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# Foreword

After a period of two years serving as editor of the *Bulletin of the Texas Archeological Society,* it is now time to turn over the duties and responsibilities of editor to the capable hands of Nancy Kenmotsu.

In order to assist the new editor and to help reduce the unfortunate time delays in publishing the BTAS that marked my tenure as editor, a specific request of future contributors is in order. With few exceptions, the submissions I reviewed and edited over the past two years had citation and reference errors. These included incorrect lists of authors, incorrect sequences of authors and dates in citations, missing references, inconsistent formats, confused publication dates, and other problems. The editing process and production of the BTAS would be much more efficient and timely if contributors would take the time to carefully check their citations and references. In addition, as stated under the heading "Information for Contributors" in the back of each BTAS volume, it would be an immense assistance if authors would consult the style guide for *American Antiquity* and follow the citation and bibliographic format guidelines in that document. A copy of the style guide may be downloaded from the Society for American Archaeology website at the following URL: http://www.saa.org/publications/Styleguide/styframe.html.

*Myles Miller*
*March 2004*

# 1989 and 1990 Excavations at the Smith Site (41UV132), Uvalde County, Texas

*Ed Baker*

## ABSTRACT

The 1989 and 1990 University of Texas at Austin and Texas Archeological Society Field School excavations at the Smith site revealed a series of buried prehistoric occupations, artifacts, and features dated between 8000-1000 years ago. These archeological deposits included at least six isolated Early Archaic burned rock features, a late Middle Archaic to Late Archaic I burned rock midden, and superimposed Late Archaic II features and associated deposits.

## INTRODUCTION

The Smith site (41UV132) is a buried multiple component Archaic site south of Utopia in northeastern Uvalde County. The site formed in the primary or T1 terrace of the Sabinal River where it exits the Edwards Plateau margin (Figure 1). Excavations carried out at the site in 1989 (Hester et al. 1989) by the summer field school of the University of Texas at Austin and in 1990 (Hester 1990a, 1990b) by the Texas Archeological Society (TAS) revealed a series of occupations, artifacts, and features dated between 8000-1000 years before present (B.P.). In terms of setting, site formation, and material culture, the site is similar to many other buried Archaic stream terrace sites at the Edwards Plateau margin.

Similarly located buried sites with evidence of at least sporadic Archaic occupations of several thousand years or more, were once said to exemplify the "Edwards Plateau Aspect" (Campbell 1948; Jelks 1951; Kelley 1947; Weir 1976) of the Balcones phase. That term was eventually discarded as accumulating radiocarbon and stratigraphic excavation data allowed a more faithful and more specific temporal subdivision of the lengthy Archaic periods. Since then, there have been a great many other published excavations of what could be called, in awkward terms, "long-term Archaic" occupational terrace sites along the Edwards Plateau margin (e.g., Black and McGraw 1985; Collins et al. 1998; Decker et al. 2000; Houk et al. 1999; Johnson 1995; Kibler and Scott 2000).

At the Smith site, excavations encountered at least six isolated Early Archaic burned rock features, a late Middle Archaic to Late Archaic I (cf. Johnson and Goode 1994) burned rock midden (BRM), and superimposed Late Archaic II features and deposits. This paper outlines excavations at the site, its likely formation processes, the kinds of artifacts and features that were recovered in the work, and briefly discusses some of the recovered tool assemblage (see also Baker 1999).

## REGIONAL SETTING

The Smith site is in an ecotonal setting, with ready access to plant and animal resources from the xeric Edwards Plateau and the spring-fed Sabinal River valley. Abundant chert cobbles, ultimately derived from Edwards Plateau limestone, are carried locally in the riverbed. Although the terrace was (and is) occasionally flooded, the site is generally flat, dry, well drained, and close to permanent water.

Like most buried terrace sites along the Edwards Plateau margin, the Smith site is on the first terrace level (T1) above the modern river bed (Figure 2). Along the Sabinal River, these terraces are typically 7-10 m above the current stream level. Floodwater will occasionally encroach onto these terraces, disburse across the flat expanse, and deposit sediments carried from upstream.

The bulk of sediment deposition occurred during the earlier half of the Holocene (10000-5000

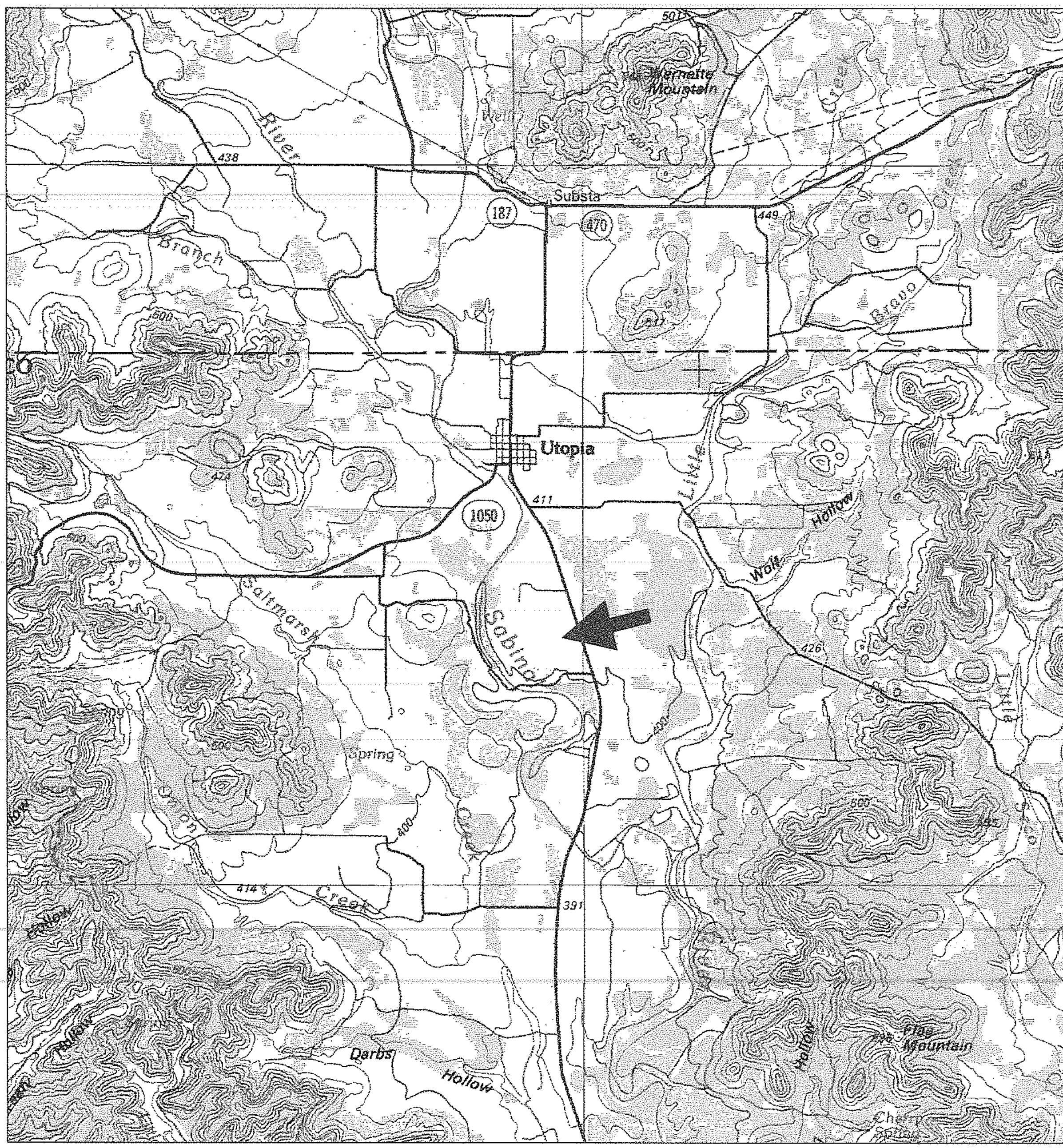



Figure 1. The Smith site (41UV132; arrow), the Sabinal River Valley, and the southern Edwards Plateau margin.

B.P.). This Early and Middle Holocene depositional phenomenon seems to be fairly typical at Holocene terraces around the Edwards Plateau margin (Collins 1995; Mear 1998) and is most likely related to both long-term precipitation patterns across the region and the similar geomorphic contexts of such buried Archaic sites along larger creeks and rivers of the plateau margin.

To date, 11 radiocarbon dates have been obtained from the principal terraces of the Sabinal River (Table 1). These dates, and a geomorphic analysis of the Sabinal River valley by Mear (1995), conform to broader temporal summaries of the geomorphology of the Central Texas (or perhaps more precisely the Edwards Plateau margin) area. The dating of the various Sabinal River and Smith site sediment units also conform to temporally diagnostic artifacts found during the excavations. As mentioned above, the site has a surficial to slightly buried Late Archaic II (cf. Johnson and Goode 1994)

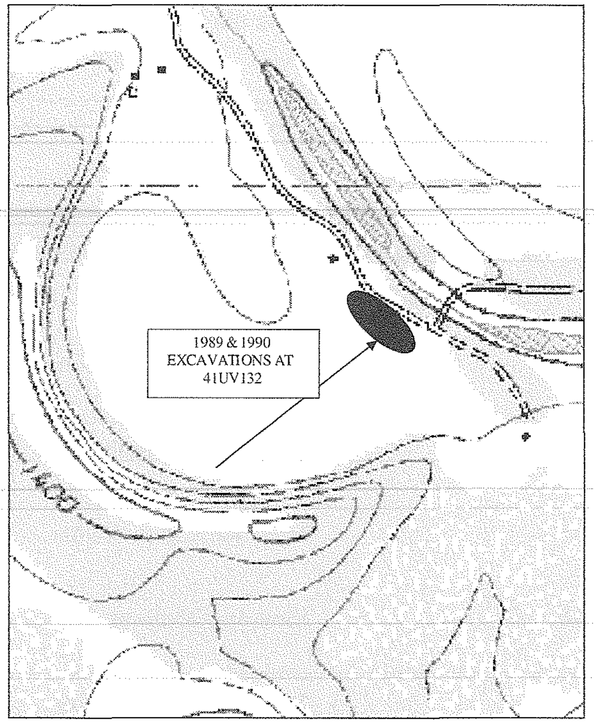



Figure 2. The Smith site terrace. Approximate scale = 1:24000.

component, with a Late Archaic I (Pedernales/ Kinney time interval) BRM beneath these. A Middle Archaic (ca. 4000 B.P.) palimpsest deposit with some intact features lies at the base of the BRM. Beneath these strata, in the lowest deposits, are several isolated Early Archaic features.

## EXCAVATIONS AND RECORDS

Thomas R. Hester recorded the Smith site (41UV132) in 1988. A couple of small potholes had uncovered chert artifacts, a few burned rocks, and unidentifiable fragments of animal bone. Diagnostic artifacts suggested that Middle and Late Archaic time periods were represented here, and given the setting, the presence of buried Archaic occupational strata was suspected. No evidence of a BRM was seen at the time excavations were started, but later excavations by a University of Texas at Austin field school in 1989 and by the TAS in 1990 exposed this midden.

Field school students excavated the site over six weeks in June and July 1989, with Hester's supervision. Thirty-one students and volunteers, along with teaching and research assistants Jeffrey Huebner, Paul Maslyk, Christine Ward, and Jon Hageman, constituted the field crew.

The first 30 cm of excavated earth contained prehistoric artifacts and fragments of 20th century glass, nails, and ceramics. This mantle of sediment represented flood deposits from a locally famous 1930s storm. Extensive gopher burrows caused vertical displacement of small and large artifacts in most areas of the site and were especially prevalent in the upper deposits. The BRM seemed to be an exception, as evidenced by the sole occurrence of contemporaneous Kinney and Pedernales artifacts in its deposits.

The 1989 field school included excavations at the Smith site as one of several projects that year. These excavations led to discovery of the buried BRM. First, a vertical and horizontal datum, arbitrarily assigned north and west grid coordinates of N100 W100, was used to establish a grid of 2 x 2 m squares over the site. The midden excavators created two long, 1 m wide trench exposures. These two trenches exposed the midden deposit (Figure 3) in profile.

These 2 x 2m squares were then divided into quadrants (NW, SW, etc.) that became the actual 1 x 1 m hand-excavated units. Each square was excavated in 10 cm arbitrary levels, with level 1 at the top of the deposit used to standardize the elevations of each unit and level them with the others. Vertical control was established with the use of transit elevations taken on the southwest corner of each unit, and was maintained by the excavators with line levels.

All feature artifacts, charcoal, and matrix samples were removed and recorded separately from the unit/level materials. Initially, all matrix was passed through 1/8-inch dry screens. When faunal remains appeared to range from absent to very badly fragmented and unidentifiable, excavations switched to the use of 1/4-inch dry screens.

## 1989 SITE EXCAVATIONS

After the burned rock midden (BRM) was found at the Smith site (Figure 4), research goals included stripping the surface of the BRM for clues as to its structure and formation and trenching the midden with a series of 1 x 1 m squares, in an attempt to expose oven features. Eventually, 27 square meters of the previously buried feature were exposed. The densest part of the midden occurred at the center of

**Table 1. Radiocarbon dates from the La Jita, Blue Hole, and Smith sites in the Sabinal River Valley, Uvalde County, Texas.**

| Site Name | Context | Corrected, Calibrated Date (One Sigma Range)/Raw Date (Calib. v. 1.3, except for Beta Analytic Dates) | Sabinal Valley "T1" Sediment Processes (Mear 1995:471) |
|---|---|---|---|
| La Jita Site (Hester 1971) TX-683 | Late Prehistoric, 10-20 cm bs | 660-520 BP 600 ± 80 | Slow soil accumulation |
| TX-684 | Sabinal point, 20-30 cm bs | 770-660 BP 810 ± 50 | Slow soil accumulation |
| TX-664 | Late Prehistoric, 0-10 cm bs | 690-560 BP 710 ± 70 | Slow soil accumulation |
| TX-681 | Edwards points, 20-30 cm bs | 960-730 BP 990 ± 60 | Slow soil accumulation |
| TX-685 | Edwards points, 20-30 cm bs | 980-800 BP 1020 ± 70 | Terrace surface stability Late Holocene Cultural Palimpsests Form |
| TX-686 | Frio points, 10-20 cm bs | 1530-1180 BP 1460 ± 80 | Slow soil accumulation |
| TX-692 | Montell/Marshall points, 30-40 cm bs | 1980-1540 BP 1460 ± 80 | Slow soil accumulation Almost No Deposition/ Mid-holocene Cultural Palimpsests and Middens Form |
| The Blue Hole Site (Mueggenborg 1994) TX-7057 | Hearth at BRM lower perimeter, Pedernales points, 120-130 cm bs | 4420-4100 BP 3840 ± 70 | Slow soil accumulation |
| The Smith Site Beta-159045 | Hearth Feature 14 | 4800-4770 BP and 4630-4430 BP (2-Sigma Cal.) 4060 ± 40 | Slow soil accumulation |
| Beta-159046 | Hearth Feature 23 Early Triangular Point | 4810-4760, 4700-4670, and 4650-4440 BP (2 Sigma Cal.) 4080 + 40 | Slow soil accumulation |
| TX-6694 (Mear 1990) | Hearth Feature 4 Guadalupe tool, Martindale point, 90-100 cm bs | 6280-6410 BP 5520 ± 90 | Rapid soil accumulation. Isolation of archeological components |

Figure 3. Monte Newton and Pam Headrick profiling excavations in 1989. The thickest, most dense portion of the BRM is profiled at right angles in the background. An Early Archaic cooking feature is exposed horizontally in the foreground. Note the old pothole at far right.

the exposure. The domed midden was 50 cm thick there, where it approached the ground surface, and the midden sloped downward in all directions. In those units where the BRM periphery was exposed, the midden was encountered between 20 and 30 cm below the surface. In other words, the exposed portion of the midden indicated it was mounded in form, densest and thickest in its center, and sloped downward and became less dense towards its peripheries. No internal structural patterns such as hearths, larger or smaller rocks, depressions, or other internal features such as stains or concentrations of artifacts were seen on the surface or within the midden. The excavated portion of the midden seemed to be constructed of dispersed structural elements (cf. Black 1997:83). Numerous Pedernales and Kinney tools were found within the midden to the general exclusion of other types, and these artifacts date the midden to the Late Archaic I period. Middle Archaic La Jita and Nolan points found at the base of the midden may be related to its earliest use, however.

La Jita and Nolan points were found immediately beneath and adjacent to the lowest levels of the burned rock midden. Within the 40 cm of matrix excavated beneath the BRM, burned rock hearths were found, along with Uvalde, Martindale, Andice/Bell, and Early Triangular forms. These lower deposits, with their many identifiable, but isolated Early and Middle Archaic features, became a focus of excavations in June 1990, by the Summer Field School of the Texas Archeological Society.

## 1990 SITE EXCAVATIONS

The 1990 Texas Archeological Society (TAS) field school had some 500 participants, who completed many excavation and survey projects in and around Sabinal Canyon; the excavations at the Smith site were among the principal TAS projects. Lori Smith Douglas, John Hageman, Jaques Jaquier, and Bob Turner co-directed the 1990 field research at the site. Forty-six 1 x 1 m units east and southeast of the BRM were excavated in 1990.

The goals of the 1990 excavations were to learn more about the Early-Middle Archaic period occupations at the site (Hester 1990a) and to further expose the surface and peripheries of the BRM. During the one-week field school, the field school participants opened 13 new excavation units, each 1 m square. The field schools' youth program excavated 12 more 2 x 2 m units, through 10-30 cm of mixed historic-to-Late Archaic II deposits, stopping at the upper surface of the BRM. Ten-centimeter arbitrary levels were used in the 1 x 1 m units, while the youth group peeled off the mixed deposits over the BRM in one natural level. All matrix was dry-screened through 1/4-inch mesh. Eight new isolated features were recognized, and several of these clearly dated to the Early Archaic. As is usual for buried terrace sites around the Edwards Plateau (Thoms and Mandel 1992:43; Prewitt 1981a:235; Wesolowsky et al. 1976:33), Early Archaic materials were much more contextually segregated and more readily and fruitfully sampled, due to their stratigraphic separation and relative isolation from the other later prehistoric components.

Figure 4. The initial exposure of the burned rock midden. The upper surface of the midden is mounded and approaches the ground surface at its highest point (top left). The burned rock midden became covered by Late Archaic II to modern sediments towards its peripheries.

## SITE RECORDS

The excavations and subsequent laboratory analysis generated an array of site records. During the 1989 and 1990 field seasons, 10 cm level forms were used to record the excavators' progress through each unit and level. Items felt to be unique were given three-point proveniences, (e.g., N102 E108, 98.30 cm below datum) were collected separately, and were given a serial number on a unique item log. Burned rocks were removed from the matrix, weighed, and recorded on the appropriate level or feature forms. All matrices went to the screens where debitage, whole snails, and other items not designated as "unique" were bagged together and sent to the laboratory. In the 1989 season crew chiefs recorded feature data in excavation journals and on level forms. In the 1990 season, the excavators recorded features on separate feature forms.

Eventually all collections were processed at the Texas Archeological Research Laboratory (TARL). The material was sorted into general groupings (i.e., snails, debitage), and then tallied for each provenience. Lab analysts removed additional noteworthy artifacts (bifaces, tool fragments, etc.), from the general collection bags and added these to the unique Item log. Another laboratory step was to take length, width, and thickness measurements of each of the broken and whole "Unique Item" artifacts. I added coded descriptions of each artifact (see Table 3, below). Artifact categories and types were checked against published references (Suhm and Jelks 1962; Suhm et al. 1954; Turner and Hester 1993) and a modicum of consensus was reached among graduate students and, of course, lead investigator Dr. Thomas R. Hester. All Smith site records are curated at TARL.

## STRATIGRAPHIC PROFILE

Excavators at the Smith site noted the cultural and natural stratigraphy of the archeological deposits as well as extensive post-depositional disturbance, especially within the later Holocene deposits. Their notes, and profiles and geomorphic assessments by Gene Mear and Mike Blum, describe a fairly straightforward geomorphic process by which the site formed.

The site (and associated alluvial terrace) formation process can be visualized in four stages (Figure 5). During the Early Archaic, rapidly accumulating alluvium covered what subsequently became discrete Early Archaic occupations represented by small burned rock features. Second, during the Middle Archaic, alluvial (stream) deposition slowed, then in essence stopped, at least partly due to the increased relative height of the terrace, but also due to increasing regional aridity. Middle Archaic artifacts accumulated on the surface and intermingled with both prior and later materials. Third, during the Late Archaic I interval, the BRM was created, with its associated Pedernales and Kinney points, while alluvial deposition occurred infrequently, if at all. Finally, from Late Archaic II through historic periods, slow alluvial deposition resumed, leaving a semi-stratified accumulation of artifacts that dated from the Late Archaic II time period to the present day. The site was capped by a 1930s flood deposit, made possible in part by the disturbance of the landscape caused by the widespread use of mechanized farming techniques and/or subsequent erosion.

The rapidly buried (ca. 0.03cm/year) Early Archaic features and artifacts accumulated between about 8000-7000 B.P. and 5000 B.P., as indicated by the recovery of the latest Paleoindian style lanceolate point fragments, Uvalde and Martindale points, and our knowledge of other buried Early Archaic settings, sites and features (e.g., Collins 1995:376; Hester 1971; Luke 1980; Sorrow 1969; Toomey 1993) from the Edwards plateau margins. Feature 4 (Table 2) was found in direct association with both a Uvalde point and a Guadalupe tool, and has a 1 sigma calibrated date of 6280-6410 B.P. or 4330-4460 B.C. (see Table 1).

The Middle Archaic occupation of the site appears to have begun by 5000 B.P. and to have lasted until about 4000 B.P. Its representative strata are only about 10 cm thick, implying that sediment accumulation had slowed considerably (ca. 0.01 cm/year) or had in fact stopped. La Jita, Early Triangular, and a few Nolan points appear together here, just below and at the base of the BRM. Feature 23 was found in direct association with an Early Triangular point. Feature 14 was found very much nearby and may be considered contemporaneous (see Tables 1 and 2). Calibrated 2 sigma age ranges for these features are 4430-4630 B.P. (2480-2680 B.C.) and 4770-4800 B.P. (2820-2850 B.C.) for Feature 14 and 4440-4650 B.P. (2490-2700 B.C.), 4670-4700 B.P. (2720-2750 B.C.), and 4760-4810 B.P. (2810-2860 B.C.) for Feature 23.

The earlier part of the Late Archaic period (ca. 4000-2500 B.P., see Collins 1995) is represented by very slow sediment deposition, by the apparent accumulation of the BRM, and by a preponderance

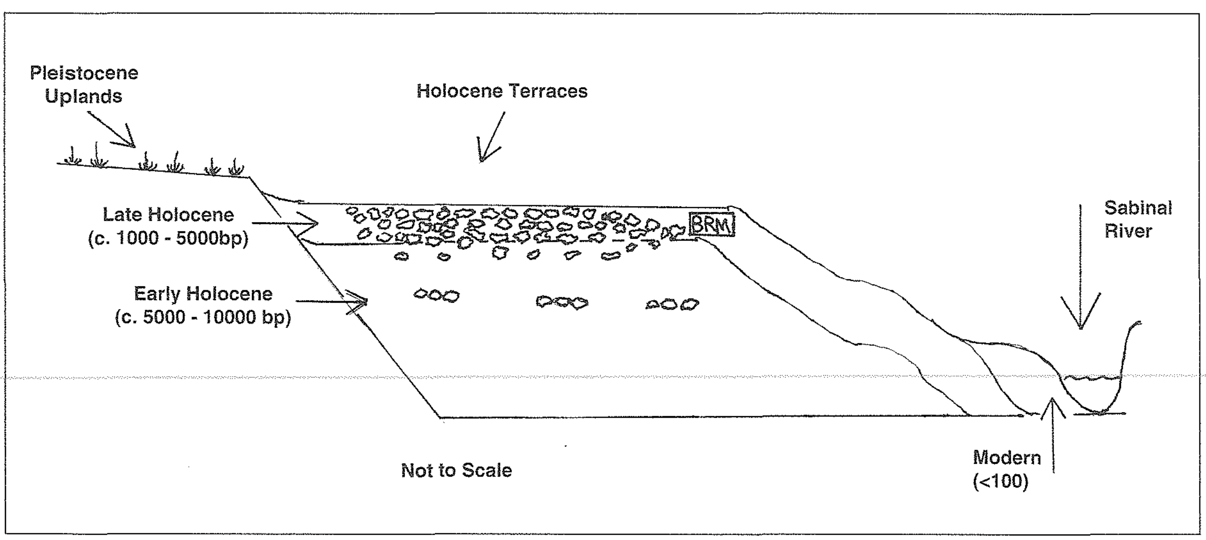



Figure 5. Schematic profile of the Smith site (41UV132), from original sketch by Mike Blum.

**Table 2: Feature Information**

| Feature # | Units/ Levels | Size (square meters) | Weight Burned Rock (BR) (kg)/ Pieces of BR/Average weight per BR (kg) | Samples/ Diagnostic artifacts | Feature Type/ Tentative Time Period |
|---|---|---|---|---|---|
| 1 | N105 W105 Levels 5-7 | 0.1 | 39/3/13 | 0 | Clustered Rock/Late Archaic |
| 2 | N105 W102 Levels 8-9 | 0.8 | –/41/– | 2 soil 1 rock | Slab Lined Hearth/ Early-Middle Archaic |
| 3 | N105 W100 Level 8 | 0.05 | 4.8/7/0.7 | All feature matrix | Clustered Rock/ Early-Middle Archaic |
| 4<br>1 (6280-6410 BP Sigma Cal. 5520 ± 90) | N100 W103 Levels 8-10 | 0.16 | 63/28/2.25 | 4+ burned clay, 7 charcoal, 2 bone, 2 debitage, 1 snail, 1 burned rock, 1 Guadalupe tool, 1 Uvalde point | Ring Hearth/ Early Archaic |
| 5 | N103 W108 Levels 8-9 | 0.7 | 30.4/105/0.32 | 3 burned rock, 1 clay, 1 soil, 1 debitage, 1 possible Angostura | Slab Lined Hearth/ Early-Middle Archaic |
| 6 | N103 W114 Level 3 | 1.2 | 9/4/2.25 | 1 glass bottle | Clustered Rock/Late Archaic II w/Historic Mixture |
| 7 | N103 W108 Level 3 | 0.1 | 8/13/0.62 | 1 La Jita | Ring Hearth /Middle Archaic |
| 8 | N105 W102 Level 4 | 0.42 | 10.6/38/0.28 | 0 | Clustered Rock /Late Archaic |
| 9 | N103 W108 Level 4 | 0.3 | 22.6/33/0.68 | 0 | Ring Hearth /Late Archaic II |
| 10 | N107 W114 Level 3 | 0.05 | 10/15/1.5 | 0 | Clustered Rock /Late Archaic II |

**Table 2:** *(Continued)*

| Feature # | Units/ Levels | Size (square meters) | Weight Burned Rock (BR) (kg)/ Pieces of BR/Average weight per BR (kg) | Samples/ Diagnostic artifacts | Feature Type/ Tentative Time Period |
|---|---|---|---|---|---|
| 11&12 have been included in F4 | | | | | |
| 13 | N107 W112 Level 4 | 0.67 | 13.6/25/0.54 | 0 | Clustered Rock /Late Archaic |
| 14 (4800-4770 BP and 4630-4430 BP, 2-Sigma Cal.) 4060 ± 40 | N105 W112 Level 10 | 0.2 | 17.2/16/1.07 | 1 charcoal 1 soil | Slab Lined Hearth/ Middle Archaic |
| 15 | N105 W100 Levels 9-10 | 1.2 | 25/–/– | 1 soil | Slab Lined Hearth/ Early-Mid Archaic |
| 16 | N103 W99 Levels 4-5 | 0.27+ | –/58/– | 1 soil | Ring Hearth/Late Archaic II |
| 17 | N105 W99 Levels 4-5 | – | 11.4/20/0.57 | 0 | Cluster/Late Archaic |
| 18 | N107 W110 Level 5 | 0.18 | 9.6/29/0.33 | 1 bone fragment 1 Multi-notched Uvalde | Clustered Rock/Late Archaic |
| 19 | N103 W99 Levels 6-7 | 0.42 | 9.1/48/0.19 | 1 soil 2 burned clay | Slab Lined Hearth/ Middle to Late Archaic I |
| 20 | N107 W99 Levels 6-7 | 0.72 | –/3/– | 1 soil | Clustered Rock/ Middle to Late Archaic I |
| 21 | N107 W101 Level 9 | 0.24 | –/3/– | 1 burned clay | Clustered Rock/ Early-Mid Archaic |

**Table 2:** *(Continued)*

| Feature # | Units/ Levels | Size (square meters) | Weight Burned Rock (BR) (kg)/ Pieces of BR/Average weight per BR (kg) | Samples/ Diagnostic artifacts | Feature Type/ Tentative Time Period |
|---|---|---|---|---|---|
| 22 | N103 W101 Level 3 | 0.35 | 24.6/14.9/1.65 | 2 burned rock 1 soil | Clustered Rock/Late Archaic II |
| 23 (4810-4760, 4700-4670, and 4650-4440 BP) | N107 W99 Levels 9-10 | 0.2 | 11.4/10/1.14 | 1 Early Triangular<br>1 charcoal, | Ring Hearth/Middle Archaic<br><br>1 soil, 1 burned rock |

of Pedernales and Kinney artifacts both within the midden and at its base. Although the mass of the BRM may date exclusively to the Pedernales/Kinney time interval, Pedernales artifacts occur in all other areas of the site and indicate how mixed the Middle and Late Archaic artifacts really are. The numerous, almost ubiquitous, Pedernales point also occurs with both earlier and later styles of artifacts in upper and lower strata, indicating the amount of natural and cultural disturbance the site has undergone, such as animal burrowing, as well as the inevitable human-generated disturbances.

Deposition appears to have finally covered the Middle Holocene stable surface and the mound of burned rock in the latter part of the Late Archaic period to modern times (post-2500 B.P.). Sediments resumed their slow accumulation, at about 0.014 cm/year. Even at this increased annual rate, the thinnest rock features, say 3 cm thick, would require over 200 years to be buried. Understandably, this time period is marked by the jumbled accumulation of Marshall, Marcos, Montell, Castroville, and Frio dart points, (a frequent condition within Late Archaic II deposits at long used-Archaic terrace sites in the Edwards Plateau; see Collins et al. [1998:59] and Patterson [1987:106-107]). Of course, displaced examples of Pedernales and earlier artifacts are also mixed in with the Late Archaic deposits. These occupational remains indicate a time span of around 2500 to 1500 B.P. for continued prehistoric use of the Smith site. Except for one Edwards arrow point, Late Prehistoric artifacts are absent from the recovered materials at the site. Historic 1930s glass and metal artifacts are scattered in the flood deposits above the midden (0-30 cm below surface).

## MATERIAL CULTURE AND FEATURES

A total of 768 non-lithic debitage artifacts was recorded as "unique items" after both field seasons and laboratory processing. These are: 302 bifaces and biface fragments, 89 cores, four drills or perforators, two ground stone tools, eight historic artifacts, 17 utilized flakes, 326 projectile points, point preforms, and probable point fragments, 14 scrapers, four unifaces, one bifacial Guadalupe tool, and one Clear Fork tool. Due to the large volume of recovered tools, only named point and tool types are discussed here (see also Baker 1999).

Of the 326 projectile points, point preforms, and point fragments cataloged, 215 were matched to published, described types, and analyzed by the collection of descriptive data (Table 3), using coded descriptors developed by Johnson (1995), among others, for tools from this part of Central Texas. In addition, a Clear Fork tool and a Guadalupe tool are described herein. The *analyzed* assemblage (a few specimens, particularly a sample of at least five Early Triangular points, were not available for analysis) can be broken down, by types, as follows: possibly Late Paleoindian lanceolate, parallel flaked fragments (n=4), Nolan (n=13), La Jita (n=30), Castroville (n=10), Kinney (n=20), Uvalde (n=7), Martindale (n=9), Pedernales (n=76), Andice/Bell (n=4), Early Triangular (n=1), Marcos (n=10), Marshall (n=11), Montell (n=8), Williams (n=3), Ensor (n=1), Frio (n=6), and Edwards (n=1).

Twenty-three burned rock features were recorded over the two field seasons (Figure 6; see also Table 2). Most of the feature matrix from the different features were sampled and curated unanalyzed at TARL. These materials may one day offer much in the way of insights into cooking pathways and associated techniques (after Ellis 1997:54-81). Table 2 offers tentative time intervals for the features, a list of curated materials for each feature, and elementary morphological groupings. The majority of the more coherent features belong to the Early Archaic, when sediment deposition was at its most rapid.

To simplify the descriptions, features have been classified into three categories (see Table 2). "Slab Lined Hearth" stone features consist of more or less contiguous horizontal concentrations of burned rock, most often still in rounded stream-cobble form, both with and without additional rock below. These often contain two layers of rock in the central portion of the hearth. "Ring Hearth" features are smaller in diameter, single-layered, and sometimes empty centered rings of limestone, recorded both with and without other burned rocks nearby (Figure 7). "Cluster" features are discontinuous groupings of burned or unburned limestone rock, which were found to be irregularly spaced, but relatively concentrated spatially. When available from excavation forms, burned rock weights and counts provide some sense of rock size and fragmentation within the various fea-

# Table 3. Projectile Point Attribute Data.

| UNIQUE ITEM NUMBER | LARGE BILLET SCARS ON FACES? | RECURVED BLADE EDGES AND TIP END? | BARB SIZE/BARB SHAPE | BLADE OR TIP RESHARPENING? | STEM SHAPE/BASE SHAPE | LATERAL CROSS SECTION | MAX LENGTH (cm) | MAX BLADE WIDTH (cm) | MEDIAL BLADE THICK-NESS (cm) | MAX BARB LENGTH (cm) | MAX STEM LENGTH (cm) | MIN. WIDTH OF STEM NECK (cm) | STEM WIDTH AT BASE (cm) | DEPTH OF BASAL NOTCH (cm) | STRONGLY ASYMMETRICAL? | STEM BEVELED? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PEDERNALES (n=76) | | | | | | | | | | | | | | | | |
| 398 | NO | YES | | YES | CONVEX SIDED | FLAT PARALLEL FACES | 6.9 | 3.7 | 0.5 | | 1.6 | 1.8 | 1.8 | 0.3 | NO | NO |
| 534 | | NO | | YES | CONVEX SIDED | | 6.1 | 3.9 | 0.6 | 0 | 2.1 | 2.4 | 2.6 | 0.6 | NO | NO |
| 569 | | YES | MODERATE, ROUNDED | | CONVEX SIDED | | 8.3 | 4.5 | 0.8 | 0.9 | 1.4 | 2 | 2 | 0.2 | NO | NO |
| 227 | | YES | | YES | CONVEX SIDED | | 5.9 | 2.8 | 0.7 | 0 | 2 | 2.1 | 2.2 | 0.5 | NO | NO |
| 411 | | NO | | YES | CONVEX SIDED | | 5.4 | 2.6 | 0.7 | | 1.9 | 2 | 1.8 | 1 | NO | NO |
| 334 | | NO | SMALL, POINTED | NO | CONVEX SIDED | | 7.5 | 3.2 | 0.6 | 0.1 | 1.7 | 2.5 | 2.5 | 0.7 | NO | NO |
| 513 | | NO | | | NVEX IDED | | 6.6 | 3 | 0.6 | | 1.6 | 2.1 | 2.1 | 0.6 | N | N |
| 351 | YES | NO | LARGE ROUNDED | NO | CONVEX SIDED | PLANO-CONVEX | | 5.6 | 0.6 | 1.5 | 1.8 | 1.6 | 1.6 | 0.2 | NO | NO |
| 72 | NO | NO | LARGE ROUNDED | NO | CONVEX SIDED | FLAT PARALLEL FACES | | 3.7 | 0.5 | 1 | 1.8 | 2 | 2 | 0.3 | NO | NO |
| 932 | | NO | | NO | CONVEX SIDED | | 7.3 | 1.9 | 0.7 | | 1.8 | 1.9 | 1.9 | 0.2 | NO | NO |
| 847 | NO | NO | MODERATE, POINTED | NO | CONVEX SIDED | THIN BICONVEX | 5.7 | 3.2 | 0.9 | 0.7 | 1.6 | 1.9 | 1.9 | 0.3 | NO | NO |
| 382 | YES | NO | MODERATE, POINTED | YES | STRAIGHT SIDED | FLAT PARALLEL FACES | 7.3 | 3.1 | 0.7 | 0.4 | 1.9 | 2 | 2.2 | 0.5 | NO | NO |
| 9 | N O | YES | SMALL, POINTED | YES | CONVEX SIDED | PLANO-CONVEX | 4.4 | 2.9 | 0.6 | 0 | 1.4 | 2.1 | | 0.8 | NO | NO |
| 80 | YES | NO | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | 7.3 | 4.9 | 1.3 | 0.6 | 1.2 | 1.8 | 1.5 | 0.4 | NO | NO |
| 75 | NO | YES | MODERATE, POINTED | NO | STRAIGHT SIDED | FLAT PARALLEL FACES | 10.1 | 3.3 | 0.8 | 0 | 2.2 | 2.2 | 2 | 0.8 | NO | NO |
| 546 | NO | NO | MODERATE, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | 5 | 3.3 | 0.5 | 0.5 | 1.5 | 1.8 | 1.7 | 0.4 | NO | NO |
| 122 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | THIN BICONVEX | 5.5 | 3.6 | 1 | 0.7 | 1.8 | 2.2 | 2.1 | 0.6 | NO | NO |
| 831 | NO | YES | SMALL, POINTED | YES | CONVEX SIDED | PLANO-CONVEX | 5.6 | 3 | 0.9 | 0.4 | 1.8 | 2 | 1.9 | 0.4 | NO | NO |
| 552 | NO | YES | SMALL, POINTED | YES | CONVEX SIDED | THICK BICONVEX | 6.4 | 3.1 | 0.8 | 0.3 | 2.3 | 2.4 | 2.2 | 1 | NO | NO |
| 503 | NO | NO | MODERATE, POINTED | | STRAIGHT SIDED | THICK BICONVEX | | 3.1 | 0.8 | 0.4 | 1.6 | 1.8 | 1.4 | 0.2 | NO | NO |
| 154 | YES | YES | SMALL, POINTED | YES | STRAIGHT SIDED | FLAT PARALLEL FACES | 4.1 | 3 | 0.5 | 0.1 | 1.3 | 1.9 | 2 | 0.2 | NO | NO |
| 175 | NO | NO | SMALL, POINTED | NO | CONVEX SIDED | FLAT PARALLEL FACES | | 3.2 | 0.5 | 0.5 | 1.6 | 2 | 2 | 0.2 | NO | NO |
| 892 | YES | NO | MODERATE, POINTED | NO | STRAIGHT SIDED | FLAT PARALLEL FACES | 8.2 | 3.2 | 0.6 | 0.1 | 2.2 | 2.5 | 2 | 0.7 | NO | NO |
| 810 | NO | | SMALL, POINTED | | STRAIGHT SIDED | THIN BICONVEX | | | | | 1.5 | 2 | 2 | 0.6 | NO | NO |
| 160 | YES | NO | | | CONVEX SIDED | PLANO-CONVEX | | 2.8 | 0.6 | | 2.3 | 2.6 | 2.6 | 0.8 | NO | NO |
| 601 | | | | | | | | | 0.7 | | | | | 1.4 | NO | NO |
| 401 | | NO | MODERATE, POINTED | NO | CONVEX SIDED | | | 2.2 | 0.5 | 0.3 | 1.9 | 2.2 | 2.1 | 0.5 | NO | NO |
| 218 | NO | YES | MODERATE, POINTED | NO | STRAIGHT SIDED | THIN BICONVEX | | 3.4 | 0.7 | 0.3 | 1.8 | 2 | 1.8 | 0.2 | NO | NO |
| 427 | NO | NO | | NO | CONVEX SIDED | THICK BICONVEX | 4.5 | 2.8 | 0.7 | 0.4 | 1.2 | 1.6 | 1.9 | 0.3 | NO | NO |
| 190 | YES | YES | MODERATE, POINTED | YES | STRAIGHT SIDED | THICK BICONVEX | 5.6 | 1.7 | 0.6 | 0.4 | 1.6 | 1.7 | 1.6 | 0.2 | NO | NO |
| 408 | YES | NO | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 3 | 0.6 | 0.3 | 1.2 | 1.6 | 1.4 | 0.3 | NO | NO |
| 378 | YES | YES | MODERATE, POINTED | NO | CONVEX SIDED | THIN BICONVEX | 4.8 | 3.6 | 0.7 | 0.6 | 1.4 | 2 | 1.7 | 0.5 | NO | NO |
| 425 | NO | NO | MODERATE, POINTED | YES | CONVEX SIDED | THIN BICONVEX | 6.8 | 3.4 | 0.7 | 0.4 | 1.8 | 2 | 1.8 | 0.3 | NO | NO |
| 912 | YES | NO | MODERATE, POINTED | NO | STRAIGHT SIDED | FLAT PARALLEL FACES | | 3.4 | 0.6 | 1 | 1.7 | 1.9 | 1.7 | 0.3 | NO | NO |
| 292 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | FLAT PARALLEL FACES | 6.8 | 2.7 | 0.5 | 0.1 | 1.5 | 1.5 | | 0.3 | NO | NO |
| 555 | YES | YES | SMALL, POINTED | NO | CONVEX SIDED | FLAT PARALLEL FACES | 7.6 | 3.3 | 0.7 | 0.4 | 2.1 | 2.4 | 2.1 | 0.7 | NO | NO |
| 47 | YES | NO | MODERATE, POINTED | NO | CONVEX SIDED | FLAT PARALLEL FACES | | 2 | 0.6 | 0.6 | 1.6 | 2 | 1.8 | 0.5 | NO | NO |
| 155 | YES | | | NO | CONVEX SIDED | PLANO-CONVEX | | | 0.6 | | 1.6 | 2 | 1.9 | 0.6 | NO | NO |
| 1007 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 3.5 | 0.7 | 0.3 | 2.2 | 2.6 | 2.2 | 0.7 | NO | NO |
| 444 | | | SMALL, POINTED | | STRAIGHT SIDED | | | 3.1 | 0.8 | 0.1 | 1.6 | 1.9 | 1.8 | 0.2 | NO | NO |
| 276 | YES | NO | MODERATE, POINTED | NO | CONVEX SIDED | FLAT PARALLEL FACES | | 4.3 | 0.6 | 1 | 1.4 | 2.2 | 2 | 0.5 | NO | NO |
| 478 | NO | YES | SMALL, POINTED | NO | CONVEX SIDED | FLAT PARALLEL FACES | | 2 | 0.6 | 0.3 | 1.7 | 2 | 2.2 | 0.4 | NO | NO |
| 505 | NO | YES | SMALL, POINTED | YES | CONVEX SIDED | FLAT PARALLEL FACES | 7 | 2.2 | 0.6 | 0.1 | 1.6 | 2.2 | | 0.8 | NO | NO |
| 1005 | YES | NO | MODERATE, POINTED | NO | STRAIGHT SIDED | FLAT PARALLEL FACES | | 1.8 | 0.6 | 0.4 | 1.7 | 1.9 | 1.9 | 0.6 | NO | NO |
| 360 | YES | NO | MODERATE, POINTED | NO | CONVEX SIDED | FLAT PARALLEL FACES | | 2.2 | 0.6 | 1.1 | 1.6 | 2.2 | 2.1 | 0.6 | NO | NO |
| 248 | NO | NO | SMALL, POINTED | NO | CONVEX SIDED | PLANO-CONVEX | | 2.4 | 0.6 | 0.3 | 2.2 | 2.4 | | 0.9 | NO | NO |
| 439 | NO | YES | SMALL, POINTED | NO | CONVEX SIDED | PLANO-CONVEX | 6.8 | 2.6 | 0.6 | 0 | 2.5 | 2.6 | 2.4 | 0.6 | NO | NO |
| 228 | NO | NO | MODERATE, POINTED | NO | CONVEX SIDED | THIN BICONVEX | 4.7 | 3.9 | 0.6 | 0.7 | 1.5 | 2.1 | 2.1 | 0.5 | NO | NO |
| 417 | YES | NO | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 3.5 | 0.6 | 0.2 | 2 | 2.3 | 1.8 | 0.6 | NO | NO |
| 839 | YES | NO | MODERATE, POINTED | NO | CONVEX SIDED | THIN BICONVEX | | 4.2 | 0.5 | 1 | 1.6 | 2 | 2.2 | 0.4 | NO | NO |
| 349 | YES | NO | SMALL, POINTED | YES | STRAIGHT SIDED | THIN BICONVEX | | 3.6 | | | | | | | NO | NO |
| 1023 | YES | NO | MODERATE, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 3.6 | 0.6 | 0.8 | 1.7 | 1.9 | 2 | 0.8 | NO | NO |
| 830 | YES | YES | MODERATE, POINTED | NO | STRAIGHT SIDED | FLAT PARALLEL FACES | | 2.1 | 0.5 | 0.7 | 2 | 2.1 | 2.1 | 0.7 | NO | NO |
| 936 | YES | YES | MODERATE, POINTED | | STRAIGHT SIDED | FLAT PARALLEL FACES | | 3.9 | 0.5 | 1 | 1.9 | 2 | 2.1 | 0.7 | NO | NO |
| 570 | YES | YES | SMALL, POINTED | YES | STRAIGHT SIDED | THICK BICONVEX | 3.7 | 2.7 | 0.5 | 0.2 | 1.7 | 1.8 | 1.7 | 0.5 | NO | NO |
| 865 | YES | NO | | NO | STRAIGHT SIDED | THICK BICONVEX | | | 0.5 | 1.1 | 1.4 | 0.6 | 2 | 0.7 | NO | NO |
| 397 | YES | NO | SMALL, POINTED | NO | STRAIGHT SIDED | THICK BICONVEX | | 3.9 | 0.4 | 0.5 | 1.5 | 2.2 | 1.7 | 0.3 | NO | NO |
| 453 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | THIN BICONVEX | 6.9 | 3.6 | 0.5 | 0.4 | 1.6 | 2.1 | 1.9 | 0.8 | NO | NO |
| 812 | YES | NO | SMALL, POINTED | NO | CONVEX SIDED | THICK BICONVEX | | 3.1 | 1 | 0 | 2.2 | 2 | 2.2 | 0.5 | NO | NO |
| 541 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 3.2 | 0.7 | 0.1 | 1.6 | 2.3 | 2.1 | 0.2 | NO | NO |
| 353 | YES | YES | MODERATE, POINTED | NO | STRAIGHT SIDED | THIN BICONVEX | | 4.5 | 0.7 | 1.3 | 1.9 | 2.1 | 2.1 | 0.7 | NO | NO |
| 1033 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | THIN BICONVEX | | 2.8 | 0.7 | 0 | 1.3 | 1.6 | 1.4 | 0.2 | NO | NO |
| 494 | NO | NO | SMALL, POINTED | NO | CONVEX SIDED | THIN BICONVEX | | 2.9 | 0.6 | 0.1 | 1.7 | 2 | 1.6 | 0.2 | NO | NO |
| 449 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 3.2 | 0.6 | 0 | 1.8 | 2.3 | 2.2 | 0.6 | NO | NO |
| 363 | NO | NO | SMALL, POINTED | NO | CONVEX SIDED | FLAT PARALLEL FACES | | 3.8 | 0.5 | 0.5 | 1.6 | 2 | 1.9 | 0.4 | NO | NO |
| 299 | NO | NO | MODERATE, POINTED | NO | CONVEX SIDED | THIN BICONVEX | | 2.2 | 0.7 | 0.5 | 1.9 | 2.3 | 2 | 0.4 | NO | NO |
| 402 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | FLAT PARALLEL FACES | | 3.9 | 2.1 | 0.3 | 1.5 | 2.2 | 2.1 | 0.3 | NO | NO |
| 426 | NO | YES | SMALL, POINTED | NO | STRAIGHT SIDED | THIN BICONVEX | | 2.1 | 0.6 | 0.9 | 1.9 | 2.1 | 2 | 0.6 | NO | NO |
| 306 | YES | NO | MODERATE, POINTED | YES | STRAIGHT SIDED | PLANO-CONVEX | | 3.8 | 0.7 | 0.4 | 2.1 | 2.2 | 2 | 0.2 | NO | NO |
| 851 | NO | | SMALL, POINTED | | STRAIGHT SIDED | PLANO-CONVEX | | 2.2 | | 0.4 | 2.1 | 2.2 | 2 | 0.4 | NO | NO |
| 88 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 3.4 | 0.5 | 0.3 | 1.8 | 2.1 | 2 | 0.3 | NO | NO |
| 224 | | | | | STRAIGHT SIDED | | | | | | 1.4 | 1.7 | 1.5 | 0.3 | NO | NO |
| 471 | YES | NO | SMALL, POINTED | NO | CONVEX SIDED | FLAT PARALLEL FACES | | 3.6 | 0.6 | 0.8 | 1.6 | 2.3 | 2.1 | 0.7 | NO | NO |
| 139 | NO | NO | SMALL, POINTED | NO | STRAIGHT SIDED | THICK BICONVEX | | 4.1 | 0.7 | 0.1 | 1.7 | 2.6 | 2.2 | 0.7 | NO | NO |
| 23 | YES | NO | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 4.1 | 0.6 | 0.4 | 2.3 | 2.3 | | 1.4 | NO | NO |
| 225 | YES | | SMALL, POINTED | NO | STRAIGHT SIDED | PLANO-CONVEX | | 3.5 | 0.7 | 0 | 2.1 | 2.4 | 2.4 | 0.8 | NO | NO |
| MONTELL (n=8) | | | | | | FLAT PARALLEL FACES | | 3 | 0.5 | 0.6 | 1.3 | 2 | 2.2 | 0.8 | NO | NO |
| 838 | NO | NO | SMALL, POINTED | NO | | | | | | | | | | | | |
| 564 | NO | YES | SMALL, POINTED | YES | STRAIGHT EDGED EARS AT DIFFERENT ANGLES | FLAT PARALLEL FACES | | 2.7 | 0.4 | 0.3 | 1 | 2.1 | 2.3 | 0.7 | NO | NO |
| 930 | NO | NO | | NO | ROUNDED BASAL EARS | PLANO-CONVEX | 4.7 | 2.9 | 0.5 | | 1.2 | 2.2 | | 0.7 | NO | NO |
| 153 | NO | NO | | NO | | FLAT PARALLEL FACES | | 3.2 | 0.4 | | | 2.2 | | | NO | NO |
| 907 | NO | | SMALL, POINTED | | ROUNDED BASAL EARS | | | | 0.5 | 0.5 | 1.2 | | | 1.1 | NO | NO |
| 6 | N O | NO | SMALL, POINTED | NO | STRAIGHT EDGED BASAL EARS IN LINE WITH EACH OTHER | THICK BICONVEX | 4.4 | 3.8 | 0.7 | 0.3 | 1.1 | 1.7 | 1.7 | 0.5 | NO | NO |
| 323 | YES | YES | SMALL, POINTED | YES | ROUNDED BASAL EARS | THIN BICONVEX | 5.1 | 3.2 | 0.5 | 0.3 | 1.5 | 2.4 | | 0.7 | NO | NO |
| 332 | NO | YES | MODERATE, POINTED | YES | ROUNDED BASAL EARS | PLANO-CONVEX | 5.3 | 4.2 | 0.4 | 0.5 | 1.4 | 2.3 | 2.5 | 0.9 | NO | NO |
| MARSHALL (n=11) | | | | | | | | | | | | | | | | |
| 951 | YES | | SMALL, POINTED | NO | CONCAVE BASE | THICK BICONVEX | | 3.3 | 0.6 | 0.7 | 1.6 | 2.1 | 2.1 | 0.1 | NO | NO |
| 193 | NO | NO | MODERATE, ROUNDED | NO | STRAIGHT BASE | FLAT PARALLEL FACES | | 3.9 | 0.6 | 0.9 | 1.3 | 1.6 | 2 | | NO | NO |
| 905 | YES | NO | | NO | MILDLY CONVEX BASE | PLANO-CONVEX | | 3.8 | 0.7 | | 1 | 2.3 | 2.4 | 0 | NO | NO |
| 1039 | YES | NO | SMALL, POINTED | NO | CONCAVE BASE | THICK BICONVEX | 6.5 | 5 | 1 | 0.3 | 1.6 | 1.7 | 1.7 | 0.1 | NO | NO |
| 803 | NO | YES | MODERATE, POINTED | YES | CONCAVE BASE | THIN BICONVEX | | 4.2 | 0.7 | 0.7 | 1.3 | 2.2 | 2.6 | 0.1 | NO | NO |
| 287 | YES | NO | SMALL, POINTED | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 3.7 | 0.7 | 0.3 | 1.2 | 2.3 | 2.4 | 0.2 | NO | NO |
| 132 | YES | YES | MODERATE, POINTED | NO | CONCAVE BASE | PLANO-CONVEX | | 4.2 | 0.7 | | 1.3 | 2.1 | 2.2 | 0.2 | NO | NO |
| 164 | NO | NO | MODERATE, POINTED | NO | CONCAVE BASE | THIN BICONVEX | | 3.6 | 0.6 | 0.9 | 1.3 | 2.2 | 2.6 | 0.1 | NO | NO |
| 383 | NO | NO | MODERATE, POINTED | NO | CONCAVE BASE | THIN BICONVEX | | 3.9 | 0.6 | 1.1 | 1.3 | 2 | 2.1 | 0.1 | NO | NO |
| 207 | NO | YES | SMALL, POINTED | YES | | THIN BICONVEX | 6.7 | 3.7 | 0.6 | 0.6 | 1 | 1.7 | | | NO | NO |
| 879 | YES | YES | SMALL, POINTED | NO | STRAIGHT BASE | PLANO-CONVEX | 6.2 | 4.2 | 1.2 | 0.5 | 0.7 | 1.7 | 1.8 | 0 | NO | NO |
| CASTROVILLE (n=10) | | | | | | | | | | | | | | | | |
| 486 | NO | NO | SMALL, POINTED | NO | MILDLY CONVEX BASE | FLAT PARALLEL FACES | | 3.8 | 0.5 | 0.7 | 1.1 | 2 | 2.2 | | NO | NO |
| 487 | NO | NO | | | | FLAT PARALLEL FACES | | | 0.7 | | 1.2 | | | | NO | NO |
| 460 | NO | YES | MODERATE, ROUNDED | YES | MILDLY CONVEX BASE | PLANO-CONVEX | | 4.8 | 0.9 | 0.8 | 1.5 | 2.3 | 2.6 | | NO | NO |
| 982 | NO | NO | MODERATE, ROUNDED | NO | MILDLY CONVEX BASE | PLANO-CONVEX | | 3.3 | 0.5 | 1 | 1.3 | 1.5 | 1.9 | | NO | NO |

