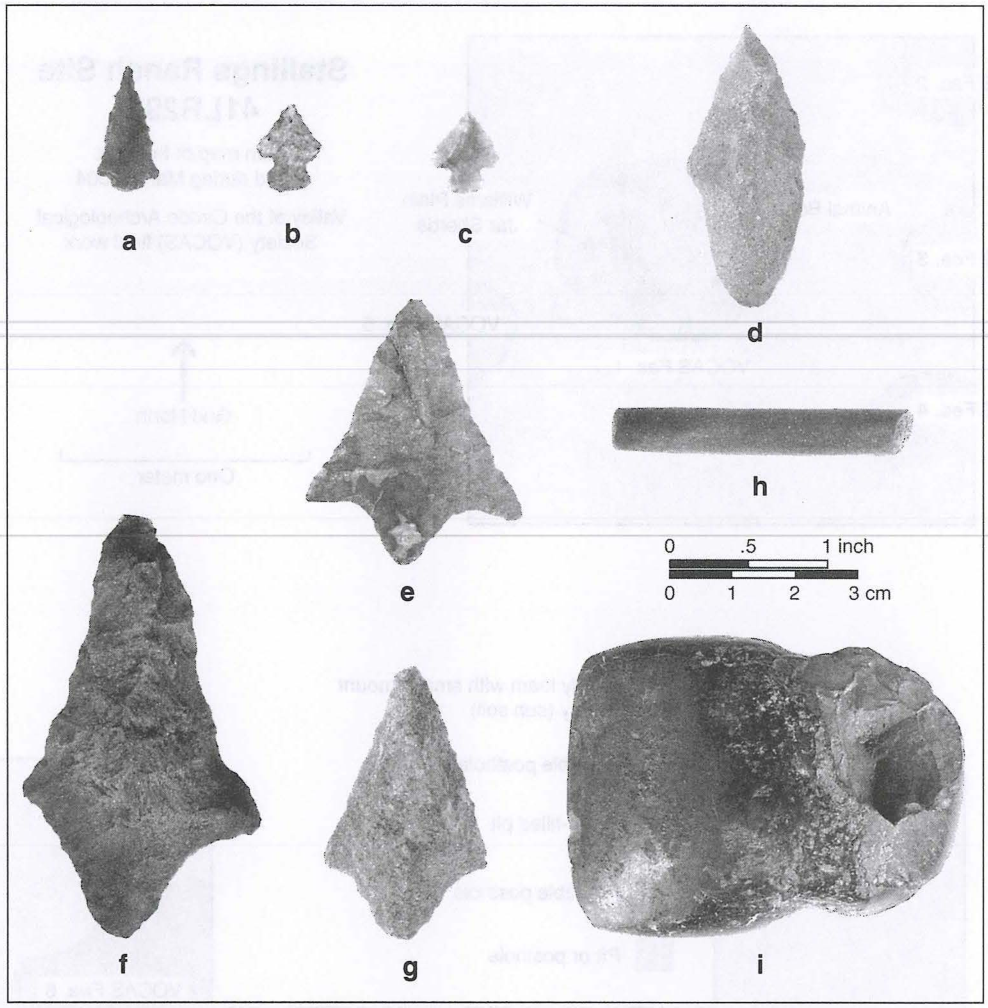

Figure 4. Sample of artifacts from the Stallings Ranch site: a, unidentified arrow point; b-c, Homan arrow points; d–g, Gary dart points; h, Red River pipe stem; i, grooved stone axe.

the post holes.

Four possible post holes or pits were noted at a depth of about 30 cm bs, and are labeled as VOCAS Fea. 2 through 5 on Figure 5. The features contained darker soil (dark brown) fill in contrast to the surrounding soil. They may be post holes that have become blurred (less distinctly defined) by rodent activity in the upper 30 cm, or they may represent small pits. Only excavation of the features will determine this.

Two trash-filled pits were also observed (see Figure 5). The feature labeled VOCAS Fea. 1 was a trash-filled pit in the central part of the site (mostly in Unit N136/E235, but also in Units N135/E234, N136/E234, and N135/E235), measuring about 50 cm in diameter. It became visible in Level 3 (at 20 to 30 cm bs) and consisted of dark brown sandy loam with charcoal flecks and about one-third of a large Williams Plain jar. Several pieces of deer bone were also found. What appear to be four unfired clay lumps were found at the bottom of the pit. They were distinctive from the surrounding natural soil matrix, but their function remains unknown.