**Table 3.** *(Continued)*

| UNIQUE ITEM NUMBER | LARGE BILLET SCARS ON FACES? | RECURVED BLADE EDGES AND TIP END? | BARB SIZE/BARB SHAPE | BLADE OR TIP RESHARPENING? | STEM SHAPE/BASE SHAPE | LATERAL CROSS SECTION | MAX LENGTH (cm) | MAX BLADE WIDTH (cm) | MEDIAL BLADE THICK-NESS (cm) | MAX BARB LENGTH (cm) | MAX STEM LENGTH (cm) | MIN. WIDTH OF STEM NECK (cm) | STEM WIDTH AT BASE (cm) | DEPTH OF BASAL NOTCH (cm) | STRONGLY ASYMMETRICAL? | STEM BEVELED? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 98 | NO | NO | | | STRAIGHT BASE | FLAT PARALLEL FACES | | 4.3 | 0.6 | | 1.2 | 2 | 2.2 | | NO | NO |
| 198 | YES | YES | MODERATE, POINTED | YES | STRAIGHT BASE | PLANO-CONVEX | | 4.7 | 1 | 1 | 1.1 | 2.2 | 2.4 | 0 | NO | NO |
| 344 | YES | NO | MODERATE, ROUNDED | NO | STRAIGHT BASE | FLAT PARALLEL FACES | 12.2 | 4.8 | 1 | 0.8 | 1 | 2.2 | 2.5 | 0 | NO | NO |
| 252 | NO | NO | MODERATE, ROUNDED | NO | MILDLY CONVEX BASE | FLAT PARALLEL FACES | | 4.5 | 0.5 | 1 | 1.3 | 2.4 | 2.6 | 0 | NO | NO |
| 64 | NO | NO | MODERATE, POINTED | NO | MILDLY CONVEX BASE | FLAT PARALLEL FACES | | 4.8 | 0.7 | 1.2 | 1.5 | 2.3 | 2.6 | | NO | NO |
| 913 | NO | YES | SMALL, POINTED | NO | MARKEDLY CONVEX BASE | PLANO-CONVEX | 6.1 | 4.4 | 0.7 | 0.6 | 0.9 | 1.9 | 2.4 | | NO | NO |
| LA JITA (n=30) | | | | | | | | | | | | | | | | |
| 394 | | YES | | YES | CONCAVE BASE | | 5.9 | 2.8 | 0.7 | | 1.5 | 2.5 | 2.2 | | NO | YES-but not cross beveled |
| 844 | NO | NO | | YES | STRAIGHT BASE | | 5.1 | 2.8 | 0.6 | | 1.6 | 2.6 | 2.6 | | NO | YES-but not cross beveled |
| 144 | | NO | | NO | STRAIGHT BASE | | 6.7 | 3.2 | 0.8 | | 1.3 | 2.7 | 2.7 | | NO | YES-but not cross beveled |
| 852 | YES | NO | | NO | CONVEX BASE | | 5.7 | 3.3 | 0.7 | | 1.9 | 2.3 | 2 | | NO | YES-but not cross beveled |
| 202 | NO | NO | | NO | CONVEX BASE | FLAT PARALLEL FACES | | | 0.5 | | 1.8 | 2.5 | 2.6 | | NO | YES-but not cross beveled |
| 180 | NO | YES | | YES | CONVEX BASE | FLAT PARALLEL FACES | 5.5 | 2.7 | 0.6 | 0 | 1.3 | 2.7 | 2.6 | | NO | YES-but not cross beveled |
| 79 | YES | YES | | YES | CONVEX BASE | FLAT PARALLEL FACES | | 3.3 | 0.8 | 0 | 1.8 | 2.4 | 2.2 | | NO | YES-but not cross beveled |
| 499 | NO | NO | | YES | STRAIGHT BASE | FLAT PARALLEL FACES | 7.2 | 3.2 | 0.7 | 0 | 1.8 | 2.6 | 2.8 | | YES | YES-but not cross beveled |
| 837 | NO | NO | | NO | STRAIGHT BASE | PLANO-CONVEX | 6.6 | 3.2 | 0.7 | 0 | 1.5 | 2.7 | 2.5 | | NO | YES-but not cross beveled |
| 501 | NO | NO | | YES | CONVEX BASE | FLAT PARALLEL FACES | 6.5 | 2.4 | 0.6 | 0 | 1.7 | 1.7 | 1.5 | | NO | YES-but not cross beveled |
| 442 | YES | NO | | NO | CONVEX BASE | THIN BICONVEX | | 2.8 | 0.6 | 0 | 1.3 | 2 | 1.9 | | NO | YES-but not cross beveled |
| 22 | NO | YES | | YES | STRAIGHT BASE | FLAT PARALLEL FACES | | 3 | 0.7 | 0 | 1.5 | 2.4 | 2.6 | | YES | YES-but not cross beveled |
| 234 | NO | YES | | YES | STRAIGHT BASE | FLAT PARALLEL FACES | 6.4 | 3 | 0.7 | 0 | 1.7 | 2.2 | 2.2 | | NO | YES-but not cross beveled |
| 108 | NO | NO | | YES | STRAIGHT BASE | THIN BICONVEX | 4.8 | 2.7 | 0.5 | 0 | 1.3 | 2.3 | 2.6 | | NO | YES-but not cross beveled |
| 525 | YES | NO | | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 3.5 | 0.5 | 0 | 1.5 | 2.4 | 2.5 | 0.1 | NO | YES-but not cross beveled |
| 521 | YES | NO | | NO | CONCAVE BASE | THIN BICONVEX | 7.1 | 3.6 | 0.6 | 0 | 1.2 | 2.2 | 2.4 | 0.1 | NO | YES-but not cross beveled |
| 35 | YES | NO | | NO | CONCAVE BASE | PLANO-CONVEX | | 4.5 | 1 | 0 | 1.5 | 2.4 | 2.5 | 0.1 | NO | YES-but not cross beveled |
| 864 | NO | YES | | YES | CONCAVE BASE | THIN BICONVEX | 4.4 | 2.4 | 0.5 | 0 | 1.4 | 2 | 2.2 | 0.1 | NO | YES-but not cross beveled |
| 49 | YES | NO | | NO | CONVEX BASE | FLAT PARALLEL FACES | 6.8 | 3.7 | 0.6 | 0 | 1.4 | 2.5 | 2.4 | | NO | YES-but not cross beveled |
| 843 | NO | NO | | YES | CONCAVE BASE | THICK BICONVEX | 8.3 | 3 | 0.9 | 0 | 1.4 | 2.4 | 2.2 | 0.1 | NO | YES-but not cross beveled |
| 848 | YES | NO | | NO | STRAIGHT BASE | THIN BICONVEX | | 2.3 | 0.7 | 0 | 1.6 | 2.3 | 2.2 | | NO | YES-but not cross beveled |
| 450 | YES | YES | | NO | CONCAVE BASE | THICK BICONVEX | 6.6 | 2.8 | 0.8 | 0 | 1.5 | 2.1 | 2.2 | 0.1 | NO | YES-but not cross beveled |
| 1058 | NO | YES | | YES | CONCAVE BASE | THIN BICONVEX | 5.5 | 4.1 | 0.8 | 0 | 1.6 | 2.2 | 2.3 | 0.1 | NO | YES-but not cross beveled |
| 355 | NO | | | | CONVEX BASE | FLAT PARALLEL FACES | | | | | | | 2 | | NO | YES-but not cross beveled |
| 379 | NO | | | | CONCAVE BASE | THIN BICONVEX | | | 0.6 | | 1.5 | 2 | 2.3 | 0.2 | NO | YES-but not cross beveled |
| 916 | NO | YES | | NO | CONVEX BASE | FLAT PARALLEL FACES | 6.4 | 3.1 | 0.6 | 0 | 1.8 | 2.4 | 2.4 | 0.1 | NO | YES-but not cross beveled |
| 926 | NO | NO | | NO | CONVEX BASE | THIN BICONVEX | | 2.8 | 0.6 | 0 | 1.6 | 2.3 | 2.6 | 0.1 | NO | YES-but not cross beveled |
| 561 | YES | YES | | YES | CONVEX BASE | FLAT PARALLEL FACES | | 2.9 | 0.7 | | 1.2 | 2.3 | 2.2 | | YES | YES-but not cross beveled |
| 217 | NO | NO | | NO | STRAIGHT BASE | PLANO-CONVEX | 5.1 | 2.7 | 0.6 | 0 | 1.3 | 2.2 | 2.3 | | NO | YES-but not cross beveled |
| 958 | NO | YES | | YES | CONCAVE BASE | THIN BICONVEX | 4.8 | 2.3 | 0.6 | 0 | 1.3 | 2.2 | 2.2 | 0.1 | NO | YES-but not cross beveled |
| NOLAN (n=13) | | | | | | | | | | | | | | | | |
| 90 | YES | NO | | YES | STRAIGHT BASE | | 7.5 | 2.1 | 0.7 | 0 | 1.3 | 1.7 | 1.7 | | NO | YES |
| 194 | YES | NO | | YES | CONVEX BASE | PLANO-CONVEX | 4.4 | 1.6 | 0.7 | 0 | 1.5 | 1.7 | 1.7 | | NO | YES |
| 516 | NO | YES | | YES | STRAIGHT BASE | PLANO-CONVEX | | 2.9 | 0.8 | 0 | 1.8 | 2 | 1.9 | | NO | YES |
| 1042 | NO | NO | | NO | CONVEX BASE | PLANO-CONVEX | 6.1 | 3.3 | 0.8 | 0 | 1.4 | 2.3 | 1.9 | | NO | YES |
| 83 | NO | NO | | YES | STRAIGHT BASE | THIN BICONVEX | 4.1 | 2.6 | 0.7 | 0 | 1.5 | 1.8 | 1.7 | | NO | YES |
| 421 | NO | NO | | NO | STRAIGHT BASE | THIN BICONVEX | | 2.9 | 0.7 | 0 | 1.6 | 2.2 | 1.9 | | NO | YES |
| 56 | YES | NO | | NO | CONCAVE BASE | THIN BICONVEX | 5.9 | 2.8 | 0.9 | 0 | 1.5 | 2.1 | 1.9 | 0.1 | NO | YES |
| 550 | NO | NO | | | STRAIGHT BASE | FLAT PARALLEL FACES | | 2.7 | 0.4 | 0 | 1.5 | 2.1 | 2.1 | | NO | YES |
| 97 | YES | NO | | NO | STRAIGHT BASE | PLANO-CONVEX | | 3 | 0.7 | 0 | 1.7 | 2.2 | 2.1 | | YES | YES |
| 11 | NO | NO | | YES | STRAIGHT BASE | PLANO-CONVEX | | 2.5 | 0.8 | 0 | 1.9 | 2 | 1.5 | | NO | YES |
| 468 | NO | YES | | NO | STRAIGHT BASE | FLAT PARALLEL FACES | | 3 | 0.6 | 0 | 1.5 | 2.1 | 1.9 | | NO | YES |
| 911 | YES | NO | | NO | STRAIGHT BASE | THIN BICONVEX | 8.2 | 2.5 | 0.8 | 0 | 1.7 | 1.7 | 1.5 | | YES | NO |
| 484 | NO | NO | | YES | CONVEX BASE | PLANO-CONVEX | 5.4 | 2.2 | 0.6 | 0 | 1.2 | 1.6 | 1.4 | | NO | YES |
| LANCEOLATE (n=4) | | | | | | | | | | | | | | | | |
| 1044 | NO | NO | | NO | STRAIGHT BASE | PLANO-CONVEX | | 2.2 | 0.7 | | 2.2 | 2 | 1.2 | | NO | NO |
| 316 | NO | NO | | NO | STRAIGHT BASE | THIN BICONVEX | 6.2 | 2.2 | 0.8 | | 1.8 | 2.1 | 1.3 | | NO | NO |
| 1028 | NO | NO | | | CONCAVE BASE | FLAT PARALLEL FACES | | 2.3 | 0.4 | 0.7 | 0.5 | 2.3 | 1.9 | 0.4 | NO | NO |
| 545 | NO | NO | | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 2.1 | 0.5 | | 1.4 | 1.9 | 1.2 | | NO | NO |
| ANDICE/BELL (n=4) | | | | | | | | | | | | | | | | |
| 563 | NO | YES | | YES | CONVEX BASE | PLANO-CONVEX | 5 | 3.3 | 0.6 | | 1.7 | 1.8 | 1.7 | | NO | NO |
| 448 | NO | NO | LONG, SQUARED | NO | CONCAVE BASE | PLANO-CONVEX | | 3 | 0.5 | 1.1 | 1.4 | 1.5 | 1.6 | 0.1 | NO | NO |
| 373 | YES | | | | CONCAVE BASE | FLAT PARALLEL FACES | | 3.4 | 0.7 | | 2 | 1.5 | 1.8 | 0.1 | NO | NO |
| 173 | NO | YES | LONG, SQUARED | YES | CONCAVE BASE | FLAT PARALLEL FACES | 4 | 3.1 | 0.5 | | 1.1 | 1.6 | 1.6 | 0.1 | NO | NO |
| KINNEY (n=20) | | | | | | | | | | | | | | | | |
| 542 | | NO | | NO | CONCAVE BASE | | 6.8 | 3.2 | 0.5 | | 1.6 | 3 | 3 | 0.1 | YES | NO |
| 322 | NO | NO | | | CONCAVE BASE | | 5.2 | 3.1 | 0.6 | | 1.1 | 3.2 | 3.2 | 0.4 | NO | NO |
| 463 | NO | NO | | YES | CONCAVE BASE | | 6.6 | 2.8 | 0.8 | | 1.7 | 3.1 | 2.5 | 0.1 | NO | NO |
| 452 | | NO | | YES | CONCAVE BASE | | 6.1 | 3 | 0.8 | | 1.6 | 3 | 2.2 | 0.3 | NO | YES |
| 336 | YES | YES | | YES | CONCAVE BASE | FLAT PARALLEL FACES | 8.6 | 3.2 | 0.6 | | 0.5 | 2.7 | 2.3 | 0.4 | YES | NO |
| 497 | YES | NO | | YES | CONCAVE BASE | PLANO-CONVEX | 8.5 | 3.4 | 1 | | 0.4 | 3 | 2.5 | 0.1 | YES | NO |
| 420 | YES | YES | | YES | CONCAVE BASE | FLAT PARALLEL FACES | 8.9 | 3 | 0.6 | | 0.6 | 2.6 | 2.2 | 0.3 | YES | NO |
| 863 | NO | YES | | YES | CONCAVE BASE | FLAT PARALLEL FACES | | 2.7 | 0.7 | | 0.8 | 2.5 | 2.2 | 0.5 | NO | NO |
| 403 | NO | YES | | YES | CONCAVE BASE | FLAT PARALLEL FACES | 6.4 | 2.7 | 0.7 | | 1.6 | 2.6 | 2.5 | 0.5 | YES | NO |
| 965 | NO | NO | | YES | CONCAVE BASE | PLANO-CONVEX | 5.9 | 2.4 | 0.5 | | 0.7 | 2.4 | 1.8 | 0.3 | YES | NO |
| 467 | YES | NO | | YES | CONCAVE BASE | FLAT PARALLEL FACES | | 2.9 | 0.6 | | 0.6 | 2.8 | | 0.3 | YES | NO |
| 954 | NO | NO | | YES | CONCAVE BASE | FLAT PARALLEL FACES | | 3.6 | 0.3 | | 2.1 | 3.4 | 2.2 | 0.4 | NO | NO |
| 335 | NO | NO | | YES | CONCAVE BASE | FLAT PARALLEL FACES | 7.8 | 2.6 | 0.7 | | 1.6 | 2.4 | 1.9 | 0.1 | YES | NO |
| 199 | YES | NO | | YES | CONCAVE BASE | FLAT PARALLEL FACES | 7.8 | 3.4 | 0.7 | | 1.8 | 3 | 2.1 | 0.3 | YES | NO |
| 340 | YES | NO | | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 3.3 | 0.5 | | 2 | 3.1 | 2.3 | 0.2 | YES | NO |
| 1026 | NO | YES | | YES | CONCAVE BASE | FLAT PARALLEL FACES | 5.7 | 3 | 0.5 | | 1.3 | 3 | 2.5 | 0.2 | YES | NO |
| 435 | NO | NO | | NO | CONCAVE BASE | PLANO-CONVEX | 6.9 | 3 | 0.7 | | 2.1 | 3 | 2.1 | 0.7 | YES | NO |
| 308 | YES | NO | | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 3.6 | 0.7 | | 2.8 | 3.5 | 2.8 | 0.2 | NO | NO |
| 472 | YES | NO | | NO | CONCAVE BASE | PLANO-CONVEX | 10.1 | 4.5 | 1.2 | | 3.2 | 4.1 | 3.2 | 0.4 | YES | NO |
| 368 | YES | NO | | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 3.3 | 0.7 | | 1.7 | 3.2 | 2.9 | 0.1 | NO | NO |
| MARTINDALE (n=9) | | | | | | | | | | | | | | | | |
| 279 | NO | NO | | YES | CONCAVE BASE | PLANO-CONVEX | 3 | 2.1 | 0.5 | | 1.1 | 1.5 | 2.3 | 0.4 | NO | NO |
| 415 | NO | NO | MODERATE, POINTED | NO | CONCAVE BASE | PLANO-CONVEX | | 2.9 | 0.5 | 0.5 | 1 | 1.2 | 1.9 | 0.2 | NO | NO |
| 551 | YES | NO | MODERATE, POINTED | NO | CONCAVE BASE | THIN BICONVEX | | 3 | 0.6 | 0.5 | 1 | 1.6 | 2.1 | 0.2 | YES | NO |
| 162 | NO | NO | MODERATE, POINTED | YES | CONCAVE BASE | FLAT PARALLEL FACES | 5.9 | 3.3 | 0.5 | 0.5 | 1.1 | 1.8 | 2.2 | 0.2 | NO | NO |
| 171 | NO | YES | SMALL, POINTED | YES | CONCAVE BASE | THIN BICONVEX | 3.6 | 1.7 | 0.6 | 0 | 1.1 | 1.7 | 2.2 | 0.3 | NO | NO |
| 567 | NO | NO | MODERATE, POINTED | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 2.8 | 0.5 | 0.3 | 1.4 | 1.5 | 1.8 | 0.1 | NO | NO |
| 145 | NO | NO | MODERATE, POINTED | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 2.7 | 0.5 | 0.7 | 0.9 | 1.3 | 1.8 | 0.2 | NO | NO |
| 574 | NO | YES | MODERATE, POINTED | YES | CONCAVE BASE | FLAT PARALLEL FACES | 4 | 2.2 | 0.5 | 0.6 | 1.1 | 1.6 | 1.9 | 0.2 | YES | NO |

**Table 3.** *(Continued)*

| UNIQUE ITEM NUMBER | LARGE BILLET SCARS ON FACES? | RECURVED BLADE EDGES AND TIP END? | BARB SIZE/BARB SHAPE | BLADE OR TIP RESHARPENING? | STEM SHAPE/BASE SHAPE | LATERAL CROSS SECTION | MAX LENGTH (cm) | MAX BLADE WIDTH (cm) | MEDIAL BLADE THICK-NESS (cm) | MAX BARB LENGTH (cm) | MAX STEM LENGTH (cm) | MIN. WIDTH OF STEM NECK (cm) | STEM WIDTH AT BASE (cm) | DEPTH OF BASAL NOTCH (cm) | STRONGLY ASYMMETRICAL? | STEM BEVELED? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 919 | NO | NO | MODERATE, POINTED | YES | CONCAVE BASE | PLANO-CONVEX | 6.3 | 2.8 | 0.7 | 0.6 | 1.4 | 1.5 | 2.3 | 0.3 | YES | NO |
| UVALDE (n=7) | | | | | | | | | | | | | | | | |
| 543 | NO | NO | SMALL, POINTED | YES | CONCAVE BASE | THIN BICONVEX | 5 | 1.4 | 0.5 | 0.4 | 1.6 | 1 | 1.7 | 0.3 | YES | NO |
| 250 | NO | NO | SMALL, POINTED | NO | CONCAVE BASE | THIN BICONVEX | | 2 | 0.5 | 0.5 | 1.3 | 1.1 | 1.7 | 0.2 | NO | NO |
| 272 | NO | YES | | YES | CONCAVE BASE | PLANO-CONVEX | 5.2 | 2 | 0.4 | 0.3 | 1.4 | 1.2 | 1.4 | 0.3 | NO | NO |
| 857 | NO | NO | | NO | CONCAVE BASE | PLANO-CONVEX | 7.9 | 3.8 | 0.7 | 0.1 | 1.8 | 1.6 | 2 | 0.5 | NO | NO |
| 894 | NO | NO | | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 2.6 | 0.4 | 0 | 1.3 | 1.5 | 2 | 0.4 | NO | NO |
| 151 | NO | NO | SMALL, POINTED | NO | CONCAVE BASE | THIN BICONVEX | | 2.5 | 0.7 | 0.5 | 1.5 | 1.7 | 2.1 | 0.3 | NO | NO |
| 293 | | NO | | YES | CONCAVE BASE | | 8.3 | 2.5 | 0.7 | | 1.7 | 0.6 | 1.9 | 0.1 | NO | NO |
| MARCOS (n=11) | | | | | | | | | | | | | | | | |
| 19 | | NO | SMALL, POINTED | | STRAIGHT BASE | | 6.7 | 4 | 0.7 | 0.7 | 1.1 | 2.2 | 2.7 | | NO | NO |
| 1017 | NO | NO | MODERATE, POINTED | NO | STRAIGHT BASE | FLAT PARALLEL FACES | 4.9 | 3 | 0.6 | 0.5 | 1.3 | 1.8 | 2.2 | | NO | NO |
| 904 | NO | NO | | NO | CONVEX BASE | FLAT PARALLEL FACES | 3.8 | 2.8 | 0.5 | | 1.2 | 1.6 | 2 | | NO | NO |
| 1027 | YES | YES | SMALL, POINTED | NO | CONVEX BASE | PLANO-CONVEX | 5.9 | 3.3 | 0.9 | 0.7 | 1.3 | 2 | 2.6 | | NO | NO |
| 1 | N O | NO | MODERATE, POINTED | NO | STRAIGHT BASE | FLAT PARALLEL FACES | | 2.5 | 0.6 | 0.6 | 0.7 | 1.5 | 2 | | NO | NO |
| 8 | N O | NO | SMALL, POINTED | NO | STRAIGHT BASE | FLAT PARALLEL FACES | | 2.9 | 0.6 | 0.5 | 1 | 1.6 | 2 | | NO | NO |
| 1040 | YES | NO | MODERATE, POINTED | NO | CONVEX BASE | PLANO-CONVEX | 7.1 | 3.9 | 1 | 0.9 | 1.1 | 1.6 | 2.1 | | NO | NO |
| 1035 | YES | NO | SMALL, POINTED | NO | STRAIGHT BASE | PLANO-CONVEX | | 3.7 | 0.6 | 0.7 | 1.6 | 1.9 | 2.7 | | NO | NO |
| 1014 | NO | NO | SMALL, POINTED | NO | STRAIGHT BASE | FLAT PARALLEL FACES | | 3.4 | 0.5 | 0.5 | 1.2 | 1.5 | 1.7 | | NO | NO |
| 834 | | | | | | | | | | | | | | | | |
| 834 | NO | YES | MODERATE, POINTED | YES | CONCAVE BASE | THICK BICONVEX | 5.6 | 3.3 | 0.8 | 0.6 | 1 | 1.6 | 1.6 | | NO | NO |
| FRIO (n=6) | | | | | | | | | | | | | | | | |
| 181 | | NO | SMALL ROUNDED | | CONCAVE BASE | | 5.3 | 2.9 | 0.6 | 0.3 | 1.3 | 2.1 | 2.9 | 0.4 | NO | NO |
| 488 | NO | NO | | | CONCAVE BASE | | 4.6 | 2.7 | 0.6 | | 0.9 | 1.9 | 2.7 | 0.2 | NO | NO |
| 1018 | NO | YES | MODERATE, POINTED | YES | CONCAVE BASE | PLANO-CONVEX | | 3.3 | 0.6 | 0.5 | 1 | 2.2 | 3.1 | 0.3 | NO | NO |
| 30 | NO | NO | SMALL, POINTED | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 3.5 | 0.6 | 0.3 | 1.1 | 1.8 | 2.3 | 0.2 | NO | NO |
| 99 | YES | NO | | NO | | FLAT PARALLEL FACES | 6 | 3 | 0.4 | 0.7 | 1.1 | | | | NO | NO |
| 1021 | NO | NO | MODERATE, POINTED | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 3.1 | 0.6 | 0.7 | | 2 | 2.9 | 0.3 | NO | NO |
| EDWARDS (n=1) | | | | | | | | | | | | | | | | |
| 54 | NO | NO | | NO | CONCAVE BASE | FLAT PARALLEL FACES | | 1.5 | 0.3 | | 0.6 | 1 | 1.8 | 0.2 | NO | NO |
| ENSOR (n=1) | | | | | | | | | | | | | | | | |
| 802 | NO | NO | | NO | CONVEX BASE | THIN BICONVEX | 3.3 | 1.5 | 0.3 | | 1 | 0.8 | 1.3 | | NO | NO |
| WILLIAMS (n=3) | | | | | | | | | | | | | | | | |
| 975 | YES | NO | SMALL, POINTED | NO | CONVEX BASE | PLANO-CONVEX | 5.6 | 2.8 | 0.6 | 0.4 | 1.8 | 1.7 | 1.6 | | NO | NO |
| 849 | NO | NO | | | CONVEX BASE | FLAT PARALLEL FACES | | | 0.5 | | 1.2 | 1.5 | 2 | | NO | NO |
| 215 | NO | NO | SMALL, POINTED | NO | CONVEX BASE | FLAT PARALLEL FACES | | 3.1 | 0.5 | 0.6 | 1.3 | 1.6 | 2.1 | | NO | NO |
| CLEAR FORK TOOL (n=1) | | | | | | | | | | | | | | | | |
| | YES | NO | | | | BIFACE, PLANO CONVEX | 9.9 | 4.6 | 2 | | 8.1 | 1 | 1 | | NO | NO |
| GUADALUPE TOOL (n=1) | | | | | | | | | | | | | | | | |
| 577 | YES | NO | | NO | | | 10.8 | 3.5 | 2.7 | | | | | | NO | NO |
| EARLY TRIANGULAR (n=1) | | | | | | | | | | | | | | | | |
| 85 | | NO | | | CONCAVE BASE | | 4.3 | 4.3 | 0.5 | | | | | | NO | NO |


Figure 6. Feature 14, a slab-lined Middle Archaic hearth. Trowel points north. Scale is in 5 cm increments.

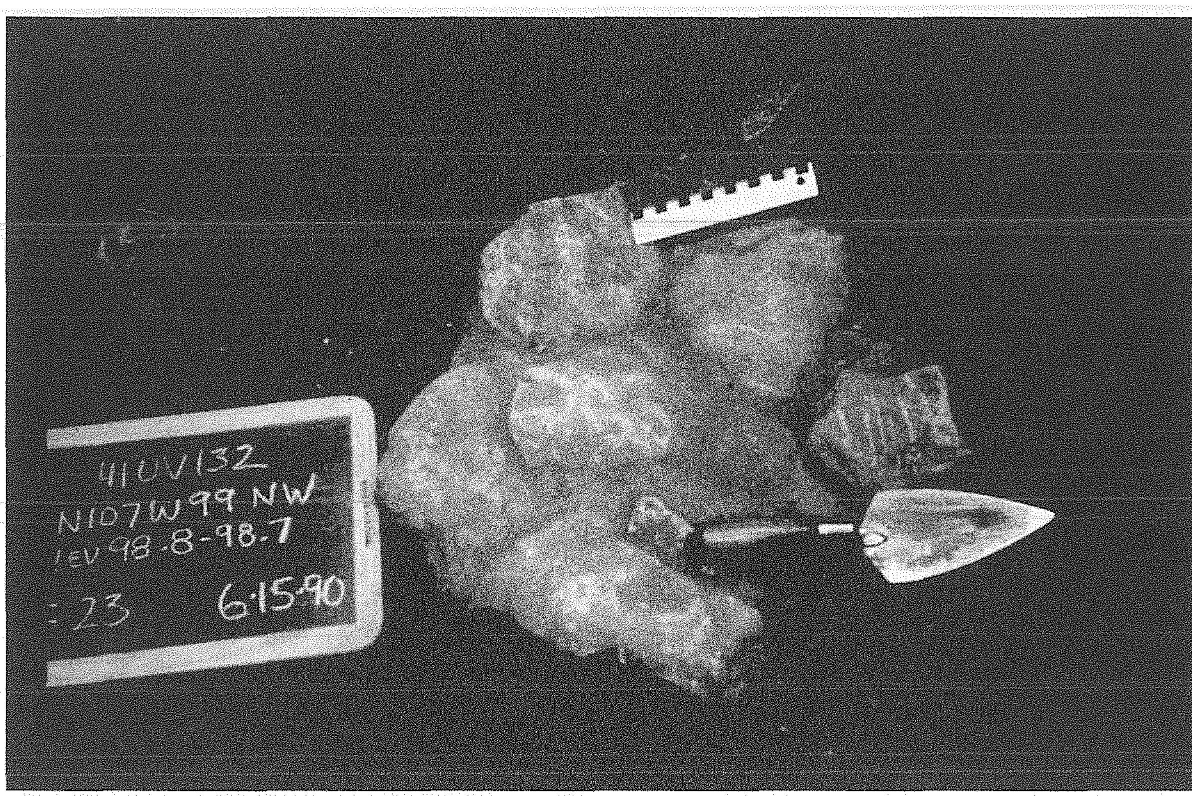



Figure 7. Feature 23, a Middle Archaic ring-shaped hearth. Trowel points north; scale is in 1 cm increments.

tures (see Table 2). Bulk soil samples from the features have not yet been processed, screened, or floated.

The time periods assigned for each feature are also listed at the far right of Table 2. These are based on the position of the feature in the excavation block and in profile. Eight features certainly predate the BRM. The rest are coeval with or postdate the Pedernales interval (of the Late Archaic I period) midden.

## SITE COMPONENTS

The Smith site is a buried Early to Late Archaic site. Suhm et al. (1954) considered similar long-term occupation sites at the Edwards Plateau margin to be evidence of a single cultural tradition, the "Edwards Plateau Aspect." Later researchers acknowledged that typical sites of the Edwards Plateau Aspect or the "central Texas Archaic" (Weir 1976) were found along the terraces of perennial and ephemeral streams, particularly where they left the Edwards Plateau. As agricultural activity and road building frequently expose these buried sites, they have become better known over the years.

## EARLY ARCHAIC PERIOD

### Site Formation Process and Features

The interpretive significance of the various occupations at the Smith site is based in great part on the site formation processes active at the time of their creation. The Early Archaic occupations here, and at many Archaic terrace sites in Central Texas, show evidence of relatively rapid burial. This rapid deposition is due at least in part to the great deal of loose sediment available on the Edwards Plateau uplands in the latest Pleistocene and Early Holocene (ca. 11,000-6000 B.P.) periods. During that time, so much loose sediment rested in today's eroded plateau uplands that earth-dwelling creatures like moles and prairie dogs lived in what are today the very thin rocky, soils known from the Edwards Plateau (Toomey 1993). In the Early Holocene, much of this accumulated upland sediment was transported to today's lowland stream terraces. The transported sediment formed thick cumulic Early Archaic soils and created buried cultural strata. Either way, up to six coherent burned rock features may belong within this time frame. These include isolated slab-lined hearth features (Features 2, 5, and 15), generally smaller open burned rock rings (Feature 4), and burned rock clusters (Features 3 and 21) (see Table 2).

It has also been hypothesized that a wetter (Figure 8) Early Holocene climate played a role in forming the thicker deposits (Collins 1995), while others suggest that it was drier then in comparison to today and that deposition was characterized, as it is today, by occasional violent flooding. In later time periods somewhat less upland sediment availability (today's floods can still deposit a lot of dirt on the Sabinal terraces), combined with a higher relative terrace elevation, and changing weather regimes, led to slow sediment deposition across the Smith Site. In either case, the Middle Holocene, post-Early Archaic, result is the same: less sediment deposition on the terrace, more lateral erosion at the terrace edges, and compressed archeological deposits and features.

## Lanceolate Component

Three lanceolate parallel-flaked tool fragments from the lowest levels at the Smith site hint at the earliest Archaic or very Late Paleoindian occupation at the site (Figure 9). One specimen is Angostura-like, with a thick central ridge and serrations on one side. The fragment exhibits an impact fracture in its midsection and an impact burin at the tip. Its stem and base are ground, with heavier grinding on the base. Another lanceolate specimen is badly burned. Very late Paleoindian style artifacts are often the earliest artifacts in collections from buried terrace sites around the region (Table 4), and they likely date to around 6800 B.C. (Hester 1980:94-108; Collins et al. 1998).

Collins (1995) indicates that these Angostura-like or lanceolate point fragments may mark, among other things, the first signs of Holocene deposition on the Edwards Plateau margin terraces, and the beginnings of today's more familiar landscapes. These latest Paleoindian lithic artifacts may be properly placed within geologically, and perhaps, culturally-specific Early Archaic contexts. Analysis of similar artifacts from the Wilson-Leonard site suggests that Late Paleoindian dart points were used alongside some of the earliest Early Archaic stemmed points, particularly those stemmed Early Archaic points exhibiting stem grinding and alternate beveling of the blade (Dial et al. 1998:318). At the Smith site, this earliest component was scarce and scattered, as it is at many sites in the region. Parts of the component may have been re-deposited or disturbed during the first flush of Holocene deposition. The points and their associated component are most interesting because they represent some of the earliest signs of a long-term cultural phenomenon (Hester 1986) that stretches across the region, namely their marking the first uses of significant places on the landscape that would see repeated occupations, and perhaps also a "shared cultural memory" of the use of such long-term sites for the next seven millennia.

Feature 5 is a slab-lined feature that may date to one of the earliest occupations of the site. An Angostura-like point, with impact burin and ground base (see Figure 9), a core, and a thick

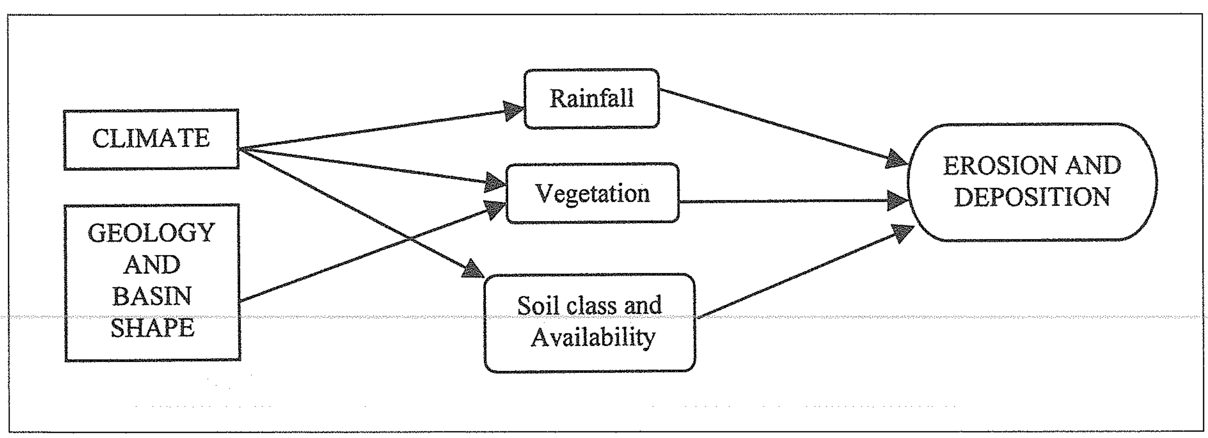



Figure 8. Factors affecting Archaic site formation on alluvial terraces of the Edwards Plateau margin (after Morisawa 1968:78).

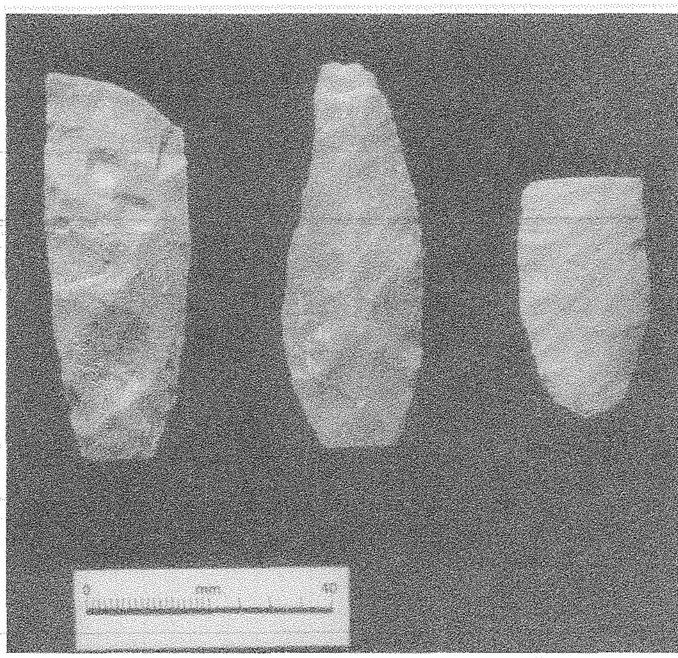


Figure 9. Lanceolate point fragments.

biface were found within the same unit/level. Two of the rocks at the northern perimeter of the feature had fractured in place. The rest of the rocks are unbroken stream cobbles, indicating a somewhat limited use-life and/or low firing temperatures for the feature.

The feature was cross-sectioned along a medial line. The sediment beneath the rocks had no charcoal, but did contain concentrations of baked clay. Very few flakes were found in or around the feature, but three rock samples and three soil samples were taken from the feature.

This feature is morphologically very similar to the other Early Archaic features. Collins (1995) noted a few years ago that what subsistence indicators there are for this part of the Early Archaic point toward the processing of deer, small animals, and plant materials for food. The small number of lanceolate points at the Smith site, with small rock features similar to later Archaic features, indicates the same subsistence pursuits.

## Uvalde and Martindale Components

Uvalde, Martindale, and similar split-stem artifacts from the southern Edwards Plateau are now thought to date to 7000-6000 years ago (Collins 1995:376; Hester 1971, 1995:436), if not slightly earlier. At the Smith site, most of the Uvalde and Martindale points occur together and below the BRM. A close examination of the 26 Uvalde and Martindale specimens shows them to occur along a typological gradient according to stem and blade treatment (cf. Hester 1971). Those with narrower blades and stems better fit definitions for Uvalde points, while points with broader blades and stems are typed as Martindale points (Figure 10). A statistical analysis of Early Archaic bifurcate stemmed points from the Wilson-Leonard site confirmed that these two point styles

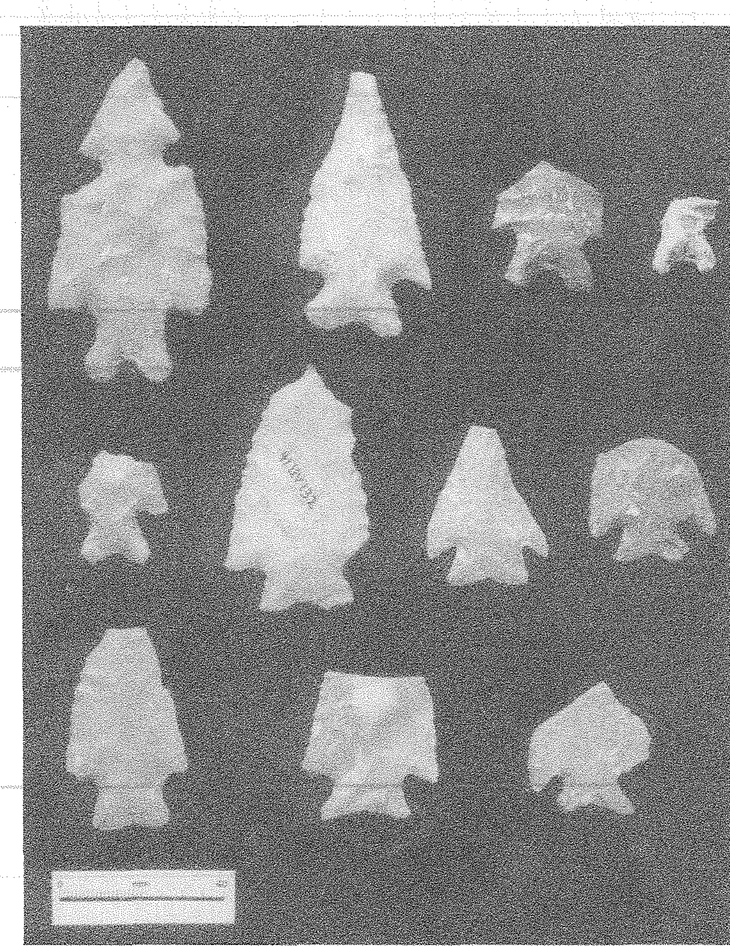


Figure 10. Uvalde and Martindale points.

**Table 4. Uvalde Area Artifact Recovery by Site and Type.**

| ARTIFACT TYPE | Anthon Site 41UV60 (Goode 2002) | Mingo Site 41BN101 (Houk and Lohse 1993) | Rainey Site 41BN33 (Henderson 2001) | Woodrow Heard Site 41UV88 (Decker, Black, and Gustavson 2000) | Blue Hole Site 41UV159 (Mueggenborg 1994) | Smith Site 41UV132 | La Jita Site 41UV21(Hester 1971) | TOTALS | Approximate Era |
|---|---|---|---|---|---|---|---|---|---|
| Plainview | 3 | | | | 1 | | | 4 | 10000 BP |
| Angostura | | | | 8 | | | | 8 | 8000 BP |
| Indeterminate Lanceolate | | | | 4 | | 4 | 4 | 12 | |
| Baker | | | | 4 | | | | 4 | |
| Uvalde/Uvalde-like | | | | 24 | 2 | | 11 | 37 | |
| Martindale/Martindale-like | | | | 37 | 1 | | 22 | **60** | 7000 BP |
| Marindale/Uvalde-like | | | | | | 19 | 2 | 21 | |
| Early Triangular | | | | 34 | 2 | 1 | 7 | 44 | 6000 BP |
| Bell/Andice | | | | 10 | | 4 | | 14 | |
| Abasolo/Abasolo-like | 4 | | | | | | 1 | 5 | 5000 BP |
| La Jita | 1 | | | 6 | 1 | 30 | 7 | 45 | |
| Nolan | | | | 10 | 2 | 13 | 12 | 37 | |
| Travis | | | | 2 | | | 2 | 4 | |
| Pandale | | | | 1 | | | 1 | 2 | |
| Langtry | | | | 10 | 1 | | 1 | 12 | |
| Almagre | | | | | | | 4 | 4 | |
| Bulverde | | | | 11 | | | 1 | 12 | 4000 BP |
| Kinney | 37 | | | 4 | 7 | 20 | 4 | **72** | |
| Pedernales | 40 | | | 105 | 52 | 76 | 101 | **374** | |
| Shumla | | | | 1 | | | | 1 | 3000 BP |
| Marshall | 6 | | | 8 | 11 | 11 | 5 | 41 | |
| Lange | | | | 1 | | | 2 | 3 | |
| Castroville | 3 | | | 21 | 8 | 10 | 11 | **53** | |
| Montell | 14 | | | 67 | 38 | 8 | 15 | **142** | |
| Williams | | | | | | 3 | 4 | 7 | |
| Marcos | 4 | | | 15 | 18 | 10 | | 47 | 2000 BP |
| Frio | 18 | | | 40 | 47 | 6 | 14 | **125** | |
| Ensor | 11 | | | 13 | 12 | 1 | 11 | 48 | |
| Zavala | 1 | | | | | | | 1 | |
| Fairland | 3 | | | 1 | | | | 4 | |
| Darl | | | | 1 | | | | 1 | |
| Matamoros | | | | | | | 1 | 1 | 1000 BP |
| Edgewood | | | | 7 | | | 3 | 10 | |
| Scallorn | 14 | 15 | 4 | | 6 | 13 | | **52** | |
| Edwards | 1 | 6 | 12 | 3 | 27 | 1 | 19 | **69** | |
| Sabinal/Sabinal-like | 6 | 15 | 4 | | 20 | | 7 | **52** | |
| Cliffton | | | | | | | 3 | 3 | |
| Triangular/Fresno-like | | | | | | | 24 | 24 | |
| Perdiz | 3 | | 23 | 8 | 13 | | 20 | **67** | 500 BP |
| N | 169 | 36 | 43 | 456 | 269 | 230 | 319 | **1522** | |

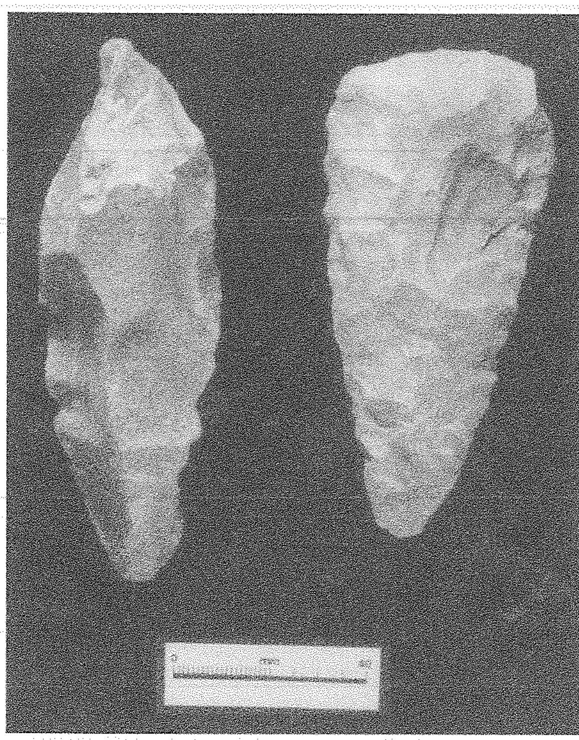


Figure 11. Guadalupe and Clear Fork tools.

have a continuum of attributes (Kerr and Dial 1998:503) that for the most part have been arbitrarily divided into broader and narrower blade styles.

Feature 4 (Figure 12) appeared to be a charcoal and debris-filled pit or pit oven, surrounded by burned rocks that dated to the Uvalde/Martindale time period or style interval. The feature was apparently constructed in a basin about 80 cm in diameter (as defined by charcoal-stained soil), and was approximately 30 cm deep. It is ringed by limestone rocks 5-15 cm in diameter; one of these stones had cracked *in situ*. In addition, about twenty 5-15 cm stones appeared to have been spread or raked northwestward up to 45 cm away from the top of the feature.

During the excavations, burned clay and charcoal flecking was noted around the feature, including those portions that spread out to the northwest. Many lumps of burned clay defined the central depression of the feature. Charcoal, a small amount of debitage, badly fragmented bone, and snails were noted within the feature matrix. As previously mentioned, a large charcoal sample with a calibrated 1-sigma age range of 6280-6410 B.P. was obtained from the feature's central depression (see Tables 1 and 2). A Guadalupe tool (Figure 11) was found within the charcoal-flecked matrix outside the stone circle. Five charcoal samples, including the dated sample, three burned clay samples, debitage, and two bone fragments were separately recovered and are curated together. Site notes on file at TARL indicate that analysis of archeomagnetic samples taken from the rocks at the perimeter of this feature by Dr. Wulf Gose (Geology Department at the University of Texas) revealed that the stones surrounding the central depression had cooled in place.

The ring-shaped Feature 4 looked like a pit oven that had been used and cleared out several times, and had formed a hardened, fired clay bottom. It may also resemble Early Archaic "cooking hearths" at the Sleeper site (Johnson 1991:47-53). These small, circular, features are typical of many Early Archaic terrace sites (e.g., Sorrow et al. 1967). Although numerous Early Archaic features have been excavated by Texas archeologists, too few have been analyzed, and too few broad Early Archaic strata have been exposed, to generalize about how, when, how often, or why exactly these rock features were used. Although we know these small features are typical for the time period, we do not know if these small features tend to occur in

Figure 12. Feature 4, a circular pit hearth.

clusters representing several fires used by the same band of people, or if they represent cook-fires (or some other fire) made by a solitary individual. In the case of the broad excavations at the Sleeper site, many sandstone grinding-type tools were found near Early Archaic features, apparently indicating that a group camp of some duration (long enough to create and use metates on-site) was represented at that time. In the Early Archaic component at the Smith site, no grinding tools or the raw material for them were found, but quite a few chipped stone tools (impacted points, a Guadalupe tool, bifaces, cores, etc.) were. Perhaps the Sleeper and Smith sites represent different kinds of Early Archaic camps.

### Transitional Early-Middle Archaic Bell/ Andice and Early Triangular Components

Alluvial deposition across the site slows considerably towards the end of the Uvalde/Martindale time period at about 70 cm below surface. The last markers of the Early Archaic components were found here, along with Middle Archaic artifacts and features. Although not clearly separated, many preserved features were found in these levels. Because this compressed, yet not totally disturbed, context occurs so often at terrace sites on the Edwards Plateau margin, distinct isolated components from this time period may best be studied at isolated upland sites, such as the upland midden at the Wounded Eye site (Luke 1980) where a small midden produced 27 Early Triangular points and bison bones, or at the Landslide site (Sorrow et al. 1967), where an anomalous heavy period of alluvial deposition isolated a Bell interval component with bison bones and hearths. Figure 13 illustrates the six Early Triangular points from the Smith site included in the analysis.

The overall impression of the Early-Middle Archaic occupations at the Smith site is that small groups camped there, probably briefly but repeatedly to conduct daily activities. While camped, they took advantage of the fresh water supply and utilized the abundant nearby chert cobbles to manufacture tools. There is evidence, from the broken and use-impacted projectile points and small burned bone fragments, that game was processed and cooked here. Vegetal processing is not evidenced directly, although the single Guadalupe tool recovered from the Early Archaic deposits may have been used for such pursuits. The many distinct features and curated feature matrices, when analyzed in detail, may yield significant information on both vegetal and animal processing.

## MIDDLE ARCHAIC PERIOD

### Site Formation Process and Features

The terminal Early Archaic archeological deposits discussed above formed when alluvial deposition slowed over the surface of the site. At the same time, it is possible, even likely, that erosion, in the form of surface gullies and lateral erosion by

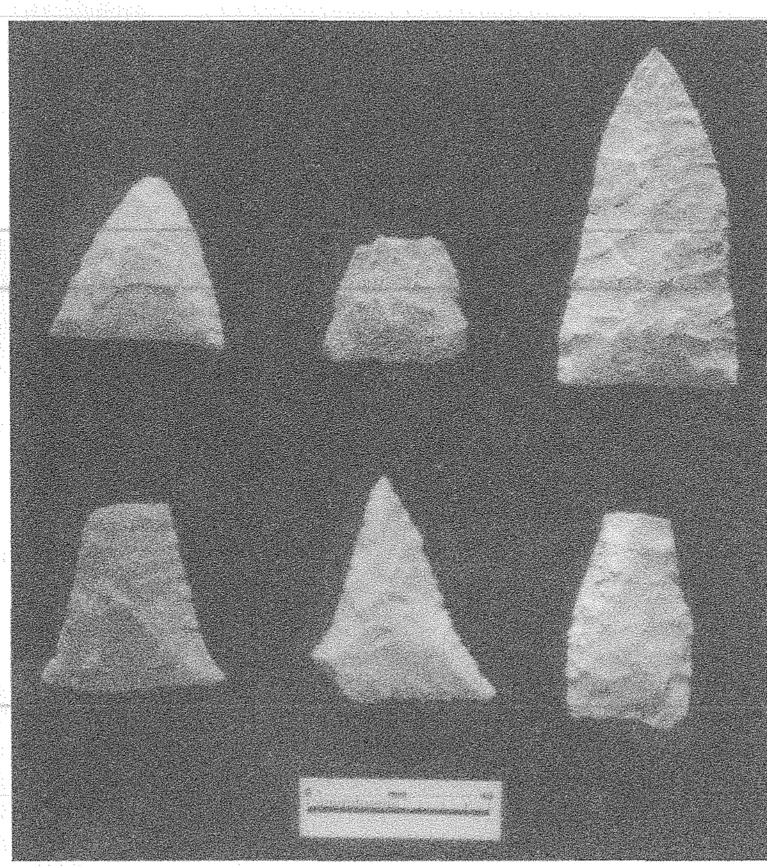


Figure 13. Early Triangular Points.

the Sabinal, became a dominant landscape process. Mear (1990) notes that the Sabinal River, and other rivers, creeks, and gullies draining the Edwards Plateau, incised downward during the Middle Archaic time period at about 5000 B.P. The end of this terrace incision occurred ca. 4500 B.P.

This period of negligible deposition and likely erosion coincides with the Middle Archaic period occupation of the site. The relatively rapid deposition of the "early" Early Archaic deposits came to an end, as did the sealing of isolated components. Up to 10 features possibly dating to the Middle Archaic time period were, however, recorded in this strata. These include Features 14 and 23 (see Table 1). The many undated features found here may also date to earlier or later time periods (see Table 2).

## Nolan/La Jita Components

Nolan and La Jita points (Figure 14) are distributed at and around the base of the BRM. The 10 Nolan points recorded appear a bit deeper, on average (level 7, 60-70 cm below surface) than the 30 La Jita style points (level 6, 50-60 cm below surface), although few attempts have been made to segregate the two temporally due to lack of good contextual data from archeological sites in the Edwards Plateau; Collins' (1995:376) study of archeological style intervals in Central Texas noted as much. In fact, that summary suggests there are no excavated sites with better than moderate integrity between the late Early Archaic and the early part of the Late Archaic, probably due to a regional hiatus in deposition by Edwards Plateau margin streams. Like the latest Early Archaic sites, sites from the Nolan/La Jita interval may present better contextual and analysis opportunities at isolated upland localities such as 41GL160 (Kelly 1987), where colluvial deposition has preserved an apparent Nolan interval occupation with small hearths, flake tools, and primary lithic reduction areas.

Feature 7, a marginal or scattered burned rock feature, was recorded with an associated La Jita point (see Table 2). The scattered rocks appeared to be burned, but no other signs of burning were found in the excavations.

The 30 La Jita points in the site collection represent perhaps the largest curated collection of its type from a single site. While most points appear to be distinctly "La Jita-shaped," on others the rounded thin bases of the La Jita style may grade into the squarer, thicker bases of the Nolan type. Unlike Nolan points, the recorded distribution of La Jita points is limited to southwestern Texas.

Hester (1985:13) reported details of La Jita-dated cooking pits, a burial, and an incipient midden of La Jita age isolated below a larger BRM. Features 19 and 20 at the Smith site were recorded just below the midden (see Table 2) and may represent similar cooking features.

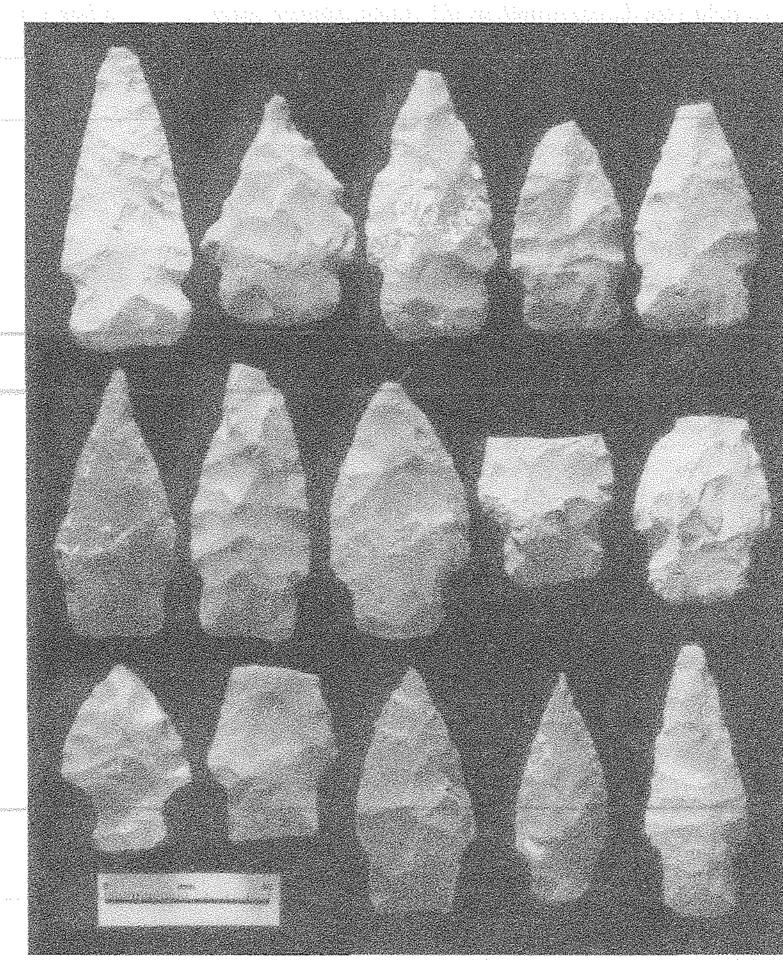


Figure 14. Nolan, bottom row, and La Jita points.

The Nolan and La Jita types have been found at other Central Texas sites both immediately below and within BRM contexts. At the Panther Springs Creek site (Black and McGraw 1985), they appeared to be related to the beginnings of all four BRMs, as well as with a large, rock-free, pit oven immediately underneath one of them. There, that midden was not well dated due to a lack of diagnostic artifacts. Sorrow (1969:45) placed Bulverde and Nolan points from the John Ischy site, in vertical Unit C, in an area of concentrated burned rock below "the major burnt rock concentration." At Jonas Terrace (Johnson 1995:285), the La Jita artifacts were assigned to a pre-midden occupation, associated with "a few small, stone-paved fireplaces."

The evidence from the Smith site and other similarly dated occupations, such as the La Jita site, indicate that many BRMs may have begun forming during this interval, perhaps as a natural extension of the repeated use of small-scale pit features on a newly stabilized landscape. Although midden building behavior is recorded in all times, places, and situations in Central Texas prehistory, the repeated occurrences of large Middle Holocene BRMs on non-aggrading (during the Middle Holocene) surfaces at the southeastern Edwards Plateau margin suggests that geomorphic processes, namely a lack of upland sediment supply, and perhaps changing weather/flood patterns, may have combined with a growing and increasingly important tradition of thermal "pit and stone" cooking to lead into the beginning of an era that has been called "the peak of burned rock midden use on the Edwards Plateau" (Prewitt 1981b:80).

## LATE ARCHAIC

### Site Formation Process and Features

Very little sediment accumulated over the site in the Late Archaic I time period. The BRM grew exponentially. The mechanics of this dual cultural/natural site formation process remains speculative, but it is now well documented that the "big middens on a stable surface" phenomena is expressed repeatedly at terraces of the Edwards Plateau margin. Perhaps the midden represents a central-focused cooking facility or more simply a large stone-lined oven (Black 1997:84-85) used to cook great batches of food. In this case, the primary structural elements should occur only within the central area of the midden. No primary thermal cooking structures were found during the field school excavations but a portion of the midden was not exposed. Likewise, no distinctly structured cooking facilities were found in units and levels surrounding the midden, excepting a few of the relatively near, and presumably later (based on profiles and geomorphology), Late Archaic II Features 6, 9, 10, 16, and 22. These features are all small and disorganized clusters and rings of rocks (see Table 2).

Dr. Gose's paleomagnetic samples of 12 burned rocks from the upper midden indicated that the surface rocks had indeed been moved since cooling (TARL site files). No hearths were located within the midden. The burned rock features possibly related to the Late Archaic I (midden) time period (such as Features 1, 8, 13, 17, and 18) are marginal, indistinct, and scattered. Taking this evidence at face value, it appears that the BRM is the only definitive Late Archaic I cooking/heating feature at the site.

After a thorough review, Black (1997:86) decided that most middens represent cooking facilities, while disposal of waste remained a "very plausible ...major secondary" formation process at some middens (cf. Hester 1971). This is very likely the case at the Smith site as great numbers of burned and/or broken Pedernales points were recovered within and near the midden along with thousands of burned pieces of debitage, indicating the disposal of waste materials. Unlike Pedernales points, which were distributed heavily within the midden and throughout the site, the majority of Late Archaic I Kinney points were found unburned and unbroken within and very near the BRM. This at least leaves open the possibility that they may have been used as tools for food preparation within or near the midden.

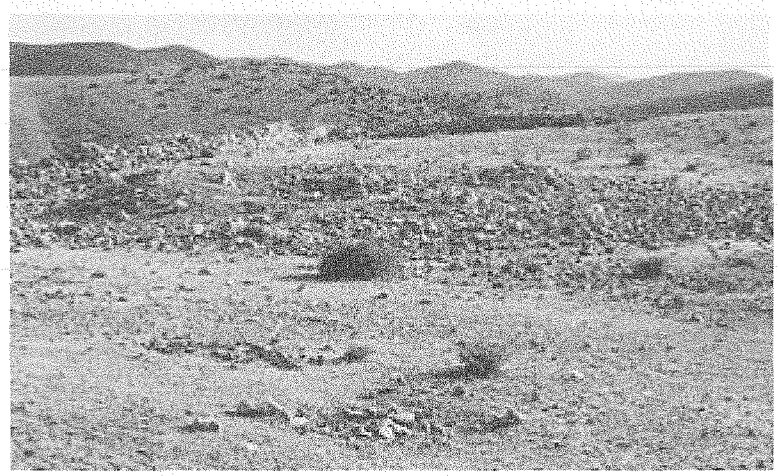
### Pedernales/Kinney Components

Pedernales points were removed from the site in large numbers. The 76 recorded points account for just over 33% of the typed projectile points (see Table 4). Although they were found, in at least limited numbers, in all post-Early Archaic contexts, their highest concentration occurred in the bottom half of the BRM and in slightly higher adjacent areas around the midden. This distribution implies that the BRM was formed in or created a depression. Smaller numbers of the points were also found in the upper half of the midden and throughout the later Archaic deposits. Pedernales-era midden sites within the rockier parts of the Edwards plateau margin, such as the Panther Springs Creek (Black and McGraw 1985), the Landslide site (Sorrow et al. 1967), the John Ischy site (Sorrow 1969), the Jonas Terrace site (Johnson 1995), the La Jita site just downstream (Hester 1971), and now the Smith site, are all free of definitive Pedernales-era hearth features within the surrounding deposits. If the midden was a centrally-focused cooking area (Figure 15a-b), the absence of nearby hearths dating to this time period may then be understandable. Conversely, if the midden was not a primary cooking facility, perhaps there should have been, although there do not appear to be, some appropriate number of contemporary hearths recorded nearby. Caution should be exercised, however, because mostly un-sampled, undated, and apparently burned, rock clusters (Features 1, 8, 13, 17, and 18) were recorded around the midden and may date to the Late Archaic I or II time frame (or conceivably even the Middle Archaic).

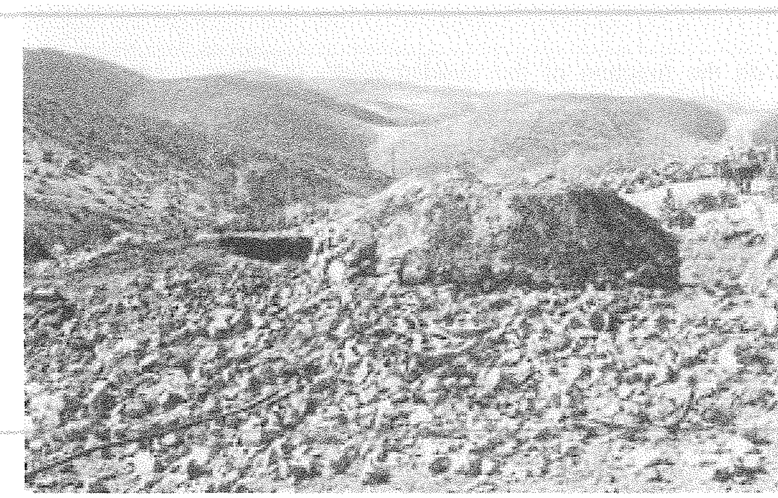
To explore this apparent abundance of projectile points and preferential use of BRM technology during the Pedernales interval, one may look away from the rock-laden Edwards Plateau margin and instead turn towards prairies to the east. At Loeve-Fox (Prewitt 1981a) and the Bull Pen site (Ensor and Mueller-White 1988), Pedernales points have been found in association with small slab-lined cooking features, indicating, perhaps, that the use of BRM technology was limited to areas with geophytes to process, even if significant amounts of limestone were on hand. At these non-midden sites, Pedernales points still formed the dominant point style.

The multiple forms of Pedernales points recovered at the Smith site are consistent with those previously reported from the Central Texas region (see Goode 2002; Suhm and Jelks 1962; Suhm et al. 1954; Turner and Hester 1993). The bases are shouldered to weakly barbed to deeply barbed. The medial and distal portions of the points vary from thin and broad to thick and long. Very few could be considered whole and 18% are burned (see Table 4). A majority of the points may well be considered refuse that was thrown into the midden. Most are snapped medially, a common manufacturing failure.

Only three of the 20 Kinney points or tools recovered from the Smith site appear over 1 m from the midden; 11 were in it, and six were found within 1 m of the BRM. The Kinney points/tools, which were (in percentages) by far the least-broken artifacts recovered at the site, may be related directly



a



b

Figure 15. The use of a rock midden: a, a "centrally-focused cooking facility" for agave; b, the aftermath of this use. Photos courtesy of Richard Stark.

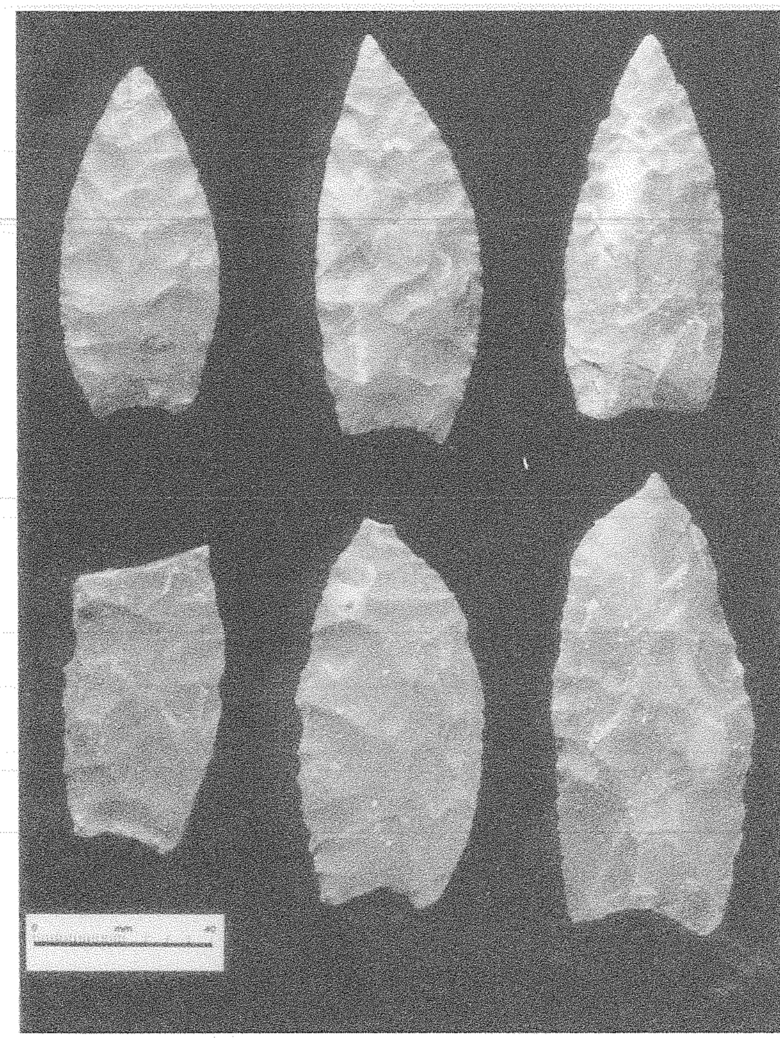


Figure 16. Large Kinney points.

but can be finely serrated along one or both lateral edges.

At the Smith site, the larger forms are all obviously bilaterally asymmetrical, and most appear to have use retouch and/or edge rejuvenating flakes removed from the convex edges (Figure 16). Many of the remnant flake scars along the convex lateral edges of the large Kinney tools appear to be dulled and somewhat buffed, perhaps indicative of use with a sawing or cleaving motion along the lateral edge. The smaller forms of the Kinney tools are much more symmetrical laterally, although a few also exhibit lateral convexity/concavity (Figure 17).

None of the Kinney artifacts, large or small, have definitive impact fractures. With some of the larger points, intentional bifacial thinning extends around the ventral (point) tip of the artifact and continues slightly along the concave lateral edge of the tool before terminating in a dull, unfinished, and perhaps unused lateral edge. In another case, an evidently complete large Kinney tool point has cortex left on its unsharpened tip, while the lateral edges exhibit dulled retouch scars from apparent use. One other large specimen appears to have been made on a flake, and is retouched bifacially only along its convex edge. The less convex edge of the flake has been left unworked. In all these larger Kinky tools it appears that only the convex lateral edge had been used.

with the function of the midden itself. In other words, most of the artifacts at the site seem to have been broken, usually during manufacture, with the Kinney tools as an exception. Their recovery from the midden is indicative of the context of their use and eventual discard.

Reports of Kinney points have often divided the type into larger and smaller forms (Shafer 1963:73; Suhm and Jelks 1962:201). Other authors, such as Weir and Doran (1980), Black and McGraw (1985), Johnson (1991) and Goode (2002), have suggested that Kinney points were used as knives, but the hypothesis remains untested and unproven. Weir and Doran (1980) proposed the Anthon type name for such specimens, particularly the larger Kinney forms, but the nomenclature never came into general use. The larger forms often occur with large billet scars,

## LATE ARCHAIC II

### Lange, Marshall, Williams, Marshall, Marcos, Castroville, Frio, and Ensor Components

During the latter half of the Late Archaic time period (that is, the Late Archaic II interval) natural deposition appears to have been renewed at the site,

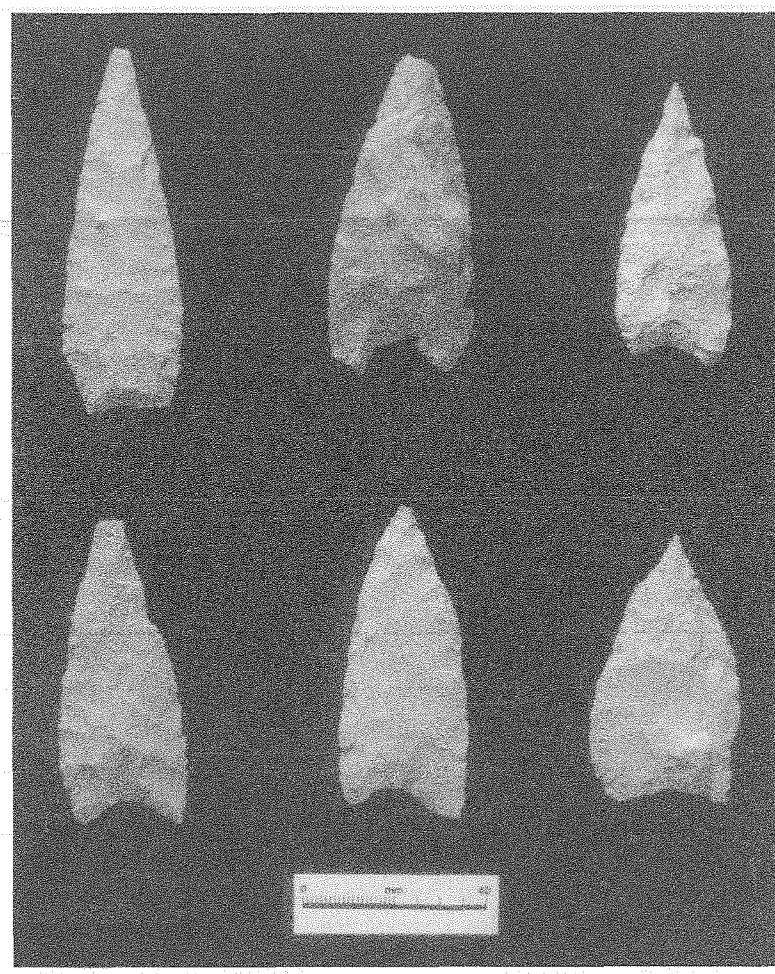


Figure 17. Small Kinney points.

served repeatedly within the Late Archaic time frame at buried Central Texas sites. The combination of slow and shallow sediment deposition, frequent disturbance by modern agriculture, and the tendency of such sites to contain multiple mixed Middle to Late Archaic components, has meant that relatively little integrity remains in sites occupied during this time period. Also, small, and shallow vertical excavations of these sorts of sites may be limiting the recognition of broader horizontal patterns that could offer more insight into the character of small burned features that appear to otherwise be disturbed.

Given these inherent limitations, it could be argued that at sites with multiple and repeated Late Archaic components and occupations in shallowly buried contexts, the specific history of occupations at such sites may be difficult, if not impossible, to reliably sort out and interpret, even if individual features can be accurately recorded. Such seems to be the case with the multiple expressions of Late Archaic II occupations at the Smith site.

After this time period, prehistoric occupation of the site seems to have ceased, save for a sole Edwards arrow point. Why this particular space was abandoned during the Late Prehistoric, after 6000-7000 years of use, remains unknown. Nearby, at the La Jita site, the transition from Archaic occupations to the Late Prehistoric is well represented (see Table 4).

## A SUMMARY AND SABINAL VALLEY RESEARCH IN RETROSPECT

Perhaps the most noteworthy aspect of the 1989 and 1990 excavations at the Smith site was the recording and sampling of up to six distinct Early Archaic features. Some of the Early Archaic burned rock features were shallow slab-lined hearths, 1-2 m in diameter. Two smaller charcoal-flecked rock-lined or enclosed pits were also found, along with two amorphous burned rock clusters. Although site "architecture" has been reported from the study of an array of well-preserved Early Archaic components (Johnson 1991; Lintz et al. 1995), no intra-site structural or feature patterning was noted here.

The Early Archaic tools from the Smith site will also have a place in future studies. Recent work (Dial et al. 1998) has shown that Early Archaic stone tools of the region, dating to roughly 8000-6000 B.P., represent a very long-lived stone tool making tradition, even by the standards of the culturally conservative Central Texas Archaic. In many excavated sites of the local region, the count of Early Archaic points outweighs those of later time periods, indicating that a successful and long-lived adaptive pattern had been adopted by this date that was designed to exploit the essentially modern local and regional environment. Extremely densely populated camps are apparently absent at this time, but small, perhaps repeatedly used, short term camps of a family unit, or perhaps groups of families, seem to be indicated from the Early Archaic features excavated in the Sabinal River area to date.

The Smith site also appears to be the third excavated site in the Sabinal River Valley reported to contain significant deposits containing both Nolan and La Jita points (Hester 1971; Mueggenborg 1994). The two types date from the same interval, or just as likely, are compressed upon the same ancient living surfaces. Their typological attributes are similar, with a broad blade and barb-less bases. One of these types, La Jita, may represent a more localized variation of the more widespread Nolan type. There are significant differences in the two types as well, as finished La Jita points have a well-thinned, bifacially-trimmed base, and rounded stems with very little similarity to the prototypical squared and beveled, thick, Nolan point stem. The temporal and typological questions related to the two types bear more examination than can be given here. The La Jita point, in particular, represents a point used over a relatively short-time span, with limited geographical distribution, and any isolated components representing this interval should be pursued in detail in future archeological research efforts on the Early Archaic in Central Texas.

Such isolated La Jita-bearing components may be rare on Sabinal Valley terraces, however, due to the lack of sediment deposition at that time. The hallmark of La Jita/Nolan occupations in the Sabinal Valley and elsewhere has been small pits and rock features buried beneath BRMs. The location and study of more isolated components of this time period should clarify the early evolution and use of burned rock midden technology within the valley.

The same could be said for Pedernales interval sites. Even sites lacking the classic stratification of components can yield important archeological data. For example, one outstanding feature of the Smith site midden is the numerous intact Kinney tools recovered from it. Kinney points or tools apparently represent a local material culture adaptation for the southeast Edwards Plateau margin. In contrast to the Pedernales points from the midden, the Kinney points/tools are unburned and unbroken. Although not proven, the Kinney specimens may represent tools (e.g., knives) used for at least one of the various activities carried on at and near the BRM.

The midden was domed in shape, rising 30-40 cm above the local (Late Archaic I) terrain. Later occupants of the site (i.e., post–Pedernales interval) do not appear to have used the midden to any noticeable extent, or at least they did not leave their dart points and other tools within it. The use and abandonment of the BRM, along with the plethora of Pedernales points (33% of all the points, see Table 4), brings forth the question of a Pedernales interval cultural or population "heyday." Looking at the projectile point data from the Sabinal Valley sites, the interval is characterized by a very high point count that cannot be solely attributed to preferential archeological sampling. These high counts may represent more people in the local region, or a different cultural dynamic bringing more people to these large midden sites; both alternatives seem likely given the locally large BRMs indicative of the time period.

It is tempting to say that the massive burned rock features may represent the accumulated debris of a group preparing large amounts of food, perhaps as center-focused cooking features designed to exploit geophytes. However, there were no such ovens delineated at the Smith site.

The evidence from the Sabinal valley burned rock middens continues to defy easy categorization. It has been frequently suggested that large Pedernales interval BRMs in the region may be indicative of a more sedentary, or at least somewhat more communal, lifestyle based on the care and harvest of the abundant geophytes of the region. The supposed warm and dry conditions of the period likely provided suitable conditions for greater geophytes growth, increased use of permanent waterways, and less flooding of adjacent terraces, thereby also allowing the midden features to accumulate as more or less permanently available appliances near sources of permanent water.

At the Smith site, Late Archaic II dart points were found scattered in the fairly thin and substantially disturbed sediments that subsequently built up, around, and eventually just over the highest part of the midden. Partially disturbed fairly shallow Late Archaic deposits seem to be the rule at Sabinal River terrace sites. The Late Archaic II deposits at the Smith site, in particular, are extremely mixed, and outside of the material culture present, do not appear to be temporally or spatially interpretable. Any well-preserved Late Archaic II sites found in the valley or in undisturbed upland contexts would surely be of great archeological research value.

The Sabinal Valley projectile point data indicates that there are only five or so frequently encountered Archaic artifact types in the valley (see Table 4). For the Archaic, these most heavily represented points are those of the Uvalde/Martindale continuum (cf. Hester 1995), Nolan, La Jita, Pedernales, and Montell types. Of these frequently encountered Archaic points, only the La Jita style seems to represent a regionally specific material culture type that is specific to the southwestern Edwards Plateau. The La Jita period was immediately followed by the formation of BRMs at several Sabinal River valley sites.

The major later types found in the Sabinal/Frio valley excavations listed on Table 4 are Frio, Edwards, and Perdiz points. Although the Mingo site has only Edwards points (Houk and Lohse 1993) of the major later projectile point types, the Rainey site has a great number of both Edwards and Perdiz specimens (Henderson 2001), and still other sites, like Blue Hole (Mueggenborg 1994) and La Jita, have not only Frio, Edwards, and Perdiz points, but also an entire array of earlier Archaic points. The data seems to indicate that single component Archaic and Late Prehistoric sites as well as multicomponent Archaic-to-Late-Prehistoric sites are all present in the general regional vicinity.

In some cases, there may well have been a reason to favor different locations at different times in prehistory, particularly at the Archaic/Late Prehistoric juncture. Of course, the best camping spots were always occupied, but with the appearance of the bow and arrow, at least some of the old camping site locations were given up, and new ones chosen. The Smith site appears to be one of these, and it would be interesting to know why the site was abandoned, when, for example, the La Jita site, just downstream, shares many of the same characteristics, but was never abandoned by prehistoric peoples. Perhaps a fuller analysis of the Smith site materials curated by the TAS—feature matrices, lithic tools, snails, soils, rocks, and shells—will provide more answers than this all too short summary can provide.

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# Some Notes on Bison, the Texas Post Oak Savanna, and the Late Prehistoric Period of Texas

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## ABSTRACT

The use of bison during the Late Prehistoric period in many regions of North America has often been interpreted as minor compared to deer and other game animals. Reasons for this include a lack of bison remains in the archaeological record, the presence of ecological barriers, and/or a particular region's lack of habitat suitable for the support of bison. Researchers have often neglected to fully understand the relationships of wildlife and their habitats. One such region is the Post Oak Savannah of Texas. This paper combines a study of bison ecology and prehistoric and historic hunting practices, as well as the incorporation of historical documentation and the hunting practices of contemporary groups in similar environmental settings. The conclusions derived from these lines of evidence results in the formulation of a practical model of bison movements and bison utilization by Late Prehistoric peoples within the Texas Post Oak Savannah region.


## INTRODUCTION

It is well known that bison were an important resource for a large number of prehistoric and historic Indian cultures. Bison were used as a food source, in the manufacture of tools and weapons, clothing and shelter, and their hides were an important trade item (Creel 1991). The use of bison probably reached its zenith during the Late Prehistoric when it is believed they reached their maximum range (Barsness 1985:21-22; McDonald 1981:105). The very adaptable nature of these animals enabled them to occupy virtually every part of North America except for southern Florida, the extreme Gulf Coast of Mississippi and Alabama, the Pacific Coast, and the Baja Peninsula. However, existing within their range are some regions described as having a more or less intermittent presence due to local environmental conditions and human activities (McDonald 1981:105). It is one of these regions that this paper will investigate.

Recent interest in the Texas Post Oak Savanna region has led some researchers to review bison presence and prehistoric use of bison within this region, especially during the Late Prehistoric period (Ahr 1998b:4). This has led to two assumptions, a presence model and a non-presence model. The non-presence model is based on two factors: (1) the seemingly impenetrable nature of the Post Oak Savanna and (2) the apparent lack of bison remains within Late Prehistoric sites. The acceptance of these ideas has led some to believe that bison in this region during the Late Prehistoric were either non-existent or their presence was too small to have any impact on the local native cultures.

Evidence supporting non-presence originates from an idea that the Post Oak Savanna, or the Post Oak "Belt" as it is often called, was composed of a dense and impenetrable mixture of vegetation that served as an effective barrier and limited movement into the region to only a few open "corridors," or via creek and river valleys (Thoms and Ahr 1995:35-36; Ahr 1998a:30; Ahr 1998b:4). It is also argued that the nature of the region contained an insufficient food supply that would have been rapidly depleted through the grazing of large numbers of bison. Lastly, some feel that intensive human predation concentrated along the edge of the Post Oak Savanna effectively reduced bison populations ultimately preventing any substantial numbers from penetrating into the region.

Keeping these arguments in mind, this paper will examine the biology and nature of bison and the Post Oak Savanna region in an attempt to determine whether or not this region could and/or did support large numbers of bison. Some may think that including a discussion of bison behavior is redundant since bison habits are well known in the literature and, therefore, a discussion of their habits is not necessary. However, before making an argument for regional presence, a basic knowledge of bison habits should be reviewed. For example, some regional researchers rely on the accounts of the 1528-1536 journey of Cabeza de Vaca in making assumptions of bison numbers during that period (Salinas 1990:115; Ricklis 1996:107-108; Ahr 1998b:3; Foster 1998:115). Based on this account, it is often accepted that bison were not in abundance at that time, not only in the Pecos River region of West Texas and New Mexico where Cabeza de Vaca first encountered bison (Barsness 1985:40), but in adjacent regions as well. However, studies of bison show that they are often absent from many parts of their "traditional" range for varying periods of time that often extends over an entire season or longer.

Thus, brief accounts of regional absences like Cabeza de Vaca's may not accurately reflect true regional population numbers at the time they are recorded. Therefore, before such accounts can be accepted or rejected or assumptions made for bison presence in a specific region such as the Post Oak Savanna, one must have some understanding of bison behavior and habits.

In addition, reasons for the lack of bison remains within regional archaeological contexts will also be explored. And lastly, an examination of Late Prehistoric hunting and subsistence practices will be discussed. Wherever possible, ethnohistoric and historic accounts of early Spanish, French, and American explorers and settlers of the region will be provided.

## BISON BIOLOGY

The species *Bison bison* first appeared around 5000 B.P. in the northern and central Great Plains region where it rapidly spread, eventually replacing the earlier form, *Bison antiquus* (McDonald 1981:102). The decline of *B. antiquus* and rise of *B. bison* is felt to be the result of environmental changes that were occurring during the early Holocene period. At that time, the primary vegetation of the Great Plains was changing from glacial forests, woodlands, and savannas to more herbaceous grasslands. This rapid expansion of grasslands was due primarily as a result of changing climatic conditions that occurred about 4000 B.P. These changes were favorable for deciduous woodlands to begin expanding westward onto prairie and prairie-forest ecotones along the edges of the central grasslands from Alberta to Texas. A northeastward expansion of grassland also occurred during this period coinciding with the northward shift of conifer forests into formerly glaciated areas after 12,000 B.P. (McDonald 1981:30).

Human activities may also have played a significant role in the vegetative changes. Prehistoric hunters were known to have employed the use of fire in their hunting practices with the most immediate effect being an increase in the openness of habitat. Periodic burnings could alter the composition and physiognomy of vegetation by eliminating or reducing larger slower-maturing woody plants and favoring the faster maturing herbaceous plants. The result would be the establishment of openings in mesic forests and the expansion of grasslands (DeVivo 1990; McDonald 1981:31).

As the expansion of the grasslands increased, *B. antiquus*, which was primarily adapted to a savanna and wooded steppe type habitat, began to decline and, coupled with the increasing presence of *B. bison*, eventually disappeared by around 5000 to 4000 B.P. *B. bison* populations rapidly expanded, reaching the maximum extent of its primary range by 3000-2000 B.P. (McDonald 1981:250). Improved habitat conditions resulting from sudden climatic changes often resulted in an increase in regional populations. Such an event was the "Little Ice Age" of the sixteenth to nineteenth centuries. This was a period of cooler and wetter conditions that favored vegetative growth, not only in North America but in Europe and other parts of the world as well (Roberts 1991:159-161). Bison reacted to these conditions in North America with a rapid increase in population around A.D. 1500 (McDonald 1981:262).

At present, there are two North American subspecies of bison: *B. bison bison,* or Plains Buffalo, and *B. bison athabascae*, or Wood Buffalo, which is the larger of the two subspecies (Cahalane 1954:81; McDonald 1981:108). Its greater size is attributed to either: (1) a suspended equilibrium in which *B. athabascae* retained large body size as it evolved from *B. antiquus* or (2) is the result of an adaptation from a grassland to a forest/woodland environment. Elements of both could be operating, but the latter is thought to have been the more important factor over time. A mixing of the two subspecies often occurs as movements of *B. b. bison* range into the boreal parklands inhabited by B. b. athabascae (Moodie and Ray 1976:45-52). It has been noted that some individual *B. b. bison* would remain within herds of *B. b. athabascae* (McDonald 1981:260-261), often resulting in a natural gene flow between the two subspecies. If larger body size was a retained characteristic from *B. antiquus*, then a gene flow between the smaller *B. b. bison* with *B. b. athabascae* should have some effect on the body size of *B. b. athabascae*. However, no observable effect on the body size of either *B. b. bison* or *B. b. athabascae* has been determined as a result of these contacts; thus supporting the idea that the larger body size of *B. b. athabascae* was a result of its adaptation to a forest/woodland environment.

*B. athabascae* is found within the boreal forests of northeastern British Columbia; northern Alberta; northwestern Saskatchewan; the southern and western District of Mackenzie, Yukon Territory; and the eastern half of Alaska. Its primary range coincides with relatively extensive parklands adjacent to the primary range of *B. bison* (McDonald 1981:109). The range of *B.bison* includes most of the United States, western Canada, and northern Mexico. Its primary range is within the central North American grasslands that occur in a north-south zone extending from Alberta and Saskatchewan south to Texas and New Mexico (McDonald 1981:102). However, it is their secondary range that is most interesting. They readily dispersed into the humid, forested eastern United States reaching the Atlantic Coast of North Carolina around 2610 B.P., eventually inhabiting regions from Florida to New York (McDonald 1981:263).

European encounters with bison in this region began with the 1539-1543 expedition of Hernando DeSoto. DeSoto first encountered bison shortly after crossing the Mississippi in the White River region of Arkansas and some of these encounters were recorded by Elvas who was one of DeSoto's chroniclers (Belue 1996:27). Their first sighting was that of a half devoured buffalo in the province of the Casqui near the White River. Among the Pacaha Indians, not far from the Casqui, Elvas recorded how these people subsisted mainly by hunting and that they would, in a very little time, pack up their dwellings and possessions and move to another campsite. Their apparent indifference to agriculture was explained due to the fact that "cattle" (i.e., bison) were so common here that no field could be protected from them (Swanton 1985:229). Later, a more extensive sighting was recorded while in southwestern Arkansas in a region inhabited by Tula Indians. Here they saw piles of hides, stores of meat, and rawhide shields (Belue 1996:27; Swanton 1985:230).

Bison populations in the East were often described as being small; however, some early chroniclers recorded seeing large numbers of "buffalo". Large numbers of buffalo were known to inhabit the Ohio region between the Scioto River and the Big Bone Lick, of which thousands were ultimately killed for their meat and hides (Belue 1996:78). Daniel Boone was once caught in the middle of a buffalo herd that took two hours to pass (Belue 1996:103). Meat hunting, hide hunting, and a pure wanton destruction of the Kentucky bison herds began rapidly during the 1770s and finally reached a point that even Daniel Boone had a law passed, specifically highlighting the diminishing numbers of "wild cattle," in an attempt to prevent the "wanton destruction of game" that was occurring (Belue 1996:109).

Populations of bison remained east of the Mississippi until the early nineteenth century. Their numbers were often small and at times considered rare, but they were present in enough numbers in some areas as to create concern when their population began to decline. Georgia even passed a law prohibiting the hunting of buffalo in some areas in 1759. However, this measure was to no avail, as the last buffalo in Georgia was killed in 1773. Those in other areas quickly followed, with the last known buffalo east of the Mississippi River being killed by Sioux Indians around 1832 (Barsness 1985:133).

Primary barriers to dispersal include physical barriers of water, ice, mountains, and biotic barriers such as dense forests, deserts, and true herbaceous tundra. Ice and water were a major influence primarily during the Pleistocene expansion. Mountains, such as the Rockies and Sierra Nevadas, are obvious barriers yet, as mentioned above, they could be and were penetrated or circumvented. Dense forests, such as the eastern deciduous forest and the zonal boreal forest were the primary forests influencing southern bison dispersal and distribution. Although bison were able to penetrate these forests, the forests made a significant impact on the rate and magnitude of dispersal into those regions (McDonald 1981:237).

Bison were obviously able to adapt to most every type of habitat except extreme wetlands and arid regions. Part of this adaptability is the ability of the species to utilize a great variety of vegetation. Bison are primarily grazers adapted best to open grasslands, but they also show extreme willingness to become browsers of woody plant foliage and/or stems when necessary. For example, during severe winters on the Plains bison have been observed eating willows, cottonwood, and branches of other trees as large in diameter as a man's thumb (Frison 1978:11). Thus, in forested regions, they would combine grazing of available grasses with browsing of small trees and shrubs (McDonald 1981:102, 196).

A woodland/forest opening environment contains limited resources and the usage of that environment by large terrestrial herbivores, such as bison, increases competition for sufficient resources. Therefore, an adaptation to a dispersed browsing strategy would permit a more flexible use of enduring woody vegetation that remain available after most of the herbaceous vegetation is eliminated through competitive overgrazing or by the expansion of woody vegetation. Dispersal tendencies also enable the search for new and dispersed sources of food, water, and space to occur when necessary. The social cohesiveness and tolerance present on grassland environments give way in forest habitats containing limited resources, to increased individuality or selfishness which results in a greater individual fitness. Defense from predators would change from one of flight to a factor of size, such as strength, intimidation and counter attacks (McDonald 1981:197). It is believed that these adaptations may have been the primary factors influencing the development of the larger body size of *B. b. athabascae*. Thus, a bison adaptation into a woods/forest environment can be seen not only as a successful one, but beneficial as well.

There are some debates concerning bison movements. The question of whether they migrate or engage in a more sedentary behavior has been highly debated (Epp 1988:310). Migration supporters argue that bison movement patterns are seasonal rotations between geographically different vegetative communities making up summer and winter ranges and that these movements are often in a north-south orientation (Morgan 1980:157).

Bison are constantly on the move for good grazing areas. In areas having good forage they may remain stationary for several days or weeks before suddenly moving five to ten miles in as many hours (Cahalane 1954:77). Frequent and periodic absences, sometimes for entire seasons, from known ranges were also noted (Barsness 1985:20), or they may show up in unfavorable regions in large numbers (Roe 1951:674). Conversely, in some regions such as a wooded environment containing intermittent grasslands, they may remain for extended periods of time. This behavior was observed by early Spanish explorers who noted bison in Central Texas during the summer months (Foster 1995:237), suggesting a more or less year round residence there (Ricklis 1996:20).

Some recent studies of bison on the northern Great Plains have provided some interesting insights into this behavior. These studies found that bison were utilizing both grassland and woodland environments. The findings concluded that those bison employed a dual dispersion practice in which some herds moved between grasslands and woodlands on a seasonal basis and other, smaller herds remained sedentary (Epp 1988:310). Essentially, this strategy allows for a large and numerous bovine species such as bison to exploit a number of diverse ecological opportunities (Epp 1988:310).

Additional studies comparing historic records on bison movements, dispersion, and foraging behavior with recent scientific studies of free ranging and captive herds have found no contradictions. Thus, these northern bison herds both migrated and did not migrate (Epp 1988:314). This behavior is, no doubt, universal within the species and, therefore, a similar behavior could be expected to occur within southern bison populations.

Their ability to penetrate dense vegetation was noted by many early explorers. Bison trails were found everywhere. They were described as having nosed into any place a man might want to go. If he wanted to ride into the dense canebrakes in the bottoms east of the Mississippi he could find a buffalo trail already there. Mountain men such as Zenas Leonard, fighting deep snow found trails broken by buffalo, and traders often followed buffalo trails through deep snow to save their horses strength. Bison trails led to good river crossings and, having gouged or cut the banks in their crossings, allowed easy access by a horse, and they led the way out of bottoms toward good feeding grounds (Barsness 1985:2). The early trails or traces followed by men such as Daniel Boone were actually bison trails (Belue 1996:105-108). In 1756, Mary Ingals' famous escape from the Shawnee Indians encamped at Big Bone Lick, Kentucky while on a salt-boiling expedition, was accomplished by following a buffalo path (Jillson 1998:8). It is obvious from these early accounts that bison were not inhibited from moving into or through difficult terrain.

In sum, this brief examination of the biology and habits of the bison has shown that the nature of the animal is one of adaptation and survival. The fact that they were able to inhabit most of North America and its varied environments is a testament to these qualities.

## THE POST OAK SAVANNA

The Post Oak Savanna is best described as a dense band of oak trees interspersed with patches of tall grasses. This region occurs from the northeast corner of Texas and angles southwest across the state for approximately 300 miles, culminating in Bexar and Gonzales counties with the majority located east of the Trinity River. This area comprises approximately 4,650,000 acres (General Soil Map of Texas 1973) and includes all or portions of 37 counties. Patches of tall grasses are found intermittently and vary considerably in size. The larger patches of grass are often called "prairies," and two of the largest of these are the Fayette Prairie and the San Antonio or String Prairie. The Fayette Prairie is located in a northeast-southwest line in the southern portions of Gonzales, Fayette, and Washington counties; the northern half of DeWitt, Lavaca, Colorado, and Austin counties; and is bordered on the south by a smaller strip of the Post Oak Savanna referred to here as the Southern Post Oak Belt (Figure 1). The Fayette Prairie region is listed as an oak savanna as opposed to a true prairie (Frye et al. 1984; Gould et al. 1960). Both vegetative types are classed as grasslands, but the two differ in that a savanna contains a scattering or clumps of trees while a prairie is treeless (Odum 1959:401). The San Antonio or String Prairie is smaller than the Fayette Prairie, being about five miles wide at its maximum and almost 100 miles long. It lies totally within the larger Northern Post Oak Belt, and also runs in a northeast-southwest direction beginning near Bastrop and ending just east of the

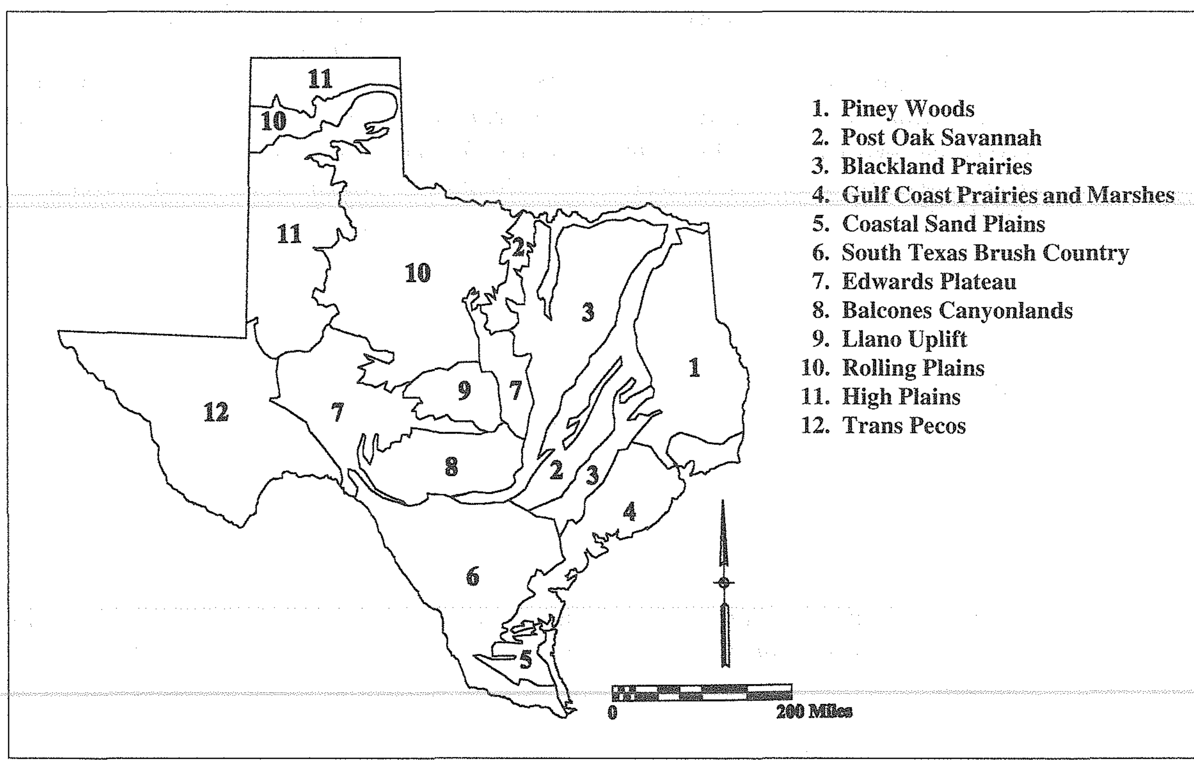


Figure 1. Ecological zones of Texas.

Trinity River (Jordan 1980:19). Like the larger Fayette Prairie, it too is actually a savanna.

Paralleling the southern edge of the Northern Post Oak Belt is a slightly raised strip of land called the Oakville Escarpment. It runs from Live Oak County through Karnes County; along the county line between Gonzales and DeWitt counties and Gonzales and Lavaca counties; and ending at the Brazos River in Washington and Fayette counties (Foster 1998:40). In ecological terms, this slightly raised strip of land is known as an edaphic climax forest. An edaphic climax forest is defined as a vegetative community that has been modified by local conditions of the substrate (Odum 1959:266-270) which, in this case, is the raised landform. Technically part of the Post Oak Savanna, the variance in the soil caused by the raised condition was not conducive to the growth of some brushy type vegetation resulting, therefore, in a more open region.

The Vegetative Map of Texas (McMahan et. al. 1984) defines the region as being a mosaic of post oak woods/forest/grasslands and post oak woods/forest. However, non-presence supporters describe the region as being composed of a dense belt of oak trees and brush with limited access except via "open corridors" (Ahr 1998a:30, 1998b:3-4; Thoms and Ahr 1995:35-36). They argue further that the open prairie/savanna portions contained only a limited amount of forage and that this low availability of forage would not be sufficient enough to support bison and. coupled with the impenetrable nature of the vegetation, the region would be an effective barrier to large scale penetration or habitation (Ahr 1998a:30, 60).

However, a more thorough examination of the Post Oak Savanna region reveals that it actually contains a rather diverse environment made up of a number of distinct vegetative zones. Two of these vegetative zones include both a woods and forest in their classifications. These are closely related vegetative zones with the primary difference being the presence of a midstory in a forest classification and no midstory in a woods classification (McMahan et al. 1984). One of these zones is classed as a post oak woods/forest/grassland mosaic. It consists of a variety of vegetative communities ranging from dense patches of woods to less dense forests to open areas of grassland.

In addition to the post oak woods/forest/grassland zone is another vegetative zone described as a post oak woods/forest. This region has a greater woodland density than the previous one due to the lack of grasslands. A characteristic of this zone is that the oaks, in conjunction of other woody species, often develop into a "thicketized" condition (General Soil Map of Texas 1973). These dense thickets vary in length and intensity and, as a result of local geographic conditions, often form finger-like projections that jut outward into the post oak woods/forest/ grassland zone. This description of the post oak woods/forest zone is probably what the non-presence supporters accepted as being representative of the region as a whole rather than only some portions.

Three major rivers, the Colorado, Brazos, and Trinity and an innumerable number of small streams cross this region. The areas paralleling these streams and rivers contain a bottomland hardwood habitat that form a mesic forest made up of oaks, hackberries, pecans, and other trees (Blair 1950:101).

The primary tree species within this region are Post Oak (*Quercus stellata*), Sandjack Oak (*Quercus stellata var. margaretta*), and Blackjack Oak (*Quercus marilandica*). Other species include Live Oak (*Quercus virginiana*), Mockernut Hickory (*Carya tomentosa*), Pecan (*Carya illinoensis*), Eastern red cedar (*Juniperus virginiana*), Hackberry (*Celtis occidentalis*), Cedar Elm (*Ulmus crassifolia*), Mesquite (*Prosopis sp.*), and Hawthorn (*Crataegus sp.*) (Harlow and Harrar 1958; McMahan et. al. 1984). Some of the primary shrubs include Yaupon (*Ilex vomitoria*), Poison Oak (*Toxicodendron quercifolia*), and Dewberry (*Rubus sp.*).

The grasses present in the patchy savanna or "prairies" were originally tall bunchgrasses such as Western Wheatgrass (*Agropyron smithii*), Silver Bluestem (*Bothriochloa saccaroides*), Little Bluestem (*Schizachyrium scoparium*), Texas Wintergrass or Needlegrass (*Stipa leucotricha*), and Hairy Triden (*Erioneuron pilosa*) (Porter 1967; Reeves and Bain 1947; Gould 1978), but these have largely been replaced by herbaceous and woody, weedy plants (Blair 1950:100; Capps 1966:5). The roots of all these species penetrate deeply (up to 6 feet) and will weigh several times more than the tops. These are slow growing grasses that often take several years to mature. Little bluestem, for example, takes three years to mature (Weaver and Zink 1946 as cited in Odum 1959:397). Some of the grasses, such as big bluestem and buffalo grass, have underground rhizomes or underground stems that grow horizontally (Porter 1967:454), while others, such as little bluestem and needlegrass, are bunchgrasses and grow in clumps. The warm season species, such as *Andropogon* (Bluestem) and *Bouteloua* (Grama grasses), begin growth in late spring and grow continuously during summer, maturing in late summer or early autumn. This slow growth, even when moisture and other conditions favor rapid growth, is an excellent adaptation for survival against heavy or intense grazing pressures by large herbivores (Odum 1959:397-400).

The soils are within the claypan area and are described as sandy, undulating, light-colored, and medium to slightly acidic. The mineralogical and chemical properties are described as being montmorillonite or mixed (Muskogee), acidic in the upper levels and alkaline to acidic in the lower portions (General Soil Map of Texas 1973).

Thus, one can derive from this discussion that the Post Oak Savanna region is a mixed and diverse biotic zone. It consists of a varied habitat that includes some dense "thicketized" areas with abundant open areas of varying sizes throughout. An unknown emigrant writing of the region in 1840 provides an interesting description of the post oaks shortly before intensive farming commenced. He writes: "Among the uplands, in addition to the prairies, there are many considerably extensive tracts of comparatively open timbered land, technically called post oak lands. These are seldom dense forests, but rather resemble thickly set orchards" (Billington 1973:107). Therefore, it appears that the region was not a totally impenetrable zone but one that contains innumerable openings that would allow for an easy access of large animals. The more extreme "thicketized" areas would simply be circumvented when encountered. In addition, the vegetation present in the grasslands combined with bottomland habitats would easily support large herbivores, such as bison, for extended periods of time.

## BISON AND THE POST OAK

It is not known at what time bison first entered the Post Oak Savanna region. The presence of bison on archaeological sites over the last 10,000 years has often been described as being intermittent (Dibble 1968; Collins 1972). A study conducted by Dillehay (1974) on bison presence and absences for the Southern Plains found two absence periods (6000-5000 to 2500 B.C and between A.D. 500 to A.D. 1200-1300) and three presence periods, the last beginning around A.D. 1200-1300 to A.D. 1550. Since Bison remains have been found on the Texas coast during the Rockport phase of the Late Prehistoric (ca. A.D. 1250-1300) (Ricklis 1996:19-21, 35) and along the edge of the Post Oak Savanna (Dillehay 1974; Moore and Bradle 1997), it can be assumed that they would have entered or were present in the Post Oak Savanna at about the same time as they reached the Gulf Coast of Texas. Population numbers were probably small until the onset of the "Little Ice Age" at the end of the Late Prehistoric when conditions were more favorable for population growth and expansion.

The presence of bison within the Post Oak Savanna region is well represented during the Pleistocene and early Holocene periods. Local fossil collectors commonly encounter remains of *Bison latifrons*, *Bison antiquus*, as well as *Bison bison* in the Brazos and Colorado River gravel deposits. The Brazos Valley Museum in Bryan/College Station contains a number of locally obtained specimens of all these species in their collection. These too, were primarily found in river deposits.

Texas A&M has been investigating a site on the banks of the Brazos in Burleson County, dubbed the Sasson site, for its discoverer. This site has produced bison bones from a deeply buried alluvial deposit that have been dated to the Pleistocene (Mike Waters 1999, personal communication).

On the other hand, Late Prehistoric sites containing bison bones have been few, but there are several located in Burleson County. Just downstream from the Sasson site, is the Buffalo Ranch site, in which bison and bear remains were found in the alluvial deposit of a buried Asa paleosol. These soils were dated around 1300 to 500 B.P., placing them within the Late Prehistoric period (Waters and Nordt 1995:314-315).

Another site containing bison bones from the Late Prehistoric is the Highway 21 site (41BU16) in Burleson County. This site is also found on an alluvial terrace of the Brazos River. The condition of most of the faunal bones was poor, and some of the larger specimens were identified only as being from a large vertebrate. Those identified as bison were assigned to both the prehistoric and Late Prehistoric/Historic periods (Roemer and Carlson 1987:109, 215, 254-258).

A single bison bone was recovered from Winnie's Mound (41BU17) in a level at or near the

Transitional Archaic-Late Prehistoric interface. It was also in very poor condition, and its assignment to bison was based on its size (Bowman 1985:39-74; personal communication, 1999). Additional archeological evidence for Late Prehistoric bison use lies in the presence of some specific artifact types. Tool assemblages often related to Late Prehistoric bison exploitation include *Perdiz* arrow points, bone-tempered and poor sand-tempered pottery, beveled knives, and small end scrapers (Creel 1991:42-45; Prewitt 1981:83-84; Turner and Hester 1993:274-276; Johnson 1994). If we are to use the argument that these artifact types are cultural indicators of a dependence upon bison, then their presence should indicate the presence of bison. As has been discussed previously, there have been few controlled archaeological sites conducted within the region that were found to contain bison bone. However, one such site, mentioned above, was the Highway 21 site (41BU16). Reviewing the artifact assemblage recovered, there were a number of *Perdiz* arrow points as well as some bone-tempered and sand-tempered pottery present (Roemer and Carlson 1987:80-93). In addition, a beveled knife was found previous to the excavation by a local amateur archaeologist (Roemer and Carlson 1987:121).

Like most regions of the country, local collectors have put a lot of pressure on the region's sites. Within the Brazos Valley alone, untold thousands of "arrowheads" have been collected over the years from plowed cotton, corn, and bean fields. However, in some cases their finds can help add a little to the known archeology of the region. One such collection has been donated to the Brazos Valley Museum in College Station which offers some good information relevant to understanding the region's lithic assemblages. It is an extensive collection that was surface collected primarily from Grimes, Brazos, Burleson, and Milam counties between the late 1890s and early 1950s. Present within this collection are many hundreds of *Perdiz* arrow points, some pottery, and a large number of two-beveled and four-beveled knives (Figures 2 and 3). End scrapers, both large and small, are also commonly found in regional collections.

The problem is that these collections of artifacts can only be identified as "local" finds, but their presence does support a regional use. Therefore, we feel the presence of some bison bone, bone-tempered and sand-tempered pottery, *Perdiz* arrow points, small and large end scrapers, and beveled knives definitely establishes that bison were present within the Late Prehistoric Post Oak Savanna.

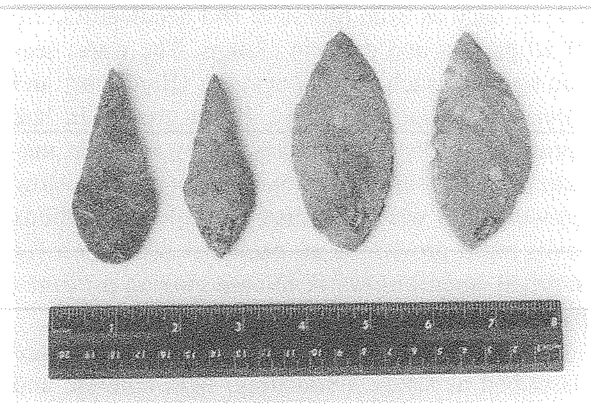

Figure 2. Beveled knife forms from Brazos County and vicinity in the Brazos Valley Museum collection (courtesy of the Brazos Valley Museum of Natural History).

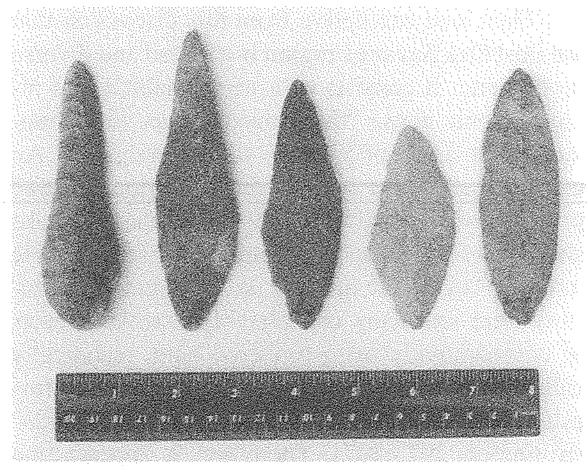

Figure 3. Various beveled knife forms from Brazos and Burleson Counties. The specimen at the far left is from 41BU16, all others courtesy of the Brazos Valley Museum of Natural History.

While the archaeological record is poor, historic accounts of bison in the Post Oak are more abundant. Early Spanish explorers often recorded encountering bison within the "Monte Grande," their name for the Post Oak Savanna region. Governor Alonso de Léon reported encountering Tejas Indians hunting bison near La Grange in May 1690. At that same time, de Léon gave a horse to a Tejas Indian messenger, intending for him to ride it. Instead, he loaded it with bison meat he had taken in hunts between the Colorado and Brazos rivers (Foster 1995:39-40). Fray Espinosa recorded seeing bison east of the Brazos (near the present day Burleson-Robertson county line) during Don Domingo Ramón's 1716 expedition (Foster 1995:119). Ramón also reported capturing two buffalo calves near the Brazos River in Burleson County and using them in a mock bullfight (Foster 1995:119,237). In June 1721, Padre Juan Antonio de la Peña reported seeing bison as far north as Waco, and in August 1768, Fray Solis reported bison in eastern Fayette County and near the Navasota River (Foster 1995:237).

Perhaps the most revealing accounts of bison in the Post Oaks are provided in the recent translation of Henri Joutel's journal of René-Robert Cavelier, Sieur de LaSalle's 1684-1687 expedition to Texas (Foster 1998). Joutel describes numerous large herds of bison and how the French, and local Indians depended on the bison as well as recounting a number of hunting adventures beginning from his stay at Fort Saint Louis until after crossing the Navasota River.

Their first encounter with the Post Oaks was in January 1685 in present day Lavaca County. Joutel describes it ". . . as thick as the densest brushwood in France and found travel within it very difficult. We would have had even more difficulty going through if we had not found some bison trails to follow in one direction or another" (Foster 1998:160-161). In describing these trails Joutel writes "When one walks in the woods, one should follow bison trails to avoid obstacles which these animals have an instinct for bypassing" and "The bison have, in spite of the density of the brush, found a means to make a passage through it by force or between two trees" (Foster 1998:161).

Even though these trails partially were an aid to travelers, Joutel complained that the trails often went between two trees that were too narrow to allow a pack horse to go between, thereby forcing them to widen up the trail, which kept their progress slow (Foster 1998:161). Near LaGrange, they killed several bison and made some "canoes" of their hides (Foster 1998:170-173).

After crossing the Colorado, LaSalle followed the "Oakville Escarpment" and on February 10 camped in an area that contained a lot of bison which Joutel noted as being unusual as they were living in the close proximity to several bands of Indians. In addition, the open areas in the vicinity had recently been burned by the Indians (who used this technique in hunting), and Joutel described watching bison feeding on newly sprouting grass in these burned over areas (Foster 1998:174-176).

Joutel continued to mention bison throughout the journey until they crossed the Brazos River near Navasota. At this point hunting began falling off due to the presence of a heavily traveled Indian trail and several Indian camps. However, they did manage to kill two bison east of the Canoe (Brazos) River on March 16 (Foster 1998:192-193) but saw no more after leaving that camp (Foster 1998:203).

LaSalle's expedition, as recorded by Joutel, only briefly encountered dense post oaks, and these were primarily the South Post Oak Belt in northern Lavaca County. After leaving these oaks they paralleled the Northern Post Oak Belt by following the Oakville Escarpment and only occasionally entered the denser oak forest. These dense post oaks along this Oakville Escarpment would often open up into small prairies or savannas. Joutel commonly refers to Indians burning these areas as part of their buffalo hunting strategy.