Another potential trash filled-pit is labeled as VOCAS Fea. 6 in Figure 5. This potential pit is similar in appearance to VOCAS Fea. 1, except that it is larger (slightly more than 1 m in diameter) and was observed deeper (about 40 cm bs) in the deposits than was VOCAS Fea. 1. Its depth and function can only be determined by future excavation.

CONCLUSIONS

The results of the March 2004 fieldwork indicate that the major occupation of the Stallings

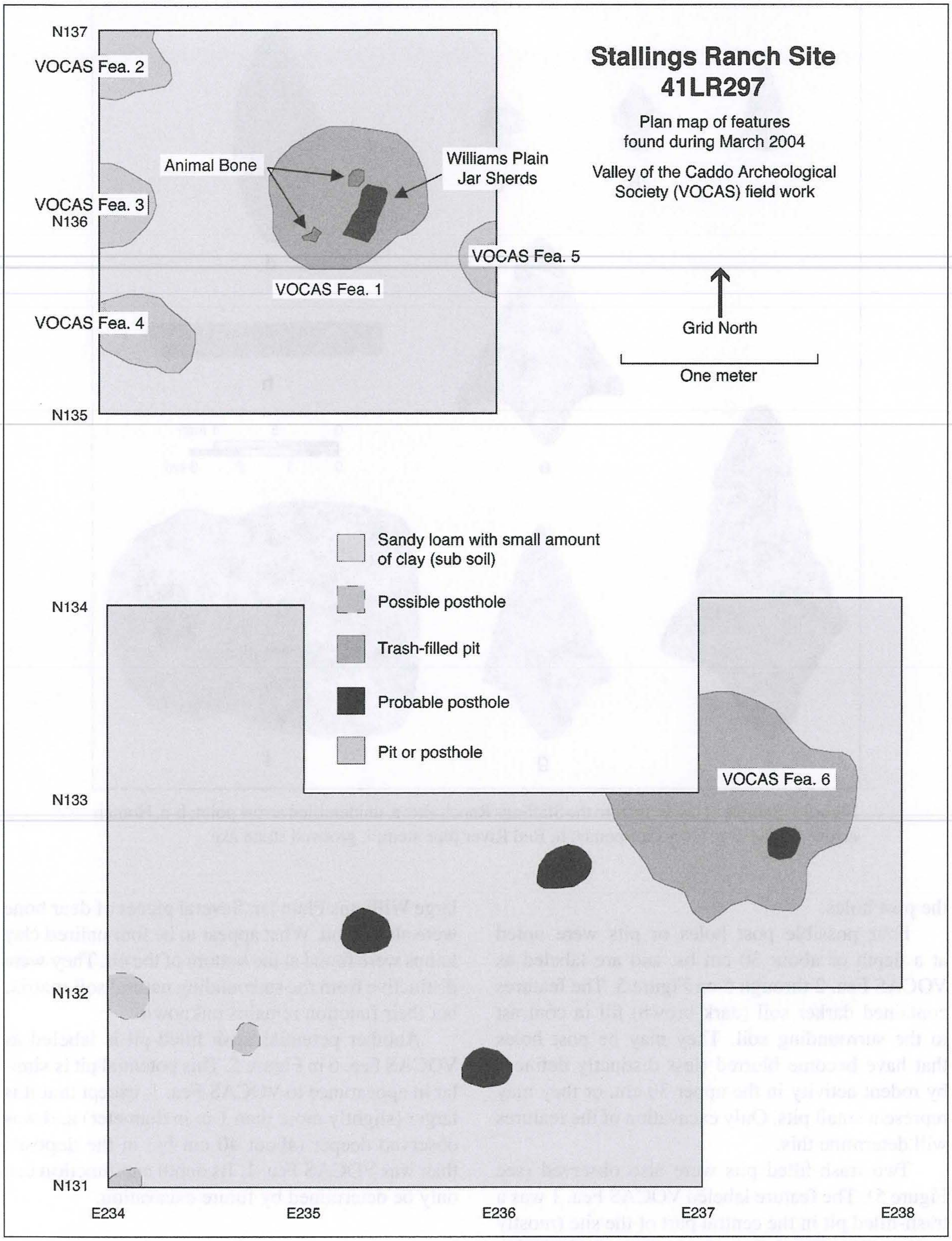

Figure 5. Plan view of selected units, at the bottoms of excavation units between 40 and 50 cm below surface, showing features.