Joutel's account readily establishes the fact that bison were observed in virtually every open area they encountered as well as containing a great diversity of bison trails through the densest vegetation regions. The Spanish chroniclers encountering the post oaks often recorded the difficult nature of the region yet, like LaSalle, they also encountered large numbers of bison. These accounts testify to the presence of bison in the Post Oak Savanna region during the seventeenth and eighteenth centuries. More recent nineteenth century accounts show that they remained abundant until at least 1850. Accounts by early settlers mention groups of Caddo Indians from East Texas roaming westward through Burleson County to the Colorado River hunting buffalo (Burleson County Historical Society 1980). In addition, Tonkawa Indians, a nomadic people well known as buffalo hunters, were often seen camping along streams in Central Texas, including Burleson County (Texas State Historical Association 1996:841).

A letter written by an early settler gives an interesting testament to the presence and overall abundance of bison between the mouth of the Little Brazos and Little rivers in Brazos and Milam counties. The letter was written by William DeWees on July 16, 1822 after he and several other families settled on the Brazos River at a point several miles north of the mouth of the Little Brazos River.

> We have no reason to fear suffering for food as the country is literally alive with

> all kinds of game. We have only to go out for a few miles into the swamp between the Big and Little Brazos, to find as many wild cattle as one could wish. If we desire buffalo meat, we are able to go out, load our horses, and return the same day. . . . When we get tired of lying around camp, we mend our moccasins, and start up the Brazos hunting buffalo, more for pastime than anything else. We frequently are gone out two or three weeks; we generally go up as high as we dare go, on account of the Whaco Indians. You would scarcely believe me, were I to tell you of the vast herds of buffalo which abound here; I have frequently seen a thousand in a day between this place, and the mouth of the Little River. (DeWees 1968:23-28).

In the following passage DeWees describes a buffalo hunt:

> In May, some six or seven of us took a trip as high as up Little River by water. . . . On our way, we would amuse ourselves by going out and shooting wild cattle, which are in great abundance here. It was dangerous for us to encamp at night, on the east side of the river, on account of the cattle coming in for water, the night being the only time they go to water. We made our station camp at the mouth of Little River on the beach! There we stayed two weeks, killing and drying buffalo meat. We went out every day, killed a buffalo or two apiece, and brought the choice pieces, particularly the tongues, into camp. . . . When one kills a buffalo, he generally lays claim to the tongue, as private property, it being a very choice piece; the other portions are shared equally (DeWees 1968:23-28).

Another traveler through the region was Ferdinand Roemer. He was German geologist who traveled around Texas between 1845 and 1847 collecting fossils and recording in a journal the types of plants, animals, geologic features, and habits of the native Indians he encountered as he traveled. One of his trips took him through Caldwell to Booneville, Franklin, and a trading post on the Brazos River. He continued up the Brazos to visit some Caddo Indians north of present day Waco before retracing his steps back to the trading post and then heading west to Austin and New Braunfels. On this trip he saw buffalo hides at a trading post called Bucksnort, located about two miles from the Brazos River at the Falls of the Brazos, which was about 40 miles (northwest) of Wheelock's Settlement (10 miles from Franklin). Here, Roemer saw Buffalo "skins" that had been brought in by Indians. These hides were brought in raw, tanned, and even painted on one side. He described their value as being determined by their size, which averaged three dollars in Houston for the plain ones and eight to ten dollars for the fancy ones (Roemer 1983:192).

He saw his first live buffalo just after crossing the Brazos River bottom near the Falls of the Brazos. Roemer wrote in his journal the following description of that encounter:

> After leaving this wooded bottom behind us, we entered a sparse oak forest which led us to an open, undulating prairie extending toward the north and east in an immeasurable distance. Just before entering this prairie, we met a young Indian who had just killed a buffalo cow and who was engaged in loading some of the choicest pieces of meat on his horse. He gladly permitted us to select several choice pieces of meat from his surplus in exchange for a handful of salt. Under the trees nearby we saw a buffalo calf which had lost its mother in the cow just killed by the Indian, running around crying pitifully (Roemer 1983:198).

Roemer continued his travel towards some Caddo Indian villages located on the Brazos River about 60 miles north of the Bucksnort trading post (this area was within the Blackland Prairie). On the way he reported seeing large numbers of buffalo in herds averaging from three to four hundred (Roemer 1983:197-198).

Although most of Roemer's account does not speak directly of definite sightings of buffalo within the Post Oak region proper, it is an important account in that it substantiates that there were still large numbers of buffalo on the edge and in close proximity to the Post Oak region as late as 1846. In addition, he provides an interesting insight into Indian buffalo hunting practices. This and the other historic accounts not only support the presence of bison within the Post oak Savanna region, but also an obvious Indian dependence upon them as well.

## THE POST OAKS AS A BARRIER?

The direction of the article, so far, has been a discussion of the biology, habits, and nature of bison and the Post Oak region. The facts presented were derived from biological and scientific studies combined with historical accounts. The conclusions of this analysis definitely supports the idea that there were bison in the Post Oak Savanna region and that it supported fairly large numbers during the Late Prehistoric and early Historic periods.

Several models describing bison movements into or through this region have been proposed (Figures 4 and 5). Huebner (1991:353) proposed the idea that bison moved through the Post Oaks and onto the Coastal prairies through corridors formed by the Brazos and Colorado rivers (Figure 4). He felt that the southeasterly flow of these rivers would cross-cut the various bands of oak woodlands and savannas providing a path of "least resistance" to the Coastal prairies. Due to the nature of the Post Oak Savanna and its bottomlands, it is doubtful that this would be a path of least resistance, but the idea that bison would have moved along some of the river "corridors" utilizing bottomlands, as well as uplands, is perfectly acceptable.

Ahr (1998a:30, 60), however, disagrees with Huebner on the assumption that bison were solely grazers, as opposed to browsers. He argues that the Post Oak Savanna is a marginal habitat because it contains a low density of grasses and that such areas are unsuitable for large numbers of bison. The adjoining region, the Blackland Prairie, would be more suitable for bison habitation and movements because it contains a higher density of the more important grasses, such as little bluestem, Indian grass, buffalo grass, and switch grass. The result is that the Post Oak Savanna would serve as a moderately effective barrier to bison movements forcing them to migrate along its edge with the Blackland Prairie (Figure 5).

Ahr seems to have failed to consider several important factors. One is that bison easily adapt to a browsing strategy which is supported by northern bison studies that showed how bison readily adapted to forest/woodland habitats as well as adopting a

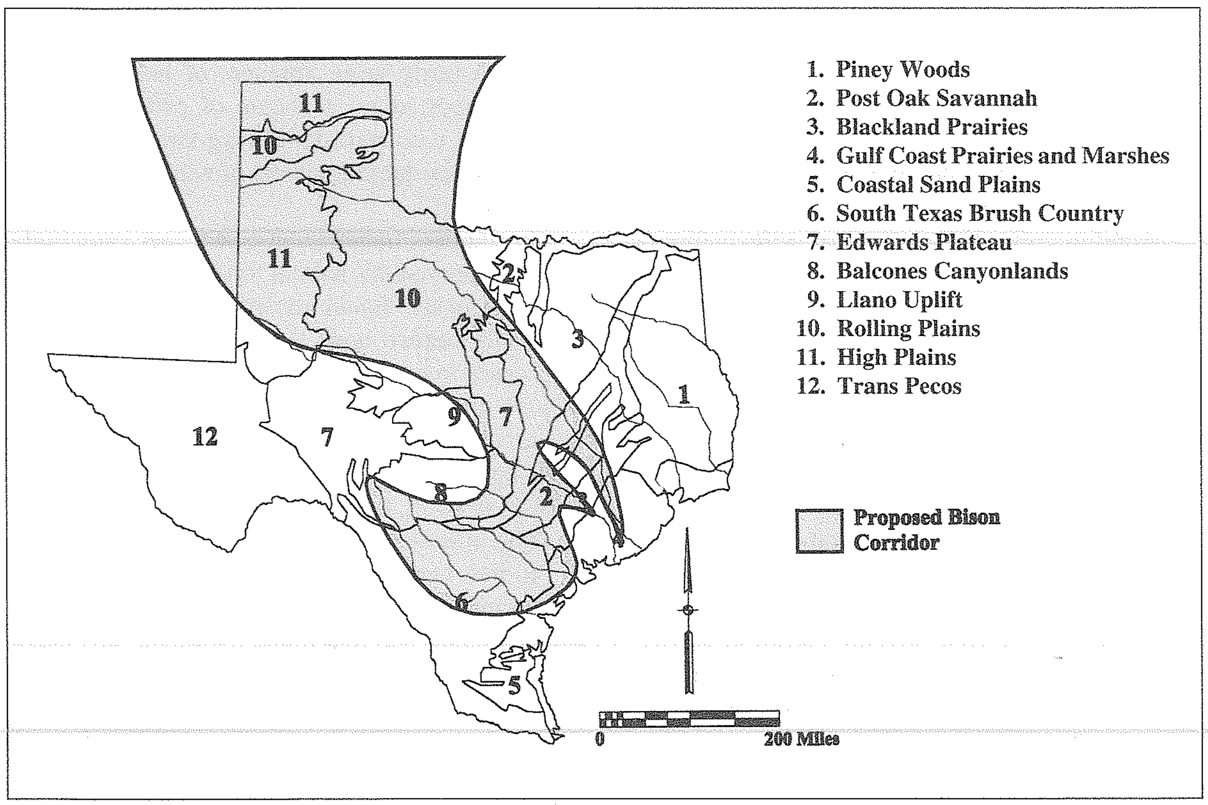


Figure 4. Route of bison movement through Texas argued by Huebner (1994).

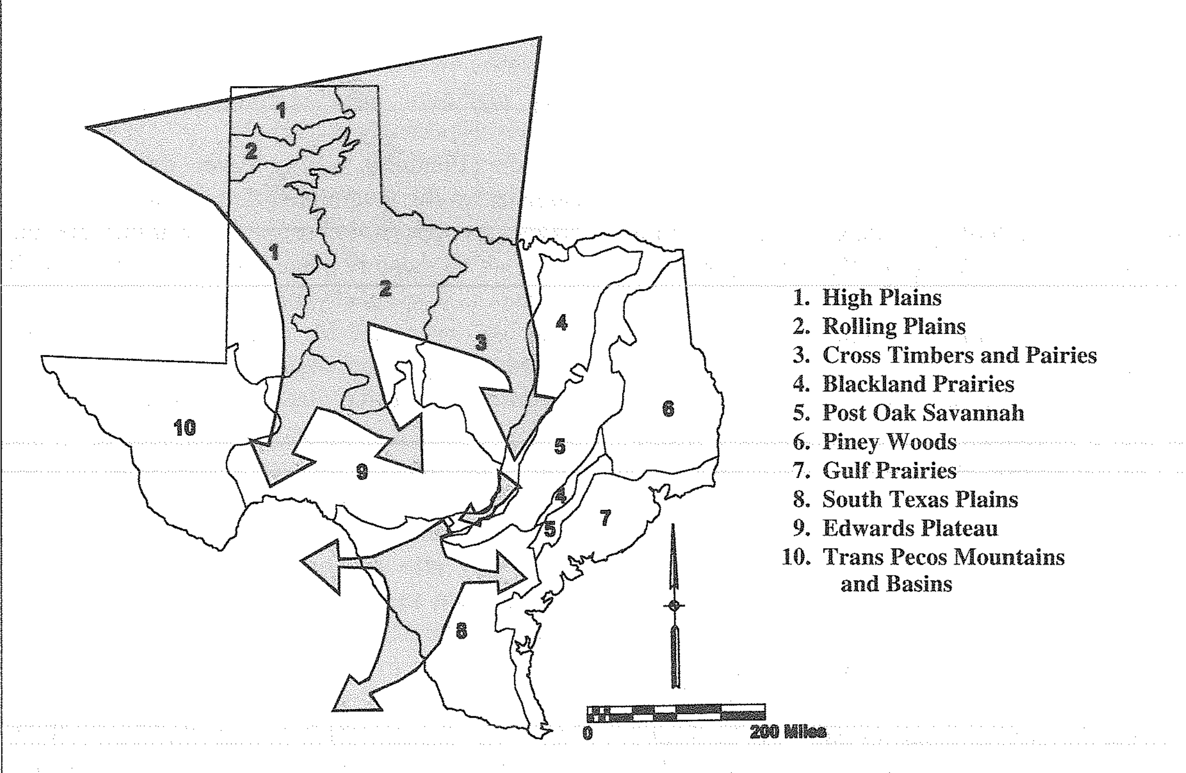


Figure 5. Route of bison movement through Texas as proposed by Ahr (1998).

browsing strategy on the Plains during periods of severe conditions. This ability at adaptation enabled bison to expand their range to the East Coast and it is difficult to believe that they would have done so had they relied solely upon a grazing strategy.

Another point Ahr overlooked is the nature of the Post Oak Savanna. By definition, it is a region made up of a mosaic of oak woods and savannas. These "savannas" varied greatly in size and number, and while most were encompassed within oak woods, some would have opened onto surrounding regions such as the Blackland Prairie. Also, the grasses found on these savannas were the same grass species found on the Blackland Prairie but in less quantity. It is evident that some of these grasses, such as the little bluestem, have adapted to overgrazing conditions by developing a slow, but continual growing season, maturing in late Summer or Fall. This adaptation results in a constant production of new growth throughout spring and summer.

Thus, by combining small woody vegetation from forest margins (and bottomland habitats) with available grasses, the region easily would have supported fairly large numbers of bison. That it did is supported by accounts of early explorers and settlers who recorded seeing thousands of bison, as well as large numbers of wild cattle, within the region.

In addition, Indian hunters, whether knowingly or not, improved this habitat through the burning of these savannas. Joutel recorded that the Indians frequently burned open areas throughout the Post oak region to move bison from one area to another as part of their hunting strategy. This procedure would result in the enlarging and/or keeping the areas open, as well as stimulating new vegetative growth. In short, the Indians were practicing a type of game management.

It has been demonstrated that bison easily moved into the Post Oak Savanna region and often remained there the year round. However, this is not to say they did not also follow the Blackland Prairie south, as Ahr suggests. The surrounding prairies were more suitable for the movements of large herds, and most of these animals probably never entered or came in contact with the Post Oak Savanna, preferring to stay on the more open plains.

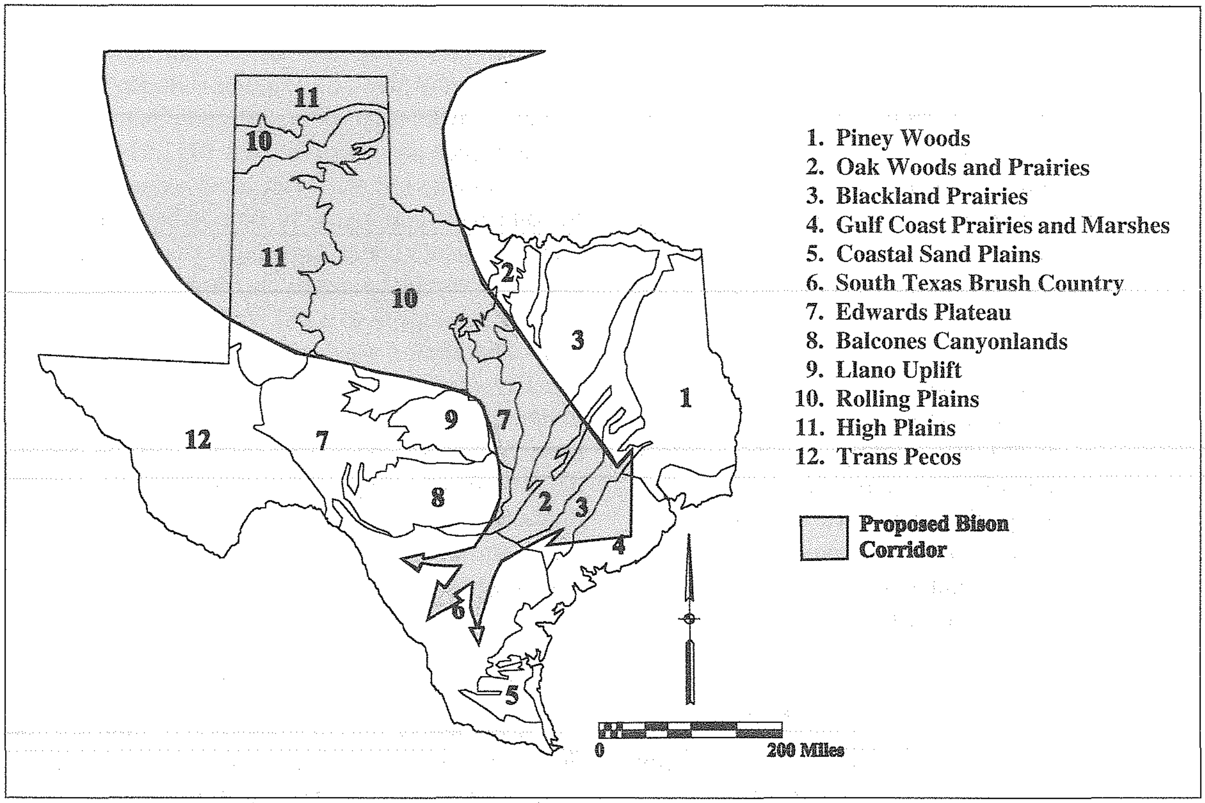


Figure 6. Proposed model of bison movement through Texas and Post Oak Savanna.

Some, though, took advantage of the diverse habitats available, not only within the Post Oak Savanna, but especially the biotic zones along the margins between it, the Blackland Prairie, and/or bottomland habitats. Thus, bison presence along the Post Oak Savanna/Blackland Prairie boundary and within the Post Oaks proper can be seen as more or less a permanent habitat for some, as well as an avenue for north-south movements of others.

The idea that the Post Oak vegetation would inhibit movement due to its density or be restricted to river systems is also rejected by both biological studies and historical accounts. An excellent example was the account provided by Joutel during La Salle's 1684-1687 expedition, in which he described their first meeting with the Post Oaks (the Southern Belt) as being extremely difficult and that the best way to move through those woods was by following bison trails (Foster 1998:161).

In summary, the Post Oak Savanna would not have been a major barrier. Although major movements of bison would have utilized the more open prairies, smaller numbers also moved into and through the Post Oak Savanna (Figure 6). Their numbers would have been dispersed by the nature of the woods/forest environment, but with the diverse habitats afforded them within the region, they would have been able to find good forage for year round habitation. Although the facts and arguments presented thus far have supported the presence of bison in the Post Oak Savanna region, it still does not answer the question of why there are so few bison remains found in the regions Late Prehistoric sites. The next portion of the paper will discuss possible reasons for this.

## PREHISTORIC HUNTING STRATEGIES

In order to make an argument for hunting practices as a causal factor for the lack of bison remains in the Texas Post Oak Savanna, it would be well to briefly examine some examples of large game procurement at other locations in space and time to determine what effect procurement methods might have on faunal assemblages and to relate these methods to those we project for the Post Oaks.

We will begin the discussion in what is considered to be the primary habitat of *B. bison bison,* namely the Great Plains. Bison hunting strategies on the Great Plains are well documented from as far back as Paleoindian times and are generally manifested in the archaeological record as products of communal hunts that involved tens to upward of a hundred animals in a particular kill episode (Bement 1999; Buehler 1997; Frison 1978; Wheat 1972). Generally speaking, jump kill sites were prevalent on the Northern Plains while arroyo trap kill sites predominated in the Southern Plains. This difference is attributed to the nature of the topography of the two regions (Buehler 1997). Campsites were often in close proximity to kill sites in order to quickly and efficiently process this perishable resource. Bison remains in these types of sites are abundant and as such, are readily visible in the archaeological record.

## Post-Archaic Southern Plains

In the periods following the Archaic, it seems that, except for the Garnsey site (Speth and Parry 1980) and a few small kills of one or two animals (Brooks and Flynn 1988), there is a paucity of kill sites in the Southern Plains, although bison remains are present at occupation sites during these times. Buehler (1997:176) posits two reasons for this: (1) the processing of bones for grease and (2) an increase in the use of bison skeletal elements for horticultural tools, both of which he argues would render kill sites less visible and/or recognizable in the archaeological record than kill sites from previous periods. Although Buehler states that the lack of kill sites makes inferences about hunting techniques impossible, we suggest that this change in faunal assemblage patterns reflects a very significant change in hunting technology and practice such as a shift to a dependence on the bow and arrow as the primary hunting weapon.

Killing bison with spear or dart points thrown by hand or with an atlatl would be done with greater certainty of success if the animals were in a compact group at close range with nowhere to run (such as an arroyo trap), than would be the case if the object of the kill was a single bison with plenty of room to run. Kill episodes of the type commonly found in the Southern Plains in Paleoindian and Archaic times presuppose a fair amount of organization. On the other hand, it would be easier to dispatch a single bison if the hunting weapon was a bow and arrow. Although the bow and arrow would not necessarily preclude communal hunts, it would, however, make it possible to accomplish a kill in a single chance encounter (Wheat 1972:91-96).

Unless the kill was made close enough to camp for others to participate in butchering, the movement of meat, bones, and hide from a kill to a campsite would be costly in terms of labor and moving a campsite to a kill would involve costs as well. The choice would largely be determined by the size of the kill and, if a single animal were involved, the cost effective choice may well have been to transport the carcass to the campsite. Selection of only certain parts for transport or changes in methods of transport (such as acquisition of horses) might further prompt a decision to move the carcass to the campsite (Roper 1992).

## Post Oak Savanna Versus Southern Plains

If the above line of reasoning is valid for the Southern Plains, it might also be used to explain the paucity of bison remains in a more peripheral region such as the Post Oak Savanna even though there are differences between the two regions. First of all, the topography of the Post Oak Savanna would have been a deterrent to the taking of bison in large communal kills typical of the Plains. In a woods/forest environment interspersed with open areas of grassland, bison would only be able to congregate in the prairie areas and preventing their dispersal into the surrounding woods would be troublesome at the least. In the more wooded areas groups would necessarily be smaller, perhaps only a few animals or even a cow-calf pair as described by Roemer (1983:198). It would be difficult indeed to assemble bison into a close, compact group even with the aid of corrals (see Speth and Parry [1980] for the possible use of corrals at the Garnsey site) and, for that matter, horses, as anyone who has gathered unruly cattle in the Post Oaks knows well. The use of the bow and arrow in the Post Oak Savanna would, moreover, make group kills unnecessary for the same reasons discussed above with respect to the Southern Plains.

Although the topography of the region precluded taking advantage of the bison's herding instincts in order to coerce them into traps for immediate slaughter en masse, it should not be supposed that the prehistoric people of the Post Oaks had no recourse but chance encounters with a bow and arrow in obtaining their meat. As mentioned earlier, woodland Indians were practicing a type of game management that was more than likely common throughout eastern North America. In fact, DeVivo (1990:308) argues that fire was the primary tool with which Indians controlled their environment. Fire was used to clear the land for agriculture, the results of which were witnessed by the DeSoto expedition (1538-1543) in the form of large maize fields, canebrakes, and open land on the southeastern coastal plains and in the southern mountains. Indians rid themselves of unwanted plant species while stimulating the growth of those that were of value through the use of fire. The periodic burning maintained canebrakes, and it has been reported that after pioneer settlement began in the Asheville Basin within the Cherokee lands, the use of fire ceased and, coupled with uncontrolled grazing, the vast canebrakes located there began to degenerate (DeVivo 1990:308).

When it was not desirable to clear land completely for agriculture, underbrush was burned to create and maintain prairie areas within the forest. This not only encouraged the growth of grasses, but in addition stimulated the rejuvenation of the burned underbrush to a tender and more palatable form better suited for utilization by browsing animals, while also increasing visibility in an otherwise thick forest. These changes in vegetation, in turn, encouraged the presence of game animals such as bison and deer and, along with continued periodic burning, enhanced the Indian's control of their movements, both long and short term. Long term movement could be likened to a change in pasturage, while short term movements could set up an ambush to facilitate killing (Belue 1999; DeVivo 1990).

To sum up thus far, there should be little reason to expect to find bison remains in kill sites reflecting communal hunts typical of the Plains in the Post Oak Savanna of the Late Prehistoric period. This is born out in the accounts of Joutel and the various Spanish chroniclers who often described only one or two Indians in a hunting encounter (Foster 1995, 1998). A good example of this was recorded by Joutel who described an incident involving a single Indian hunting a bison shortly after crossing the Colorado River in Fayette County on February 1, 1687. "The Indian had previously wounded the bison and was trailing it. The animal, somewhat provoked, would run after the Indian who would, in turn, follow after the bison. This back and forth game continued for some time until the Indian gave up" (Foster 1998:168). Although this account is rather amusing, the incident lends support to a single hunter hunting strategy.

We must now address a second difference between the two regions regarding bison remains, namely the differing amounts of bison remains in occupation sites. Buehler (1997) reports that although numbers of kill sites are generally diminished in the Southern Plains in post-Archaic times, bison bone is still present in campsites. In the Post Oak Savanna, there is not only a dearth of kill sites, but also a scarcity of bison bone from known campsites. Therefore, bison presence in this region in the Late Prehistoric requires further explanation.

Buehler (1997) states that bison bone present in occupation sites is often in the form of horticultural tools and numerous small fragments thought to have been broken for the extraction of bone grease. Other scholars have also noted quantities of bone chips believed to have been used in grease manufacture in the Southern Plains such as Garza complex occupations, Antelope Creek phase sites, and other sites in northern Texas, as well as in Toyah phase components in west central and central Texas (Quigg 1998).

In an area such as the Post Oak Savanna, however, it is quite possible that grease may have been procured from other sources less labor intensive than extracting it from bison bone. Other important fauna of the region included bear (Smith 1995:12, 93), raccoon, and beaver, all of which carry a significantly high proportion of fat known both ethnographically and experimentally to yield a correspondingly high amount of oil or grease of excellent quality. For example, after European contact bear oil was in great demand as it had a wide array of uses ranging from cooking to oiling the bore of a rifle and was a primary trade item in Nacogdoches during the 1830s (Yantis 1984:12; Smith 1995:93). It was reported that one bear could yield from 75 to 100 pounds of grease (Berlandier 1969; Blair 1950; Roemer 1983:232). These animals were very common, and grease from them could be obtained through routine butchering processes with a minimal amount of effort. Therefore, one would expect that Late Prehistoric peoples of the Post Oaks may well have used them as a source of grease or oil rather than acquiring it through the more tedious method by the breaking and boiling of bison bone.

Because of its abundance and workability, wood might also have been used for the manufacture of horticultural and other tools (Newcomb 1961:293) that Plains people made from bison bone or, if a bone tool was required, a deer bone may have sufficed. In sum, bison bone may not be present at occupation sites because it was not needed for the products that Buehler cites. If the bone from a particular bison kill was not needed in and of itself, it may have simply been left where it fell, thereby assigning it a low visibility in the archaeological record. However, bone that would have been transported back to camp along with the meat is quite another issue and one that has been debated extensively and has likewise been the subject of numerous studies, both archaeological and ethnographic. We will briefly focus here on only a few of these.

## The Hadza

If we can allow ourselves to suppose that the behavior of modern hunter-gathers is at least relevant to that of prehistoric hunter-gatherers, then some further insights might be gained from a brief review of an ethnographic account of Eastern Hadza hunting practices. The Eastern Hadza occupy a region of northern Tanzania where the vegetation is described as being "primarily mixed savanna woodland" and where "medium/large game animals are locally abundant" (O'Connell et al. 1988:115). As of 1988, they were still occupied as full-time hunter-gatherers, hunting the animals that make up their prey with only a bow and arrows, the tips of which are sometimes poisoned. The Hadza practice two types of hunting: (1) intercept hunting, where the prey animal is shot from blinds near water sources (utilized mainly in the dry season) and (2) encounter hunting, which is simply making opportunistic visual contact with a prey animal anytime the perpetually armed men leave camp (O'Connell et al. 1988:117). They also scavenge the kills of other predators.

The authors provide quantitative data on bone transport for 39 butchering episodes (O'Connell et al. 1988:150-155) where the prey ranged in size from impala averaging 40 kg in weight to giraffe averaging 670 kg. Falling between these extremes and most often obtained are warthog, alcelaphine antelope, zebra, and eland. The data obtained for these occurrences suggest several interesting parallels to practices and strategies projected for hunting in the Post Oak Savanna during the Late Prehistoric. Incidentally, the average weight range for *B. bison* (Davis and Schmidly 1994:28) would include that given by O'Connell et al. (1988:Figure 4) for giraffe. Treatment of carcasses by the Hadza varied across species in the order of selection of elements for transport and the number of elements selected from individual carcasses. In addition, the authors observed that some bones were stripped of meat and marrow which was consumed in the field during the butchering process. The type and number of these also varied across species.

Apropos of the point of the present study, the most striking variations in carcass treatment occurred between the two largest species (giraffe and eland) and the remainder of the prey species. Giraffe and eland provided the only cases where a substantial amount of meat was left at the kill/butchering site. The larger animals killed at greater distances from camp accounted for most of the low numbers of skeletal elements transported. For giraffe, no more than 20% of the elements in any given category were removed in five cases, and, in four out of five cases, no bones were removed. In contrast, zebra and alcelaphine antelope averaged 70% of the bone transported (O'Connell et al. 1988:150-155). Giraffe and eland were taken at greater distances from the base camp than the rest of the prey species. The larger animals averaged a 2.5 hour walk from camp as opposed to 20-45 minutes for the other species (O'Connell et al. 1988:Figure 5). The authors explain that "larger animals shot at greater distances from camp are more likely to be pursued, and that larger animals wherever shot are likely to be pursued further, simply because the potential returns from doing so are much greater" (O'Connell et al. 1988:130).

The authors also note that butchering often takes place under time constraints due to such factors as approaching sundown, the distance from camp, or the distance of the kill site from water. It becomes clear that the larger the game animal and the greater the distance from camp, the greater will be the incentive to more efficiently transport meat from the larger animals, especially when the situation is complicated by the constraints of time. The kill sites or butchering sites are generally used only once and are described by the authors as "places where animals are killed or scavenged are disarticulated for transport to a residential base" and were noted as occurring "in stream channels, on hillsides, in grassy swales, and along ridges—in short, wherever the animal in question finally succumbed" (O'Connell et al. 1988:140). These sites are thus rendered less visible in the archaeological record than occupation sites because they are not used repeatedly and there is no pattern to their location.

### Earlier Studies of Bone Transport

Archaeologists have long been interested in the variable frequencies of different skeletal elements in faunal assemblages. Previous studies have been conducted in which this variation is attributed to differential transport. Three of these are cited by O'Connell et al. (1988) and deserve mention here. First of all, in working with North American Plains assemblages, T.E. White (1952, 1953, 1954) inferred that larger carcasses were likely to be stripped of meat at the kill site in order to reduce the cost of transporting bone, and that limbs were the most likely elements to be moved because they possessed a high meat to bone ratio. Similar is Perkins and Daly's (1968) model of bone transport based on their faunal analysis of a Neolithic site in Turkey which exhibited a disparity between the number of cattle foot bones and the number of leg bones. They reasoned that this was because the former were left attached to the hide while the latter were thrown away, again presumably to reduce weight. They dubbed this disparity the "schlepp effect." A third study discussed by O'Connell et al. (1988) is Binford's (1978) model of the Nunamiut, which asserts that generally the more meat, marrow, and grease attached to a bone, the more likely it is for that bone to be transported.

As stated by O'Connell et al. (1988), the Hadza data contradict these previous studies in particular details concerning primarily which elements are transported and which are left. What is important, however, is that they conclude that, in spite of the differences in carcass treatment patterns demonstrated by the studies discussed above, they all reflect the maximization of net nutritional benefit relative to processing and transport costs. Furthermore, differences in treatment patterns reflect different conditions of carcass acquisition. For example, carcasses are taken in groups of up to 60 individuals by the Nunamiut and are largely destined for storage, whereas the Hadza acquire carcasses one at a time for immediate use (O'Connell et al. 1988:143-144). We infer the latter type of acquisition and its corresponding type of treatment for hunting in the Late Prehistoric Post Oak Savanna, based on the evidence presented thus far. Additional support for this bison hunting and processing strategy comes from studies of Mississippian sites in woodland parts of North America not generally considered to be "prime" bison habitat. For example, it is reported that both deer and bison were killed in the forest near the Vista Rock Shelter (23SR20) in the Ozark highlands of southwestern Missouri (O'Brien 1978). O'Brien attributes the rarity of animal bone in habitation sites to the practice of butchering the animals where they fell.

In Caddoan sites within the Arkansas River drainage region of eastern Oklahoma, faunal analysis led Brown et al. (1978) to conclude that bison hunting was a long-range activity where meat, containing only a minimal amount of bone, was transported from hunts in the west to the easternmost settlements. The idea of long range hunting is supported by Smith (1995:12-13) who describes Texas Caddo Indians hunting bison during the winter with stone tipped arrows but had to travel a considerable distance to the west in the vicinity of the Brazos and Navasota rivers to find them. Smith (1995:13) adds that they only had dogs for pack animals which limited the amount of meat carried back to their villages.

An account by Simars de Bellisle, a young French officer abandoned by his shipmates while filling water casks on Galveston Island in 1719, and subsequently captured by a group of Akosisas Indians provides some insight into the amounts of meat taken during a buffalo hunt. In his account (Folmer 1940:216-214), Bellisle describes a buffalo hunt in which the men from his and another band traveled three days to a prairie covered with bison where they killed fifteen or sixteen of them with their bows and arrows. They apparently took little meat as Bellisle recounted that within four days they were again searching for food.

A similar account supporting this strategy for the Southern Plains during the late nineteenth century is provided by Barsness (1985:66). He describes the technique of Indian butchering thus in the following. "As of old, they severed the meat from the bones to reduce the weight to be carried back to camp. Such butchering white men called 'Indian Fashion' and complained that it may do on the prairies but a good deal of meat is lost in this manner."

A situation also exists in the Florida Panhandle that is very much like the circumstances in the Texas Post Oak Savanna for about the same time period. It is generally believed that bison were present in Florida as "small unobserved groups" at least as early as DeSoto's time but DeSoto and other Spanish explorers did not mention them (Belue 1996:28). There is, however, some documentation for the presence of bison from the late sixteenth to very early eighteenth century, but bison remains have not been reported from any known Late Prehistoric site (Brose and Percy 1978:86).

## THE LACK OF BISON BONE IN THE LATE PREHISTORIC POST OAK SAVANNA

The aforementioned situation appears paradoxical at first glance. As we have shown, historical documentation, bison ecology, and the structure and ecology of the Post Oak Savanna region places them there, and yet there is only minimal faunal evidence of their presence, even at sites dating within the last few centuries. This issue has elicited various explanations.

Several reasons could account for the scarcity of bison bones in Late Prehistoric sites. One is the problem of relatively poor bone preservation within the region. Faunal preservation throughout the region is considered to be poor and is represented mostly by burned and small unburned fragments (Thoms 1993:13). Animals identified by these fragments are usually deer and smaller sized mammals, birds, and fish. Although some bison material has been identified (Roemer and Carlson 1987:109), most large bones can only be placed in a large vertebrate category.

Another explanation for the lack of bison bone, as well as other faunal remains, may be site location. Those sites that do contain faunal material are usually located on low (floodplain) terraces and valley margins (Huebner 1991:348), such as 41BU16 (Highway 21 site). However, the settlement patterns of Late Prehistoric peoples probably play a major role in faunal absence. Several good accounts by Joutel (Foster 1998:172,174,183-184) describes the dependency upon bison by the Indians he encountered, and that these groups were highly mobile, staying at a particular site only as long as there was food, i.e. bison, in the vicinity. He also noted their reluctance to stay long in any area was also due to a fear of being attacked by other enemy groups. Another observation of the constant mobility of some groups was DeSoto's chronicler Elvas' description of the Pacaha Indians in eastern Arkansas (Swanton 1985:229).

The strategy for short term occupancy is supported by archaeological evidence that includes numerous lithic scatter sites, of various sizes, found in the region's upland settings (Dickens 1993a, 1993b; 1995; Ensor 1987; Kotter 1982). Such sites having limited, short term occupations do not lead to the production of large midden deposits usually necessary for faunal preservation. In addition, the soils of the Post Oak Savanna, especially upland soils, are composed of well drained, slightly acidic undulating sands, and these do not provide good conditions for faunal preservation. Although the lack of faunal preservation has some merit, it is still an inadequate explanation because the remains of other species, whose bones are less dense and should thus be less well preserved than bison, make up the majority of faunal material from sites that do contain such.

Another theory for the lack of bison bone in the Post Oak Savanna centers on the idea that deer were the more important resource (Thoms 1993, 1994). The fact that deer bone has been found commonly within regional Late Prehistoric sites suggested to Thoms that these animals were utilized more frequently than bison and as such were the more important resource. Thoms (1993:13-14, 1994:17-20) utilized modern deer density and population studies as well as a few ethnohistoric accounts of hide use to support this argument. There is no question deer were an important resource and one that was probably harvested on a regular basis. However, Joutel recorded that the Indian groups he encountered from the time they left Fort St. Louis were constantly hunting bison and that many were involved in the hide trade. This does not support a low dependence strategy.

It is also argued that human predation prior to the depopulation caused by European diseases kept bison out of the Post Oaks, and that the resulting lack of hunting pressure after A.D. 1500 coupled with favorable climatic changes brought about by the Little Ice Age, allowed bison to inhabit the region and others like it throughout the southeast

(Ahr 1998b; DeVivo 1990; Thoms 1993). Recent research leaves little doubt that epidemic diseases brought about through European contact devastated native populations. What is not yet clear is the means, the manner, and the rate at which these diseases spread, and the extent to which they affected a particular region.

Dobyns (1983) postulates a smallpox pandemic that began in 1518 in Santo Domingo and was carried to Mexico by Cortez and his entourage. There it devastated the native population, and, according to Dobyns, ultimately destroyed millions of people throughout the New World. While this occurrence was widely catastrophic, it is doubtful that it was pandemic in every part of Americas. Other sixteenth century epidemics originating in Mexico are well documented, but current evidence suggests that these epidemics did not spread northward (Snow and Lanphear 1988). Populations north of Mexico were sparse by comparison, and geographical buffer zones existed between some populations. The spread of epidemic diseases from other possible sources (e.g. Cabeza de Vaca or the DeSoto/Moscoso expeditions) that were introduced to these populations depended on several factors in addition to the presence of buffer zones. These factors include the size of the infected population and those surrounding it, the length of common territorial boundaries, the depth of the buffer zones, levels of interaction, and chance (Snow and Lanphear 1988:17). Therefore, keeping these factors in mind and studying the historical records, one can conclude that there is a general lack of evidence for a massive human population reduction in the sixteenth century for the Post Oak Savanna region (Dobyns 1983; Ewers 1973; Snow and Laphear 1988).

Conversely, there is evidence from the late seventeenth century journal of Henri Joutel (Foster 1998) for a significant human population in the region. In February of 1687, Joutel conversed with two unidentified Indians near the Colorado River crossing in Fayette County a few leagues south of the "great forest." The Indians named approximately forty tribes, both friend and foe, that Joutel listed in his journal (Foster 1998:171-172). Joutel also noted a temporary scarcity of bison in the region and was told by his informants that this was due to the large number of Indians there. "For this reason they (Indians) disperse in order to subsist better, and they drive the bison back and forth to each other. It seemed from this that the woods and rivers are their boundaries for hunting" (Foster 1998:172).

LaSalle's company crossed the river and began the march toward the Brazos which would also take them through some portions of the densely wooded areas of the Post Oak Savanna about four leagues farther on according to Joutel accounts.

> The bison were found in rather large numbers, which was surprising, in the middle of several bands of people who roamed in these areas. In addition, the grass was burned and almost none had appeared. But these animals seem to delight in searching for the small sprigs of grass just appearing to sprout. We stayed there for two days; during that time we killed several bison which we smoked for our provision (Foster 1998:174).

Farther on toward the Brazos, after working through dense woods for about half a day, the Frenchman stopped and Joutel records what they saw in his diary, ". . . we arrived in a very pretty prairie where we noticed a great many tracks of men who must have passed through there the same day. We also spotted two smoke plumes that appeared to be very close, one to the northeast and the other to the southwest" (Foster 1998:175). Joutel continues by stating that, "Bison were not abundant in this area, the natives who had set fire to the grass had scattered them. Besides, Indians had hunted there for some time" (Foster 1998:176).

Examples such as these occur throughout the journal, both within and outside the Post Oaks proper. It is quite evident then that both bison and humans were present in substantial numbers in the late seventeenth century. This evidence suggests that there was no massive human depopulation in the Post Oak Savanna in the sixteenth century allowing bison to enter (see Ricklis [1996] for a similar conclusion in his study of the Karankawas).

There is another possible reason, not discussed heretofore, that Indians of the Post Oaks would not have transported bone back to camp. This reason concerns meat preservation. Throughout his journal, Joutel relates that Indians smoked meat at the kill sites before taking it back to camp, a process that the French were quick to adopt. Smoking the meat immediately subsequent to butchering would, of course, prevent spoilage in a humid environment such as the Post Oak Savanna. Prevention of spoilage would be a prime consideration for people traveling through, like the French, or for Indians moving to a base camp some distance away from a kill, especially if they were carrying more meat than would be immediately consumed by their group. A cut of meat smoked "bone-in" is more likely to spoil than the same cut smoked boneless. If Indians of the Post Oak Savanna were cognizant of this difference, they would have all the more reason to separate the meat from the bone at the kill site.

## SUMMARY AND CONCLUSIONS

In the light of the evidence for the presence of bison in the region from the beginning of the Late Prehistoric, as well as evidence for the presence of a significant number of people, we reiterate that the most tenable explanation for a lack of bison bone in archaeological sites may well be related to the procurement strategies of the people who hunted there. This section will summarize the evidence and formulate a bison procurement strategy modeled for the region that should satisfactorily explain the paucity of bison remains.

First of all; climatic conditions changed early in the Late Prehistoric, allowing for an expansion of bison into habitats adjoining the Plains, such as the Post Oak Savanna. Thus, people inhabiting the region would have been able to utilize a Plains resource as well as the resources common to woodland environments. In addition, there is evidence suggesting that many people utilized the region without permanently residing there (Foster 1995, 1998) Secondly; the bow and arrow came to be the primary weapon for hunting (Turner and Hester 1993), and (as previously discussed) this weapon would have facilitated animal procurement in a forested environment where large communal kills would be difficult. The need for entrapping the animals, moving a camp to a kill site and other highly organized activities requiring the coordinated efforts of large groups would be reduced. Large communal hunts are not indicated by the documented accounts. Instead, one or two hunters are generally seen. Joutel's journal does seem to indicate that there was perhaps a mutual agreement between tribes and/or groups of people concerning bison hunting and the use of fire in driving the animals back and forth from one open area to another. Also noted was the use of dogs, perhaps either to cut an animal out of a group or to hold one or more animals at bay (Foster 1995, 1998:172-174, 181).

Like the Hadza, the people of the Post Oaks would have practiced opportunistic visual encounter hunting, but intercept hunting also came into play to the extent that bison location could be predicted through the purposeful use of fire in forcing the movements of the animals through known avenues (bison trails) or to selected areas. Methods of carcass acquisition would have been broadly similar to Hadza methods as would methods of carcass treatment. Joutel gives evidence that the indians probably often worked under time constraints much like the Hadza. In addition to factors such as approaching darkness or distances from water mentioned by O'Connell et al. (1988), territorial boundaries and the proximity of enemies would impose time constraints as well (Foster 1998:171-172, 183-184). Deer-size and smaller carcasses would have been transported to the campsite largely intact to be butchered there, while bison would have been butchered where they fell with little or no bone transported, since the transport of bone would be costly in terms of labor and time.

In addition, bison bone would not have been transported back to camp because it likely was not needed for tools or grease. As discussed above, these items could be obtained more easily utilizing other fat-bearing animals and the substitution of wood for tools normally thought to be made from bone.

In conclusion, the picture that emerges for bison procurement in the Late Prehistoric Post Oak Savanna is one of a growing dependence upon bison that had increased with the rapid expansion of bison populations after A.D. 1500. Bison procurement strategy was composed of various peoples that hunted singly or in very small groups. Prey was generally located on an opportunistic basis and obtained at a rate of one or two animals at a time. Any deer-sized or smaller prey obtained would be taken to the base camp complete. However, if the prey animal was a bison, the carcass would have been butchered at the kill site in such a way that its bones were not transported back to camp. Thus, these single-use kill sites would leave little evidence on the landscape and, as such, would not enter the archaeological record of most Late Prehistoric sites in the Post Oak Savanna of Texas. Lastly, the paucity of bison bone is partly due to the paucity of the archeology of regional late Prehistoric sites and we predict that when these sites are dug, some traces of bison will be found.

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# The Toyah Bluff Site (41TV441)—Changing Notions of Late Prehistoric Subsistence in the Blackland Prairie Along the Eastern Edge of the Edwards Plateau, Travis County, Texas

*James Karbula*

**ABSTRACT**

Hicks & Company conducted archeological testing and data recovery at a Late Prehistoric site (41TV441) at the proposed location of Southeast Metropolitan Park in Travis County, Texas. A total of 54 shovel tests, 34 backhoe trenches and two open area blocks were excavated during the data recovery. The investigations documented an extensive Late Prehistoric occupation site spanning the transition period between the Austin and Toyah intervals in Texas prehistory. Site chronology indicates an occupation from approximately A.D. 1235 to 1425. Site data may suggest the association of Toyah peoples in the Blackland Prairie with plant food processing as early as A.D. 1235. The report focuses on possible implications of these data on the transition period between the Austin and Toyah intervals.

## INTRODUCTION

On behalf of the Travis County Transportation and Natural Resources Department (TNR) and HNTB Engineering Inc., Hicks & Company (H&C) conducted testing and data recovery of a Late Prehistoric site (41TV441) in Travis County, Texas. The site is the location of Travis County's proposed Southeast Metropolitan Park. The project fulfilled TNR's responsibilities under Section 106 of the National Historic Preservation Act (1966, as amended) and the Texas Antiquities Code (TAC) relative to the development of park infrastructure. The project falls under Section 106 because of the use of federally assisted matching grant funds. The work occurred under Texas Antiquities Code Permits 2018 and 2074.

Southeast Metropolitan Park is located approximately 20 miles southeast of the City of Austin, adjacent to SH 71, in southeast Travis County, Texas (Figure 1). The site is located in the Blackland Prairie approximately 20 kilometers east of the Balcones Escarpment fault zone and the eastern edge of the Edwards Plateau. Southeast Metropolitan Park covers roughly 300 acres located between SH 71 on the south end and a branch of Onion Creek located to the north. The western and northern boundary of the park is formed by Onion Creek. The site is located on a high terrace that overlooks the creek to the west, within 200 meters of the SH 71 roadway (Figure 2). The scarp forming the terrace measures approximately 15 meters in height affording a commanding view of surrounding countryside. This includes a view of the Austin metropolitan skyline some 20 miles to the west.

The Toyah Bluff site terrace is relatively flat but to the north is a series of high, rugged, steep hills. The hills are heavily dissected and represent very rough topography. On the east edge of the terrace containing the site is the remnants of an ephemeral drainage. This drainage moves water runoff from the hills to the southeast area of the park. In modern times, such runoff results in ponds and marshy areas. Thus, the flat terrace area of the site was strategically situated on top of the bluff overlooking Onion Creek, west of the ephemeral drainage and marshy areas, and south of the high, eroded hills.

The site is divided into eastern and western halves by a gravel driveway. The eastern flank gently slopes down to the edges of the tiny drainage. The drainage at times provided some deposition of sandy sediments to the site's eastern flank. The archeological deposits are slightly deeper in this

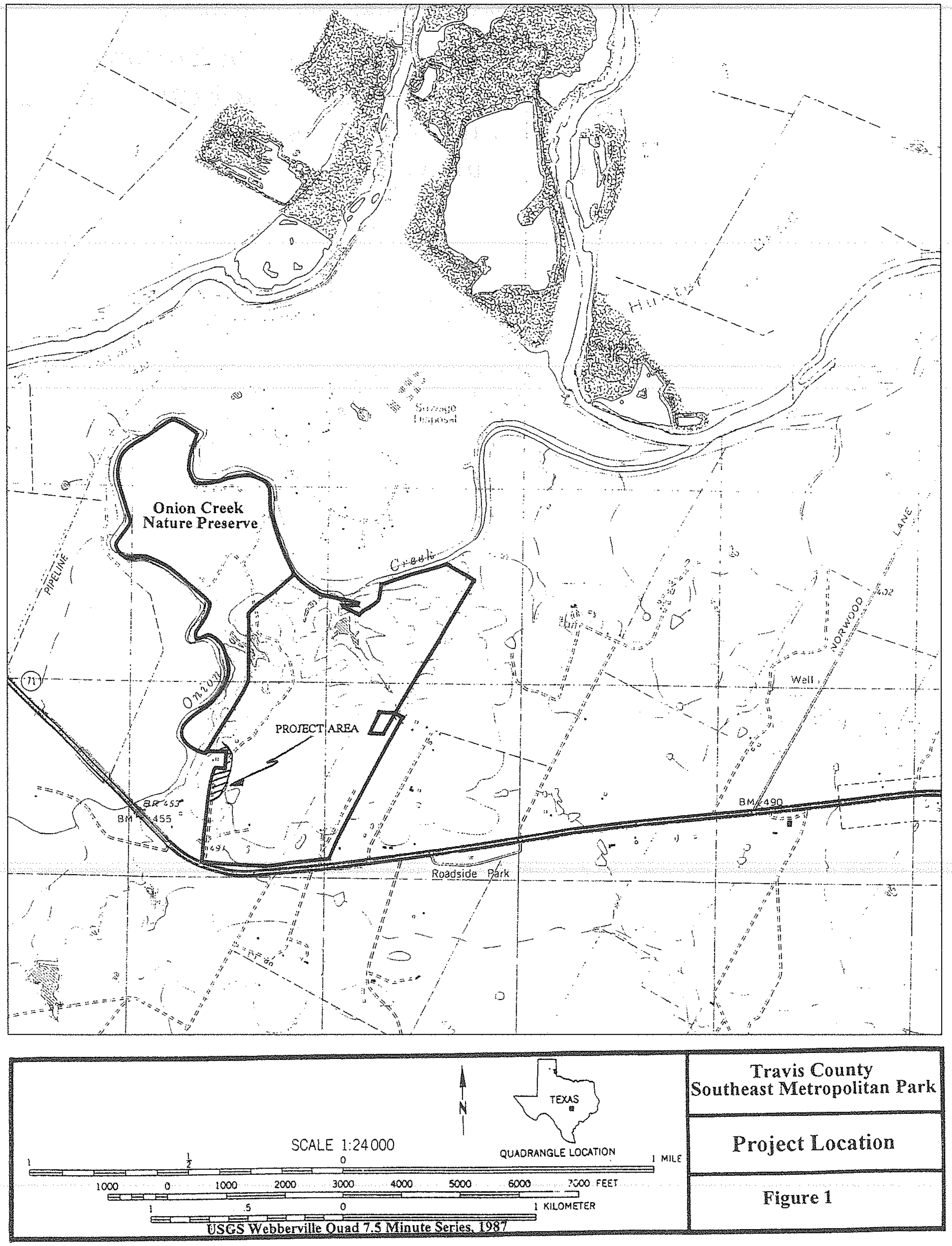


Figure 1. Project Location.

area and somewhat better preserved. The western flank is relatively flat and has not been subject to any alluvial deposition in recent times, only restricted aeolian deposition. Much of the western flank of the site is destroyed by erosion and the placement of modern houses. The very western edge of the terrace remains private property and is outside of the study area. The portion of the Toyah Bluff site (41TV441) that once extended into this area is highly disturbed.

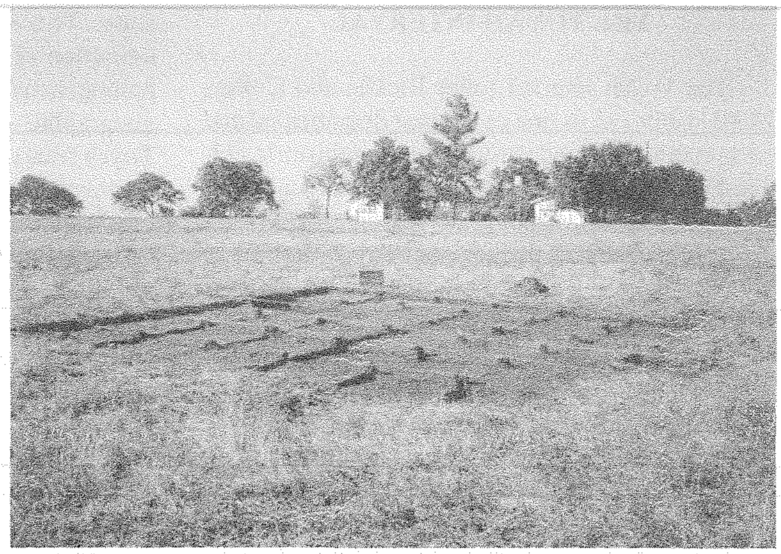

Figure 2. Overview of General Site Area with Block 1 in Foreground. The Onion Creek terrace is located behind the house.

The archeological deposits are shallowly buried and the site has been subject to much natural erosion and historic modification. The upper 10-15 centimeters in many areas are completely disturbed. In fact, due to the erosion and historic/modern disturbance, the site might be described as containing only isolated intact pockets of preserved Late Prehistoric materials. It is fortuitous that testing and data recovery occurred in 1998 for in a few more years natural and cultural modification would have completely destroyed the site and much important information would have been lost.

The site undoubtedly offered a diverse and readily available resource base during the latter part of the Holocene period. Onion Creek offered riverine resources. The marshes to the east and north of the site formed a lacustrine environment. Charred organic remains at the site suggest the presence of abundant onion plants, probably locally available along and in the marshy areas. Quartzite outcroppings in the hills and limestone in the terraces provided the raw materials for tools and the construction of cooking appliances. Oaks and other riparian trees along the margins of the creek offered shelter, wood, nuts, and game. The high bluff provided protection from most Onion Creek floods and also great visibility.

The data recovery consisted of the excavation of 54 shovel tests (50 x 50 cm), 34 backhoe trenches and two large open area excavation blocks. Shovel tests were utilized to locate intact site deposits and for planning purposes for the placement of open area excavations. The numerous shovel tests (50 x 50 cm) in reality functioned as small data recovery units. Backhoe trenches were utilized to delineate site limits, to test for intact deposits, and to document site stratigraphy. Data recovered from the shovel tests and backhoe trenches enabled investigators to place Blocks 1 and 2 in the most highly concentrated areas of prehistoric remains. The result was the documentation of an extensive set of intact Late Prehistoric remains in both excavation blocks.

On the west side of the site, west of the gravel road bisecting the site, a single zone of intact prehistoric cultural material was recorded in Block 2 from approximately 15-30 centimeters below the surface. This cultural zone contained an incredibly dense accumulation of multiple overlapping burned rock features and a variety of stone tools. The zone of occupation was consistently 15 centimeters thick, except where pit features were excavated into the underlying, culturally sterile, Pleistocene, orange silty clays. On the east side of the gravel road, on the east edge of the site (Block 1), a single zone of cultural material was recorded from approximately 25-40 centimeters below the surface. Holocene deposition was more pronounced on the eastern edge of the site, near the ephemeral drainage. Again, the bottom edges of pit features were present below the main lens of archeological material. This cultural zone was better preserved than most portions of the site. It was buried deeper and the sediments clearly demonstrated evidence of extensive anthropogenic modification.

## THE TOYAH INTERVAL

The Toyah interval (after Ricklis and Collins 1994) stands out as one of the best documented and presumably well understood of the prehistoric culture-historical time periods in central and adjacent regions of Texas. Among the reasons for this are the large numbers of documented Toyah sites many of which represent short lived, isolated occupations with distinctive lithic and ceramic assemblages (Black 1986; Johnson 1994; Quigg and Peck 1995; Ricklis and Collins 1994). The distinctive nature of these assemblages was first recognized as the Toyah focus of the Central Texas Aspect (Kelley 1947; Suhm et al. 1954). Toyah assemblages consisted primarily of Perdiz arrow points and bone tempered pottery. Subsequent studies elaborated on the material culture and/or related behavioral implications of Toyah sites and assemblages (Jelks 1962) and recognized its widespread nature across Texas (Black 1982).

Prewitt (1981, 1985) assimilated and integrated much of the extant Toyah data and redefined the Toyah as a "phase" utilizing the Midwestern Taxonomic System. The Toyah were associated with a consistent, highly variable artifact assemblage confined to a discrete segment of the prehistoric chronology (Ricklis 1994:207). Prewitt (1981:83-84) noted differences between the Toyah and the preceding Austin phase. Prewitt (1981) suggested a Toyah reliance on bison hunting and possibly some measure of sporadic maize horticulture. Toyah assemblages were documented to consist of Perdiz and Clifton arrow points, Leon Plain and Doss Redware bone tempered pottery, beveled knives, small end scrapers, flake drills and a variety of bone tools (Black 1986:254; Prewitt 1981:83). Major sites were the Smith Rockshelter (41TV42), Kyle (41HI1), Oblate (41CM1), Berclair (41GD4); Finis Frost (41SS20), Loeve-Fox (41WM230) and Hinojosa sites (41JW8). Trade with coastal and eastern groups was recognized by the presence Goose Creek Plain and Caddo influenced ceramics (Prewitt 1981:84). The estimated age for the geographically widespread Toyah was 650-200 BP (A.D. 1300-1750).

As part of the Hinojosa site studies, Black (1986:255) called into question the notion of a Toyah phase. Instead, Black (1986:255) presents a compelling argument that the Toyah represent the spread of an archeological "horizon" across the state. The original Willey and Phillips (1958) definition of a phase is intended to characterize a homogenous cultural entity restricted to a specific geographic region (Black 1986:255). However, Toyah sites are well documented across a variety of contrasting and/or diverse environmental zones. Citing Willey and Phillips (1958:30), Black (1986) suggests that the terms "horizon" and/or "tradition" represent the most practical means for effecting culture-historical integration on a pan-regional scale. The term horizon encompasses the broad and rapid spread of cultural traits and assemblages. This broad and rapid spread is reflected spatially in the distribution of archeological sites across diverse environmental zones. Therefore, the Toyah may better fit the "horizon" or "tradition" concept due primarily to noted inconsistencies in Toyah assemblages. Such inconsistencies include the presence of foreign ceramics and/or the absence of important lithic tool forms such as beveled knives (Johnson 1994:240-242). There are also notable differences in the radiocarbon ages between Toyah sites in central and north-central Texas and those in south Texas and adjacent regions. These differences may indicate that the Toyah do not precisely represent the spread of a homogenous assemblage in conjunction with a specific group of people.

Building upon these ideas, Ricklis (1994:208) proposed that the Toyah reflect the spread of a "techno-complex" of lithic tool forms across the state, one oriented towards the processing of large mammals. Problems with the horizon concept include the overall geographic distribution of many of these lithic forms beyond the known distribution of the Toyah. According to Ricklis (1994:208), the spatial continuity suggested by the Willey and Phillips (1958) definition of "horizon" can only be demonstrated for certain Toyah traits. In addition, ceramic forms evidenced from certain Toyah sites exhibit considerable stylistic variability. Based on the consistent presence of Toyah lithic forms in association with the bones of large mammals (bison, deer, antelope), Ricklis (1994:208) suggests that Toyah assemblages reflect the infusion of a tool techno-complex well adapted to the procurement and processing of large game. A direct correlation is drawn between the procurement/processing of large prairie/savannah ungulates and the spread of the Toyah tool assemblage. Ricklis (1994:208) and others (Prewitt 1981; Quigg and Peck 1995), with good reason, associate

Toyah lithic forms with a focus on bison hunting. Ricklis and Collins (1994) also utilize the more generic term "interval" to describe this culture-historical period, rather than phase, horizon, or tradition. We also prefer the use of the term "interval" rather than the typically accepted term "period" or other such nomenclature.

Johnson (1994) in his analysis of the Toyah Buckhollow site (41KM16) accounts for some of these discrepancies with suggestions of a "classic" vs. a non-classic Toyah culture. Classic Toyah culture is defined as part of a more widely distributed Toyah Complex found in the San Angelo area, the Edwards Plateau and the inland Coastal Plain (Johnson 1994:241). Classic Toyah is distinguished mainly by the presence of a distinctive, crude, plainware utilitarian pottery. Such pottery may have originated in the Mogollon areas of the southwestern United States (see Johnson 1994). The presence of this plainware and associated lithics is attributed to the influx of a specific group of people whose ceramics exhibit southwestern influences (Johnson 1994:271). A widely traveled and traded bison processing toolkit consisting of Perdiz arrow points, beveled knives, flake-blade endscrapers and flake drills may have accompanied the migration of these groups. Spread of the toolkit may have been a reaction to a regional increase in bison on both the Southern High Plains and also in adjacent, environmentally marginal areas (A.D. 1200-1300). The widespread adoption of this toolkit may have been a functional response by existing groups to the increased availability of bison. This argument in part, may account for some of the assemblage variability observed at many Toyah sites.

In support of these interpretations is an observed difference in Toyah assemblage diversity from that of the earlier Austin interval. Johnson (1994:272) suggests there is a great difference between the earliest Toyah tools and manufacturing techniques and those of the preceding Austin interval. This difference, although not dramatic, is evidenced between the Toyah and the preceding Blow Out Mountain cultures of the San Angelo area (Creel 1990). The recently excavated Austin Interval assemblage from a burned rock midden at the Heard Schoolhouse site (41UV86) on the Edwards Plateau is striking because of its lack of diversity (Black et al. 1997:233). Notably lacking are scrapers, engravers and/or perforators, which are common at all Toyah sites. The implication for Johnson (1994) is that the arrival of a different group of people stimulated the rather rapid adoption of a unique lithic assemblage in response to the increased availability of bison. For Ricklis and Collins (1994), these differences signify the adoption of the lithic techno-complex by extant groups to more efficiently process a variety of large mammals, especially bison.

## GEOMORPHIC SUMMARY

The 41TV441 site location is dominated by the terracing system of the Colorado River and one of its primary tributaries Onion Creek. The ridge containing the site represents an erosional relic terrace of the Onion Creek drainage system. This terrace was probably formed during the Middle to Late Pleistocene geological epoch. Geomorphic data indicates the entire top of this ridge is an upland erosional surface. The surface consists of Pleistocene sediments (orange, silty clays) overlain by a thin layer of transported Holocene deposits. Limited slope wash from the neighboring hills and aeolian deposition contribute to the relatively thin lens of Holocene sediments (ca. 50 cm) containing the site. The slopewash and aeolian factors are also part of the active erosional processes and overall only serve to slow the rate of erosion. These conditions allow for the formation of a condensed stratigraphic lens of archeological material. Erosion likely reduced the thickness of the deposit before it was again shallowly buried. The net effect of this system on archeological deposits is to collapse multiple and time dispersed occupations into a single zone or surface. The exception to this is the area of the ephemeral drainage along the eastern portion of the site. The small drainage appears to have provided a more reliable source of sediment deposition.

Three basic stratigraphic zones were consistently observed across the site. These exhibit characteristics similar to a structured soil pedon: Ap, A and B horizons. The upper zone (0-15 cm) consists of a highly disturbed sand loam plow zone (Ap horizon). This zone contained numerous displaced artifacts. This Ap horizon overlies a thin A horizon (15-60 cm) which consists of a compacted clayey silty sand deposit. Prehistoric cultural materials are isolated to the A horizon. The A horizon exhibits extensive anthropogenic modification. Although the basic mineral components to the A horizon are locally derived, the sediments are jet black in color and laden with organic matter. The organic component to the A horizon sediments represents as much as 8% of the total soil constituents. This highly organic black anthrosolic zone was consistently associated with intact Late Prehistoric materials. Such a high organic content is probably the result of intensive burning activities. The sediment resembles the fine organic matrix identified within burned rock middens in other central Texas sites (Black et al. 1997; Karbula 1997). The thin A horizon overlies a culturally sterile, deep, reddish brown Pleistocene clay (B horizon).

The nature of the cultural-bearing, organically rich anthrosol is consistent with the overall state of preservation of the prehistoric materials at the site. Numerous elements of burned wood charcoal and processed plant remains were recovered. The state of excellent preservation, in part, is attributed to the presence of a perched water table in the sediments. Excess water from heavy rains, or from the nearby drainage, collects over the top of the lower clay zone (no more than 50 centimeters deep), and cannot penetrate the lower impermeable, clay layer (B horizon). This produces a perched water table. The water accumulates in the upper 50 centimeters of sediments (or less). Evidence of this was observed in several of the backhoe trenches excavated on the lower portions of the ridge. Following heavy rains, water rested on top of the impermeable clay layer and seeped into freshly excavated trenches causing collapse of the profiles. This nearly constant state of moisture in the soil inhibits the normal oxidation and decay of the extant organic matter. The water content acts as a barrier and prevents atmospheric oxygen from penetrating into the cultural deposits. This process slows down the production of carbon dioxide and normal decay. The end result is sediment rich in preserved organics, generated by a unique set of preservation circumstances.

There is no real way to discern to what degree the site was constantly inundated. Alternating wet-dry conditions are generally considered to be detrimental to organic preservation. However, the perched water table observed during the field investigations, and the presence of the marshes adjacent to the site, suggest of a nearly constant state of saturation. The ephemeral drainage marking the eastern boundary of the site is in reality a run-off channel for funneling water from higher elevations down slope. This run-off channel is the primary mechanism for inundating the marsh. Even in drier conditions, the marsh likely remained somewhat wet. Local residents confirmed these observations during the course of the field investigations. There has probably been little deviation to this pattern over the last several hundred years.

## FEATURES AND ARTIFACTS

Ten features were recorded in Block 1. Three of these were relatively large pits (Fea. 2, 5, 11). Two features were dense clusters of burned limestone, quartzite and ocher rocks located immediately adjacent to the pits (Fea. 1, 4). One feature was more of a single lens scatter of burned limestone and quartzite rocks (Fea. 3). Rock features were generally present in two types: 1) pits with intact basin-shaped rock beds or 2) disorganized clusters of fractured quartzite rocks. The basal remnants in the pits generally consisted of large, burned rounded limestone clasts. The adjacent single lens clusters generally consisted of small, heavily burned, highly fractured quartzite cobbles. Ocher and burned chert cobbles were consistent but infrequent elements of these features. All of the rock features contained some elements of charcoal. Two postholes (Fea. 7, 8) and two wooden stakes (Fea. 6, 10) were also recorded in Block 1.

A total of 11 rock and/or charcoal stained earth features were identified in Block 2. These consisted of an overlapping series of rock oven beds, associated rake-out piles, and individual hearths. All of these materials were part of a dense accumulation of shallowly buried, in-situ cooking/kitchen related prehistoric debris (Figure 3). Rock features resembled those in Block 1 except pit features were smaller in size. Features 9 and 12 represented overlapping pit features with rock beds lined into shallow basins (ca. 20 cm deep basins). Similar to Block 1, these were composed primarily of large, rounded, powdery limestone clasts. Adjacent rock features were more scattered and disorganized and contained primarily burned and fractured quartzite (Fea. 13, 16). One pit that was relatively free of rock was recorded (Fea. 15). Additional rock features in Block 2 consisted of discrete concentrations of both limestone and quartzite in equitable mixes (Fea. 17, 18, 19) and rock filled pits (Fea. 24).

Invariably, rock features at the site consist of three types of rocks (limestone, quartzite and chert). The rock beds of pit features from both blocks contain similar ratios of these three types of rocks. Those features interpreted to represent the rock beds of earth ovens are of varying sizes ranging from approximately 60 centimeters to nearly two meters in diameter and are composed primarily of large rounded limestone clasts. In contrast the second type of feature consists primarily of smaller quartzite cobbles. In some cases these are interpreted to represent displaced lid rock or rake-out piles from the ovens (Fea. 13, 16, 24). In others a more equitable mix of limestone and quartzite rocks are present in a single, spatially discrete layer, and in the absence of stained sediments, suggest small, independent hearth features (Fea. 17, 18). The latter are interpreted to represent small cooking or warming fires or perhaps discard piles. In several instances, earth oven beds and possible rake-out piles are located either in close proximity to one another and/or are spatially overlapping (Fea. 2, 15/16). In Block 2, Features 9 and 12 are interpreted to represent rock ovens of the type found in Block 1, only smaller. The continuity observed in hearth feature morphology between the two blocks is striking.

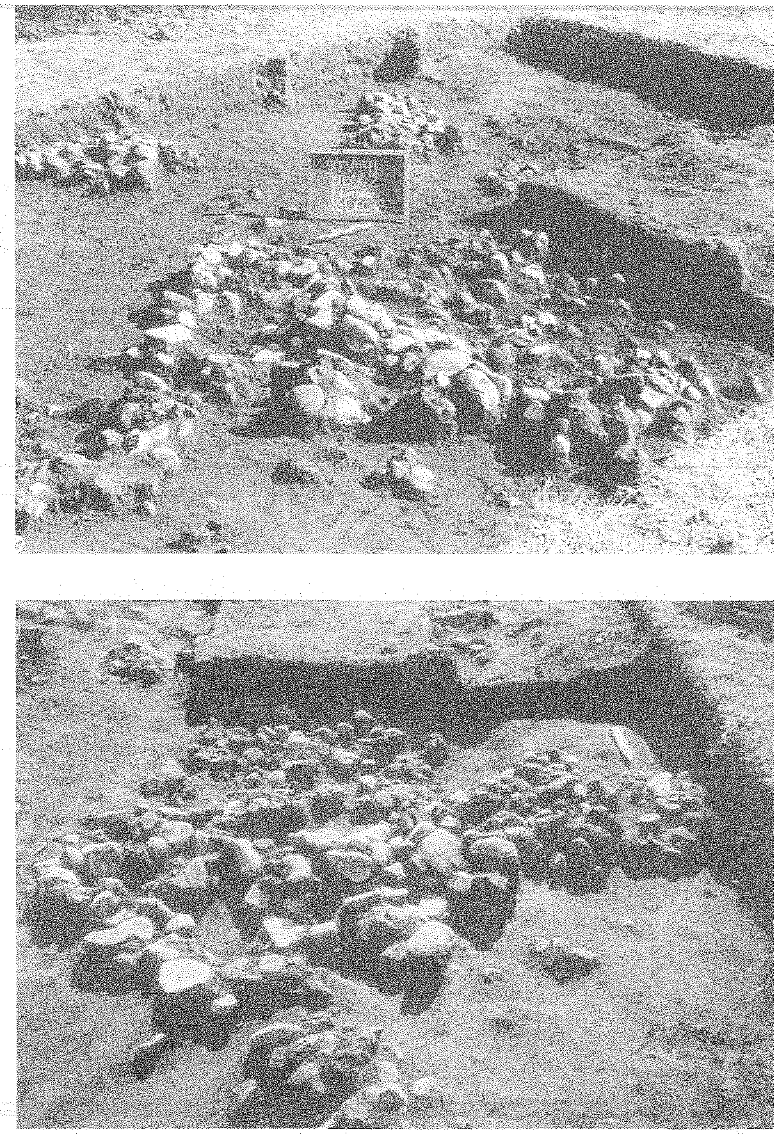

Figure 3. Photographs of Kitchen-Midden Complex in Block 2 with the primary features isolated.

A diverse array of stone and other tools are recorded at the Toyah Bluff site. Mainly Perdiz but a few Scallorn and side-notched oddities represent the arrow points (Figure 4a and 4b). Two heavily utilized dart points were also recovered (one during the testing phase) whose basic shape and form is somewhat suggestive of the Late Archaic (Ensor/Fairland). These dart points were presumably imported into the site by the Late Prehistoric inhabitants. Bifaces and a high volume of heavily burned debitage were recorded. These materials represent many different stages of lithic manufacture and/or resharpening behavior. Most of the bifaces were finished utilized specimens. Three of these are beveled knives (Figure 5a and 5b:Lots 200, 222, 296). Blades tools and modified blades are relatively common in the assemblage (Figure 6). Scrapers, perforators and modified flakes were present. Modified flakes with both burins and gravers are recorded. Red-yellow ocher is prolific at the site. A few small, poorly preserved pottery sherds were recovered from both blocks (see below). Rounding out the Toyah Bluff assemblage are cores, core tools, and core fragments, one piece of grooved stone, one

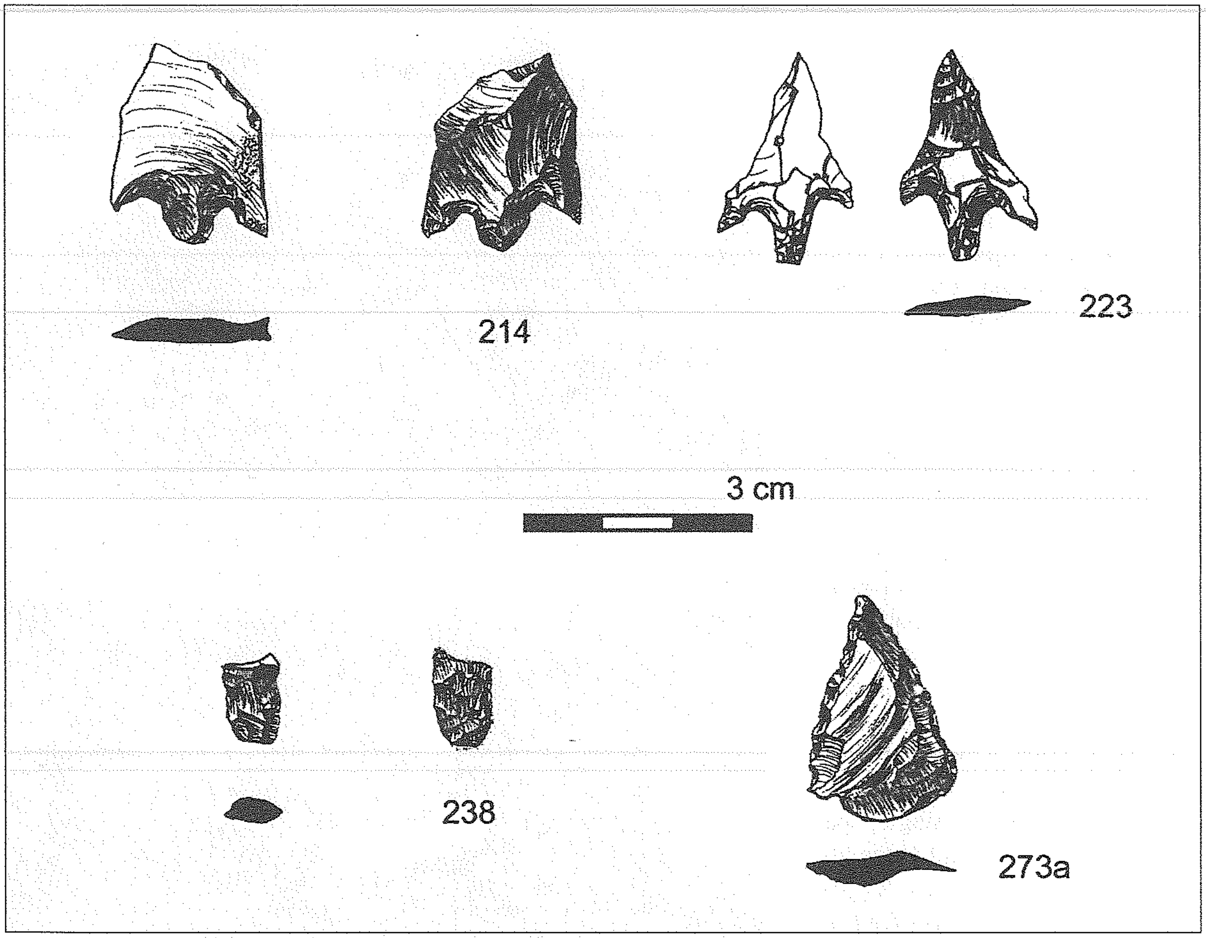


Figure 4a. Projectile Points from the Toyah Bluff Site (41TV441) Block 1. Numbers denote provenience lots for the artifacts.

miscellaneous stone and a limestone concretion. In contrast to other Toyah sites, no personal items such as beads or decorated marine shells or smoking pipes were recovered.

The overall assemblage at the site conforms quite well to other documented Toyah assemblages on the Edwards Plateau, the Blackland Prairie, and to a certain extent the coastal regions. There is generally some variation in Toyah assemblages from all of these areas. A few Scallorn, Toyah, and/or other expanding stem or side notched arrow points typically occur in what are considered pure Toyah lithic assemblages (Black 1986; Johnson 1994; Treece et al. 1993). There is also variation in ceramic types in different regions in terms of tempering, vessel shape and exterior decoration. While nearly undecipherable, Toyah Bluff ceramics exhibit some variation in temper and possibly manufacturing techniques. A total of 48 sherds were recovered representing three basic types. The Toyah Bluff assemblage lacks sandstone shaft abraders and soapstone pipes and bone implements and/or decorated bone items. It contains unusually large numbers of manos and metate fragments.

## Earth Ovens and Charred Bulbs

Earth ovens are multi-functional appliances utilized for the cooking of a variety of both plant and animal foods. Although smaller ovens may be used for the short term cooking of meat, the largest and hottest ovens with the longest cooking periods are utilized to cook fatty meats or plant foods (Dering 2001:B-14). Bulb producing plants (geophytes) were a source of carbohydrates to a wide range of prehistoric inhabitants in Texas. Bulbs are plants consisting of modified thickened leaves arranged around a central compressed stem, such as an onion (Dering 2001:B-14). The use of earth oven

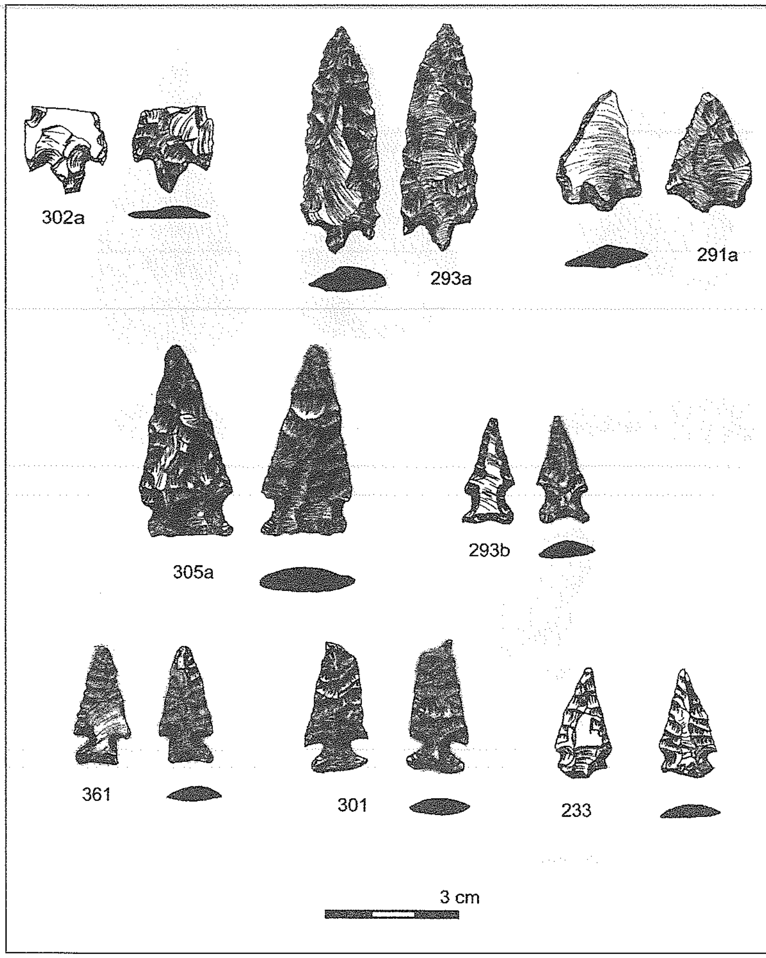


Figure 4b. Projectile Points from the Toyah Bluff Site (41TV441) Block 2. Numbers denote provenience lots for the artifacts.

cooking is necessary for individuals to eat large quantities of most bulbs in the Lily family, including onion (*Allium* sp.). This is primarily because of the allelopathic or secondary metabolites (sulfites) present in most underground storage organs (Dering 2001:B14). A significant percentage of the complex carbohydrates in most bulbs must be broken down by hydrolysis into simpler, smaller compounds before human digestion. Hydrolysis of the chemicals in most plants is accomplished by baking for extended periods of time in an earth oven (Dering 2001:B-14). Wild onions may contain nearly 20% non-reducible sugars that need to be broken down before humans can digest them (Dering 2001:B-14).

There are several methods of earth oven construction, all of which include some variation of the placement of rocks, fuel, food, packing material and sediment (Ellis 1997; see also discussion below). One method is to excavate a shallow hole, pile a large quantity of wood in it, and then stack rocks on top of the wood (Ellis 1997). The fire transfers heat to the rocks which act as the heating element in the oven (rock bed). After the fire burns down to coals, moist packing materials such as grass or the branches of shrubs are placed directly on the rocks (Dering 2001: B-14). The bulbs are wrapped in moist vegetal packing material and then covered with earth. The packing material insulates the food from the extreme heat of the rocks and the coals generate the steam needed for cooking. The resulting steam and heat provide the environment necessary to break down indigestible chemicals within the plant (such as inulin). The low oxygen, high temperature steam environment of the oven reduces the large chain carbohydrates to edible food. The process requires an extended period of time, often more than 24 hours.

There is a high potential for the carbonization of the plant remains within an earth oven. This is due to the fact that the oven exposes the food to extreme heat in an oxygen-poor, reducing atmosphere (Dering 2001:B-14). The packing material, the food, and the fuel wood tend to combust to charcoal rather than mineral ash. The amount of carbonized plant material from the firing of each oven however, other than wood or packing material, should be quite small. Any carbonized food is probably the result of an accidental occurrence. When the food is cooked, the oven is opened. This process often spreads fire-cracked rocks and charred plant material across the current living surface. It is therefore not unusual to have evidence of food remains from both feature and non-feature contexts at any site in which earth oven cooking was common.

The reader is referred to a number of sources for detailed accounts of the structural elements of pit ovens, possible cooking technologies (Black et al. 1997) and evidence of plant food processing in

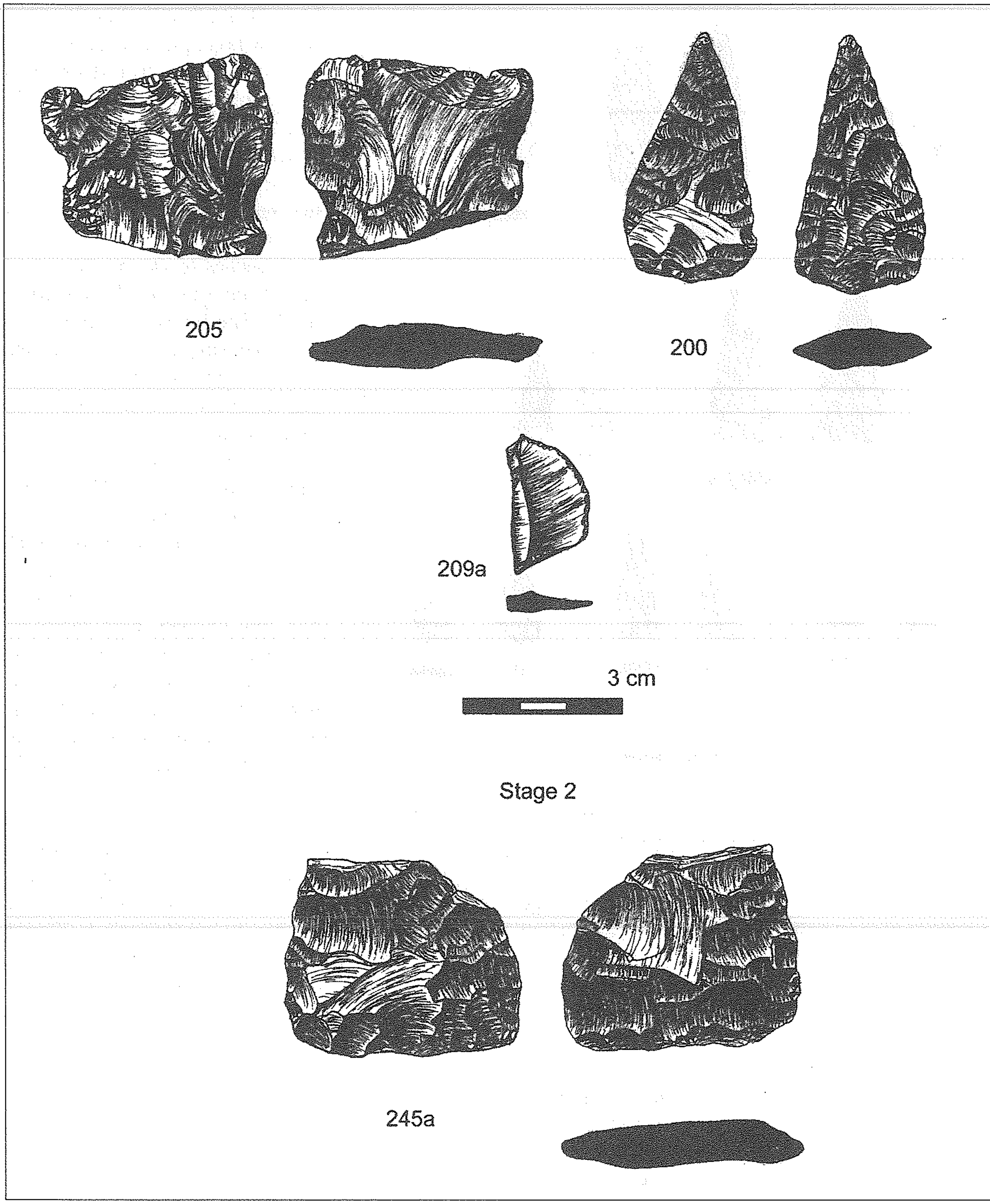


Figure 5a. Select Bifaces from the Toyah Bluff Site (41TV441) Block 1. Numbers denote provenience lots for the artifacts.

ovens at prehistoric sites (Black et al. 1997; Black et al. 1998a, 1998b; Johnson 1991, 1995; Johnson and Goode 1994). The possible utilization of pit oven features in Late Prehistoric sites has recently been documented at the Honey Creek site (41MS32, Black et al. 1997). Numerous types of possible plant foods were recovered in direct association with Toyah age pit oven features at Honey Creek including charred onion bulbs. The oft overlooked Toyah component at the Kyle site records numerous charred onion sheaths and the presence of pit oven like features (41HI1, Jelks 1962).

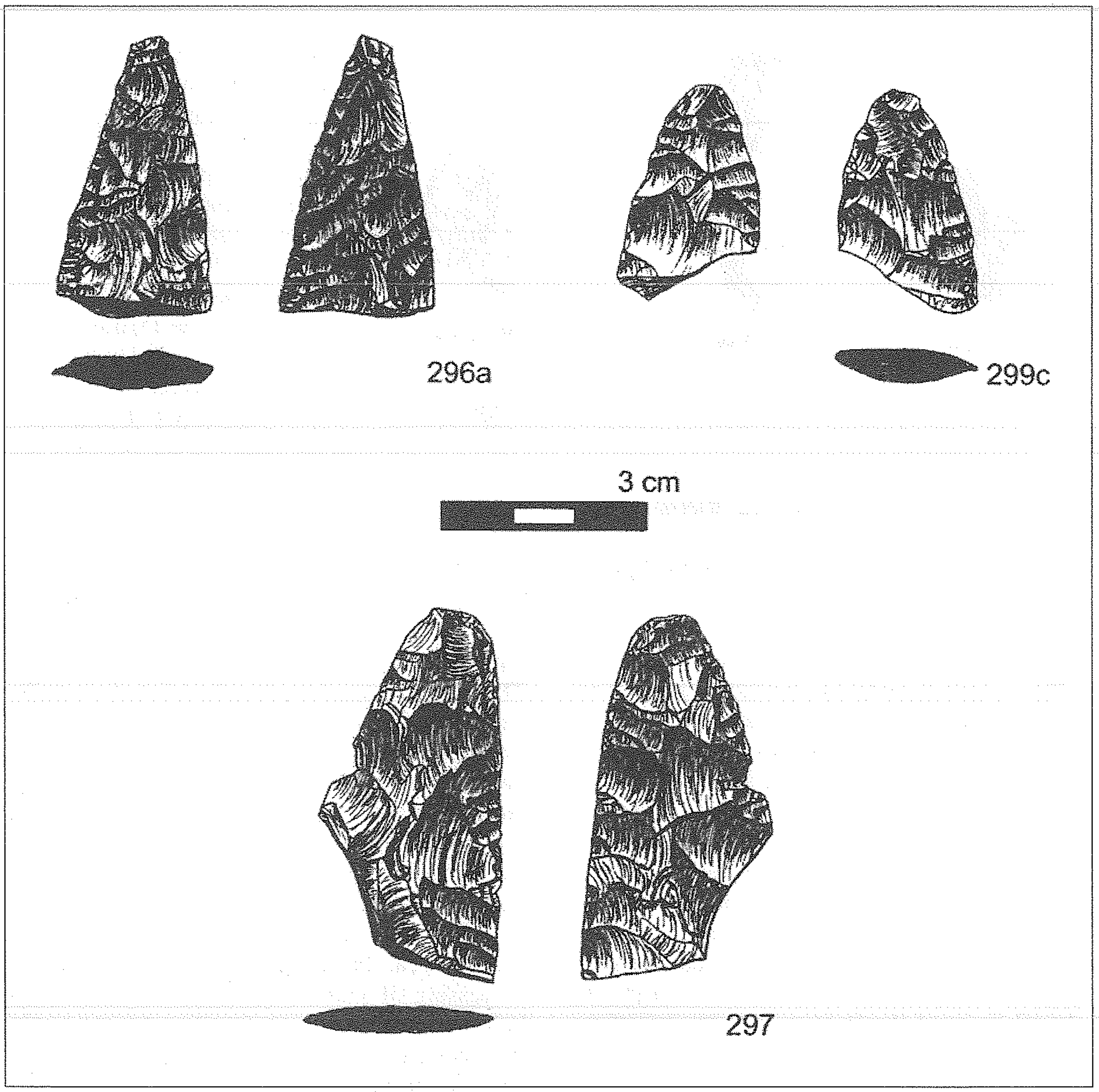


Figure 5b. Select Bifaces from the Toyah Bluff Site (41TV441) Block 2. Numbers denote provenience lots for the artifacts.

At Honey Creek, evidence for oven clean out events (Black 1997:262-265) was identified which extended for one meter beyond the perimeter of two rock features (Fea. 7 and 8). One feature (Fea. 8) was convincingly argued to represent the clean-out debris from another (Fea. 7). Carbonized plant material including charred fuel wood and food was associated with both the oven (F7) and the adjacent debris scatter (Fea. 8) (Black 1997:119; Dering 1997:590). The charred plant debris recovered from the cleanout area adjacent to the earth oven included fragments of yucca/sotol leaf. These materials were part of the food load which was accidentally carbonized during the baking process in the oven (Dering 2001:B-15). In this situation, it would be expected that cleanout trash, especially charcoal, would be scattered across the living surface of the site by human activities and natural forces (Fea. 8).

## Toyah Bluff Pit Ovens

### *Block 1*

The association of earth ovens, ground stone and charred onion bulbs is well demonstrated at the Toyah Bluff site. In particular, the morphology and

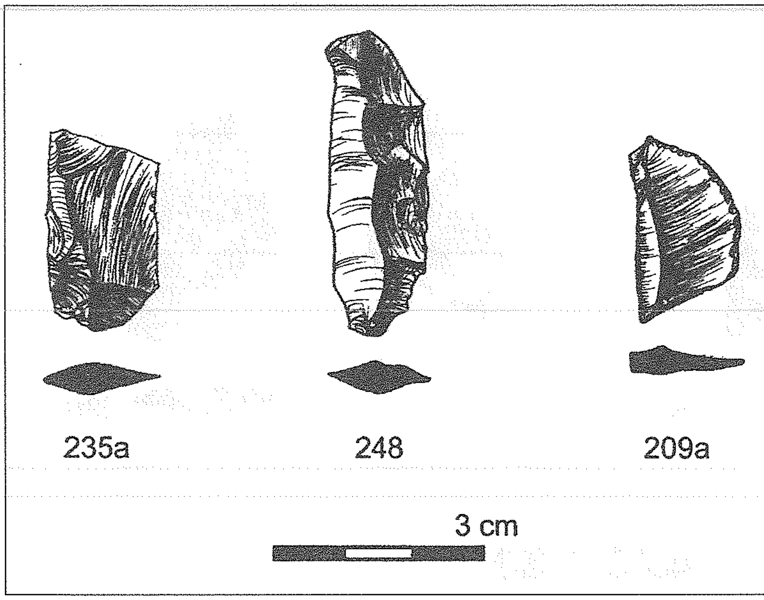


Figure 6. Blades and Modified Blades from the Toyah Bluff Site (41TV441).

content of Features 2 and 11 in Block 1 are central to the contextual, temporal, functional and cultural analyses of the site. Both are interpreted to represent multi-functional earth ovens primarily used for plant food processing. Feature 2 was located in the northwest corner of Block 1 (TUs 9, 10, 15, 16). Feature 2 consisted of a relatively large pit (1x2.2 m in diameter) containing a clearly defined bed of burned rocks lined into a shallow basin (Figures 7-9). The edges of the pit were discrete and marked by distinctive dark, charcoal stained sediments and by the outline of the rocks in the lower basin. The vertical range of the feature, from the top of the stain to the bottom of the rock bed, was approximately 27 centimeters (98.51-98.24, Figure 9). The rock bed consisted of approximately 80 rocks lined in close array in the bottom of the basin. Approximately 50 of the 80 rocks in the basal element were large (10-15 cm in length) rounded, powdery white limestone clasts. The remainder consisted of smaller (ca. 10 cm in length) fractured pieces of quartzite and the occasional chert cobble. The pit extended down into the underlying, culturally sterile clays.

A dense, disorganized pile of fractured quartzite and limestone rocks was present immediately adjacent and west of the upper edges of the stain. Approximately 20 of the 30-35 rocks in the western mound were small, heavily burned quartzite fragments (10 cm or less in length along one axis). These appeared disorganized or heaped into a pile approximately 15 centimeters high (98.51-98.35). A few large, rounded limestone clasts (greater than 10 cm in length) and broken chert cobbles were also part of this rock heap. The mean elevation of the rocks along the western edge (98.45) averaged approximately 10 centimeters higher than the rocks in the bottom of the basin (98.35, see Figure 9). The majority of the rocks in the basin were present within a 10-15 centimeter range (98.4-98.25). Those in the center of the pit were still lower in elevation.

The spatial proximity of the western mound, the stain, and the rock bed suggests a functional relationship between the different Feature 2 elements. The rock bed represents mostly in-situ elements of the feature. The western mound represents a disturbed or displaced feature element. The compositional and spatial variations of the different elements are interpreted to represent functionally distinctive, specific technological components that define overall feature morphology. The construction and systemic use of these different elements represents an important and consistent subsistence behavior at the site.

Macrobotanical associations suggest the pit feature (Fea. 2) may have been utilized in the processing of plant foods. Three charred onion bulb fragments were recovered in direct association with Fea. 2 (Lots 97, 100, 101). A fourth was collected from Test Unit 10 in Level 3 overlying Fea. 2. A charred green or fresh acorn fragment was also identified adjacent to Fea. 1, during the testing phase, which spatially overlapped Fea. 2. Supporting the association of plant foods is the presence of three pieces of ground stone in Fea. 2 (Lots 311a, 314a, b). One of the pieces of ground stone (Lot 314) has a lipped edge suggestive of a metate fragment. The other appears to be a mano fragment (Lot 311a). The feature may not solely have been used for plant processing as a bison premolar/molar fragment (Lot 254) was recovered overlying the pit in Level 3. Matrix samples from feature fill contained a plantain seed and numerous small charred elements of live oak and Texas persimmon wood.

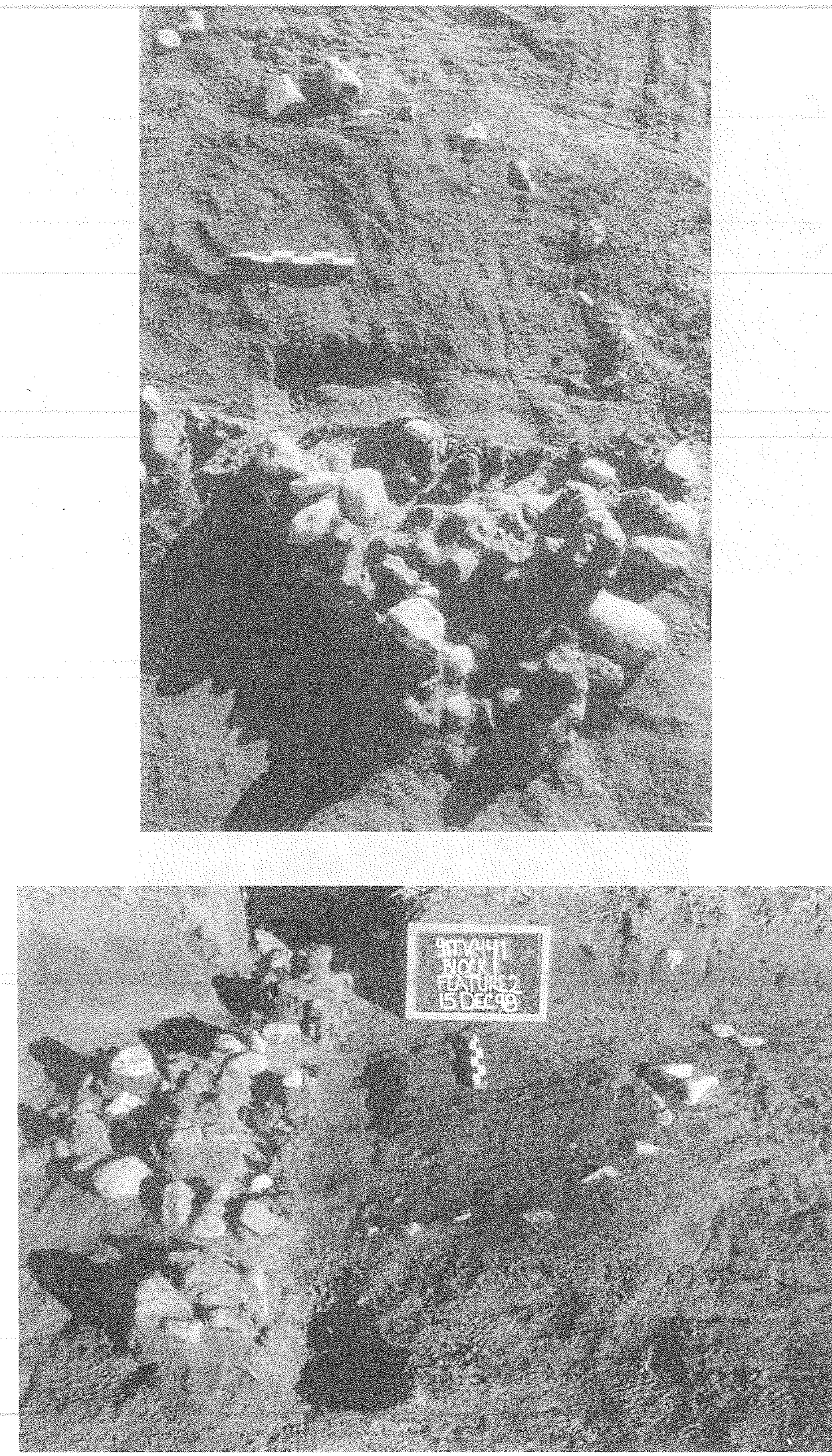


Figure 7. Overview of Feature 2 with Associated Stained Sediments.

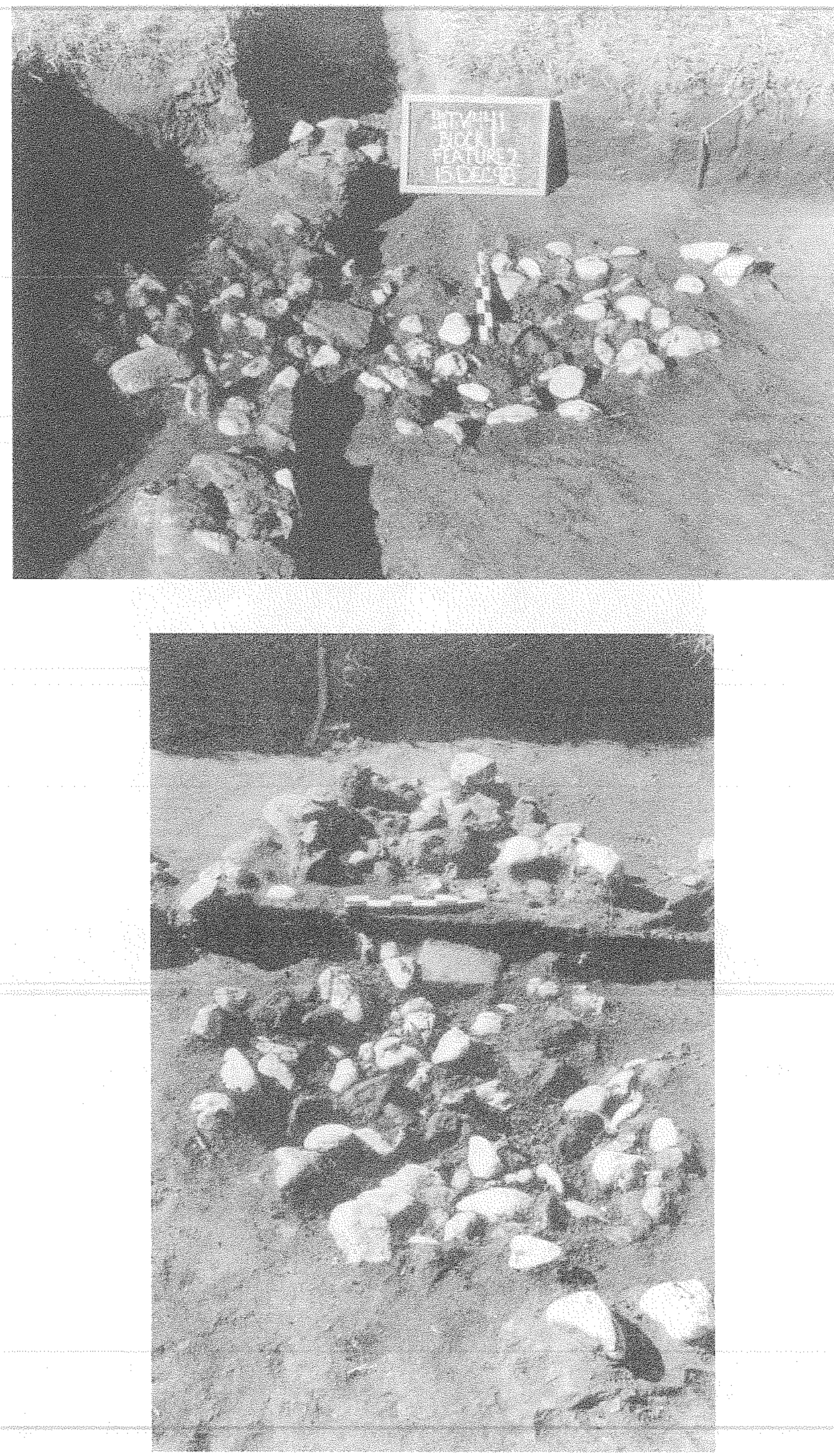


Figure 8. Feature 2 with Associated Large Rock Bed and Rake-out Pile.

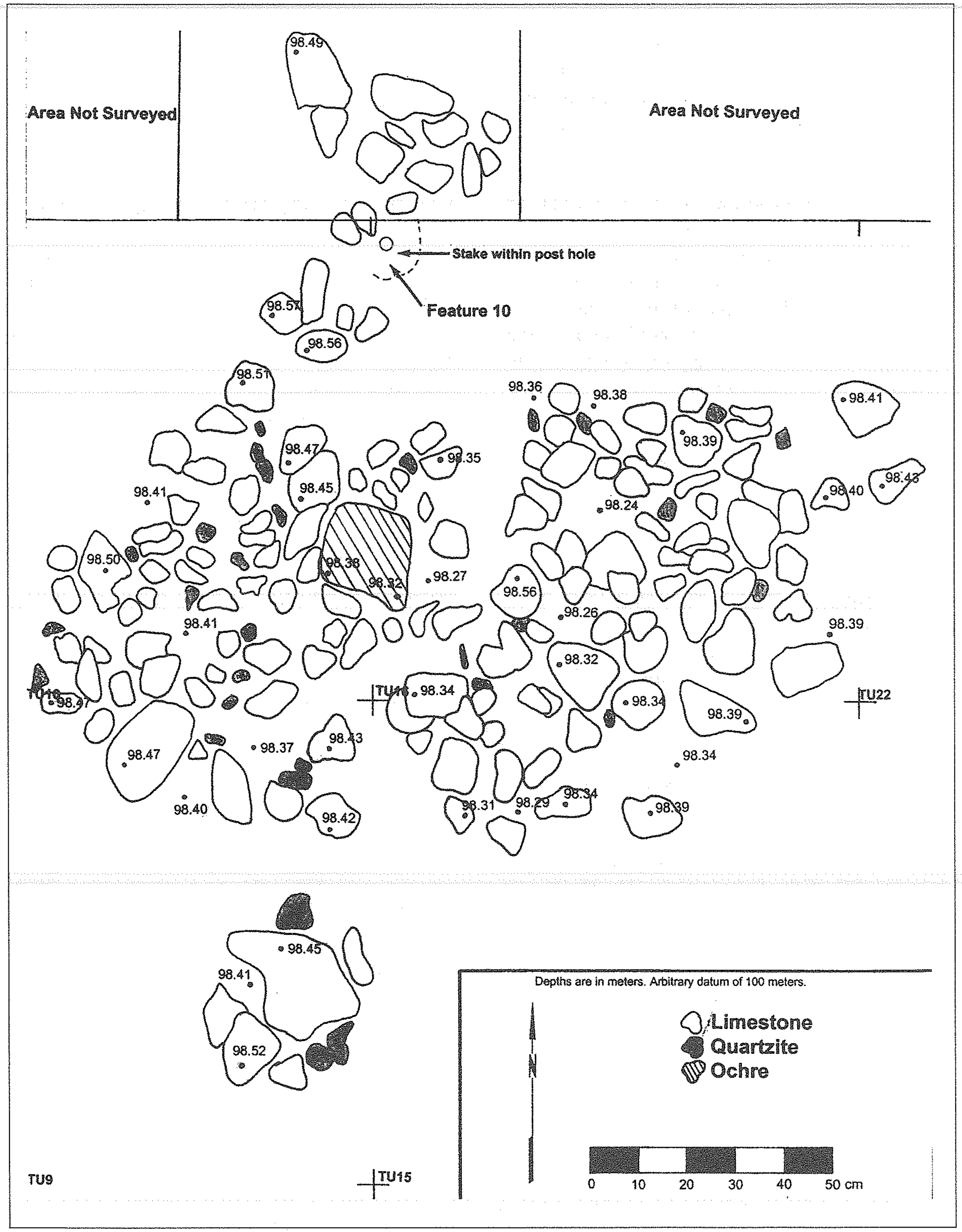


Figure 9. Planview of Feature 2.

Feature 11 was nearly identical in morphology to Fea. 2. This deep pit feature was located immediately south of and adjacent to Fea. 4 (a small concentration of limestone and quartzite rocks- contained one piece of ground stone), in the south central portion of Block 1 (TUs 25, 26). The top of the stained earth of Feature 11 was detected at the bottom of Level 3 and the top of Level 4 (TU 26, 98.43-98.41). The linear stain of Fea. 11 measured approximately 1x.5 meters in diameter. The matrix fill of the pit consisted of a dark black anthropogenic sediment. The outline of the pit and the fill was highly visible against the surrounding terrace deposits. The pit measured approximately 30 centimeters in depth (98.40-98.10). Small fractured pieces of quartzite were recorded along the upper edges of the pit (98.41-98.31) and along the upper northeast corner (n~20, 98.34). Progressively larger rocks were recorded deeper in the pit and these angled inwards towards the center.

A total of 80 rocks were recorded in the central rock bed of the pit (Figure 10). A grouping of approximately 10 large rocks was present in the bottom of the pit. Several of these measured close to 20 centimeters in length (along one axis). One appeared to have cracked in situ, through either weathering or burning. The central grouping of these rocks consisted of 80-90% large, rounded, burned limestone clasts. These are interpreted to represent the remnants of the basal cooking element of an earth oven.

Charcoal was abundant in Fea. 11 at and below the level of the lowest rocks. Four sediment samples from the fill of the feature (Lots 31, 35, 36, 40) collected at or below the level of the rocks yielded six charred onion bulb fragments along with live oak and Texas persimmon wood charcoal. Three quartzite mano fragments were recorded in Fea. 11 (Lot 341a-c). The presence of multiple charred onion bulb fragments and ground stone in the feature, coupled with its pit morphology, is suggestive of plant food processing (Black et al. 1997).

### *Block 2*

In Block 2, Features 9 and 12 are interpreted to represent the basal elements of earth ovens (Figures 11, 12). Both are excavated into shallow pits approximately 20-30 centimeters below the tops of the rocks. The beds consist almost exclusively of large, burned, rounded limestone clasts. The basins extend below the level of the rocks and charcoal was present in the bottom of the basins, below the rocks. Features 13, 15 and 16 were located immediately adjacent and partially overlapping with the F9/12 complex. Feature 13 was a single lens of rocks thick and composed primarily of quartzite. Its disorganized and jumbled appearance coupled with the lack of any basin was suggestive of a lid rock or rake-out pile. Feature 15 was located between Fea. 13 and Fea. 16. Feature 15 consisted of a pit lacking rock. The pit itself was delineated in profile by tracing the edges of the charcoal stained earth. A few burned rocks and other artifacts lined the upper edges of the pit. Charcoal and 1-2 stone tools were found in the bottom of the pit. Feature 16 was a relatively large single lens of rocks abutting the rockless pit (Fea. 15). Feature 16 was composed primarily of fractured quartzite cobbles but contained a variety of different types of burned rocks and stone tools. Feature 16 is interpreted to represent a lid rock or rake-out pile from Fea. 15.

A total of 15 pieces of ground stone were recorded in Block 2. Two conjoining pieces of a sandstone mano were collected from within F9 (Lot 349a, b). This sandstone material does not appear to be local and the artifact may have been imported into the site. Two charred pieces of another refitted mano fragment were recovered from the sediments overlying F9 (Lot 347a, b). A mano/hammerstone was recovered immediately adjacent to Fea. 14 and F9/12 in TU 45 (Lot 293d). Two refitted pieces of a mano fragment were recovered from Fea. 24, in TU 43 (Lot 262a, c). A third ground stone fragment was also recorded in this same cluster (Lot 362b) and a fourth less than a meter distant (Lot 363).

Charred onion bulbs are common in Block 2. These were recovered in apparent association with the rock features. Six charred elements in Block 2 were identified as onion bulbs of the Lily family. The proveniences of these are: 1) the matrix of Fea. 12 (Lot 57); 2) immediately adjacent to F9/12 (Lot 103); approximately 50 centimeters north of Fea. 12 (Lot 99); underneath the rocks in F9 (flotation sample 51); 5) in the sediments associated with Fea. 19 (Lot 102) and 6) in Test Unit 53, adjacent to Fea. 16 (Lot 104).

The recovery of charred bulbs from both feature and non-feature contexts at the site is characteristic of the earth oven cooking process (Dering 2001:B-11). A total of four of the charred onion bulb fragments (Lots 99,101,102,103) come from non-feature contexts. The recovery of even a small



Figure 10. Overviews of Pit Feature 11.

Figure 11. Profile and Cross Section of Feature 9/12 Complex in Block 2. Feature 9 is at left. Notice the basined pit.