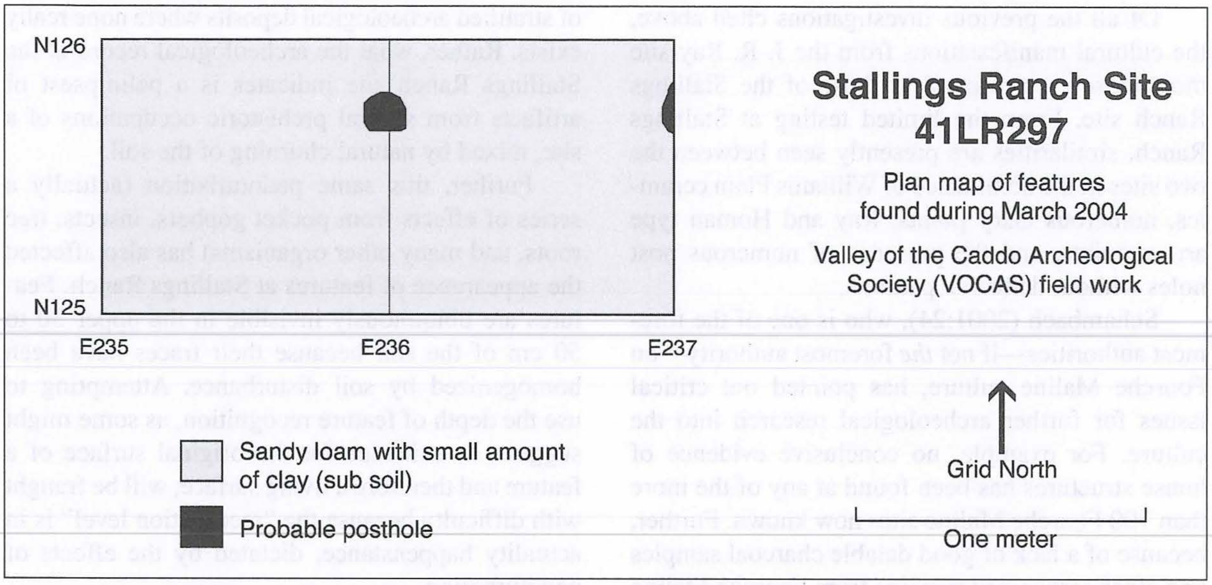

Figure 6. Plan view (60 cm for Unit N125/E235 and 40 cm for Unit N125/E236) showing post holes.

Ranch site occurred during the Woodland period, more specifically by people that can be assigned to the Fourche Maline culture. There are some artifacts found during the work that can be related to other temporal periods, such as the bottom portion of a large, untyped Archaic dart point made of Edwards chert and five decorated Caddo ceramic sherds, but the majority of the artifacts found here suggest that it was occupied by a late Fourche Maline (ca. A.D. 700-800) culture group. Fourche Maline culture sites are little known or studied in Texas. For this reason, the Stallings Ranch site is extremely important to the understanding of the archeological record of northeast Texas.

At least five other site localities are known to exist in other portions of the Stallings Ranch that are not discussed in detail here, but that we believe will ultimately contribute more information about the archeology of the Pine Creek basin in general. Perhaps the most important is on a low natural mound approximately 670 m north of the Stallings Ranch site. Ben Faulkner, one of the Stallings Ranch hands, found artifacts there that include a variety of Gary and Archaic dart points and sherds of Williams Plain ceramics. On March 25, 2004, a fragment of a boatstone, probably made from Colbert Creek diorite, was found on the plowed surface of the site. The absence of arrow points suggests this is a Fourche Maline occupation slightly earlier in time than the Stallings Ranch site.