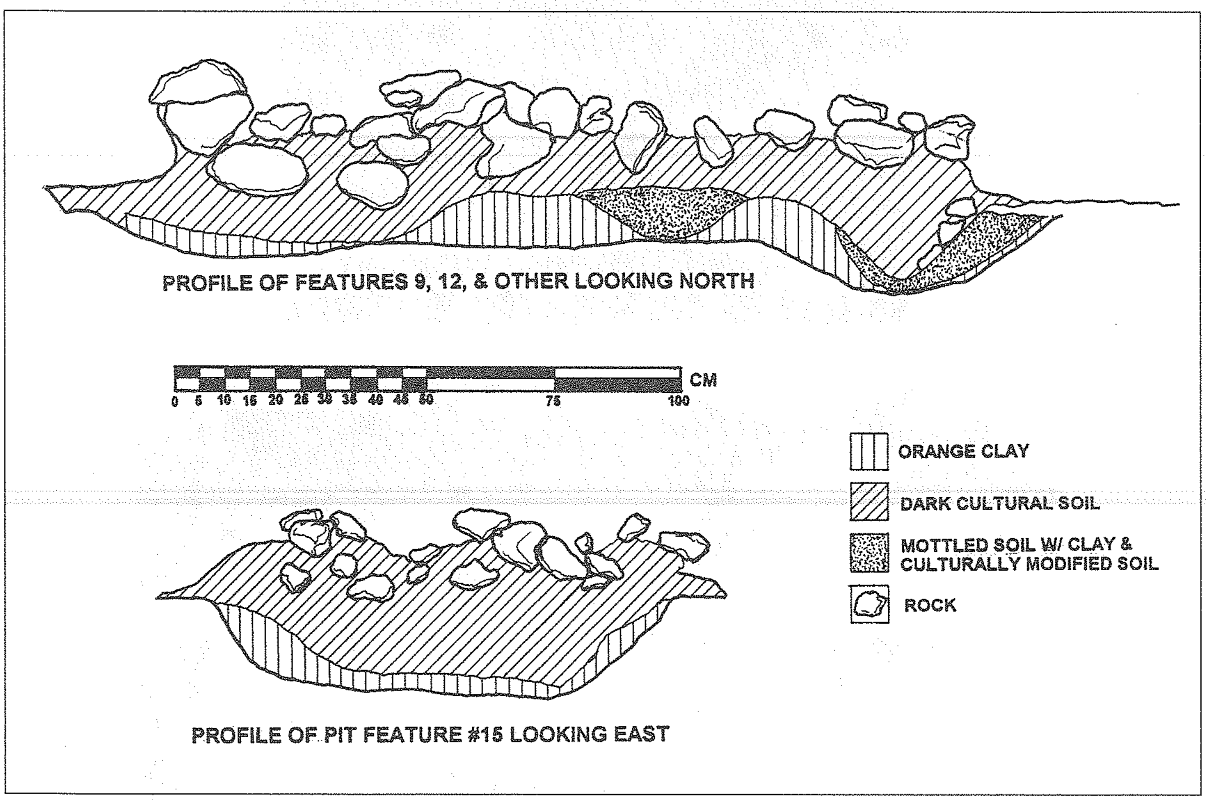


Figure 12. Profile of Pit Features 9, 12, and 15.

number of these bulbs around the edges of these features indicates a functional relationship, for several reasons (Phil Dering, personal communication 1999). For one, plant foods processed in the ovens would likely have been raked out leaving the majority of the surviving elements located outside of and adjacent to the oven, not necessarily within it. The edible onion bulbs would have been consumed and only a few charred, inedible fragments would be left behind. Second, the organic preservation at prehistoric sites is generally such that the survival of only a few charred plant remains may indicate much larger processing events. The presence of charred bulbs or bulb elements from both feature and non-feature contexts indicates the intensity of earth oven use at the site (Dering 2001:B15). In addition to the non-feature material, whole bulbs were noted in Feature 9, and fragments in Features 2, 9 and 9/12 and 11. The presence of bulb fragments from these rock features backs up the evidence of food remains from the non-feature samples and confirms the functions of these earth ovens at the Toyah Bluff site.

## Oven Structure

The structure of earth ovens at the Toyah Bluff site is consistent with several posited models of oven construction and use (Ellis 1997). The earliest ovens at the site appear to have been constructed by first piling wood into the basin, burning it, and then adding rocks, either heated or unheated. The basins in the F9/12 complex in Block 2 show evidence of burned sediment and charcoal was recovered under the basin rocks. Ellis (1997:69) describes a similar construction technique utilized by the Yana of north-central California. Under this method, the wood is fired and the rocks placed on top of the wood. The fire dies down and the rocks collapse into the bottom of the pit. Then the remaining layers of the oven are added. The archeological signature of this technique includes a burned or oxidized soil rind within the pit, a jumbled rather than layer arrangement of basined rocks and large chunks of charcoal (because of the reduced oxygen environment). In this manner, charcoal would be found under, among and atop the rocks (Ellis 1997:69). Ellis (1997) emphasizes variation and recombination of various oven construction techniques. The rocks in F9/12 in Block 2, and Fea. 11 in Block 1, exhibit loose but basically patterned arrangements of basin rocks. Charcoal in Fea. 11 was recovered under, between and on top of the rocks.

Feature 2 in Block 1 may have been constructed differently. The rock bed in Fea. 2 is a closely patterned arrangement. Charcoal was recovered both between the rocks and on top of the rock bed. Such a construction technique is consistent with that observed by the Karok of northern California and the Panamint Indians of southern California, with minor variation (Ellis 1997:67). Under this scenario, the pit is lined with rocks and the fire built on top of the rocks. The ashes are removed leaving the hot rock bed as the heating element. This is followed by the addition of layers of packing material and food. A second fire was then built on top of the oven and/or additional layers of heated stones were used as part of the packing material. The archeological signatures of these types of ovens, again with some variation, would include a lack of burned sediment remaining in the pit. The original pit matrix, however, which would be displaced when the food was removed, would contain bits of burned sediment and charred fragments of packing material. There would also be an organized, patterned rock bed. Under the scenario of additional layers of heated stones, the process of opening the pit and retrieving the food would differentially displace individual rocks from the multiple layers. Many rocks would get tossed out and/or mixed with the burned soil and charred vegetal material. The signature of this type of an oven would consist of a lower, intact pavement of rocks, overlain by a matrix of burned soil, ash, small charcoal flecks and burned rocks. Charcoal would be found on top and among the rocks, as in Fea. 2.

Other documented methods of construction are equally plausible at the Toyah Bluff site. Under a recombination of the above techniques, stones may have been heated in a fire beside the pit. Then hot coals from the adjacent fire were raked into the pit followed by a layer of stones. Hot stones could be added as additional layers of packing material, along with the food. This technique utilizing two separate fires is documented among the Miwok of central California (Ellis 1997:74). The archeological signature resembles those of fires placed first in the pit, but adds the new element of a second fire and additional heated stones. There are two instances at the Toyah Bluff site where smaller rock features are located immediately adjacent to the ovens (Fea. 1, 4). These are not interpreted as discard piles. The second fire method is particularly appealing for the Toyah Bluff site because of the large numbers of heavily burned quartzite rocks that are recorded in apparent rake-out or discard piles. These quartzite rocks could have been heated in adjacent fires.

In fact, the function of the quartzite rocks in these ovens at the Toyah Bluff site is an intriguing and unknown aspect. Hundreds of heavily burned quartzite rocks are present. Some of these are present in the rock beds but most are recorded in adjacent and physically attached piles interpreted to represent discard or rake-out from the ovens. A plausible scenario is that these ovens used heated layers of quartzite as part of the packing material. The heavily burned nature of many of these rocks (fire fractured, blackened) suggests the direct application of flame and consistent with the second fire beside the pit technique. Overall, the use of heated rocks as part of the packing material seems to be consistent with the large numbers of heavily burned quartzite, and their contexts at the site. However, a heavy emphasis on stone boiling is also possible. There may be some evidence of this at the site in the form of intensively processed bone fragments. Skin lined pits and pottery jars were certainly available to the native inhabitants. Boiling and degreasing bones to make pemmican, a transportable foodstuff, is certainly documented among the Toyah (Quigg and Peck 1995). The quartzite rocks may have been ideal for this purpose.

Black et al. (1997:54) suggest that compared to igneous and metamorphic rocks, limestone breaks down faster and produces more waste for the same number of heating/dowsing episodes. By contrast, quartzite is more resilient when heated and allowed to cool in place. In experiments, quartzite rocks exposed to repeated heating/dowsing episodes could be reused for long periods before they exhibited noticeable color changes and jagged breaks (Black et al. 1997:54). In fact, archeological evidence from the northwest United States suggests differential patterning in the breaks exhibited by burned quartzite cobbles (Black et al. 1997:54). It would be interesting to compare the Toyah Bluff rock data within the framework of these results. This is a definite avenue of future research. For the most part, the Toyah Bluff quartzite rocks are heavily burned, reddened, blackened and exhibit jagged fracture patterns. Spatial association suggests that concentrated piles of these may have been part of the earth ovens. All of the piles interpreted as rake-out/discard contained large limestone rocks as well and there were no isolated piles of pure quartzite. Still, a combination of stone boiling and the use of hot quartzite rocks in the ovens is plausible. A charred but fresh acorn was recovered near Feature 2 in Block 1. The current data set does not provide a definitive answer on this issue.

## SITE DATING

The dating of charred organic remains in association with these hearth features indicates a series of overprinted Late Prehistoric events. The geomorphic situation is also consistent with that of a culturally overprinted archeological surface. Yet, the total range of occupation indicated by the radiocarbon dates for the site as a whole is only some 225 years. The earliest dates are from Block 2. A charred onion bulb from Fea. 12 (Lot 57) has yielded an AMS radiocarbon assay of 800 +/-60 B.P. (Intercept 1235 A.D., Beta 131108). Charred live oak wood (Lot 92) from the bottom of Fea. 15 yielded an AMS radiocarbon assay of 800 +/- 50 B.P. (Intercept 1205 A.D., Beta 131110). Thus, the spatially overlapping complex of pit and other features from Block 2 range at 2-sigma probability from approximately A.D. 1040 to 1290 with intercepts at A.D. 1205 and 1235. The onion bulb from Fea. 12 (Lot 57) was embedded deep within the matrix of the feature within the rock bed and appears to represent primary context, despite the erosional terrace situation. The temporal framework from the Block 2 features is therefore terminal Austin interval. These dates might be interpreted as consistent with the presence of Scallorn and other side-notched arrow points present in Block 2, and/or the transitional Archaic dart point that was recovered in Block 2.

The AMS radiocarbon dates from Block 1 are later but consistent with those from Block 2. In Block 1, charred live oak wood (Lot 84) from Fea. 11 yielded an assay of 710 +/- 50 B.P. (intercept A.D. 1275, Beta 131109). The 2-sigma calibrated range is A.D. 1205-1300. The wood from Fea. 11 was collected from numerous charcoal elements embedded between the bottom rocks of the bed in the pit and there is no evidence of disturbance or significant overprinting in Block 1. Still later, a charred onion bulb (Lot 97) from Feature 2 in Block 1 yielded an assay of 520 +/- 60 B.P. (Intercept A.D. 1425, Beta 131111). The 2-sigma calibrated range is A.D. 1310-1480. Similarly, the onion bulb fragment from Fea. 2 was collected from charcoal stained sediments between the rocks of the immense rock bed, at the base of the rocks. The Fea. 11 date is terminal Austin or transitional into the Toyah Interval. The Fea. 2 assay falls squarely into the known range of the Toyah in central Texas. Each of these features was excavated by the aboriginal inhabitants on the same archeological surface, approximately 150 years removed in time. Yet, the pits are identical and contain the same types of charred materials in the form of oak wood and onion bulbs.

Three of the intercept dates between the two blocks are very consistent and range within about 70 years of each other (intercepts from A.D. 1205-1275). The total range of occupation indicated for the site is approximately 225 years but could be more based on the heavy density of Toyah related materials near the surface. There is an increasing density of Toyah diagnostics in the upper disturbed portions of the site.

## ASSEMBLAGE COMPOSITION

One of the critical issues at the site given the radiocarbon dates (ca. A.D. 1225) is the co-occurrence of Scallorn and other side notched arrow points with Toyah diagnostics. In Block 2, Toyah and Austin phase diagnostics co-occur within the context of a diverse assemblage. Two Scallorn (Lot 301, 361) and two unclassified side-notched arrow points (Lot 293b, 233) were recovered in Levels 2-3 along with two Perdiz preforms (Lot 291a, 293a), one Perdiz point (Lot 302a), one beveled knife (Lot 296), three blade-like flake tools/blades (Lot 370, 373e, 292c), one uniface (Lot 312), and one perforator (Lot 301a). Three additional flake blades were recovered from the contextual zones (Levels 2-3) in shovel tests immediately adjacent to Block 2 (Lot 95c, d, 110b). Overall assemblage diversity in the contextual zones in Block 2 includes 17 bifaces, 10 pieces of groundstone, 13 cores/core fragments, seven modified flakes and 13 pieces of ocher. The radiocarbon dates are early for what is considered to be the range of the Toyah and consistent for what has generally been considered the end of the Austin phase.

The presence of Scallorn and other side notched arrow points is consistent with either an Austin or a Toyah Interval occupation. The AMS radiocarbon dates (A.D. 1225) are consistent with an Austin Interval occupation, according to the current literature. However, the presence of a possible Perdiz preform seemingly in context adjacent to Fea. 14 (Lot 299a, 99.36 below datum) is suggestive of Toyah influences. Two blade-like flake tools (Lot 370, 373e) were found in apparent contextual sediments in Test Units 42 and 46, in the southern portion of Block 2. These were located adjacent to the rock filled pit Fea. 25 which contained a Scallorn arrow point (Lot 361). A modified blade was recovered from the screened sediments of Unit 44, adjacent to F9 and Fea. 13. In this context, blade technologies are Toyah indicators.

The presence of a beveled knife (Lot 296a) and numerous small, intensively processed bone fragments in the matrix fill of Fea. 13 tolerably argues for a Toyah feature. These artifacts were not found on the erosional surface but in the fill of Fea. 13, which appears to be the rake-out pile of a pit feature whose morphology is uncharacteristically Toyah. Additionally, intensively processed bone fragments are Toyah indicators, and overall assemblage diversity is also suggestive of a Toyah occupation. In contrast, Austin phase assemblages are noted for a lack of diversity (Black et al. 1997). There are two possible interpretations for the Toyah Bluff assemblage. Toyah materials may be overprinted onto an Austin Interval series of features throughout several hundred years at this site, or the peoples who constructed the central midden complex of Block 2 were utilizing a blade oriented and highly diverse lithic assemblage during what is characteristically considered pre-Toyah times.

Two Toyah lithic forms are present in the contextual zones of Block 1 and the overall assemblage is diverse. One modified blade (Lot 248) and a modified flake perforator manufactured on an expanding stem arrow point (Lot 273a) were recovered from Level 3 of Block 1. The stone tool assemblage in Levels 3-5 consists of five bifaces, 10 pieces of ground stone, seven cores or core fragments, two modified flakes and 10 pieces of ocher. Given the erosional nature of the terrace, some of these forms could have migrated down through the sediments. Others may be the result of Toyah occupations occurring on the same original surface as earlier occupations.

Although ceramics were recovered from the Toyah Bluff site, very little can actually be said about the ceramic making industry and use, since most of the sherds found were very small and highly eroded. Based on paste alone, however, a few inferences have been made. The ceramic assemblage supports the idea that the people who lived at 41TV441 were culturally affiliated with the Toyah people. Eighteen of the ceramic sherds recovered at the Toyah Bluff Site (Group 1) exhibit characteristics that fall well within the range of Toyah ceramics. These ceramics are made of course sandy paste tempered with bone. All appear to be undecorated. However, a second ceramic type, Group 3, suggests that there may also have been other cultural influences operating. Fifteen ceramic sherds fall into the Group 3 category, defined by a fine hard sandy paste with only occasional bone tempering. The Group 3 ceramics strongly resemble undecorated Rockport ceramics of the Texas coast and may indicate cultural influences from other regions, such as the Texas Coast or the Eastern Cross-Timbers region.

## SYNTHESIS AND CONCLUSIONS

The cultural zones in both blocks 1 and 2 exhibit non-random patterning for all artifact classes. Clearly the burned rock features, especially the pit ovens, exhibit patterned arrangements. Debitage, bone and ceramics are present throughout both blocks but are localized and concentrated near the features. Although the upper portions are somewhat disturbed, these zones represent a series of intact Late Prehistoric subsistence related events. The occupations occurred from approximately A.D. 1200 to at least A.D. 1425. This time frame spans what has consistently been thought of as the late and/or transitional Austin Interval into the Toyah Interval of central Texas prehistory. There was clearly a Toyah presence at the site. This assertion is based on the recovery of Perdiz arrow points, beveled knives, endscrapers, perforators, modified flakes and blades, ocher and bone tempered ceramics. There are also Scallorn and other expanding stem arrow points recovered in close spatial proximity to the earliest dated hearth features at the site.

The most remarkable aspect of the site is the consistent association of earth ovens, ground stone implements and charred onion bulbs with Late Prehistoric lithic artifacts and radiocarbon dates. There is a consistent set of associations between pit oven features and charred plant remains throughout the entire history of the site. Charred onion bulbs are present in and around the Feature 9/12 complex in Block 2 at A.D. 1235, in Feature 11 in Block 1 at A.D. 1275, and in Feature 2 in Block 1 at A.D. 1425. One definite function of the site is onion bulb processing. Animals and shellfish were also processed and presumably consumed. The plant food processing aspect is not unheard of (Black et al. 1997) but is relatively unique for a Late Prehistoric site. At least one of the earth ovens is Toyah in age (Fea. 2). The possibility of plant food processing in earth ovens is particularly unique for a possible Toyah occupation, especially in the relative absence of significant faunal remains at the site (see below). So, given that the site function remains consistent, the issue becomes, were these Austin or Toyah Interval occupations, or both?

Erosion at the site makes it difficult to definitively address this issue. Artifacts from the later Toyah occupations could have filtered down through the sands and into the earlier ones. This aspect may be more pronounced in Block 2. Throughout two hundred years or more of intermittent Late Prehistoric occupation, artifacts were discarded and compressed into a single zone or archeological surface remnant, then shallowly buried by a combination of factors.

There are three possible interpretations for the origin of the Toyah Bluff site. These are: 1) An invasive Toyah group initially occupied the site ca. 1200 A.D. bearing attributes of "Classic" Toyah culture, but also some variations in terms of side notched arrow points and different styles of a crude utilitarian pottery (manufactured or later acquired). These people then intermittently occupied the site to process plants, animals and shellfish throughout several hundred years; 2) An Austin Interval group was replaced by an invasive Toyah group in the later history of the site or 3) an Austin Interval group gradually experimented with and adopted a blade technology throughout a history of intermittent occupations, and evolved into a Toyah culture. Whichever is the case, it is certain that earth ovens were utilized to process a variety of subsistence resources, especially onion bulbs.

We favor the idea of an Austin Interval group gradually adopting a blade technology and contracting stem arrow points for several reasons. It is reasonably well documented that Austin Interval peoples processed plant foods. Hearth features are constructed and utilized in the same manner throughout the history of the site, to process the same sorts of subsistence materials, which argues against succeeding groups of different sociocultural affiliations. There is also evidence of a Perdiz arrow point and blade technology that intensifies through time. The patterning observed in lithic reduction debris and faunal materials also remains consistent throughout the history of the site. The following discussion explores these and related issues and focuses on the implications of the data on the three possibilities mentioned above. The possibility is also explored that the site may represent a warm season Toyah plant food processing station (Black et al. 1997).

## Hearth Feature Morphology and Utilization

One very important aspect among many at the Toyah Bluff site (41TV441) is the consistent morphology of the hearth features. At least one use of all the pit oven features at the Toyah Bluff site was for the processing of onion bulbs. Charred onion bulbs were recovered from a number of pit oven feature contexts at the site. A total of 10 charred onion bulbs were recovered from Block 1, within or adjacent to the major pit features (Fea. 2, Fea. 11). Six additional onion bulbs or bulb fragments were recovered in Block 2. The use of pit oven features for the processing of plant foods and related incipient burned rock midden formation has been extensively detailed in the recent archeological literature, though generally not related to Toyah sites (Black et al. 1997; Black et al. 1998a, 1998b; Jelks 1962; Johnson 1991, 1995; Johnson and Goode 1994). Supporting the possible association of ovens and plant foods at the Toyah Bluff site is the notable presence of ground stone. A total of 29 pieces of ground stone were recovered at the site, nearly all of it in hearth feature contexts.

Pit oven features at the Toyah Bluff site likely functioned in many capacities, not just for plant food processing. A number of animal bones were recovered in hearth feature contexts. In general, animal bones are one of the least numerous of the documented artifact classes but were clearly part of the subsistence strategy. It is tempting to suggest that plant food processing was more important than animal food processing at the Toyah Bluff site, given the physical remains (earth ovens, 29 pieces of ground stone). Other Toyah sites exhibit the presence of thousands of bones in specialized intensive processing areas (Creel 1990; Johnson 1995; Ricklis 1995). It is also possible that poor faunal preservation coupled with erosion at the site has destroyed most of the remaining animal bone. It may be that a bone processing area once existed in other areas along the ridge but now is heavily disturbed. Bivalves may also have formed a very important dietary component. Numerous elements of fresh water mussel were recovered and these can be baked easily in an earth oven.

The radiocarbon dating of associated macroplant remains coupled with feature morphology illustrates a consistent method of construction and use of pit ovens throughout the history of the site, though tending towards elaboration in size. The same types of rocks were employed in the pit ovens, in the same types of arrangements. The same types of plant foods were processed in ovens of varying sizes. Hearth features that span some 225 years or more in time are associated with the same sorts of charred plant remains, exhibit the same technology, and most are associated with ground stone. Such continuity strongly suggests a single ethnic group who maintained a consistent subsistence technology through time, at a particular location on the landscape. This observation has important implications for the issue of whether the Toyah represent an influx of a specific toolkit or the migration of an invasive people.

## Site Function

It is well documented that Austin phase peoples created and/or utilized a number of burned rock middens (Kleinbach et al. 1995; Quigg and Ellis 1994; Treece et al. 1993). Radiocarbon dates and subsistence data from the Honey Creek (41MS32) and other central Texas sites suggest a strong presence at and/or the utilization of a number of burned rock middens by Toyah peoples (Black et al. 1997). It has also been effectively argued that burned rock midden formation is functionally related to the use of earth ovens (Black et al. 1997, 1998b). The kitchen-midden complex at the Toyah Bluff site has all the appearance of a burned rock midden in the early stages of formation. The very high density of burned rocks and other artifactual debris is clearly the result of multiple instances of earth oven utilization.

The consistent association of ground stone with the pit features and charred onion bulbs cannot be ignored. In discussions of the Honey Creek site (41MS32, Black et al. 1997) the authors suggest the possibility of the existence of other types of Toyah sites than just bison/deer processing stations, or stone tool manufacturing localities. These authors posit that the generalized need for starchy foods may have fostered a measure of reliance on plant foods, and that these types of sites may be obscured in the archeological record. Late Prehistoric sites of this nature are difficult to detect because they are generally overprinted onto the remains of earlier occupations, including burned rock middens. Such a subsistence strategy may have been practiced during the warmer seasons when bison were generally less available in central-Texas. Late prehistoric plant food exploitation at the Honey Creek site may have been primarily a warm season occupation (Black et al. 1997). Creel (1990) suggests that Late Prehistoric bison exploitation at 41TG91, in northwest central Texas was primarily a cold season activity. As part of the 41TG91 study, Scott and Creel (1990) posit that the lower portion of the Toyah A-3 zone was a warm season occupation because of the relative scarcity of bison bone in the presence of numerous, warmer season small mammal bones.

Was the Toyah Bluff site primarily a warm season plant food processing station focused on the utilization of a burned rock midden? This possibility must be accounted for, and given the physical data at the site, is even quite likely. Bison and deer processing stations at 41TG91, the Buckhollow site (41KM16), the Mustang Branch site (41HY209T, Ricklis 1994) and the Hinojosa site (41JW8, Black 1986) record many thousands of large mammal bone fragments, in the presence of many smaller mammal elements and rarely a pit feature or a piece of ground stone.

The Toyah Bluff site (41TV441) was definitely a different type of site than has been typically documented in the settlement-subsistence system of the Late Prehistoric Interval of this area along Onion Creek, adjacent to the Edwards Plateau. Several Toyah sites upstream, which post-date the Toyah Bluff site, represent specialized processing areas and/or base camps. These sites exhibit considerable functional and structural diversity within a very limited area (41HY202A, 41HY209T, 41HY209M, Ricklis and Collins 1994). Yet none of these sites resemble the Toyah Bluff site. The Barton Site North (41HY202A) is a distinctive lithic production/stone tool manufacturing area. The Mustang Branch site (41HY209T) is a large mammal processing and possible base camp. Still another site (41HY209M) is a burned rock midden which exhibits a thin layer of Toyah refuse overlying what appears to be an Austin Interval occupation. Was the Toyah Bluff site a burned rock midden in the making? If so, were these people Austin or Toyah people, or both? These are some the important questions for future research at other sites that emerge from the analysis of the Toyah Bluff site.

## The Toyah Techno-complex

### *Implications for the Austin/Toyah Regional Framework*

It seems clear that the first group occupying the site processed onion bulbs, animals and shellfish, in a series of spatially overlapping pit ovens and/or rockless pits represented by Block 2. Occupation of the site continued intermittently for at least 225 years, probably more. Throughout this time pit ovens were constructed closer to the ephemeral drainage to the east of the site (ca. A.D. 1275-1435). These were larger and placed farther apart than their predecessors on the western ridge. The morphology of these pit features was identical in form, structure and content to those located to the west. Continuity was maintained in hearth feature morphology and utilization throughout the site's history. Stone tool manufacturing and refurbishing was consistently an important site activity. At some point, Toyah lithics came to dominate the site, but when? The erosional terrace situation and its possible effects on assemblage composition have been noted. We will more closely examine the most plausible scenario of site formation.

An Austin Interval group gradually experimenting with and adopting a blade technology throughout intermittent occupations at the site seems the most plausible explanation. In fact, we favor the idea of an Austin Interval group in the process of either adopting the Toyah lithic techno-complex or initially occupying the site with a blade technology in hand. For one, Austin phase peoples are well known for the construction of burned rock middens which presumably can be equated with earth ovens and a certain measure of plant food exploitation (Black et al. 1997). There is certainly evidence of incipient midden formation and plant food exploitation at the site. Secondly, the only material aspect that really changes throughout the history of the site is the ratio of numbers of side-notched to contracting-stem Perdiz projectiles. All but one of the side-notched arrow points were found in association with the kitchen-midden complex in Block 2 in areas that yielded the earliest dates (ca. A.D. 1205-1235). Most of the Perdiz arrow points were recovered in the upper disturbed sediments. Only two Perdiz points were recovered in the contextual zones of either block. This may reflect an increased reliance on Perdiz forms in the later history of the site.

One of these Perdiz arrow points was recovered relatively deep in the sediments adjacent to Fea. 14 in Block 2. The artifact is an aberrant Perdiz-like preform. It is longer than all of the Perdiz points recovered at the site. Its crude, bifacial morphology is suggestive of experimentation rather than fine tuned production. This artifact was recovered immediately adjacent to the main earth ovens in the kitchen midden complex and from the same context as the Scallorn and other side notched arrow points. A number of blades and blade-like flakes were also recovered in the contextual zones of Block 2. The presence of this odd Perdiz-like preform might suggest experimentation with a contracting stem variant of arrow point while side-notched arrows were still in use. Ricklis (1994) suggests that the bifacial Perdiz forms may have preceded the flake-Perdiz forms. In Block 1, a modified *blade* and a perforator manufactured on an expanding stem arrow point were recovered, but no Perdiz arrow points (Levels 3-4). The presence of these two artifacts is consistent with the idea of the possible adoption of a blade technology that did not yet include large numbers of Perdiz arrow points.

In support of the adoption of the lithic techno-complex, Ricklis (1994:301) suggests that there is no compelling evidence for the migration of the Toyah peoples and the subsequent displacement of existing groups. The corollary to large scale migration is that much of the indigenous central Texas population must have retreated in the face of a dynamically expanding Toyah occupation. Based on the documented radiocarbon evidence, this must have occurred during the A.D. 1300's. Yet, there are few documented archeological components of post A.D. 1300 range that can be attributed to such displaced groups. In fact, nearly all of the sites that date to this period yield Toyah-like assemblages. Ricklis (1994:303) also convincingly argues that evidence of the diffusion of the Toyah tool kit is straightforward along coastal areas of Texas. The Rockport component of Site 41RFea. 21 in Refugio County, Texas exhibits Toyah complex traits and subsistence patterns, yet sandy paste, asphaltum-coated and/or decorated Rockport ware pottery. Ricklis (1994:304) suggests that the linguistically and ethnically distinct coastal Karankawans rapidly responded to the influx of bison and adopted the primary elements of the toolkit. The data from this and other coastal sites supports the adoption of the toolkit rather than the influx of people.

The geomorphic situation on the terrace precludes a definitive answer. A prominent scenario is that an Austin Interval group initially occupied the site bearing both side-notched arrows and some measure of a blade technology (or began to adopt Toyah lithics shortly thereafter), and were experimenting with Perdiz points and other pure Toyah lithic forms. Through time, Toyah lithic forms were more widely utilized evidenced by the increasing density of these forms in the upper sediments of the site. The use of side-notched arrows was gradually phased out at the site in favor of the use of Perdiz points. If so, then the Toyah Bluff site (41TV441) may represent evidence of the adoption of the Toyah lithic techno-complex slightly earlier than has been previously documented in central-Texas (ca. A.D. 1200).

## Cultural Ecological Model

If the Toyah in this region represent the influx of lithic techno-complex, then the site may represent a continuation of the basic Austin Interval subsistence adaptation. Under a culture-ecological model for the diffusion of the Toyah complex (Ricklis 1994) and its effects on Austin Interval groups, culture change through time would have been measured in a number of different ways. In response to the stimulus of a return to relative arid climatic conditions, bison may have become more prevalent in the area (Ricklis 1994). Bison represented a greater subsistence resource in terms of food quantity and invaluable hides. The mobility of existing groups increased in response to the mobile nature of the bison. The adoption of an available technology geared to the procurement of large game may have been facilitated by increased mobility and constant contact with neighboring groups (Ricklis 1994). These peoples may have practiced their subsistence rounds in limited interaction spheres based on the observed variation in regional ceramics (Ricklis 1994).

As these groups became more highly mobile, sites became more specialized in function (bison processing, lithic reduction, plant food processing) and a greater number of different types of sites appeared in the archeological record. These peoples may have adopted new technology and strategies to exploit bison, but did not give up previously established, reliable subsistence practices. Plant food processing localities such as the Toyah Bluff site continued to be utilized but perhaps less frequently due to the increased focus on large game. Burned rock midden locations would have been revisited with the new tool kit in hand. The result would be Austin Interval and Transitional-Late Archaic middens that appear to be culturally overprinted with Toyah debris (thin veneer hypothesis, Black et al. 1997). These ideas account for some possible aspects of culture change between the Austin and the Toyah Intervals, instead of the migration of peoples, and are consistent with the archeological record.

The Toyah Bluff site provides no real answers but accentuates the questions. There is compelling data to suggest that the adoption of the lithic technocomplex occurred earlier in this area than is previously documented (ca. A.D. 1235). There is also compelling evidence to suggest that groups with Toyah affiliations (people or tools) had a greater reliance on plant food processing than previously thought. Better stratified and preserved sites which contain definite individual components which date to this time frame are necessary to thoroughly address these issues. These are certainly the types of sites and sorts of research questions that should and could be profitably addressed in any future research dealing with the Austin/Toyah regional framework.

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# Radiocarbon Dating of a Deer Image from the Lower Pecos River Region, Texas

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## ABSTRACT

Organic carbon was extracted for radiocarbon analysis from a pigment sample removed from a small pictograph in Seminole Canyon (Site 41VV75) in the Lower Pecos River region of southwest Texas. The dated figure is a dark, purple/red painting of a deer measuring approximately 10 to 20 cm in length. The sampled figure is part of a larger panel of a series of eleven deer traveling upwards and to the right as one faces the panel. The sample was taken from a highly degraded image using a new scalpel blade. Plasma-chemistry was used to extract organic carbon. Because the background contamination from unpainted rock was negligible, the age is expected to be reliable. However, as always with a single radiocarbon determination, caution is advised pending further studies. Radiocarbon analysis provided an uncorrected age estimate of 1280 ± 80 years before present (B.P.). This estimate is in close agreement with a previous age of 1280 ± 150 years B.P. obtained from a red-pigmented Red Linear painting at another site in the area, 41VV162A. The deer pictograph is approximately 1500 years younger than almost all of the Pecos River genre paintings we have dated from the same shelter. It is most likely of the Red Linear genre.

## INTRODUCTION

The advent of tandem accelerator mass spectrometry (AMS) for radiocarbon analysis greatly reduced the amount of carbon necessary for an age estimate (Bennet et al. 1977; Muller 1977; Nelson et al. 1977) so that even a small pictograph sample might be dated. Over the past decade, radiocarbon dates have been obtained from pictographs in several states, including Arizona (Armitage et al. 2000; Farrell and Burton 1992), California (Armitage et al. 1997), Missouri (Diaz-Granados et al. 2001), Montana (Chaffee et al. 1994a), Utah (Chaffee et al. 1994b; Geib and Fairley 1992), Wisconsin (Steelman, Rowe, Boszhardt and Southon 2001), and several locations in Texas (Chaffee et al. 1994c; Hyman et al. 1999; Ilger et al. 1994a; 1995, 1996; Pace et al. 2000; Russ et al. 1990, 1992). Pictographs from several countries have been also dated, including Angola (Ilger et al. 1995), Australia (Armitage et al. 1998; David et al.1999, 2001), Belize (Rowe et al. 2001), Brazil (Rowe and Steelman 2003), France (Ilger et al. 1994b), Guatemala (Armitage et al. 2001), Mexico (Ilger et al. 1995), and Russia (Steelman, Rowe, Shirokov and Southon 2001).

The present study is concerned with pictographs in the Lower Pecos River region of Val Verde County, Texas. There are four prehistoric genres of rock paintings in the Lower Pecos River region. The most common and impressive style is polychrome Pecos River genre (Kirkland and Newcomb 1937; Grieder 1966; Turpin 1982). Nineteen samples of this genre in a rockshelter at Site 41VV75 have been radiocarbon dated to the era 2750 to 4200 years B.P. (Chaffee et al. 1994c; Ilger et al. 1995, 1996; Pace et al. 2000; Russ et al. 1990, 1992). A less common, but similar polychrome Lower Pecos Bold Line Geometric style (Turpin 1986a) has not yet been subjected to radiocarbon analysis. A third genre is the much rarer Red Linear (Kirkland and Newcomb 1937; Grieder 1966; Turpin 1984, 1990) which is arguably the style subject of this paper. Previously, one radiocarbon age estimate of 1280 ± 150 years B.P. has been obtained from a pictograph representing this genre at Site 41VV162A (Ilger et al. 1994a). Finally, for the fourth style, Red Monochrome (Kirkland and Newcomb 1937; Grieder 1966; Turpin 1986b), there is archaeological evidence placing it in the time span of ca. 650 to 1350 B.P. (Turpin 1986b) based on the presence of painted illustrations of bows and arrows. One radiocarbon age estimate of 1125 ± 85 years B.P. has been obtained from a pictograph of this style (Ilger et al. 1994a).

In the rockshelter site 41VV75 in Seminole Canyon State Historic Park there is a panel with about eleven highly degraded pictographs of deer. Each measures about 10-20 cm in length and the series of deer seem to be progressing upward and to the right of the shelter as one faces the images. They are located near the center of the shelter. Figure 1 shows one of the better-preserved images of these deer; however, it is not the image studied here. The image we sampled was one of the more badly spalled of the group. This panel of deer does not fit neatly into any of the four styles. Of the four prehistoric genres, only Red Linear and Pecos River styles are plausible for the deer paintings at 41VV75. The deer are more realistic than is typical for accepted Red Linear paintings, but the small size is more characteristic of Red Linear style than for Pecos River style, although small Pecos River genre paintings do exist. Similar deer figures at Panther Cave, White Shaman site, and Cedar Springs are painted amidst many Pecos River style paintings that are typically slightly larger in size. No depictions of deer measuring a meter in size are found in the Pecos River genre paintings. Well-defined images of the Pecos River style are often, but not always large scale, i.e., meter size and larger. The radiocarbon age estimated in this work is not consistent with our earlier dates on Pecos River genre paintings: nineteen radiocarbon determinations from 41VV75 yield age estimates that range from 2750 to 4200 years B.P., older than the age estimate for the deer depiction dated here. On the other hand, it agrees exactly with the one previous radiocarbon age estimation for a Red Linear figure.

## EXPERIMENTAL PROCEDURE

Rubber gloves were worn during sample collection and handling. Surface material about the

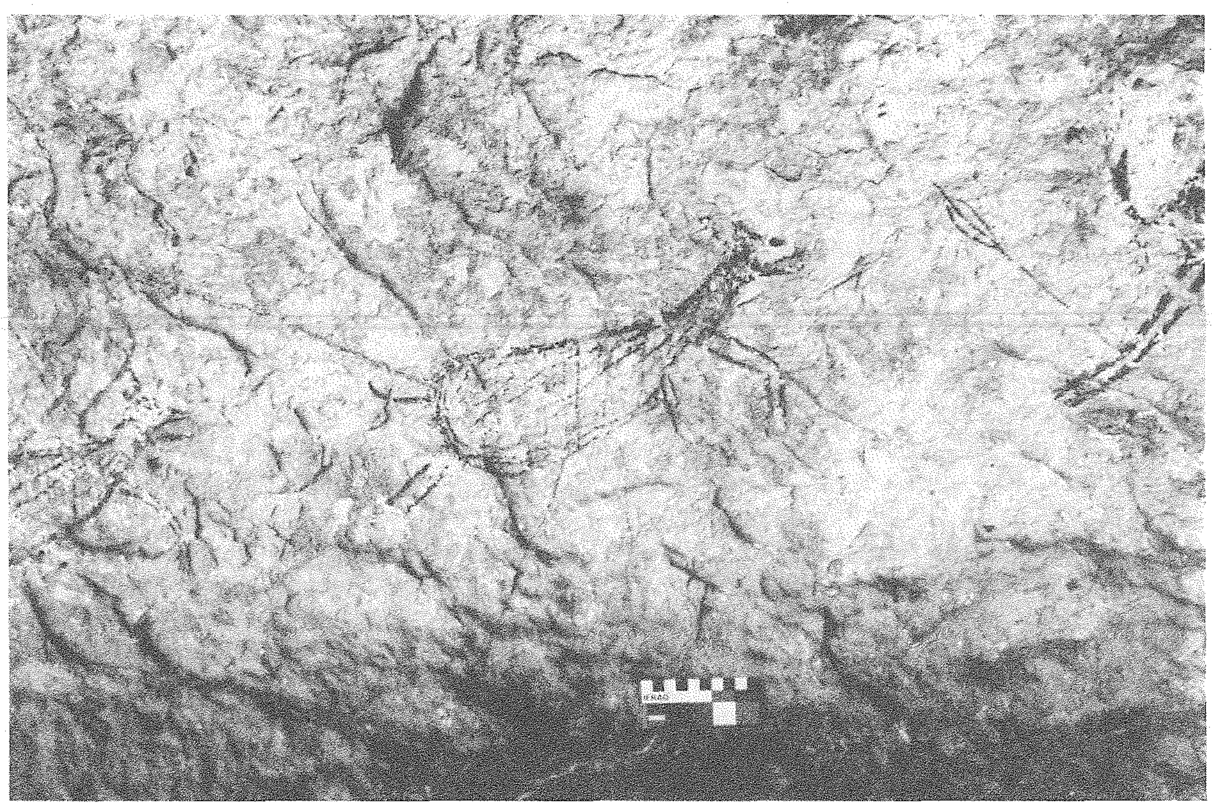

Figure 1. One of the better preserved and visible of a series of eleven deer images depicted in 41VV75. When facing the panel the deer seem to be running more or less in a line up and to the right. This image is in much better condition than the image selected for dating.

size of a dime was removed from the dark purple/red deer figure approximately using a scalpel with a new blade. The pictograph sample was deposited directly onto a piece of aluminum foil, wrapped, and sealed within a plastic bag. The painted motif was photographed before and after sample collection. An unpainted stone sample nearby was also taken to provide a background age determination.

The sample was taken to Texas A&M University and treated with 1M NaOH for 30 minutes and sonicated at 50°C to dissolve humic acids that could potentially contaminate the sample. This is a conventional procedure used to remove humic acids from archaeological charcoal before radiocarbon dating (e.g., Bowman 1990). The NaOH-treated charcoal samples were then rinsed with doubly distilled de-ionized water, filtered, and left to dry. The dry residue was then deemed ready for plasma-chemical extraction of the organic carbon for radiocarbon analysis.

We use radio-frequency generated, low temperature (~150°C) oxygen plasmas to remove organic material from paint samples, leaving the substrate rock and accretion carbonates and oxalates intact. The organic carbon is then analyzed by AMS. Since the introduction of our plasma-chemical technique in 1990, we have demonstrated its validity on numerous samples of known $^{14}C$ content. The dates we have obtained on rock paintings from Angola, Guatemala, France, Missouri, Montana, Texas and Utah are consistent with the age ranges expected from archaeological inference (see Rowe 2001). We have also dated non-pictograph sample materials with previously determined radiocarbon ages, including wood charcoal, wood samples used in the Third International Radiocarbon Laboratory Intercomparison, a painted Egyptian ceramic, and African Ostrich shell (see Hyman and Rowe 1997). Satisfactory agreement among age estimates was observed in all cases. Moreover, our analyses of $^{14}C$-free samples, such as graphite, Albertite, IAEA wood, and Axel Heiberg wood, demonstrated that our technique does not add significantly to the modern carbon background for AMS procedure.

We clean the system with oxygen plasmas before sample insertion to rid reaction surfaces of organic contamination and/or adsorbed $CO_2$. After the system was cleaned, the deer pictograph sample was placed into the chamber. Argon plasmas were then run to remove adsorbed $CO_2$ from the sample by inelastic collision of the non-reactive, but high energy, argon atoms with the adsorbed $CO_2$ molecules. With these precautions, negligible contamination is expected from the system or sample surfaces during plasma extraction of a pictograph sample. After the sample was loaded into the plasma chamber, the chamber was evacuated to below the $10^{-4}$ torr range and filled with 0.2 torr ultra-high purity argon (99.999%). Argon plasmas were run until the amount of carbon, as $CO_2$, desorbed by the plasmas was $\leq$0.001 mg carbon. This amount of carbon has a negligible effect on the estimate of sample age. An oxygen plasma extracted organic carbon from the charcoal paint sample from the deer motif. The $CO_2$ produced was collected by freezing in a liquid-nitrogen-cooled glass-finger and sent to the Lawrence Livermore National Laboratory Center for Accelerator Mass Spectrometry (CAMS).

## RESULTS

The radiocarbon content of the sample was measured at CAMS. The radiocarbon age could not be corrected for isotopic fractionation because the plasma extraction procedure does not yield sufficient sample material for the measurement of both $^{13}C$ and $^{14}C$. A standard $\delta^{13}C$ value of –25 mil has been assumed for this and previous radiocarbon age determinations of rock art pigments. The uncorrected age estimate was returned as 1280 ± 80 years B.P. (CAMS # 29315). The calibrated age range for the sample is 1290-1090 B.P. (A.D. 660-860) at 1s and 1340-1000 B.P. (A.D. 610-950) at 2s using the OxCal calibration program (Ramsey 2000).

## DISCUSSION

Turpin (1984, 1990, 1995) gave in-depth descriptions of the Red Linear rock paintings in the Lower Pecos River region of southwest Texas and discussed the age of the Red Linear style on the basis of interpretation of cultural and faunal remains and their association with Red Linear rock paintings. Turpin (1984:191) reported that, "Attempts to place the Red Linear in a chronological perspective using stylistic attributes has produced contradictory lines of evidence." She concluded that Red Linear paintings date to the late Archaic, but are more recent than Pecos River genre paintings. Further thought has apparently not changed her view (Turpin 1990, 1995). One of Turpin's arguments is largely based on the chronological occurrence of documented remains of bison in the Lower Pecos region (Dillehay 1974). Then, if the scene at 41VV162A "commemorates a successful bison kill, its most probable age is Late Archaic" (Turpin 1984:193). As Dillehay (1974:184) stated, "the documented extension of their range into the Lower Pecos region during the Archaic period is between 2600 and 1400 years ago." In general, it seems that Turpin thus tentatively placed Red Linear between 2600 and 1400 years B.P. Ilger et al. (1994) determined a radiocarbon date of 1280 ± 150 years B.P. for one of the "bison" images at 41VV162A. That date barely overlaps within experimental error with the recent extreme, i.e., 1400 years B.P., of Turpin's estimate for the time range of Red Linear paintings. The radiocarbon age estimate of the purple/red deer motif appears to be consistent with the extreme lower age estimate for the Red Linear genre (Turpin 1986a, 1995) and is the same age as the one previous radiocarbon date for that genre. Thus we conclude that the dated deer motif in shelter 41VV75 is contemporaneous with the Red Linear style and was probably drawn by the Red Linear people.

## ACKNOWLEDGMENTS

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# A Study of Two Ancient Bows from Trans-Pecos Texas

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## ABSTRACT

This paper presents the results of the Accelerator Mass Spectrometer (AMS) dating and the subsequent analysis of two ancient wooden bows recovered from the Trans-Pecos region of Texas. One bow predates the Apache intrusion into the area, and the other dates to very near or perhaps some years after the proposed time of this intrusion. Analysis reveals that the culture and environment were the primary factors that molded the design of these bows. The bows are compared to prehistoric and historic native bow forms of different environments.


## INTRODUCTION

Bow and arrow technology was a relatively recent arrival prehistorically in Texas. Its introduction is assumed to coincide with the occurrence of smaller projectile points such as Scallorn and other corner-notched styles (Hester 1980; Prewitt 1983; Turner and Hester 1999). This conclusion is based at least in part on the idea that the hafting elements of such points fit the diameter of an arrow (Christenson 1986; Hamilton 1982; Patterson 1985; Pyszczyk 1999; Thomas 1979). Hence, the question of the arrival of the bow is generally established by means of indirect dating. The opportunity to date ancient bows directly is seldom presented in the state, as is the opportunity to study early bows of known dates. Recently, however, two bows from rockshelters or caves in southwest Texas were directly dated using Accelerated Mass Spectrometry (AMS) radiocarbon dating. One of the bows was found in Terrell County and was dated to 545 +/- 40 B.P. (CAL A.D. 1300-1440); the other came from Presidio County and yielded a date of 190 +/- 40 B.P. (CAL A.D. 1640-1950). With the exception of the American Southwest, few bows of this age are available for study in North America, and there is no study that we are aware of dealing with bows of this age from Texas. Furthermore, no study that we are aware of deals with self-bows of this particular type, excepting the work of Baker (1994). This paper presents an analysis of the two bows, including an overview of the environment they came from, how they were manufactured, and more importantly, why they were built the way they were. A comparison of these bows to types from other regions of North America and other parts of the world is also provided.

## CHRONOLOGY OF THE BOW IN NORTH AMERICA

The following brief chronology of the bow in North America will serve to provide at least some background for the bows analyzed in this paper. It generally follows Blitz (1988). The earliest evidence comes from the Arctic where a microblade technology from 9000 to 6000 B.C. may be paralleled with Old World Mesolithic usage as arrow barbs; however, clear evidence for the bow only occurs after 3000 B.C., with initial dates appearing in the western Arctic and later dates appearing in a progression from west to east. Interestingly, Blitz reports the occurrence of small recurved composite bows made of antler from the central Canadian arctic of the Pre-Dorset period (2500-800 B.C.). These composite bows are short and are manufactured with glue and sinew, implying a sound knowledge of bowyer technology as well as a probable tie to Asia where this type of bow reached a high level of technical sophistication by historic times (McEwen et al. 1991).

Blitz judges from the archaeological evidence that the microblade arrow barbs of the Arctic and Old World Mesolithic contexts were replaced by small bifacially flaked arrow points prior to the appearance of the bow south of the boreal forests. Furthermore, he finds that the best evidence for the earliest appearance of the bow south of the boreal forests occurs at around A.D. 200 in the Great Basin and Intermontane West and the Northern Plains of Saskatchewan and Alberta. In other regions of North America, including the Pacific Northwest and California, the Great Lakes and Northeastern Woodlands, the Midwest and Southeast, and the Plains, all archaeological evidence points to a date of A.D. 500 or later for the introduction of the bow. LeBlanc (1999:101) suggests the self-bow came into the northern Southwest about A.D. 200, but other evidence places its introduction in the southern Southwest about A.D. 700-800 (Dockall 1991; Shafer 2003). Regarding Texas, Blitz cites separate works by Aten (1984) and Hester (1977) that propose dates of A.D. 500-600 for the Upper Texas Coastal Plain and A.D. 1200 for South Texas and the Rio Grande Valley, respectively (Blitz 1988:127-131). Prewitt (1983) offers compelling radiocarbon evidence tracing the slow movement of corner-notched Scallorn arrow points and Austin phase diagnostics from north to south across the central part of the state. According to Prewitt's estimates, the bow appears in south and southwest Texas about A. D. 800-900. A date of A.D. 1000 has been suggested for the Lower Pecos (Shafer 1981:130).

Blitz concludes from his survey that although the bow was used for many centuries in the Arctic, once south of the boreal forest its spread was rapid, implying diffusion from north to south rather than episodes of independent invention. He also states that archaeologists have used point size as the primary indicator of the advent of the bow, except in rare cases where bows and arrows are found in the archaeological record (Blitz 1988:131-132). The present paper is not intended to be a critical review of Blitz's work but is used to provide some chronological background for the description and analysis of two rare archaeological bows from Southwest Texas. However, there is a point in Blitz's argument that should raise questions about the diffusion of the bow from the Arctic to the rest of the continent. Blitz states that the archaeological bows found in the Arctic are composite horn bows whose arrows were likely tipped with composite points utilizing microblades. He further states that once south of the boreal forest bifacially flaked points replaced the composite points. However, the earliest known archaeological bows south of the boreal forest are not composite horn bows but self-bows made of a single stave of wood, as are the bows in the present study. Horn composite bows probably appeared south of the boreal forest only after A.D.1700 and likely coincided with the use of horses (Hamilton 1982:92-93). This, taken together with the long period of time between the appearance of the bow in the Arctic and the appearance of a very different type of bow along with a different type of arrow point in more southern regions, may call his theory of diffusion from the Arctic into question.

## SOUTHWEST TEXAS ENVIRONMENT

Mr. Doug Perrin of Denton, Texas and his father, Mr. Leonard Perrin, found the older of the two bows while hunting deer in Terrell County in November of 1994. Doug Perrin found the bow lying on a shelf at the back of a small solution cave in a sheer bluff some six or seven meters above the bottom of a dry creek. The locality was just to the east of Sanderson Canyon and about one and a quarter kilometers north of the Rio Grande. One end of the bow was wedged into a crevice where the cave pinched out. In removing the bow from the crevice, Perrin unfortunately broke off one end of the bow; however, the break occurred so that the two pieces refit cleanly. In addition, the break facilitated the extraction of small samples of wood for both identification and dating purposes. He found nothing else in the cave.

The second bow dated in this study is in the Dan Knight Collection, which was donated to the University of Texas before 1936 and is now housed at the Texas Archeological Research Laboratory (TARL) in Austin, Texas. This bow was found, also in a cave, in Presidio County about sixteen miles southwest of Marfa along with a fragmentary grass mat. Like the Perrin bow, it was broken, but in this case one end is missing.

Their archaeological locations place these bows in the Chihuahuan biotic province in Trans-Pecos Texas (Blair 1950). The province is characterized by a great diversity of physiographic features. It includes the Toyah Basin, whose eastern rim makes up the eastern boundary of the province, and the Stockton Plateau, an extension of the Edwards Plateau limestone. Alternating basins and mountain ranges of diverse composition and origin make up the rest of the topography of the province. The physiographic diversity results in a flora and fauna that vary largely according to altitude and proximity to water. Climate is classified as arid (Blair 1950:105-107).

Vegetation is described as a shrub-short grass savanna. Creosote bush, acacia, yucca, prickly pear, lechuguilla, sotol, desert hackberry, and Texas persimmon are present on uplands adjacent to deep, narrow canyons capable of supporting various oaks, mesquite, native pecan, cottonwood, and little-leaf walnut (Bandy et al. 1980; Dering 1999; Marmaduke 1978). Elevated plains of the more mountainous regions support a good cover of grama grasses while thorny shrubs dominate the foothills. Oak and cedar occur at higher elevations in some of the mountain ranges, as do pines and relict stands of hardwoods. The composition of these higher altitude associations vary from mountain mass to mountain mass and include ponderosa pine, white pine, Douglas fir, Arizona cypress, quaking aspen, and bigtooth maple (Blair 1950; Marmaduke 1978).

Animals also vary in accordance with the diverse habitats provided by the aforementioned physiographic features of the region. Some ninety-two species of mammals occur in the Trans-Pecos. About one third of these (of which all but two are rodents) are restricted to the region, giving it the greatest number of unique species in the mammalian fauna of Texas (Davis and Schmidly 1994:5). Principal species of the region include white-tailed deer, mule deer, jackrabbit, desert cottontail, squirrel, javelina, raccoon, fox, skunk, ringtail, badger, black bear, porcupine, coyote, bobcat, and cougar. There is also a wide variety of lizards and snakes. Bison, antelope, elk, and mountain sheep were present in late prehistoric and early historic times (Bandy et al. 1980; Blair 1950; Davis and Schmidly 1994).

## THE REGIONAL ARCHAEOLOGY

Evidence of all four of the major divisions of the prehistory of North America is present in the Trans-Pecos of Texas. The Paleo-Indian era is known from the projectile point types *Clovis, Folsom,* and *Plainview.* The drives of extinct forms of bison as evidenced by the association of their bones with Folsom and Plainview points in Bone Bed 2 at Bonfire Shelter demonstrate Paleo-Indian reliance on the hunting of big game as an economic pursuit (Dibble and Lorrain 1968; Marmaduke 1978). Furthermore, these people were not likely permanent residents but instead followed the migratory patterns of the large game animals that provided their subsistence. Only traces of their existence are found in the region, generally in the form of projectile points in surface finds for the most part (Shafer 1981).

A major climatic shift occurred at the end of the Pleistocene in the Trans-Pecos that defines the beginning of the Archaic. The marginal desert conditions began about 9500 B.P. and persisted until historic times. Although punctuated by shorter climatic intervals, both xeric and mesic, the climate persisted, giving rise to a long-lived, conservative economy well adapted to the environment. This adaptation emphasized the use of a wide range of food sources, including some deer hunting, but mostly the exploitation of small animals such as rabbits, squirrels, rats, mice, snakes, and fish (Williams-Dean 1978; Lord 1984). More important was the use of plants, especially desert succulents such as sotol, lechuguilla, and yucca (Marmaduke 1978; Shafer 1981; Williams-Dean 1978; Stock 1983).

While the transition between the Paleo-Indian and Archaic eras is marked by a climatic and environmental shift, the Late Prehistoric era is introduced by a technological shift that does not occur simultaneously throughout the region. In fact, the actual technological innovations that signal the shift are not all the same. Generally, most agree that the manufacture of pottery, the development of agriculture, the establishment of villages, and the use of the bow and arrow mark the Late Prehistoric in Texas. It is obvious, however, from the archaeological record that not all of these traits occurred in the Trans-Pecos at the same time, nor were they all adopted throughout the region. Thus, the beginning of the Late Prehistoric in the Trans-Pecos is highly variable. Corn, for example, was introduced in far west Texas as early as about 1500 B.C. (Tagg 1996). Brownware pottery and corn/beans/squash agriculture appear in the far western portion of the Tran-Pecos in the Hueco Bolson around El Paso as early as A.D. 400 (Miller 1995; Shafer et al. 1999). In the La Junta district, around the confluence of the

Rio Conchos and the Rio Grande, agriculture and pottery occur probably somewhat later although their arrival in this part of the region remains undated. Villages with pithouses and later pueblo-style houses were developed in both areas as well (Boisvert 1985; Cloud et al. 1994; Lehmer 1958; Shafer et al. 1999). On the other hand, in the eastern Trans-Pecos, agriculture was not a factor, and ceramics appear very late in the prehistoric sequence, possibly not until about A. D. 1700. Projectile points are the primary temporal markers, and the nomadic hunting and gathering way of life remained much the same until the Historic period (Shafer 1981).

The Post-contact period in the Trans-Pecos began when Cabeza de Vaca crossed the area in A.D. 1535. While his exact route remains a source of controversy, it is known that he passed through La Junta de los Rios (Cloud et al. 1994). Early Spanish entradas following the Rio Conchos north out of Mexico passed through the La Junta district as well. The Spanish came into contact with various groups called Jumanos, Julimes, and possibly Gediondos (Wade 2003). The Jumanos seem to have been widely distributed in time and space, but exactly to whom the name applies is a subject for debate. Other early historic groups who may have inhabited the region include the Chisos groups from the Big Bend area, the Tobosos, and various other groups and bands (Griffen 1969; Kenmotsu 1994). By A.D. 1680, Apaches were present in the Trans-Pecos as a result of their displacement from the Southern Plains by the Comanches moving down from eastern Colorado and western Kansas. This, together with native wars and turmoil caused by Spanish colonization, virtually eliminated these early groups by death, displacement, or assimilation (Bandy et al. 1980; Boisvert 1985; Cloud et al. 1994; Marmaduke 1978; Shafer 1971, 1981).

## THE BOWS

This section of the paper presents a physical description and analysis of the manufacture of the bows. The reader is encouraged to examine the drawing in Figure 1 in order to be familiar with the common archery terms used in the following description. Both these bows can be classified as self-bows because they are made from s single wooden stave. Self-bows are also generally considered to be long bows (Baker 1992; Hamilton 1982).

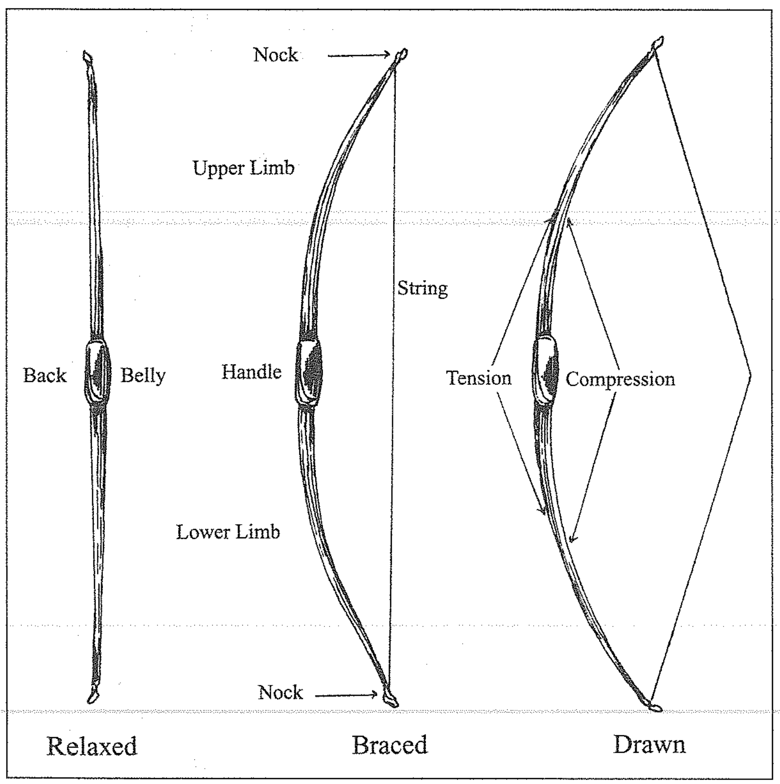



Figure 1. Typical self-bow illustrating major parts and areas of force.

### The Perrin Bow

As mentioned earlier, the Perrin bow was found in a cave in Terrell County about one mile east of Sanderson Canyon and one mile north of the Rio Grande (Figure 2). A wood sample collected from the specimen yielded a radiocarbon age estimate of 545 +/- 40 B.P. (CAL A.D. 1300-1440), making it the older of the two specimens. The length of the bow from tip to tip is 162.5 cm while the length along the curve of the limbs is approximately 173 cm. This difference illustrates the fact that the limb tips are considerably deflexed, meaning they are bent toward the belly of the bow. A measurement of this deflection was obtained by placing a straight edge

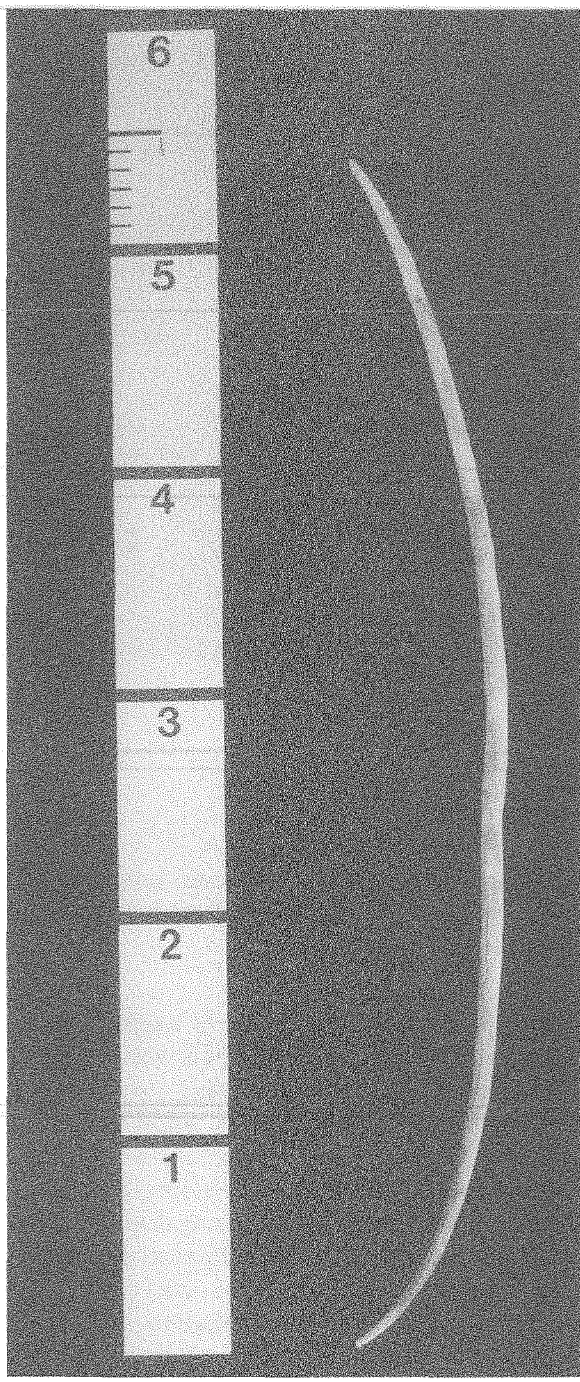
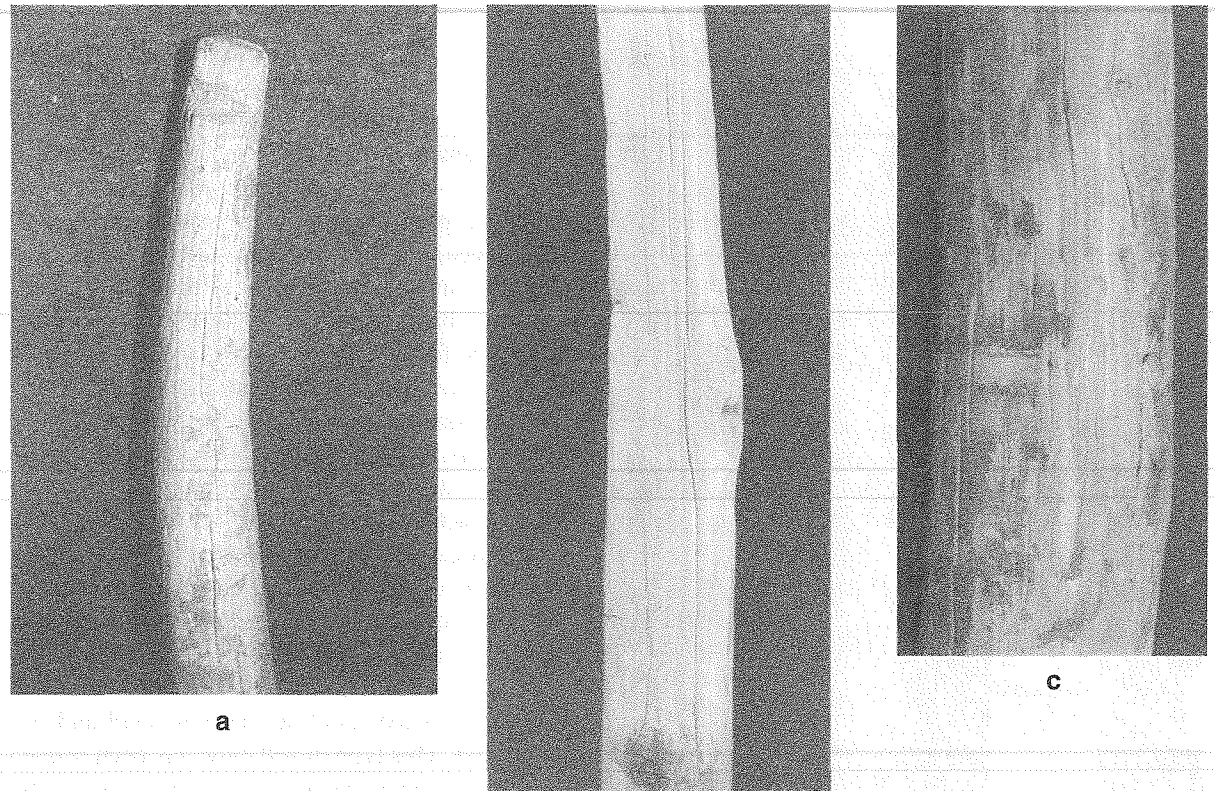



Figure 2. The Perrin bow (scale increments are in feet, not metric measures).

at the back of the handle, or grip area, and adjusting the bow so that if it were strung, the bowstring would be parallel to the straight edge. The distance was then measured from each tip to the line of the straight edge. The nock end tip measured 20.6 cm from the line, and the other end measured 23.6 cm. While this is an estimate, it does give further indication of the amount of deflex in the limbs. Although self-bows commonly exhibit some deflex (especially after sustaining numerous episodes of use), this amount of deflex is significant because it is specific to xeric environments where trees large enough to provide good bow staves are scarce. Larger trees can produce staves with fewer knots and more importantly, bows with flatter, wider backs and bellies. The flatter, wider morphology spreads the forces of both tension and compression across the width of the bow instead of concentrating these forces down the very longitudinal center of the limbs, as in the case of the rounded cross section of the bows in the present study. Many Native American bows, as well as Neolithic bows from Europe, are flat and relatively wide, being rectangular or trapezoidal in cross section. Some were built to have a narrower but thicker handle, which prevents the bow from bending through the handle and forces the limbs to do more work, resulting in reduced shock to the bow hand and improved cast. This type of self-bow has been proven to be an efficient and durable design, especially when made of resilient woods such as yew, elm, hickory, or bois d'arc (Allely and Hamm 1999; Baker 1992, 1994; Bergman 1993; Comstock 1993; Hamilton 1982).

Most self-bows from more mesic environments are either straight or somewhat reflexed when unbraced although as stated above, many so-called straight bows retain a slight deflex. This phenomenon is called "string follow" or "taking a set" and occurs because wood is weaker under compression than it is under tension. Wood on the belly of the bow does not totally recover from the forces of compression placed on it when the bow is braced, drawn, and shot. Most self-bows will exhibit deflexion to some degree, and most archers who shoot this type of bow generally feel that a certain amount of string follow, about 2.5-6.5 cm, is acceptable and can cut down on hand shock when the drawn bow is released and snaps back to its braced position (Baker 1992). The Perrin bow is not only deflexed significantly more than is normal for the so-called straight limb self-bows, but also the limbs are deflexed asymmetrically. Although the nock end measures about 3 cm less deflex than the other end, the deflex is sharper (Figure 2).

As mentioned previously, one limb tip has a nock cut in .6 cm from the end (Figure 3a). The



a b c

Figure 3. Details of the Perrin bow: a) upper limb tip of the Perrin bow showing the nock which is cut on only one side, b) back side of the Perrin bow illustrating the care with which the bowyer treated knots in the wood, c) lower limb of the Perrin bow illustrating the remains of rawhide and/or sinew wrapping.

nock is on one side only and measures .3 cm wide and .25 cm deep, which means it was probably tied when the bow was braced instead of using a fixed loop. The bowstring would have been tied on the unnocked end either with a series of half hitches where the taper of the limb would prevent slippage or with a wrapping of sinew or rawhide used as a shoulder to provide support for the knots. The bowstring would likely have been tied on the nock end also since the nock is only a groove on one side. The lack of a groove circumscribing the tip would seem to make it difficult for the more familiar fixed loop to hold without slipping. This seems to suggest that the bow may possibly have been braced for extended periods of time, perhaps a cause of the amount of "set" or deflex in the limbs.

At the center, or what one would assume is the handle, the Perrin bow measures 2.6 cm in width and 3.1 cm in thickness. From here, both limbs taper toward the tips. The tip on the nock end measures approximately 1.1 cm wide and 1.1 cm thick. The tip at the other end measures roughly 1.0 cm wide and 1.3 cm thick. This bow was evidently constructed from a limb or possibly a small tree or sapling. J. Phil Dering of Texas A&M University has identified the wood as *Juglans microcarpa,* commonly known as little-leaf walnut (Dering, personal communication, 2001). Dering describes these trees as often having multiple stems so that a fairly straight sapling could be obtained rather easily. Both ends of the bow were worked down to produce the taper that the limbs possess although obviously more wood was removed from the larger end. Most of the wood was removed from the sides and belly of the bow so that the limbs would bend evenly without breaking, a process is known as "tillering" the bow. When a bow is bending properly for the maximum amount of cast and the least amount of hand shock, it said to have the correct "tiller." The smallness of the limb tips reduces mass at the part of the limb that has to travel the farthest, allowing the tips to travel the distance from full draw back to braced position faster, thereby increasing arrow speed and efficiency of the bow (Baker 1992, 1994).

It is evident upon examination that the bowyer took a fair amount of care in working the back of the bow. Figure 3b is a close view of a knot that occurs on the back of the bow, showing that instead of scraping the knot down flush with the back, the bowyer left wood around the knot to strengthen the limb in this area. Knots on the back of such a bow are prime places for the bow limb to break under forces of tension. Furthermore, the great majority of the knots are on the belly where they are not so critical to the performance of the bow, and the bowyer could simply more or less disregard them when he tillered the bow. This suggests that the bowyer was more than a little familiar with the properties of the wood and more specifically, with how these properties reacted to the stresses placed on the wood when used in a self-bow. The effects of age on the wood of the bow (including signs of rodent gnawing) make it difficult to tell whether the bowyer exposed and followed one growth ring along the back. Following one growth ring adds strength and durability to the back of the bow when it is placed under tension, thereby making the bow more efficient and powerful as well as durable. Although it is likely that the bowyer may have violated the growth ring along the back given the cross section and diameter of the bow, it is evident that most of the shaping work was done on the belly and sides. This was done in order to conserve the integrity of the growth ring as much as possible, and further suggests the expertise of the bowyer.

Another indication of the bowyer's work is a trace of what apparently was a sinew and/or rawhide wrapping around the circumference of the limb about 55 cm from the unnocked end (Figure 3c). This wrapping was needed because the wood grain on the back had separated under tension and had begun to lift. Sinew is very capable of preventing any further lifting of the grain that would lead to limb failure and breakage. The senior co-author's daughter currently shoots an elm self-bow having the same problem. A bowyer friend corrected the problem using the same type of sinew wrap as the one observed on the Perrin bow.

The deflex in the bow limbs has been described earlier. At the present stage of this study, it is impossible to tell how this deflex occurred. The most apparent explanation is that because of the way that the bow was tillered, forces of compression caused the bow to take a large degree of set, especially if it had remained braced for long periods of time. The bow does exhibit compression cracks on the belly. If the bow were left in the cave braced until the bowstring decayed or was eaten by rodents, it would undoubtedly stay in the deflexed shape in which it was found. The type of wood from which the bow was manufactured could also be a factor as well as the amount of curing time given before the bow was put into service. In his discussion of bows from Africa, Longman and Walrond (1894) relate that this type of bow is prevalent across time and space, dating as far back as ancient Egypt. They cite ethnographic accounts stating that the bowstring is permanently fixed on both ends after the bow is saturated with oil and bent to the deflexed shape over a fire (Longman and Walrond 1894). This is another possibility. It is likely that the deflexed limbs observed in both the Perrin bow and the Knight bow were purposefully shaped this way.

## The Knight Bow

As mentioned earlier, this bow is Item #51 in the Dan Knight Collection now housed at the Texas Archeological Research Laboratory (TARL) in Austin, Texas (Figure 4). A wood sample taken from the specimen yielded a radiocarbon age estimate of 190 +/- 40 B.P. (CAL A.D. 1640-1950). Like the Perrin bow, it too was found in a cave, and further, its shape and method of manufacture are very similar to the Perrin bow. The distal portion of one limb is broken and missing. The length of the part remaining is 118 cm from limb tip to the break and 119.8 cm along the curve. In order to obtain a more meaningful idea of the length of this bow, the direct length from tip to tip and the length along the curve were estimated by following the curve of the limbs. The estimated length of the bow is about 133 cm from tip to tip and 137 cm along the curve, which is roughly some 40 cm shorter than the Perrin bow. The width of the estimated center of the bow is 2.5 cm, and the thickness here is 2.2 cm. This is also the thickest and widest part of the bow. The complete end of the bow has a partial nock grooved in on one side about one cm from the tip. The groove is about .25 cm wide and .1 cm deep. The complete limb tip is .9 cm wide and .95 cm thick.

The bow has a longitudinal split on the belly for most of its length. This could have occurred due to drying; nonetheless, it would have little effect on

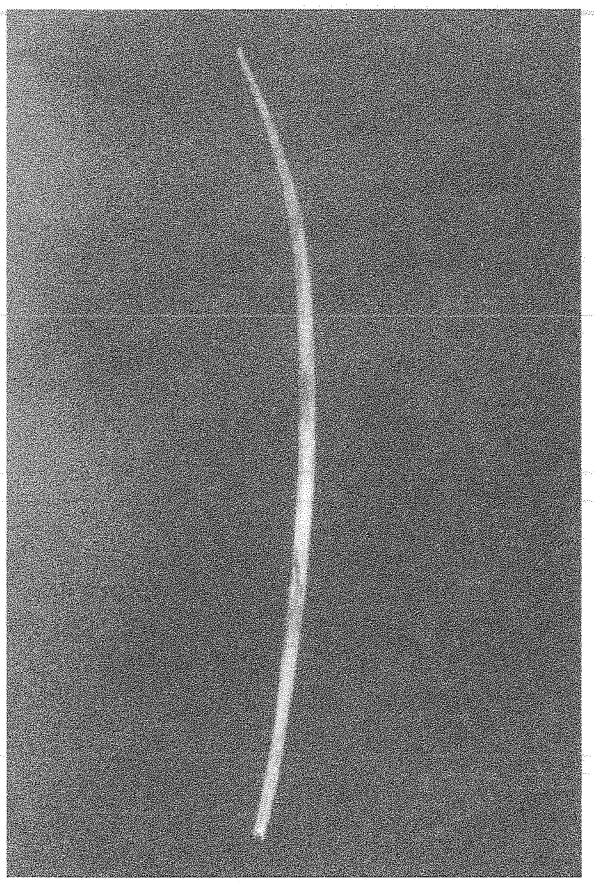


Figure 4. Item #51 in the Dan Knight Collection. The bow is missing a portion of the lower limb. Photograph courtesy of the Texas Archeological Research Laboratory.

the bow's functionality. There are no noticeable compression cracks on the belly. There is a crack shown in Figure 5 that runs across the grain on the back about 9 cm from the broken end at a raised knot which was more than likely purposefully left by the bowyer to add strength to the limb as discussed above. This crack runs across to a hole on the lateral edge of the limb where a longitudinal crack also originates. The hole is about .2 cm in diameter and appears to be filled with what is perhaps glue. This substance also fills the longitudinal cracks in the same area, giving the indication that perhaps after it was recovered, a piece of the bow broke off and was glued back in place. It is also possible that the bow failed here during its use-life and the owner attempted to repair it. However, there is no indication of the application of sinew. Sinew wrapping as seen on the Perrin bow would not likely have repaired a problem like this. A sinew backing run longitudinally, on the other hand, would be more apt to solve the problem. Still, it is not likely that the hole just described occurred during the bow's use-life.

There is a darkened or stained area on the lateral aspect about 27 cm from the broken end, another area 8 cm long on the opposite side near where the handle would be, and still another on the back about 14 cm long also near the handle area. On the complete limb, while all edges still show some convexity, there are indications of flattening, especially from the limb tip to about 34-35 cm in toward the center. The scraping marks of the tool used to tiller this limb can be observed.

Referring again to Figure 4 and to Figure 6, one can see a slight recurve in the complete tip. A recurved tip generally improves cast and efficiency

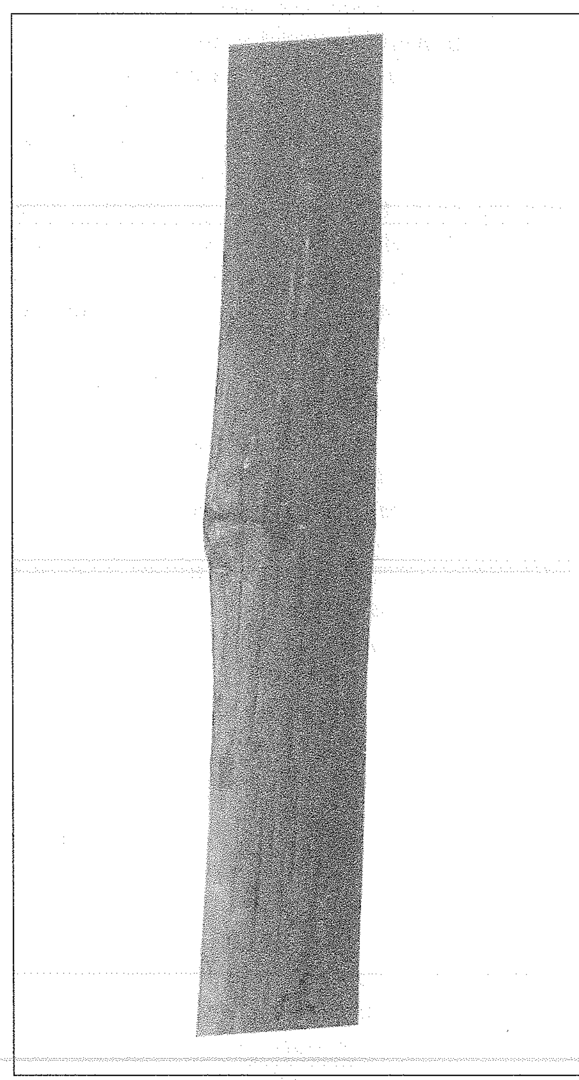


Figure 5. The broken end of the Knight bow also showing the raised knot on the back of the bow. Photograph courtesy of the Texas Archeological Research Laboratory.

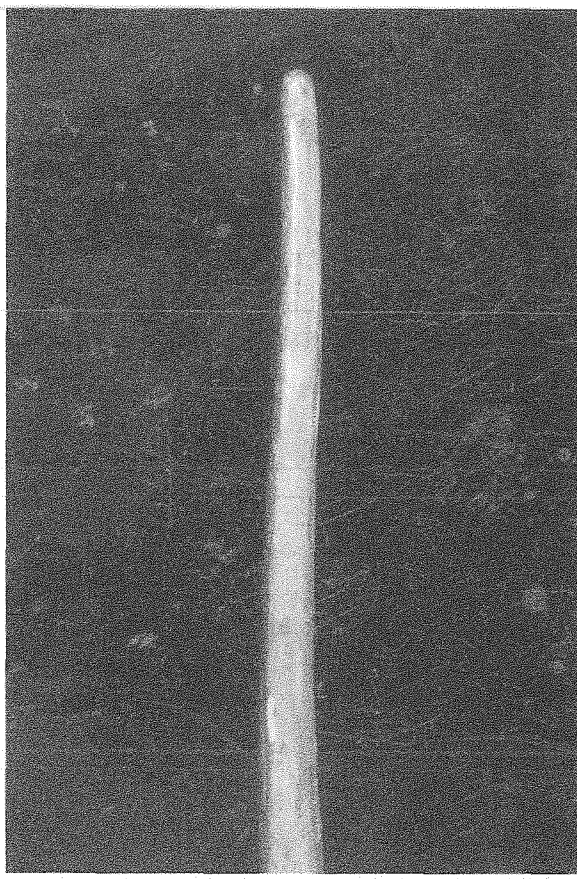


Figure 6. The upper limb tip of the Knight bow showing the nock and slight recurve. Photograph courtesy of the Texas Archeological Research Laboratory.

especially in a shorter bow. This recurve, however, is so slight that in this case the improvement it lends to the bow is more in the nature of maintaining a straighter limb with less set or string follow while still retaining the small tips. This in itself would have increased the efficiency of the bow and also may account for the 40 cm difference in length since recurved limbs can be shorter than straight limbs with less risk of breakage. It was not determined how the recurve was placed in the bow limb tip. It could have been the natural way the limb grew; it could have been shaped with moist heat; or it could have been formed when the bow wood was green. Regarding the bow wood, a determination of the particular tree from which this bow was made was not possible. Table 1 presents a quick comparison of the dimensions of the two bows.

The values for some dimensions of the Knight bow are estimates because of the broken end. Given the small sample size, statistical tests to determine the significance of the observed dimensional differences would be rather meaningless. The impression one gets, however, is that the slight differences in width and thickness are largely a factor of the difference in length as well as the respective sizes of the saplings from which the bows were manufactured.

## DISCUSSION

In the descriptions of these bows, much emphasis has been placed on the amount of deflex in the limbs. This type of side-view profile is generally thought of by bowyers and archers alike to be inefficient and generally poor. Thus, the question here is why would native peoples who must have depended on the bow and arrow for at least a part of their subsistence design such a bow. Or do these bows appear so simply because they entered the archaeological record braced and the long period of time it took for the bowstring to deteriorate caused them to take an excessive amount of set? Longman and Walrond (1894) describe native peoples of Africa and other parts of the world as keeping their bows braced by tying the bowstring on both ends, which forces the bows into deflex. They imply that these people did not have the knowledge or expertise to build bows correctly. It must be realized that they were writing at a time when western European and American bowyers and archers felt that the English-style longbow was the epitome of the bowyer's art and compared bows from any and all cultures to their idea of a perfect bow. Saxton Pope thought much the same way in comparing bows in his famous work of 1923 (Pope 1962). The problem with these studies is that they attempted to analyze bows from different cultures out of context. An artifact such as a bow must be studied in the context of the culture that produced it (Baker 1992, 1994; Bergman et al. 1988; McEwen et al. 1991).

There is little doubt that the design of the bows in this study was no accident, nor were the bows manufactured out of ignorance. Instead, they were most likely weapons perfectly capable of performing what was required of them in the arid, unchanging environment of Trans-Pecos Texas. First of all, large trees of resilient, elastic wood capable of producing wider, flatter, and thus more efficient bows are scarce. Furthermore, it is easier to make bows with rounded cross sections using stone tools than bows with rectangular cross sections, especially if it is necessary to use small trees. Attempting to

**Table 1. Measurements of the bows.**

| Measurement in cm | Perrin Bow | Knight Bow |
|---|---|---|
| Length tip to tip | 162.5 | 133.0 (estimated) |
| Length along curve | 173.0 | 137.0 (estimated) |
| Deflex measurement | 20.6 and 23.6 | 11.0 (estimated) |
| Width at center or widest point | 2.60 | 2.50 |
| Thickness at center or widest point | 3.10 | 2.20 |
| Width of tips | 1.1 and 1.0 | 0.90 |
| Thickness of tips | 1.1 and 1.3 | 0.95 |
| Width at midpoint of limb | 2.4 and 2.5 | 2.00 |
| Thickness at midpoint of limb | 2.6 and 2.7 | 1.90 |

flatten the back of a bow made from limbs or saplings such as the ones in this study would only serve to cut through growth rings to such a degree as to insure failure. Another factor that one must consider is the dry climate. Low humidity means low moisture content in the wood, making it less elastic, and is probably the prime cause of the deflexed limb profile of these bows. When braced, their profile would remain the same as when they were unbraced, thus putting less strain on the limbs. In other words, the force upon the limbs of such a bow is only exerted when the bow is drawn. Therefore, a straight or reflexed profile bow in such low humidity would be much more likely to break. While it is true that deflexed bows are less efficient than straight or reflexed bows, they should be well capable of killing at least deer-sized game.

## DATING THE BOWS

Accelerator mass spectrometry (AMS) radiocarbon dating provided a means of directly dating the specimens that required only a trace of organic material (i.e., as small as 50 micrograms). This method is used to date small or valuable samples. Small pieces of wood were extracted from each bow and sent to the AMS National Science Foundation Laboratory at the University of Arizona. The results are presented in Table 2.

The 2-sigma, calibrated age range for the Perrin bow is A.D. 1300-1440, which places it clearly in the Late Prehistoric period. It can not be considered an early example of a self-bow because the bow and arrow had been in use in this region for at least 400 years, if not longer. Given this early date, it is not possible to determine cultural affiliation.

The calibrated age estimate for the Knight bow is A.D. 1640-1950 and thus this bow be attributed to the Historic period of this part of the state. While the bow could have been used by Apache groups, there are a number of other groups in the Presidio County region that could have been responsible for the manufacture of this bow, including Julimes and Jumanos, among others (Kenmotsu 1994; Wade 2003).

## CONCLUSIONS AND SUGGESTED FURTHER STUDIES

The bows in the present study have presented an excellent opportunity for directly dating two artifacts that represent a rare type in Texas and in North America in general. The bows were further analyzed regarding dimension, bow type, and the bowyer's work, all related to the type of environment where bows such as these are found. Deflexed bows, such as those in this study, are found mostly in more arid environments used by hunters on foot. They are completely different from, and in most cases, predate the familiar Plains bow which was short, definitely adapted to horseback use, and was often backed in its entire length with sinew (Hamilton 1982). They are also different from the long bows of more temperate regions of North America, such as those of the Eastern Woodlands peoples, whose bows are self-bows but are generally flat in cross section and straight to slightly

**Table 2. Radiocarbon age estimates on wood samples obtained from the Perrin and Knight bows.**

| Laboratory Number | Sample Number and Type | Sample Weight | $\delta^{13}C$ (0/00) | Fraction Modern | Corrected $^{14}C$ age B.P. |
|---|---|---|---|---|---|
| AA-23398 | #1, Perrin Bow, wood | 1.21 mg | -23.3 | 0.934 +/- 0.0047 | 545 +/- 40 |
| AA-23399 | #2, Knight Bow, wood | 1.36 mg | -25.4 | 0.976 +/- 0.0048 | 190 +/- 40 |

2-sigma dendrochronological calendar calibrations:
#1 Perrin bow A.D. 1300 - 1440
#2 Knight bow A.D. 1640 - 1950

deflexed in profile. One of the best examples of the bowyer's art from this region of North America is the famous Sudbury bow collected in 1660 in Sudbury, Massachusetts, and now in the Peabody Museum. This hickory bow is thick and narrow in the handle, wide and flat through the limbs, and tapering toward the tips. Bowyers and archers (including Saxton Pope) who have studied and replicated the bow consider it perhaps one of the most well designed bows ever made (Baker 1994; Hamilton 1982). However, it is doubtful that the Sudbury could have been manufactured or used in the environment of the Texas Trans-Pecos in Late Prehistoric times. In his review of bows from different parts of the world, Baker sums it up succinctly. In discussing deflex-tip bows, he states, "As much as any other, this bow demonstrates the precision with which cultures molded bow designs to their particular needs" (Baker 1994:63).

Regarding the dates of the bows in the present study, the Perrin bow dating to A.D.1405±40 is a very good example of an indigenous weapon that predates European contact. The Knight bow dating to 1760±40 could possibly have been in use around the time of the Apache intrusion into the Trans-Pecos. The fact that it is substantially shorter than the Perrin bow and that the remaining tip has a slight reflex may indicate a shift in the way bows were being built. This is far from conclusive, however. The bows still have much in common. More bows from this region need to be documented and studied. Another avenue to pursue is replication of bows of this type. Because of their conjectured relative inefficiency compared to other types of bows, few bowyers today have replicated them.

In addition to replication of these bows, performance tests similar in approach to those of Bergman et al. (1988) are also in order. These researchers took Pope's study of 1923 to the next logical step, conducting performance tests on seven bow types from around the world including an African self-bow of the type discussed above. While this bow is very similar to the bows of the present study, there are differences. Self-bows from the Trans-Pecos, including those in the present study, should be replicated and performance tested at every opportunity, as well as being analyzed and dated. Bows from the archaeological record should be closely studied whenever possible, and in so doing, we will learn something of the culture that produced them.

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# Detecting Historic Indian Sites—
# The Case for Metal Detecting as an Archeological Strategy

*J. Brett Cruse*


## ABSTRACT

The Southern Plains were inhabited by a number of Indian groups during the Historic Period. Historic Indian sites, however, represent only about one percent of the 5,800 recorded archeological sites from a study sample of 72 Texas counties located in the Southern Plains. Of the 61 recorded historic Indian sites in the study sample, only 29 were recorded by professional archeologists. This paper proposes that historic Indian sites are being largely overlooked by professional archeologists due to inadequate survey and identification techniques. These techniques are considered inadequate because they are primarily designed to identify prehistoric sites that are marked by lithic and ceramic artifacts, which were largely replaced in the Historic Period by metal items acquired through trade with Europeans. This study examines the documentary and archeological evidence for the use and incorporation of European trade goods, particularly metal items, into the material culture of the historic Southern Plains Indians, and concludes that in order to identify historic Indian sites, professional archeologists must incorporate the use of metal detectors into their survey and site evaluation methods.


## INTRODUCTION

During the latter part of the Historic Period on the Southern Plains (after ca. A.D. 1700), the region from southern Kansas to central Texas was occupied by various Indian groups including the Apaches, Kiowas, Kiowa-Apaches, Comanches, Southern Cheyennes, Arapahos, and others. The occupation of the region by these historic Indians is well documented in the journals of early explorers, naturalists, members of military expeditions, and in the oral histories and calendars of some of the Indian groups themselves. While archeologists working in the region have recorded, documented, and excavated numerous locations that were occupied by prehistoric Indian groups, comparatively few historic Indian sites have been investigated or even identified in the region by professional archeologists.

The argument could be made that so few historic Indian sites have been identified because the historic Indians occupied the region for a relatively brief time, only about 200 years. Thus, the argument would conclude, a brief occupation period would result in a low number of sites. Still others might argue that because the historic Indian groups were so mobile and they occupied locations for only brief periods, little evidence of their occupation would be left for archeologists to find. While both of these arguments have merit, they do not adequately account for the small number of historic Indian sites that archeologists have recorded in the region.

The fact that the historic Indians were so mobile after the adoption of horses would suggest that numerous locations would have been utilized as camp and village sites. At each site location the occupants would have built fires, erected shelters, processed foods, and made or repaired tools. Each of these activities should leave some kind of residue or evidence of its occurrence. In other words, the historic Indians of the Southern Plains were doing the same basic kinds of activities as their prehistoric predecessors. If that is the case, why have so few of their sites been identified? The primary cause appears to be the inadequate survey and identification techniques currently used by archeologists. These techniques are designed to identify prehistoric sites by discovering the debris and tools the prehistoric groups used and left at a site, namely lithic and ceramic items. During the Historic Period, however, lithic and ceramic tools were gradually replaced by items, primarily metal, acquired through trade with Europeans. Therefore, different

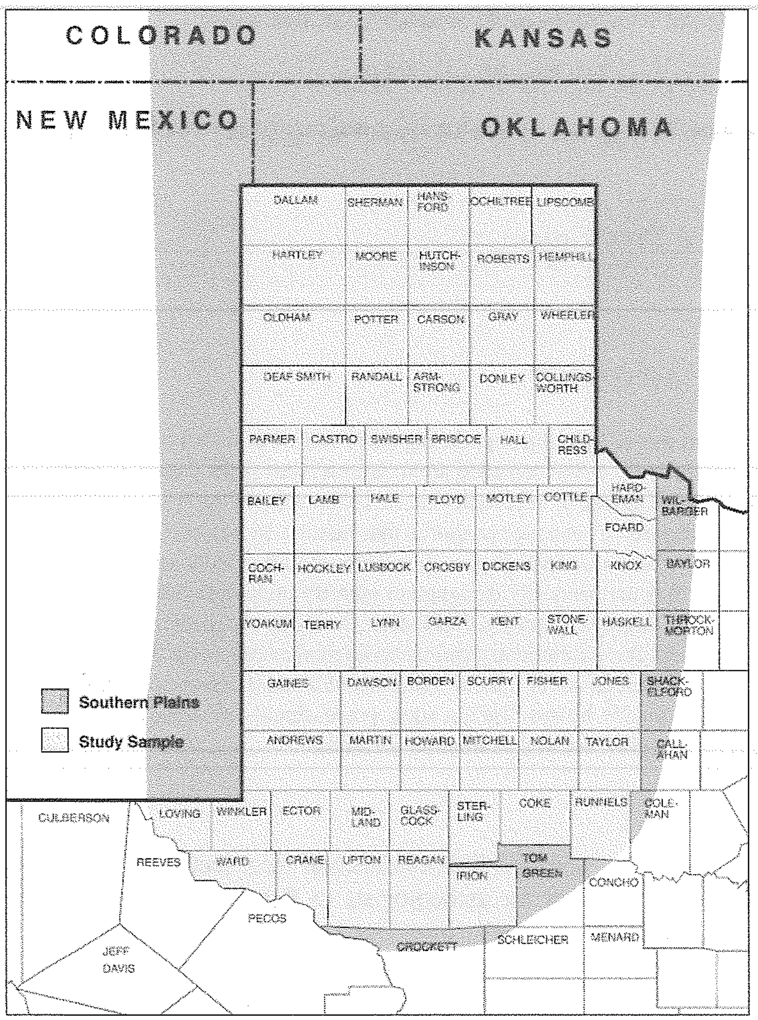


Figure 1. The study sample of Texas counties within the Southern Plains.

and more refined techniques are needed to locate these items.

In order to examine the material culture of the historic Indians of the region and to identify those items that might be found in an archeological context, this study begins by discussing the Indian groups that occupied the Southern Plains during the Historic Period and the impact that European trade goods had on the material culture of the tribes. The paper then examines the archeological evidence for historic Indian sites from 72 Texas counties that correspond to the portion of the Southern Plains that extends into Texas (Figure 1). Finally, the question of why so few historic Indian sites have been identified is examined and recommendations are offered for how archeologists can modify their field survey methods so that historic Indian sites will be identified.

## HISTORIC INDIANS ON THE SOUTHERN PLAINS

The Historic Period on the Southern Plains was marked by dramatic and revolutionary changes in material culture and population movement. The influx of Europeans into the region and all the things they brought with them—including horses, firearms, and diseases—set into motion a series of events that would change the cultural fabric of the region forever, and ultimately resulted in the permanent relocation or removal of the Indian tribes. Though European contact was first made with Indian groups on the Southern Plains by the Coronado Expedition in 1541, the Spanish presence in the Southwest did not have a substantial impact until about 1600 when Spaniards became permanently established in New Mexico. The Apache were dominant on the Southern Plains at the time of the Coronado Expedition, but other groups such as the Teyas and Jumanos also occupied the region. The Southern Plains Indian groups at this time were nomadic hunters and gatherers who relied heavily on the procurement of bison for sustenance and shelter.

Between 1541 and ca. 1700, the occupants of the Southern Plains had only limited access to European goods. Secoy (1953:20-24) suggests that horses and metal tools were appearing in the Plains in small quantities by 1650 and that the Pueblo Revolt of 1680 greatly increased their availability. By 1700, then, European goods were making their way into the Southern Plains through long-established trade networks between Puebloan and Plains groups (Spielmann 1991). This exchange of European goods for buffalo hides, meat, tallow, and slaves would continue to intensify to the point that it would become a major factor in the cultural transformation of the Southern Plains tribes.

One reason for the ever-increasing availability of European goods in the region may have been the desire by the Southern Plains Indian groups to acquire horses. This point is illustrated by the report of Fray Alonso de Posada who was in charge of the mission at Pecos in the 1650s. He noted in his report that the Apaches brought bison robes and captives to the mission to trade for horses (Tyler and Taylor 1958:301-303). It appears that by A.D. 1700, most Southern Plains groups had adopted an equestrian lifestyle (Secoy 1953; Worcester 1944).

With the acquisition of the horse came revolutionary changes to the cultures of the Southern Plains. Groups suddenly became highly mobile and were able to travel long distances and over large areas. Cultural boundaries began to break down, as groups who had traditionally pursued a foraging existence on the margins of the Plains now moved onto the Plains where they became specialized bison hunters. One of these groups was the Comanche, who began to move into the region from the northwest in the early 1700s. The Comanches eventually displaced all of the previous occupants of the Southern Plains and established relatively unrestricted access to European goods from two separate sources—the Spanish to the west and the French to the east. In 1705 the Comanches made their fist recorded visit to Taos Pueblo to trade, and in 1709 they made a formal agreement with New Mexico that allowed them to trade at Taos (Kenner 1969:28). That the Comanche trade with the Spanish quickly became well established is evident in numerous Spanish documents of the period. Don Pedro Rivera, for example, in a report published in 1736, observed that the Comanches appeared annually in New Mexico to trade (Kenner 1969:36).

The Spaniards in New Mexico were the only practical source of European goods for the Comanches until the 1740s when they began to have indirect access to French traders to the east. In 1746 the Comanches allied with the Wichitas who were concentrated in settlements along the Red River in present central and southern Oklahoma. The Wichitas were involved in trade with the French who controlled Louisiana and who had established a trading post in 1714 on the Red River among the Natchitoches Indians (Gilmore 1992:124). That the Wichitas traded with the French is evident in the frequency of European artifacts in Wichita sites dating between 1700 and 1760 (Bell 1984:376-377; Hofman 1989; Perttula 1992). Documentary evidence that the Comanches acquired French trade items from the Wichitas comes from Fray Francisco Atanasio Dominguez who described a Taos trade fair in 1776. Of the fair, he states:

> They [the Comanches] also sell good guns, pistols, powder, balls, tobacco, hatchets, and some vessels of yellow tin (some large, others small) shaped like the crown of the friars' hats.... They acquire these articles, from the guns to the vessels, from the Jumanas Indians, who have direct communication and trade with the French, from who they buy them (Adams and Chavez 1956:252; brackets added).

The Jumanas Indians to which Fray Dominguez refers were actually the Wichita (Scholes and Mera 1940).

In 1786 New Mexico Governor Juan Bautista de Anza negotiated a long-lasting peace with the Comanches who had been raiding the New Mexican settlements. Because of the peace, exchange between the New Mexicans and the Comanches and other Southern Plains Indians broadened in scope. At the same time, Hispanic settlements began to be established along the Pecos River to the east of Pecos Pueblo. The New Mexican settlers were attracted to the Pecos River lands not only because of their value for grazing, but also because of their proximity to the Comanche trade. Many New Mexican traders began to venture onto the plains in an effort to take the trade to the Plains Indians. This "Comanchero" trade soon replaced the trade fairs that had been traditionally held at Taos and Pecos (Kenner 1969; Levine and Freeman 1982).

The number of documentary records describing Comancheros increased significantly after the opening of trade along the Santa Fe Trail in 1821. Stephen Long, who explored New Mexico and West Texas in 1819 and 1820, noted well-worn trails following the Canadian River from New Mexico to the Plains (Kenner 1969:80). Other American military explorers of the mid-1800s, such as Abert (1846), Marcy (1850), and Simpson (1850), traveled across the Plains following well-established cart roads that they attributed to Comancheros. During the third quarter of the nineteenth century, other military personnel who were trying to find ways to safely travel across the seemingly endless Llano Estacado, and later attempting to track the Comanches to their camps on the Llano Estacado, documented and mapped Indian and Comanchero trails, water sources, and camps throughout the Texas Panhandle and eastern New Mexico (e.g., Shafter [1933] and Alex L. Lucas' *1875 Map of the Country Scouted by Colonel McKenzie* [sic] *and Shafter, Capt. R. P. Wilson and Others in the Years 1874 & 1875*, Record Group 77, National Archives).

While the Comanches dominated a large portion of the Southern Plains during the Historic Period and are mentioned more often than others in connection with the Comanchero trade (hence the name), other Indian groups also occupied the region. The Kiowas, who had been pushed by the Dakota Indians from the Black Hills region of present South Dakota and Wyoming, occupied the area of the upper Arkansas in the late 1700s and early 1800s. From this area, the Kiowas were successful at pushing the Comanches further to the south. Though early hostilities existed between the Kiowas and Comanches, they became allies, probably around 1790 (Mayhall 1962:15). A similar alliance was made with the Southern Cheyennes and Arapahos in 1840 (Grinnell 1956). The peace that was forged between the various tribes of the Southern Plains proved permanent, and together they lived, hunted, raided, and fought mutual enemies until the last of the tribes were forcibly removed from the region by the U.S. Army in 1874.

## MATERIAL CULTURE OF HISTORIC SOUTHERN PLAINS INDIANS

If European trade goods played a significant role in the material culture of the historic Southern Plains Indians, then it stands to reason that some of these items should be represented in the archeological record. This section provides a brief review of the documentary evidence that provides insights into the kinds of materials that were traded to the Southern Plains tribes. Table 1 provides a list of trade items discussed by various scholars. Most of the information contained in Table 1 was derived from the work of Levine and Freeman (1982), who conducted extensive research into the New Mexican-Plains Indian trade; more recent sources are also included.

A review of the items in Table 1 shows that the array of goods traded was quite extensive. The items range from metal tools used for food preparation (knives, pots, utensils), and hide processing and leather working (awls, scissors, fleshers), to weapons and firearms (metal projectile points, guns, ammunition, gunflints, musket balls). Other items were for personal adornment (rings, bracelets, conchas, glass beads), horse tack and equipment (bridles, bits, saddles), and fire making (strike-a-lights). Kenner (1969:37) states that by the mid-1700s, the quantity and variety of goods that the New Mexican traders could offer to the Comanches was continually increasing. It appears that by the early-19th century, European trade items were quickly replacing the traditional stone, bone, and clay tools and containers of the Southern Plains Indians.

While many of the trade items were in the form of foodstuffs, cloth, robes, and textiles that would probably not be preserved in an archeological site, the metal and glass items should be preserved in historic Southern Plains Indian sites. Several of the references in Table 1 are, in fact, archeological reports that discuss metal and glass trade items encountered during investigations of a particular site. These reports form the basis of the following section, which examines the nature and distribution of historic Indian sites in the Texas portion of the Southern Plains.

## THE STUDY SAMPLE

The Texas Historic Sites Atlas, which is maintained by the Texas Historical Commission, was consulted to determine the number, type, and distribution of documented historic Indian sites in the Texas portion of the Southern Plains. Archeological site records from 72 counties in the Panhandle, South Plains, and Lower Plains were examined. It was found, however, that some of the records within the Atlas database are incomplete. Therefore, the site records at the Texas Archeological Research Laboratory (TARL) were also utilized. A search revealed that more than 6,300 archeological sites have been recorded for the 72 counties within the study sample. However, since some of the site records did not include information on types of artifacts found at the site, only those that contained this information were included in the study. This resulted in a study sample of 5,800 site records (Table 2). Of these, only 61, or 1.05 percent, were determined to be historic Indian sites or sites that contained a historic Indian component.

If the artifacts recovered or observed at the site by the recorder included items such as metal projectile points, glass beads, copper or brass bracelets, or other European trade items, the site was

**Table 1. Items in the European-Southern Plains Historic Indian Trade.**

| Item | Reference |
|---|---|
| **Metal Items** | |
| awls | Carroll and Haggard 1942:110, Cruse et al. 2001:38, Noyes 1993:19 |
| axes, hatchets | Crosby County Historical Commission 1978:7, Eagleton 1955:201, Noyes 1993:19, Ray and Jelks 1964:137-138 |
| bridles, bits, tack, saddles | Adams and Chavez 1956:252, Bennett 1968, Crosby County Historical Commission 1978:7, Cruse et al. 2000:42, 2001:40, Monahan 1969:59-60, Newcomb 1955:188, Simmons and Turley 1980:98-115, Suhm 1962:107-110, Taylor 1975, Word and Fox 1975:20-27 |
| buckles | Newcomb 1955:187, Ozee 1955, Simmons and Turley 1980:113-115 |
| buttons | Cruse et al. 2000:42, 2001:39, Ozee 1955, Parker 2000:48, Ray and Jelks 1964:134, Suhm 1962:88-90 |
| coins | Crosby County Historical Commission 1978:7, Parker 2000:48 |
| guns, ammunition, muskets, firearms, musket balls, lead | Baker 1940:2, Cabeza de Baca 1954:42, 47, Collinson n.d.:8, Commission of Indian Affairs 1872:503, Crosby County Historical Commission 1978:7, Cruse et al. 2000:31-40, 56-68 87-89, 2001:31-37, Eagleton 1955:217, East 1927:24, Faulk 1961:179, Gregg 1933:435, Guffee 1976:33-37, 44-45, Haley 1935:163, 1953:24, Hatfield n.d.:1, Hill 1936:37, Hughes and Willey 1978:240, Kenner 1969:85, 171, Lange 1979:202-203, Loyd 1939:18, McClure 1948:28, 59-60, 62-63, Marcy 1938:133, Monahan 1969:60-61, Newcomb 1955:187, Noyes 1993:19, Robertson and Robertson 1978:40, Taylor 1975, Wallace 1968:26-27 |
| iron hoops/strips | Anonymous 1946:96, Gunnerson 1969:34, Hughes and Willey 1978:250-251 |
| iron spears/lances | Anonymous 1946:96, Cabeza de Baca 1954:42, Crosby County Historical Commission 1978:7, Faulk 1961:179, Guffee 1976:33, Haley 1953:18, 21, Simmons and Turley 1980:177-179, Taylor 1975 |
| knives | Adams and Chavez 1956:252, Baker 1940:2, Bennett 1968, Burnet 1954:123, Cabeza de Baca 1954:47, Carroll and Haggard 1942:110, Cruse et al. 2000:44, 68-70, Crosby County Historical Commission 1978:7, Faulk 1961:179, Foster 1960:56, Haley 1935:163, 1953:24, Monahan 1969:60, Robertson and Robertson 1978:40, Simmons and Turley 1980:130-133, Taylor 1975 |
| metal jewelry, ornaments | Bennett 1968, Cruse et al. 2001:40, Monahan 1969:59-60, Ray and Jelks 1964:134-137, Shawn 1975:23-24, Suhm 1962:88-89, 93-97, Taylor 1975, Whipple 1853 (Part 1):32, (Part 3):52-53, Word and Fox 1975:28-31 |

**Table 1.** *(Continued)*

| Item | Reference |
|---|---|
| metal projectile points | Crosby County Historical Commission 1978:7, Cruse et al. 2000:42, 68, 2001:36, 62, Hughes and Willey 1978:262, Kenner 1969:85, Randall 1970:46, 52, Robertson and Robertson 1978:43, Shawn 1975:23, Simmons and Turley 1980:177-179, Whipple 1853 (Part 1):31, Word 1963:60 |
| metal tools, fleshers | Cruse et al. 2000:44, Gunnerson 1969:34, Hughes and Willey 1978:251, Lange 1979:202-203, Noyes 1993:19, Word and Fox 1975:41-42 |
| needles | Noyes 1993:19 |
| pots, pans, kettles, utensils | Bennett 1968, Burnet 1954:137, Cruse et al. 2000:44, Haley 1935:166, Newcomb 1955:187-188, Robertson and Robertson 1978:41, Taylor 1975 |
| scissors | Noyes 1993:19 |
| strike-a-lights | Bennett 1968, Simmons and Turley 1980:120, 122 |
| tinklers, bells | Crosby County Historical Commission 1978:7, Cruse et al. 2000:42, 44, 2001:38, Hughes and Willey 1978:251, Noyes 1993:19, Ray and Jelks 1964:131-134, Suhm 1962:87-89, 91 |
| **Glass Items** | |
| beads | Arnot n.d.:5, Baker 1940:2, Crosby County Historical Commission 1978:7, Gunnerson 1969:34-35, Haley 1935:163, 1953:24, Hill 1936:37, Hughes and Willey 1978:250, Lange 1979:202-203, Ozee 1955, Parker 2000:46, Pearce 1936:41-42, Pike 1967:41, Ray and Jelks 1964:129-132, Shawn 1975:19, Suhm 1962:94-95, Tafoya 1893:2-5, Word 1963:60, Word and Fox 1975:14-19 |
| mirrors | Noyes 1993:19, Monahan 1969:59, Ray and Jelks 1964:137, Word and Fox 1975:32 |
| **Foodstuffs** | |
| beans | Foster 1960:56, Hill 1936:37 |
| bread, panocha | Anonymous 1946:96, Baker 1940:2, Cabeza de Baca 1954:47, Carroll and Haggard 1942:110, Commission of Indian Affairs 1872:503, Coues 1970:64n, Haley 1935:162, Monahan 1969:72, Pike 1967:41, Riley 1978:56-63, Robertson and Robertson 1978:38, Whipple 1853 (Part 1):31 |
| coffee | Baker 1940:2, Loyd 1939:18-19, Robertson and Robertson 1978:38 |
| corn, flour | Kenner 1969:80, Monahan 1969:72, Whipple 1853 (Part 1):31 |
| fruit | Anonymous 1946:96 |

**Table 1.** *(Continued)*

| Item | Reference |
|---|---|
| pinole | Coues 1970:64n, Haley 1935:162, Monahan 1969:72 |
| piñon nuts | Hill 1936:38, Riley 1978:56-63 |
| salt | Anonymous 1946:96, Collins 1931:113, Faulk 1961:180, Riley 1978:56-63 |
| sugar | Commission of Indian Affairs 1872:503, Kenner 1969:178, Kessell 1979:428, Monahan 1969:59-60, Robertson and Robertson 1978:38 |
| tobacco | Adams and Chavez 1956:252, Baker 1940:2, Burnet 1954:123, Eagleton 1955:212, Haley 1935, 1953, Kessell 1979:428, Monahan 1969:59, Pike 1967:41, Whipple 1853 (Part 1):31 |
| whiskey, wine | Baker 1940:2, Cabeza de Baca 1954:47, Haley 1935:163, East 1927:24, Kenner 1969:165-166, 171, Loyd 1939:21 |
| **Textiles** | |
| blankets and cloth | Adams and Chavez 1956:252, Anonymous 1946:96, Burnet 1954:123, Cabeza de Baca 1954:47, Collins 1931:113, Collinson 1963:65, Eagleton 1955:213, Faulk 1961:179, Haley 1935:166, 1953:24, Hill 1936:38, Kenner 1969:70, Kessell 1979:428, Monahan 1969:72, Noyes 1993:19, Pike 1967:41, Ray and Jelks 1964:137-138, Robertson and Robertson 1978:41, Suhm 1962:103-105, Tafoya 1893:3, Wallace 1968:46, Word and Fox 1975:9-14 |
| **Hides/Livestock** | |
| hides, robes, tallow, meat | Adams and Chavez 1956:252, Collins 1931:113, Collinson 1963:65, Eagleton 1955:212-216, Faulk 1961:180, Ford 1972:38-39, Haley 1953:23, Hatfield n.d.:1, Monahan 1969:70-71, Pike 1967:41, Riley 1978:56-63, Simmons 1967:11, Whipple 1853 (Part 1):31, 34 |
| leather | Eagleton 1955:200-213, Newcomb 1955:187, Word and Fox 1975:9 |
| livestock | Adams and Chavez 1956:252, Burnet 1954:123, Cabeza de Baca 1954:48, Commission of Indian Affairs 1872:503, Coues 1970:64n, Haley 1935:163, 1953:23-24, Hill 1936:37-38, Simmons 1967:34, Wallace 1964:23, 1968:6, 26, 34, Whipple 1853 (Part 1):34 |
| **Other Items** | |
| *comales* (griddles) | Simmons and Turley 1980:117 |
| gunflints and powder | Faulk 1961:179, Hughes and Willey 1978:240, McClure 1948:28, Monahan 1969:60-61 |
| paints | Carroll and Haggard 1942:110, Haley 1935:163, 1953:24, Robertson and Robertson 1978:42, Tafoya 1893:5 |

**Table 1.** *(Continued)*

| Item | Reference |
|---|---|
| slaves | Adams and Chavez 1956:252, Robertson and Robertson 1978:40, Simmons 1967:34 |
| wooden items | Riley 1978:56-63, Word and Fox 1975:39 |

considered to be historic Indian or to have an historic Indian component. Some site forms mentioned the occurrence of tepee rings, but unless the forms noted the presence of one or more artifacts indicating an occupation by a historic Indian group, the sites were not included in the study sample. A few rock-art sites with depictions of clearly historic subjects, such as longhorn cattle, horses, guns, or people in European-style dress, were included even though no artifacts were noted in the site records.

Only 26 of the 72 counties in the study sample had one or more recorded historic Indian sites. The types of historic Indian sites within these counties are presented in Table 3. On the basis of the data recorded on the site forms, the 61 historic Indian sites were separated into three types: camps/villages, burials, and rock-art sites.

### Camps and Villages

Most of the historic Indian sites (n=38, or 62.3 percent) in the study sample were classified as open camps or villages. The site records for 30 of the camp/village sites list the occurrence of metal projectile points. Four of these site records also mention the presence of glass trade beads. Four other site records list glass trade beads as the only diagnostic artifact used for classifying the site as historic Indian, though one of these also mentions unspecified "historic metal artifacts."