Beyond the ranch, other sites with Woodland occupation also exist in this general area. The lower reaches of the Pine Creek basin have been subject to one of the most extensive archeological investigations in this general area of northeast Texas (Mallouf 1976). During that survey, excavations were conducted at the Alfred Mackin Caddo mound, located on the Nolan Creek tributary of Pine Creek, but where cultural materials thought to be related to the Woodland occupation includes plain ceramics with a medium-coarse paste and ceramic pipes of the Graves Chapel or Miller's Crossing variety. Additional evidence of Woodland occupation in the area was recovered in 1991 and 1992 when the Texas Archeological Society field schools were conducted at the J. R. Ray site (41LR135), in the upper headwaters of Nolan Creek (Bruseth et al. 2001). Characteristics that support a Woodland component at the Ray site include Poole pipe fragments, Williams Plain pottery sherds, French Fork Incised pottery sherds, and the presence of Homan arrow points. In addition, archeological investigations associated with construction of Pat Mayse Dam and reservoir, northwest of the Stallings Ranch site, were conducted in 1966–1967 (Lorrain and Hoffrichter 1968), where materials similar to those recovered from the Mackin site and the Ray site were recovered. The latest investigation of the general area prior to those under discussion here were several extensive surveys and site test excavations conducted at Camp Maxey, which is only 6 km due west of the Stallings Ranch. This work has produced further evidence for Woodland occupation in the area based primarily on the presence of Late Archaic to Woodland period dart points (Nickels et al. 1999).

Of all the previous investigations cited above, the cultural manifestations from the J. R. Ray site most closely correspond to those of the Stallings Ranch site. From the limited testing at Stallings Ranch, similarities are presently seen between the two sites in the dominance of Williams Plain ceramics, numerous Gary points, Ray and Homan type arrow points, and the presence of numerous post holes without definable patterns.

Schambach (2001:24), who is one of the foremost authorities—if not *the* foremost authority—on Fourche Maline culture, has pointed out critical issues for further archeological research into the culture. For example, no conclusive evidence of house structures has been found at any of the more than 700 Fourche Maline sites now known. Further, because of a lack of good datable charcoal samples and other carbonized remains from Fourche Maline sites, there is a critical need to better date the culture. From the testing effort, a few post holes were found that may be parts of structures. They can be investigated during subsequent work at the site to further investigate what Fourche Maline structures look like. Further, charcoal is present in feature contexts, and can be used to date the age of the Fourche Maline occupation. The Stallings Ranch site provides the potential to address these issues. For this reason, the Stallings Ranch site may be one of the more significant Woodland period sites known in this part of the Red River basin at this time (personal communication by Don Wyckoff to Larry Banks on April 3, 2004). Many of these issues have been addressed during the 2005 and 2006 field schools at the site conducted by the Texas Archeological Society.

Finally, we present some cautionary guidance on the interpretation of artifacts and features during future work at the site. The Stallings Ranch site is situated on a clearly non-aggrading landform. Artifacts found in the soil have migrated downward through pedoturbation, and their depths do not reflect cultural levels or living surfaces. The exception to this will be those items found in features clearly defined as pits in the soil, where prehistoric people placed the items in a pit in the ground. To appreciate this fact of soil mixing, one only has to look at nearby historic period sites where artifacts are also found at depth in the soil, yet clearly were placed on the modern surface only a few decades ago. Far too many archeologists working in northeast Texas have fallen into the trap of interpreting the vertical distribution of prehistoric artifacts as evidence of human occupation frozen in time, or of the existence of stratified archeological deposits where none really exists. Rather, what the archeological record at the Stallings Ranch site indicates is a palimpsest of artifacts from several prehistoric occupations of a site, mixed by natural churning of the soil.

Further, this same pedoturbation (actually a series of effects from pocket gophers, insects, tree roots, and many other organisms) has also affected the appearance of features at Stallings Ranch. Features are ubiquitously invisible in the upper 30 to 50 cm of the soil because their traces have been homogenized by soil disturbance. Attempting to use the depth of feature recognition, as some might suggest, as evidence for the original surface of a feature and therefore a living surface, will be fraught with difficulty because the "recognition level" is in actuality happenstance, dictated by the effects of pedoturbation.

Moreover, the detection of real and convincing complete house patterns will ultimately prove elusive at the site, as pedoturbation has left us with only selective archeological traces of once complete house structures. Today we find only scattered post holes forming inconclusive patterns. Many post holes from former structures simply have not preserved in the soil. Complicating this even further are the "false" post holes left from decayed plant roots such as *Cnidoscolus texanus*. All of this presents a great challenge for future work at the Stallings Ranch site that will have to be addressed during future archeological investigations.

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