Two sites in the camp/village category are problematic because neither appears to have been investigated sufficiently to confirm occupations by historic Indians. The first is site 41ST3 in Sterling County. The site record indicates that it is a known Kiowa camp, but the only artifacts mentioned are cores, bifaces, and lithic debris. The other site, 41AM1, in Armstrong County, is the reported location of Comanche, Kiowa, and Southern Cheyenne encampments that were attacked by Colonel Ranald S. Mackenzie and the Fourth Cavalry on September 28, 1874. Though the military records leave little doubt that 41AM1 is the location of the battle (Wallace 1968:123-124), no systematic archeological investigations have been conducted to confirm the locations of the Indian villages or the battle site.

The investigations that have taken place at the historic Indian camp/village sites have largely been confined to surface collecting where one or more historic Indian items were recovered. Eight of the sites, however, have been subjected to more intense investigations by professional archeologists. In order to examine the characteristics of the components at these sites, they are briefly reviewed below. The sites are discussed in the order of their approximate chronological occurrence.

### The Headstream Site (41KT51)

The Headstream site was recorded and investigated during the Lake Alan Henry Reservoir Project (Boyd et al. 1993). The site is situated on an alluvial terrace on the east side of Grape Creek in Kent County. During the investigations at the site, 89 $m^2$ of the site area was hand excavated and seven backhoe trenches were excavated. The excavations revealed five cultural features including a midden, a rock-lined hearth, two small, unlined basin hearths, and a baking pit. Four radiocarbon and three archeomagnetic dates indicate that the site was occupied during the mid-1600s.

The investigations recovered 4,499 artifacts, the majority of which are chipped stone, though ceramics account for nearly 20 percent of the artifacts. The diagnostic chipped-stone artifacts include 21 arrow points of Fresno and Lott types, as well as untyped triangular and expanding-stem specimens. The ceramics included a variety of wares including

**Table 2. Number of Recorded Sites, and Number and Percent of Historic Indian Sites by County.**

| County | *Number of Recorded Sites | Number of Historic Indian Sites | Percent Historic Indian Sites |
|---|---|---|---|
| Andrews | 52 | 0 | 0.00 |
| Armstrong | 10 | 2 | 20.00 |
| Bailey | 9 | 0 | 0.00 |
| Borden | 14 | 0 | 0.00 |
| Briscoe | 534 | 4 | 0.75 |
| Carson | 76 | 0 | 0.00 |
| Castro | 2 | 0 | 0.00 |
| Childress | 106 | 1 | 0.94 |
| Cochran | 1 | 0 | 0.00 |
| Coke | 185 | 1 | 0.54 |
| Collingsworth | 30 | 0 | 0.00 |
| Cottle | 22 | 0 | 0.00 |
| Crane | 27 | 0 | 0.00 |
| Crosby | 116 | 5 | 4.31 |
| Dallam | 34 | 1 | 2.94 |
| Dawson | 8 | 0 | 0.00 |
| Deaf Smith | 16 | 0 | 0.00 |
| Dickens | 24 | 1 | 4.17 |
| Donley | 23 | 0 | 0.00 |
| Ector | 14 | 0 | 0.00 |
| Fisher | 81 | 1 | 1.23 |
| Floyd | 85 | 4 | 4.71 |
| Foard | 186 | 0 | 0.00 |
| Gaines | 60 | 0 | 0.00 |
| Garza | 660 | 10 | 1.52 |
| Glasscock | 2 | 0 | 0.00 |
| Gray | 67 | 0 | 0.00 |
| Hale | 24 | 0 | 0.00 |
| Hall | 69 | 0 | 0.00 |
| Hansford | 127 | 4 | 3.15 |
| Hardeman | 112 | 0 | 0.00 |
| Hartley | 45 | 2 | 4.44 |
| Haskell | 36 | 0 | 0.00 |
| Hemphill | 23 | 0 | 0.00 |
| Hockley | 1 | 0 | 0.00 |
| Howard | 77 | 0 | 0.00 |
| Hutchinson | 206 | 0 | 0.00 |
| Irion | 91 | 0 | 0.00 |
| Jones | 76 | 0 | 0.00 |
| Kent | 153 | 3 | 1.96 |
| King | 65 | 0 | 0.00 |
| Knox | 97 | 0 | 0.00 |

**Table 2.** *(Continued)*

| County | *Number of Recorded Sites | Number of Historic Indian Sites | Percent Historic Indian Sites |
|---|---|---|---|
| Lamb | 7 | 0 | 0.00 |
| Lipscomb | 3 | 0 | 0.00 |
| Lubbock | 113 | 1 | 0.88 |
| Lynn | 9 | 0 | 0.00 |
| Martin | 40 | 0 | 0.00 |
| Midland | 38 | 2 | 5.26 |
| Mitchell | 80 | 1 | 1.25 |
| Moore | 203 | 0 | 0.00 |
| Motley | 18 | 5 | 27.78 |
| Nolan | 90 | 1 | 1.11 |
| Ochiltree | 41 | 2 | 4.88 |
| Oldham | 252 | 1 | 0.40 |
| Parmer | 7 | 0 | 0.00 |
| Potter | 239 | 2 | 0.84 |
| Randall | 56 | 1 | 1.79 |
| Reagan | 62 | 0 | 0.00 |
| Roberts | 47 | 0 | 0.00 |
| Runnels | 229 | 0 | 0.00 |
| Scurry | 17 | 1 | 5.88 |
| Sherman | 4 | 0 | 0.00 |
| Sterling | 105 | 3 | 2.86 |
| Stonewall | 77 | 0 | 0.00 |
| Swisher | 30 | 0 | 0.00 |
| Taylor | 200 | 1 | 0.50 |
| Terry | 25 | 0 | 0.00 |
| Upton | 22 | 0 | 0.00 |
| Ward | 71 | 0 | 0.00 |
| Wheeler | 20 | 0 | 0.00 |
| Winkler | 48 | 0 | 0.00 |
| Yoakum | 1 | 1 | 100.00 |
| TOTAL | 5,800 | 61 | 1.05 |

*Does not include site records that contain no information on artifact types, unless they are records of rock-art sites with clearly historic depictions.

Tewa Polychrome, red-slipped sherds of the Tewa tradition, unslipped and slipped redware sherds of Puebloan origin, and Pecos Glaze V polychrome. A number of utility wares could not be identified, but most of them are similar to Puebloan-made plain and striated wares such as Pecos Faint Striated. The only artifacts from the site indicative of European contact are two faceted cobalt-blue glass beads. Their source of manufacture was not determined.

Boyd (1997:170) interprets the Headstream site to be a multifunctional base camp that was occupied repeatedly over a period of time. He considers the site to be affiliated with the Garza complex (ca. A.D. 1400 to 1700).

**Table 3. Historic Indian Site Types.**

| Site | Camp/Village | Burial | Rock-Art Site |
|---|---|---|---|
| 41AM1 | X | | |
| 41AM2 | X | | |
| 41BI34 | X | | |
| 41BI46 | X | | |
| 41BI449 | X | | |
| 41BI544 | X | | |
| 41CI7 | X | | |
| 41CK148 | | X | |
| 41CB27 | X | | |
| 41CB28 | X | | |
| 41CB29 | X | | |
| 41CB53 | | X | |
| 41CB81 | X | | |
| 41DA21 | X | | |
| 41DK15 | X | | |
| 41FS1 | | X | |
| 41FL1 | X | | |
| 41FL45 | | X | |
| 41FL63 | | X | |
| 41FL87 | X | | |
| 41GR24 | X | | |
| 41GR38 | X | | |
| 41GR43 | | X | |
| 41GR51 | | | X |
| 41GR52 | | | X |
| 41GR57 | | | X |
| 41GR60 | X | | |
| 41GR282 | | | X |
| 41GR344 | | | X |
| 41GR414 | | | X |
| 41HF2 | | | X |
| 41HF8 | X | | |
| 41HF86 | X | | |
| 41HF124 | | X | |
| 41HT1 | X | | |
| 41HT148 | X | | |
| 41KT51 | X | | |
| 41KT53 | X | | |
| 41KT164 | | | X |
| 41LU2 | | X | |
| 41MD2 | X | | |
| 41MD28 | X | | |
| 41MH18 | | X | |

**Table 3. Historic Indian Site Types.**

| Site | Camp/Village | Burial | Rock-Art Site |
|---|---|---|---|
| 41MY1 | X | | |
| 41MY24 | X | | |
| 41MY25 | X | | |
| 41MY26 | X | | |
| 41MY27 | X | | |
| 41NL8 | | X | |
| 41OC13 | | X | |
| 41OC49 | X | | |
| 41OL4 | | | X |
| 41PT114 | X | | |
| 41PT137 | X | | |
| 41RD24 | X | | |
| 41SC3 | | | X |
| 41ST3 | X | | |
| 41ST87 | X | | |
| 41ST91 | | X | |
| 41TA29 | X | | |
| 41YK1 | | X | |

## The Longhorn Site (41KT53)

The Longhorn site is on an alluvial terrace of Grape Creek only 800 m upstream from the Headstream site. Like the Headstream site, the Longhorn site was recorded and investigated in conjunction with the Lake Alan Henry Reservoir Project (Boyd et al. 1993). The archeological investigations at the site consisted of the hand excavation of 340 $m^2$, with the majority of the units located in four large blocks. In addition, 14 backhoe trenches were excavated and a large portion of the site area was surveyed using a proton magnetometer.

The archeological investigations identified 50 cultural features and recovered 9,029 artifacts (Boyd 1997; Boyd et al. 1993). In addition, 18 radiocarbon dates and three archeomagnetic dates were obtained. The most common features identified were post molds, most of which are interpreted as being associated with three separate tepee structures. Other posts may have been for outside structures such as shade arbors. One of the tepee-associated post molds contained a *Bos* horn core interpreted as representing a tie-down stake for securing the tepee foundation (Boyd 1997:177). Each tepee structure also had a well-defined, unlined basin hearth with ashy fill. Three other basin hearths that are not associated with the tepee structures were also discovered.

The artifact assemblage from the site contained more than 6,000 lithics, 2,595 ceramics, and 11 historic artifacts. The lithic tool assemblage contained a high frequency of unifacial tools, which are dominated by Plains-style end scrapers thought to be related to the processing of bison hides. Projectile points and bifaces were not well represented at the site, but the projectile point forms that were identified include Fresno, Washita and Harrell-like, and Lott.

The ceramic assemblage was varied and represented a minimum of 24 vessels and four pipes. Two of the pipes are rectangular-bodied Pecos-style pipes, and most of the ceramics are of Puebloan manufacture. The ceramics include Tewa Polychrome, Pecos Glaze V Polychrome, glaze-painted wares of various Glaze E and/or F forms, Salinas Redware, redwares of various Glaze E and/or F forms, and a micaceous plainware from the Taos/Picuris area.

The historic artifacts from the site include 5 majolica sherds, 4 possible gunflints, a lead ball, and an unidentified iron fragment. In addition to the cow horn core, a horse tooth was also recovered, providing further evidence of European-introduced animals at the site.

The site was dated by 18 radiocarbon and 4 archeomagnetic assays associated with cultural features. According to Boyd et al. (1993:209), the dates and the artifacts indicate that "the Longhorn Site was occupied most intensively during the A.D. 1600s, perhaps extending into the early A.D. 1700s." The Longhorn site is interpreted as a residential base camp that was repeatedly occupied on a periodic or seasonal basis and affiliated with the Garza complex.

### Site 41HF86

Site 41HF86 is a rockshelter located at the head of a small tributary drainage to Horse Creek in Hansford County. It was excavated as part of the data-recovery investigations at Palo Duro Reservoir (Quigg et al. 1993). Thirteen 1 x 1 m units were excavated in the shelter. The deposits vary from 30 to 80 cm thick and contain evidence of multiple occupations, though the deposits had undergone considerable disturbance from extensive use of the shelter in modern times. Nonetheless, three aboriginal hearths were encountered.

Although the disturbance of the deposits prevented separation of the cultural materials into coherent assemblages, a radiocarbon sample from one of the hearths produced a calibrated calendar age of A.D. 1480-1658. Ten Washita and Fresno arrow points were recovered, as were several historic artifacts, including a native-made brass arrow point fragment and a metal finger ring. The site is interpreted as being temporarily occupied during the late Protohistoric or early Historic Periods.

### The Broken Jaw Site (41HF8 Block B)

The Broken Jaw site is located on an alluvial terrace of Palo Duro Creek in Hansford County. Like site 41HF86, it was excavated as part of the data-recovery investigations at Palo Duro Reservoir (Quigg et al. 1993). The 18 $m^2$ excavation of Block B exposed two shallow, unlined hearth features. From one of the features an iron, native-made arrow point was recovered. Quigg et al. (1993:241) state that the metal arrow point probably dates to between A.D. 1750 and 1874, but they offer no supporting evidence for this date.

Other artifacts from the Block B excavations include a Marcos dart point, a Harrell and two Fresno arrow points, three scrapers, a biface, two ground-stone pieces, a bone tool, three small sherds of late Pecos-like glazeware, and three *Olivella* shell beads. Faunal remains include 814 animal bones, most of which appear to be bison. Quigg et al. (1993:241) do not assign a cultural affiliation to the site, but they note that the Tierra Blanca Complex (A.D. 1300-1650) is a possibility.

### The Sandstone Ledger Site (41BI34 Area II)

The Sandstone Ledger site is located on a small terrace on the west side of Tule Creek in western Briscoe County. Along the southern edge of the site, a talus slope to the southwest leads to a sandstone face, which contains more than two dozen petroglyphs from which the site takes its name (Willey and Hughes 1978:254). The Sandstone Ledger site was recorded in 1970 by James Malone who conducted the initial survey prior to the construction of Mackenzie Reservoir in Tule Canyon (Malone 1970). Malone recorded the site based on a small hearth he observed eroding from the edge of the site.

In 1973 the site was investigated in conjunction with the construction of Mackenzie Reservoir (Hughes and Willey 1978). The work at the site consisted of documenting the rock art and 41.4 $m^2$ of hand excavations. The excavations revealed three hearths, all of which are described as "small, shallow, unlined fire basins" (Willey and Hughes 1978:264). The dimensions of the hearths ranged from approximately 43 cm to 52 cm in length, from 31 cm to 55 cm in width, and from 3 cm to 8 cm in thickness. Two of the hearths, Features 1 and 2, contained charcoal, but there is no indication that the charcoal was submitted for chronometric dating. Small bone fragments from Features 1 and 2 were also noted.

Other than the bone fragments and a single piece of shell, only 13 other artifacts were recovered from the site and all of these were found on the surface. These include 7 lithic specimens (1 core, 4 flake tools, 1 uniface, and 1 thin biface), and 5 metal items. Three of the metal artifacts are iron and include a complete arrow point, a chiseled piece identified as a flesher bit, and an unidentified piece of cut metal. The other two metal artifacts are brass items, one of which is a small piece of chisel-cut metal and the other is an expended cartridge identified as .45-70 caliber that was found "more than 600 feet north of the northernmost excavations" (Willey and Hughes 1978:262).

Willey and Hughes (1978:264) interpret the Sandstone Ledger site as most likely a single-component occupation by historic Indians. However, they state that the petroglyphs at the site, which consisted of 27 linear grooves, "may or may not be associated with the occupation." The small number of artifacts recovered suggests that the sampled area of the site was occupied briefly.

### The Sand Pit Site (41BI46 Area II)

Like the Sandstone Ledger site, the Sand Pit site was investigated in 1973 in conjunction with the construction of Mackenzie Reservoir. The site had been recorded in 1970 when an eroding hearth and lithic debitage were observed (Malone 1970). The site is situated on a south-side terrace of Tule Creek near its juncture with Cope Creek. Previously, the surface of the site area had been bladed to facilitate sand-quarrying operations associated with the construction of the reservoir dam. The excavations at the site (a total of 73.6 $m^2$) documented 5 unlined hearths and recovered 2,263 artifacts (Willey et al. 1978:231-253). The hearths are described as being small, shallow, basin-shaped, and unlined, with circular to oval plan outlines. The dimensions of the hearths range from approximately 30 cm to 40 cm in length, 27 cm to 40 cm in width, and 3 cm to 11 cm in thickness. Fill from the hearths was composed of light gray ash with some charcoal flecks, and burned and unburned bone fragments. Artifacts found in or near the hearths included lithic flakes, metate fragments, abraded stones, burned and unburned bones, butchered bones, glass beads, and sheet iron.

The artifacts from the site include chipped stone (1,454), ground stone (28), unmodified stone (22), modified bone (11), unmodified bone (690), shell (1), ceramic (4), glass beads (12), and metal (41). Of note within the chipped-stone artifacts were 11 arrow points (1 Washita, 1 Reed-like, 1 Young-like, 6 Fresno, and 2 unidentifiable tips) and 5 gunflints. Two of the gunflints appear to have been made by the Indian occupants of the site, while the other three are European-made and thought to be "Dutch style and made between 1750 and 1775" (Willey et al. 1978:251).

The ceramics from the site include one piece of burned clay and three rim sherds. The sherds include a Rio Grande utility ware, an unidentified black polished utility ware, and a San Lazaro Glaze Polychrome. The Rio Grande utility sherd dates from A.D. 1350 to 1600. The San Lazaro Glaze Polychrome derives from Tonque Pueblo where it was made between ca. A.D. 1450 and 1475. Willey et al. (1978:250) indicate, however, that this sherd was recovered "several hundred yards" northeast of the Sand Pit site proper and is probably not associated with the Sand Pit occupation.

The 12 glass beads recovered from the site are all white, some of which are described as being "iridescent" while others are not (Willey et al. 1978:250). All but one of the beads measure 2 x 3 mm. The one exception measures 7 x 7 mm.

Of the 41 pieces of iron recovered, most are small, cut pieces that appear to be discarded scraps from the manufacturing of tinklers. The other metal artifacts include the handle and a portion of the blade from a knife and a long (38 cm) flesher fashioned from the rim of a wagon or buggy wheel.

The Sand Pit site is interpreted as being a multi-component site. An early occupation (A.D. 1350-1600) is suggested by the Rio Grande utility ware, and a later Comanche occupation (A.D. 1750-1800) is indicated by the gunflints and the relative abundance of iron. While many of the lithic items from the site may be attributed to the earlier occupation, Willey et al. (1978:253) believe that some of the lithics are associated with the later occupation as well. Nevertheless, these authors suggest, "Iron was beginning to be substituted for stone implements and glass for shell ornaments. The people at the Sand Pit site then were making a transition from stone-, bone- and shell-using technology to a metal and glass one" (1978:253). They also speculate that the small, unlined hearths like the ones at this site and at the Sandstone Ledger site may be representative of historic Southern Plains Indians.

### The Floydada Country Club Site (41FL1)

The Floydada Country Club site is a multi-component site located in Blanco Canyon near the head of the White River in Floyd County. In the early 1960s, Jim Word, an avocational archeologist from Floydada, excavated either 4 or 5 test units at various locations across the site. Word (1963:40) indicates that four units were excavated, but later reported (Word 1991:99) that five units were excavated. The units measured 5 square feet, for a total area of either 9.2 $m^2$ or 11.5 $m^2$. In 1975 the Texas Archeological Society (TAS) held its field school at the site where an additional 108 $m^2$ of site area was excavated (Word 1991).

From the excavations conducted at the site in the 1960s, 15 artifacts were recovered that appear to be associated with a historic Indian occupation of the site. These include seven blue glass beads, a piece of brass "similar to brass inlays used in decoration of rifles," a broken cartridge extractor from a rifle believed to have been used "in the late 19th century," three .44 caliber Henry rimfire cartridges, one iron arrow point and an arrow point preform, and a ceramic ocarina (Word 1963:60).

During the 1975 TAS excavations, only four artifacts were recovered that were attributable to historic Indians. These include a blue, round glass bead that dates from 1820 to 1836 (Word 1991:102); a piece of cut metal that may be debris from manufacturing of an arrow point; an ox bow yoke pin; and a tinkler that "contained a glass bead in the narrow part" (Word 1991:70). The bead found in the tinkler is apparently not the same blue glass bead mentioned earlier, but no additional information for this "second" bead is given.

Word (1991:99) states that artifacts from the site that are associated with the Historic Period include "metal projectile points, steel awls, rifle cartridge cases, and parts of rifle locks." This suggests that more than one metal arrow point was found at the site. He further states, "several homemade flints for a flintlock rifle were also found on the surface of the site." The steel awls, parts of rifle locks, and gunflints are not described further. It is assumed that these items have been found at the site by private collectors who may have described or shown their finds to Word.

No features have been found at the site that can be attributed to an occupation by historic Indians. Word (1991:100) suggests that the historic Indian artifacts are probably associated with a temporary occupation of the site by Comanches.

### Site 41BI544

Site 41BI544 was identified in 1999 when archeologists with the Texas Historical Commission were documenting the Battle of Red River site. This battle was a running engagement between the U.S. Army and Southern Cheyenne and Comanche Indians that occurred on August 30, 1874, near the Prairie Dog Town Fork of Red River in present Armstrong and Briscoe counties. During the survey of the battle site, the archeologists, who were using metal detectors to locate and record artifacts associated with the battle, found a number of metal tools and other metal items that apparently had been discarded by the fleeing Indian families as they were trying to stay ahead of the advancing U.S. Army (Cruse et al. 2000:42-46).

According to Colonel Nelson A. Miles (1874a, 1874b), who was commanding the U.S. forces during the battle, the army was advancing toward an Indian village that was located near the mouth of Tule Canyon. After reaching the location of the village, the army discovered that the Indians had burned the village and any supplies they could not carry with them as they fled. The army pursued the Indians, but when they could not catch up with them, they returned to the location of the village and camped there for several days.

As the archeological survey team made its way up Tule Canyon, site 41BI544 was located (Figure 2). Based on the items recovered during the survey, the site appears to be the location of the Indian village referred to by Colonel Miles and the subsequent camp of the military.

An earlier archeological survey had been conducted in this portion of Tule Canyon in 1974 by Susanna and Paul Katz (1976). Their survey, however, which was conducted without the aid of metal detectors, failed to locate site 41BI544. They did identify a number of prehistoric sites in the area. One of these sites (41BI81) is immediately east of 41BI544, while another site (41BI82) is located near the west end of 41BI544. No indications were found that either of these sites had been occupied by historic Indians.

The investigations at 41BI544 were designed to locate the site, define its boundaries, and obtain a large enough artifact sample to confidently identify temporal occupations. The site area was traversed using metal detectors to locate metal items. When a metal object was located, it was excavated and identified. The artifact location was then precisely mapped using a Trimble™ Pro XRS sub-meter accurate global positioning system receiver. Though no excavation units *per se* were excavated, some 185 shovel probes were excavated where metal artifacts were identified.

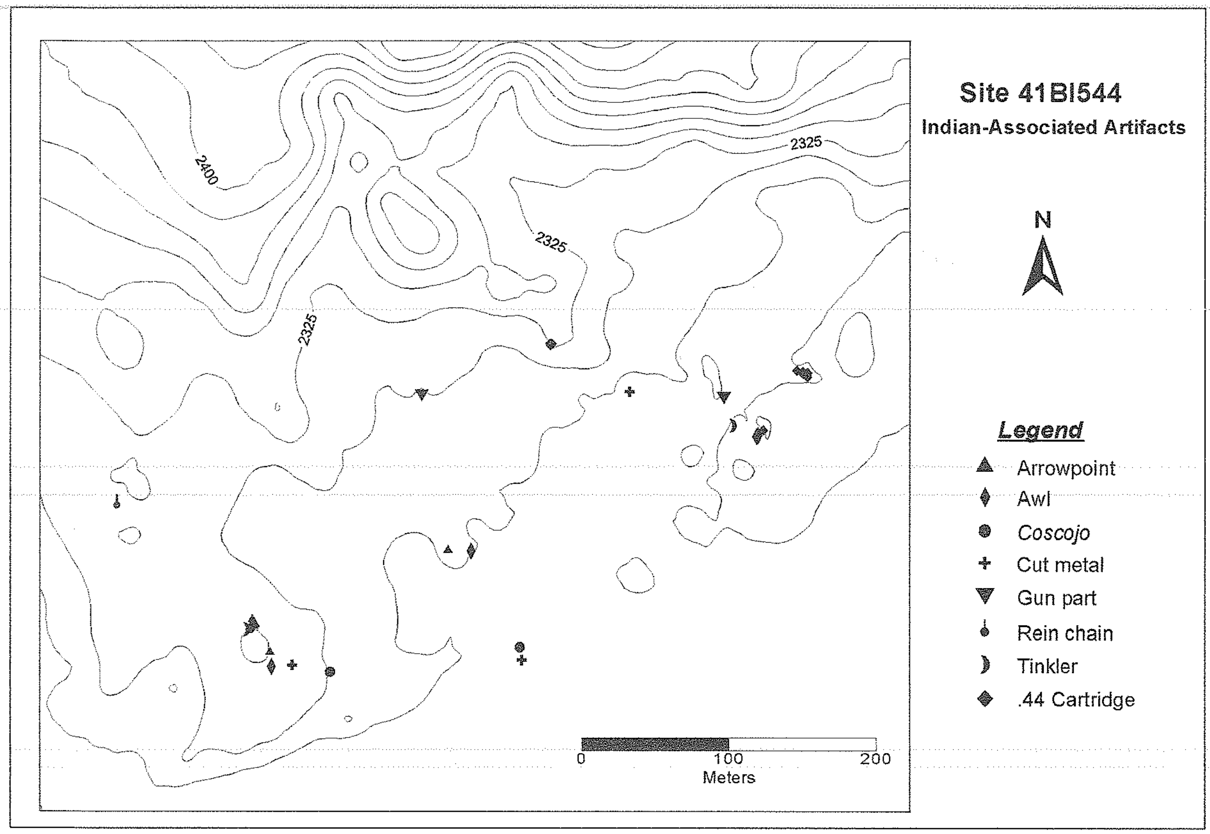


Figure 2. 41BI544 site map showing the distribution of historic Indian artifacts.

It is noteworthy that no lithic flakes, tools, or ceramic artifacts were recovered from the shovel probes.

A total of 185 metal artifacts and one gunflint were recovered from the site. Of these, 137 items are attributed to the U.S. Army occupation of the site, and they are not discussed further in this paper. Of interest to the current study are the 48 metal items and the gunflint believed to be associated with the Indian occupation of the site (Table 4). A variety of items are among the recovered metal artifacts, including six arrow points (Figure 3), an arrow point preform, and several pieces of cut metal. At least three of the arrow points appear to have been native-made (Figure 3 d-f). These three points, along with the preform and the cut metal pieces, suggest that arrow points were being manufactured at the site. Several horse-related items were also recovered. These include *coscojos* (Figure 4 a) or jingles that would have been attached to a Mexican-style bit, and a rein chain and ring (Figure 4 d and b) that were parts of a bridle. The tinklers were probably attached to clothing with a leather tassel or thong. Other items recovered include awls, two small buckles, buttons, and part of a spoon.

Several firearm-related artifacts were also recovered. These include bullets, cartridges, and a gunflint. The bullets include two .44 caliber Winchesters, two .50 caliber Sharps, and a native-made .57 caliber round ball fashioned from copper. Eleven expended .44 caliber Winchester cartridges were also recovered. The bullets and cartridges are typical of the kinds of firearms the Indians were using in 1874 (Cruse et al. 2000, 2001). The single gunflint recovered was found on the surface. It appears to be a European-made gunflint of dark gray chert. The gunflint suggests that some Indians may still have been using flintlock rifles.

The limited investigations conducted at 41BI544 suggest that this site was the location of the Indian village that the U.S. Army was trying to capture at the Battle of Red River in 1874. The variety of Indian-related artifacts indicates that a diverse range of activities was conducted at the site including arrow point manufacturing, leather or hide working, horse-related activities, and the production of munitions for firearms.

**Table 4. Indian-Related Artifacts at Site 41BI544.**

| Item | No. |
|---|---|
| awl | 4 |
| buckle | 2 |
| bullet .44 Winchester | 2 |
| bullet .50 Sharps | 2 |
| bullet .57 round ball | 1 |
| button | 2 |
| cartridge .44, expended | 11 |
| gunflint | 1 |
| *coscojo* | 2 |
| arrowpoint | 6 |
| arrowpoint preform | 1 |
| rein chain | 1 |
| rein chain ring, brass | 1 |
| spoon | 1 |
| strap | 1 |
| tinkler | 2 |
| unidentified brass fragment | 3 |
| cut metal fragment | 6 |

## DISCUSSION

From the foregoing summaries of the tested or excavated historic Indian sites in the study sample it is difficult to draw any firm conclusions regarding settlement and artifact content, though one general trend seems apparent: the reliance on European metal and glass trade goods increases through time. The archeological data generally parallels the historical documents with regard to the use and incorporation of European goods into the material culture of the Southern Plains Indians. Sites such as Headstream and Longhorn provide clear evidence that European goods were being incorporated into the Southern Plains material culture by the mid- to late-1600s. By the mid-1800s, it appears that the reliance on Euro-American goods by historic Indians had increased significantly, as evidenced by the varied artifact assemblages at sites such as Floydada Country Club and 41BI544.

The archeological data suggests that early historic Southern Plains Indians were using lithic and ceramic technologies, but these were gradually abandoned as metal and glass items became increasingly available. Of particular note is the presence of lithic arrow points at six of the investigated historic Indian sites. It may be that arrow point types such as Fresno, Garza, Harrell, and Washita continued to be used into the Historic Period on the Southern Plains. How long lithic arrow points continued to be used by historic Indians after they acquired firearms and metal for making arrow points is unknown. Archeologists should not assume, therefore, that all sites that yield late arrow point types are necessarily Late Prehistoric in age, especially if those sites have not also produced Late Prehistoric ceramic types or chronometric dates that would support a Late Prehistoric temporal placement. It may be that these sites are in fact historic Indian sites, and they should be searched with metal detectors in an effort to locate metal artifacts that would prove their historic affiliation.

From the historic Indian sites that have been investigated, it appears that evidence of tepees may or may not be found and, therefore, we cannot assume that all historic Indian campsites will contain evidence of tepees. One feature type that seems to be common on historic Indian sites is the small, shallow, unlined, basin hearth. This feature type has been found at five of the eight investigated sites. Though similar features have also been recorded at prehistoric sites, several of the small basin hearths associated with the historic Indian sites discussed above were hearths inside tepees.

### Burials

After camps and villages, burials are the next most common historic Indian site type (n=13, or 21.3 percent) in the study sample. Of the burials in the sample, only the Morgan Jones (41CB53) and Canyon Creek (41OC13) burials have been investigated and reported by professional archeologists (Parsons 1967; Shafer et al. 1994). The other recorded burials were all found by avocationals and, unfortunately, they had been disturbed in varying degrees. Nonetheless, several of those burials were subsequently studied by professionals and the results of those studies published (Newcomb 1955; Ray and Jelks 1964; Suhm 1962; Word and Fox 1975).

Of the 13 burials, six were located inside small rockshelters, four were recorded as crevice burials, two were interments at open camps, and one was not identified as to the type of interment. The site

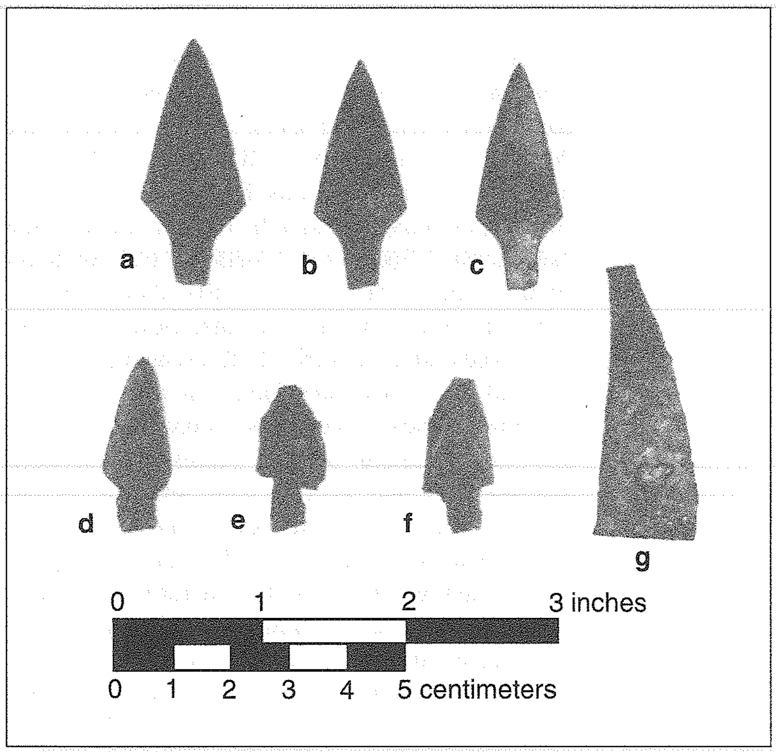


Figure 3. Metal arrow points and preform from 41BI544.

The abundance of European trade items found associated with the historic Indian burials clearly reflects the importance of European trade items to the historic Southern Plains Indians and their dependence on them. Conspicuously absent from each of the reported burials is any evidence of the use of stone, bone, or clay technologies.

records for 12 of the burials mention the presence of European trade goods. The site record for site 41HF124 states that this site is probably a historic Indian crevice burial, but when the site was mitigated in 1990 prior to the construction of the Palo Duro Reservoir, no evidence of a burial was found nor were any artifacts recovered (Quigg et al. 1993:353). The excavators did find evidence, however, that the site had been vandalized at an earlier date.

The most common artifacts recorded in association with the historic Indian burials are glass beads (Table 5). Eleven of the site records list beads associated with the burial. The Cogdell burial (41FL45) in Floyd County contained approximately 150,000 beads (Word and Fox 1975). The next most common items mentioned are horse gear and tack of various sorts including bits, buckles, and pieces of native-made saddles. Other artifacts commonly mentioned are metal bracelets, brass bells, buttons, tinklers, conchas of copper, brass, and silver, mirrors, guns, and metal tools of various kinds including axes, hoes, and knives. One of the burials, the White site burial (41YK1), was even associated with a metal trumpet (Suhm 1962).

## Rock-Art Sites

Rock-art sites make up the last type of historic Indian site in the study sample. Records for only ten rock-art locations that contain design elements or objects attributable to historic Indians (Figure 5) were found in the study sample. However, Boyd (1997:Table 29) lists nine additional rock-art sites in the region that contain historic motifs; these sites have not been officially recorded at TARL. Six of the recorded sites (41GR51, 41GR52, 41GR57, 41GR282, 41GR414, and 41KT164) are petroglyph sites. Two of the other recorded rock-art sites, 41GR344 and 41OL4, contain both petroglyph and pictograph representations, while sites 41HF2 and 41SC3 appear to be pictograph rock-art locations.

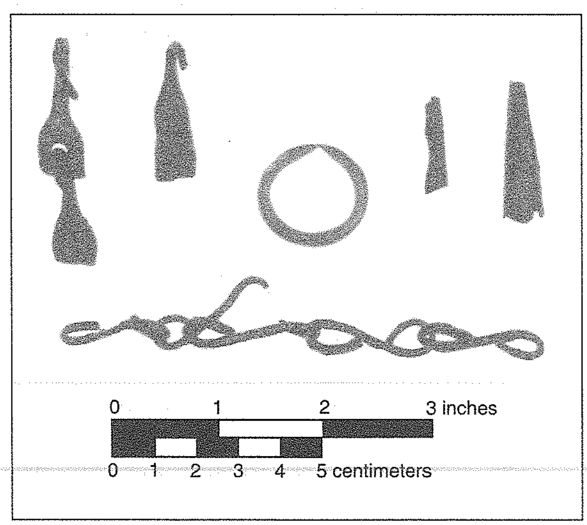


Figure 4. Miscellaneous metal artifacts from 41BI544: a, *coscojos*; b, brass ring; c, tinklers; d, rein chain.

**Table 5. Items Associated with Historic Indian Burials.**

| Site: | Yellowhouse | White | Watson | Morgan Jones | Cogdell | Canyon Creek | 41CK148 | 41FL45 | 41GR43 | 41MH18 | 41NL8 | 41ST91 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference: | Newcomb 1955 | Suhm 1962 | Ray and Jelks 1964 | Parsons 1967 | Word and 5 Fox 197 | Shafer et al. 1994 | — | — | — | — | — | — |
| **Metal Items** | | | | | | | | | | | | |
| Beads | | | | | | X | | | | | | |
| Bells | X | X | X | | | | | | | | | |
| Bracelets | | X | X | | X | X | | X | | | | X |
| Buttons | | X | X | | X | X | | | | | | |
| Conchas | | X | | | X | | | X | | | | |
| Euro. tool | | X | X | X | X | | | X | | | X? | |
| Euro. weapon | X | | | | | | | | | | | |
| Finger rings | X | X | X | | X | X | | X | | | | X |
| Horse gear | X | X | X | X | X | X | | X | X | | | |
| Knife | X | | | | | | | | | | | |
| Utensils | X | | | | | | | | | | | X |
| Tinklers | X | X | X | | | X | | | | | | |
| Trumpet | | X | | | | | | | | | | |
| **Glass Items** | | | | | | | | | | | | |
| Beads | X | X | X | X | X | X | X | X | | X | X | X |
| Mirror | | | X | | X | | | X | X | | | |
| **Foodstuffs** | | X | | | X | | | | | | | |
| **Textiles** | X | X | X | X | X | | | X | | | | |
| **Other Items** | | | | | | | | | | | | |
| Hair pipes | X | X | | X | X | | | | | | | |
| Leather | X | X | | | X | X | | X | | | | |
| Perf. tooth/claw | | | | X | X | | | X | | | | |
| Pigment | | | X | X | | | | | | | | |
| Stone pipe | | | | | | | | | | | | X |
| Shell pendant | | | | X | X | | | X | | | | |

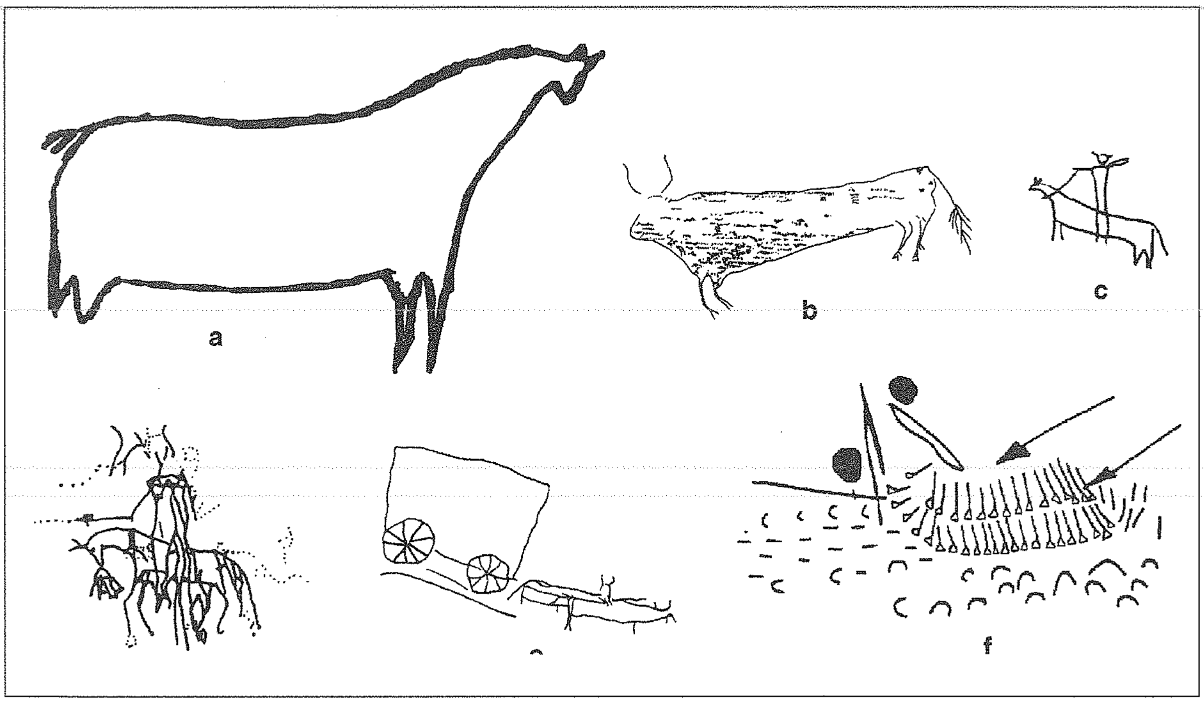


Figure 5. Examples of historic Indian rock-art motifs (from Boyd 1997:Figures 35 and 36, drawings not to scale): a, horse from 41KT164; b, longhorn from 41GR344; c, horse and rider from 41GR51; d, horse with decorated halter and rider from 41GR282; e, oxen-pulled wagon from 41GR51; f, rifles and other weapons from 41GR52.

A number of the rock-art sites contain design elements that reflect the use of and dependence on European trade goods. At the Verbena site (41GR52), for example, a petroglyph panel contains a group of 38 lines with small, appended triangles extending from their bases (Figure 5 f). Parsons (1987:269) presents a convincing argument that these represent flintlock rifles. Similar design elements have been identified at the Mujares Creek site in Oldham County.

At the Ward Petroglyph site (41GR282), one of the design motifs depicts a rider on a horse with a highly decorated bridle (Figure 5 d). This motif is a good depiction of the Mexican-style bridles of the 18th and 19th centuries (Keyser and Mitchell 2001:202). On the Mexican-style bridles, hanging under the lower lip of the horse, a metal plate or bar was attached to the bridle bit from which a number of jinglers or *coscojos* were attached to the head strap, cheek bands, and bit (Di Peso 1953:193). Cruse et al. (2000:42-44) describe a headstall plate and several *coscojos* that were recovered at the Battle of Red River site.

According to Boyd (1992:74), the historic Indian rock-art of the Southern Plains appears to be of a biographic, or storytelling, nature similar to that defined for the Northwestern Plains (Connor and Connor 1971; Keyser 1987). For additional information on historic Indian rock-art sites in the Texas portion of the Southern Plains, see Boyd et al. (1990), Jackson (1938), Kirkland (1942), Kirkland and Newcomb (1967), Parsons (1987), and Upshaw (1972).

### Historic Indian Site Distribution

The distribution of the recorded historic Indian sites as shown in Figure 6 reveals that most of the sites occur within the Caprock Canyonlands region as defined by Boyd (1997:7-9). The Caprock Canyonlands region is associated with the Caprock Escarpment, which separates the eastern edge of the Llano Estacado from the western edge of the Lower Plains. Of the 61 recorded historic Indian sites, 37 occur within this region. The higher density of sites within the Caprock Canyonlands is likely due to environmental or ecological factors. As Boyd (1997:37-53) has demonstrated, the resource-rich Caprock Canyonlands environmental zone was more intensively utilized by Native American peoples during the late Holocene than were the adjacent regions. The abundance of

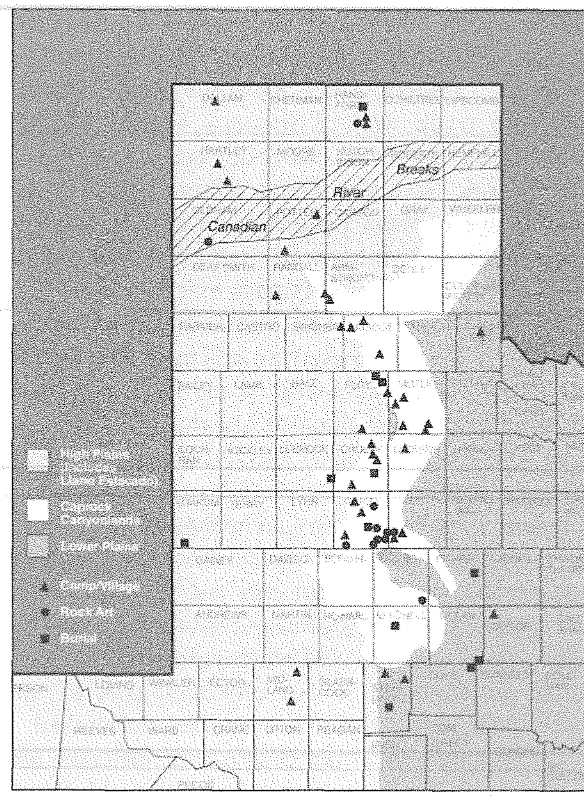


Figure 6. Distribution of historic Indian sites in relation to the natural regions within the study area.

springs and other natural resources made the region particularly attractive. In addition, the canyonlands would have offered abundant shelter and protection from the elements during the coldest winter months. The many rockshelters, overhangs, and crevices of the canyonlands offered locations that were often utilized by historic Indians to bury their dead, while the many sandstone cliffs and exposures found throughout the region provided ideal surfaces for rock-art.

This is not to suggest that the adjacent Llano Estacado and Lower Plains regions were not utilized by historic Indians. The grasslands of the Llano and Lower Plains were the favored habitats of the bison. Nevertheless, the scarcity of wood and other subsistence resources on the Llano Estacado probably dictated that occupation of this region was ephemeral and most likely took the form of temporary seasonal camps associated with hunting. It is possible, however, that in times of sufficient rainfall the historic Indian bison hunters could have had longer-term habitations near the many pluvial lakes that dot the Llano Estacado. It seems apparent, though, based on the distribution of the recorded historic Indian sites, that the Caprock Canyonlands region was favored by historic Indian groups.

The fact remains that only 61 historic Indian sites have been recorded in the 72-county study sample. Of significance are the surprisingly high percentages of recorded burial and rock-art sites in the study sample. Combined, these two site types account for nearly 38 percent of the recorded historic Indian sites in the study sample. This suggest that historic Indian burials, which are often located in relatively easily found rockshelters, and rock-art sites that are generally easily seen, are being found and recorded while many habitation sites are not being identified. The question of why the historic Indian habitation sites are not being identified is examined in the following section.

## Why Historic Indian Sites Are Not Being Identified by Archeologists

Of the 5,800 recorded sites in the study sample, most were recorded by professional archeologists under the auspices of state and federal cultural resource laws. It is somewhat surprising that of the 61 historic Indian sites that have been recorded in the study sample of 72 counties, only 29 were recorded by professional archeologists, while the remaining 32 sites were recorded by avocationals. A closer look at the site records for the 29 sites recorded by professional archeologists suggests that at least 11 of these were found by private citizens or avocationals who then reported the sites to professionals. It seems that most sites overall are identified and recorded by professional archeologists, but the majority of historic Indian sites are identified by avocationals. Why are professionals not identifying historic Indian sites?

As mentioned, I believe that the survey techniques now utilized by archeologists are not adequate to identify most historic Indian sites. Currently, site identification techniques are designed to locate lithic and ceramic artifacts, but as Boyd (1997:62) points out, the replacement of chipped lithic arrow points and beveled knives with metal arrow points and knives may have resulted in a significant reduction in the manufacture and archeological occurrence of both of these lithic tool categories. The presence of firearms may have further decreased the reliance on native technology. The availability of metal pots and pans, axes, wedges, and hammers may have had similar effects on the numbers of ceramic vessels, cobble tools, manos, and hammerstones in Protohistoric artifact assemblages.

If European and American goods largely replaced native technology during the Historic Period on the Southern Plains, site identification techniques that search only for lithic and ceramic artifacts will fail to identify most historic Indian sites. Further, if the preserved material culture of the historic Indians of the Southern Plains was composed largely of metal items, clearly the time has come for archeologists to use metal detectors when surveying areas where historic Indians are known to have been.

Information gleaned from the historic Indian site records and from the avocationals who have identified several of the historic Indian sites (Ben Grundy, personal communication 2002; Alvin Lynn, personal communication 2002) indicates that at least eight of the historic Indian camp/village sites in the study sample were identified by avocationals using metal detectors. Other historic Indian sites recorded by avocationals may have also been located with the aid of metal detectors, but that information is not always recorded on the site records. If avocationals are successful in locating historic Indian sites by utilizing metal detectors, then professional archeologists should take heed and systematically incorporate metal detectors into their survey strategies.

To date, metal detectors have been used by professional archeologists on a very limited basis, usually when they are attempting to document specific types of historic sites. Perhaps the best-known examples of metal detector use by professional archeologists are the relatively recent investigations conducted at battle sites such as the Little Bighorn site in Montana (Barnard 1998; Scott et al. 1989) and the Red River War battle sites in the Texas Panhandle (Cruse et al. 2000, 2001). Another Texas site where metal detectors have been successfully used is the recently discovered Coronado site in Blanco Canyon (Flint and Flint 1997). In fact, it appears that, other than the investigators at the Red River War and Coronado sites, professional archeologists have never used metal detectors as part of their survey investigations within the study area.

## CONCLUSIONS

Historic Indian sites on the Southern Plains have been largely overlooked by professional archeologists whose survey strategies are designed to locate sites containing primarily lithic and ceramic artifacts. The significance of metal artifacts obtained through trade with Europeans should not be underestimated when considering the archeology of the historic Southern Plains tribes. Most of our knowledge of these peoples has come from early ethnohistorical documents, which indicate that historic Southern Plains Indians relied on European trade goods to some extent, particularly metal items, and this reliance increased through time. This seems to be borne out particularly by the items that have been found in association with historic Indian burials, and, to a lesser extent, by the few investigations of historic Indian campsites. Given the apparent importance of metal items, archeologists must begin to incorporate the use of metal detectors into their survey strategies. Avocationals and relic collectors are successfully locating historic Indian campsites by using metal detectors, and professional archeologists must do the same if this important part of the archeological record is to be identified and studied.

Obviously, it is not practical or efficient for archeologists to begin lugging around metal detectors along with their shovels and screens when they are conducting general surveys of an area. Rather, the point of this paper is to attempt to make professional archeologists become more aware of the presence of historic Indian sites and to point out the need for developing ways to better identify and assess those sites.

Professional archeologists must begin to recognize the potential "traits" for Historic Period Indian sites. For example, as mentioned earlier we should not assume that just because a site yields late style arrow points that the site is necessarily Late Prehistoric in age if the site has not also produced Late Prehistoric ceramics or supporting chronometric dates. The use of lithics for producing arrow points may have continued into the Historic Period until they were eventually replaced by metal points. These types of sites should be examined with metal detectors to search for historic period metal artifacts.

Hays (1989:257) has emphasized that the greatest potential for study of the archeological remains of historic Indians on the Southern Plains is the survey and testing of habitation sites and more comprehensive analysis of the artifacts from those sites. Wallace and Hoebel (1952:14) list five criteria that Plains Indians considered when choosing a campsite, namely the availability of food, forage for horse herds, shelter, safety, and convenience. The archeologist searching for historic Southern Plains Indian sites should also keep in mind that the available documentary accounts indicate that a historic Plains Indian camp may be as small as a single tepee, or a village that may have extended for several miles.

At the few historic Indian sites that have been professionally investigated within the study sample, only the Longhorn site (41KT53) has produced archeological evidence (in the form of post molds) of tepees. Therefore, we should not assume that every historic Indian campsite will contain evidence of tepees. However, sites with such features probably hold the highest likelihood of being historic Indian, and they should be carefully surveyed with metal detectors.

This study used historic Indian sites from the Texas portion of the Southern Plains as the study sample, but the use of metal detectors would likely prove beneficial in locating historic Indian sites in other regions as well. For example, Prikryl (2001:68-69) points out that there have been no pre-reservation Tonkawa sites recorded in Texas even though the Tonkawas occupied a large area of north-central Texas between the Red River and San Antonio from about 1700 until the late 1800s. Prikryl (2001:69) suggests that one reason Tonkawa sites have not been identified is that the number of European trade goods the Tonkawas had was probably small compared with that of their Wichita and Caddo neighbors, and as a result it will probably be difficult to distinguish historic Tonkawa sites from pre-contact era sites. Prikryl may be correct, but I would maintain that the Tonkawas were not isolationists and that they did acquire European trade goods, as did virtually all historic Indian groups. These trade items should be found in historic Tonkawa sites, and these sites can probably be located if archeologists search for metal artifacts rather than focusing only on lithic and ceramic artifacts.

Until sufficient numbers of historic Indian habitation sites can be identified and investigated by professional archeologists, basic research questions concerning settlement, subsistence, and warfare will remain unanswered. Additionally, finding substantive archeological evidence of historic Indians is critical for understanding the complex social interactions between the various tribes and how the tribes adapted to the tremendous changes brought on by European contact.

The incorporation of metal detectors by professional archeologists into their survey strategies would not only aid in recognizing historic Indian sites, but would also improve assessments of historic Indian components. One can only wonder how many of the recorded sites within the study sample are incorrectly classified as "low-density prehistoric lithic scatters" that warrant "no further work." Perhaps most of the low-density lithic scatters within the study sample are nothing more than lightly used prehistoric sites, but many of them may be historic Indian sites where metal items had replaced lithics. If these sites were resurveyed using metal detectors, the result might be a more correct assessment of their temporal affiliation and occupational history.

Until recently, it seems that many archeologists have viewed metal detectors as tools to be used only by "treasure hunters." We should keep in mind, though, that treasure hunters also use shovels and screens just like archeologists, but that does not make them archeologists. As Connor and Scott (1998) point out, metal detectors are effective and inexpensive remote-sensing tools with real value to archeologists working at sites where metal artifacts are likely to be part of the site assemblage. The time has arrived for archeologists to use whatever resources are available to identify all the significant sites within their survey areas and to dispense with their bias toward lithic and ceramic sites. Contact and Historic Period Indian sites potentially contain a wealth of information that is largely being overlooked.

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# The *Denbigh* Project 2002
# Excavation of a Civil War Blockade Runner

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## ABSTRACT

The British coastal paddle steamer *Denbigh* ran the Union blockade between Havana and Mobile and then between Havana and Galveston. The ship was one of the most successful blockade runners of the Civil War until, in late May 1865 while on an inbound run, she ran aground in shallow water at the entrance of Galveston Bay. Unable to free herself, the *Denbigh* was destroyed when daylight revealed her predicament to the blockading Union fleet. The Institute of Nautical Archaeology at Texas A&M University located the site in December 1997 and investigated the wreck each summer from 1998 through 2002. The present report summarizes the excavation of the site with emphasis on the final and most recent field season.

## INTRODUCTION

The *Denbigh* was an iron-hulled paddle steamer 182 ft. (55.5 m) long. As a Liverpool coastal passenger-ship built by Laird's in 1860, she was noted for her speed. As a blockade-runner in the Gulf of Mexico in 1863-1865, she was one of the most successful and famous of the Civil War. The *Denbigh* ran aground at the entrance of Galveston Bay (Figure 1) in late May 1865 and then was shelled and burned by the Union blockading fleet. The goals of the Institute of Nautical Archaeology's (INA) *Denbigh* Project are research, education, and public outreach. Archaeological research at the *Denbigh* site is particularly important because, although there is historical evidence for her operations, the historic record preserves almost nothing of her construction details. For example, plans of the ship have not survived, although descriptive information on the dimensions, cargo capacity, operational history, and other aspects of the vessel exist (Table 1).

The Institute of Nautical Archaeology at Texas A&M University located the *Denbigh* shipwreck site (41GV143) in December 1997 and has continued to investigate the wreck during the following summer field seasons between 1998 and 2002. The 2002 work at the *Denbigh* shipwreck was the project's fifth field season. Prior work included predisturbance mapping during the 1998 field season, test excavations in 1999, and two summers of full-scale excavation during the 2000 and 2001 seasons (Arnold 1987, 2001a, 2001b, 2001c; Arnold et al. 1997, 1999a, 1997b, 2000; Hall 2002; Hall et al. 2002; S.B. Oertling 2002; T.J. Oertling 2002; G. Powell 2002; Watson 2001).

The 1998 season pre-excavation mapping of the *Denbigh* included recording the remains of the vessel's machinery that protruded above the muddy, 6 foot deep (ca. 2 m) floor of the bay to a height usually just below the water surface. The site had been located during an INA reconnaissance survey using position data from a late 19th century Corps of Engineers map that yielded the distance and bearing from the Bolivar Light House. In addition to mapping exposed remains, this phase included remote sensing surveys using magnetometer, side-scan sonar, sub-bottom sonar, and fathometer. The exposed remains consisted of portions of the *Denbigh's* boiler, paddle wheels, and the very upper parts of the twin steam engines. The deck level was just below the muddy sand bottom.

The 1999 season test excavations consisted of three units: one centrally located in the engine room, one in the forward area thought to be a cargo hold, and one toward the stern in an area thought to lie beneath the crew quarters. The engine room revealed that the major components of the *Denbigh's* machinery were intact. This was welcome but somewhat unexpected since engines and other

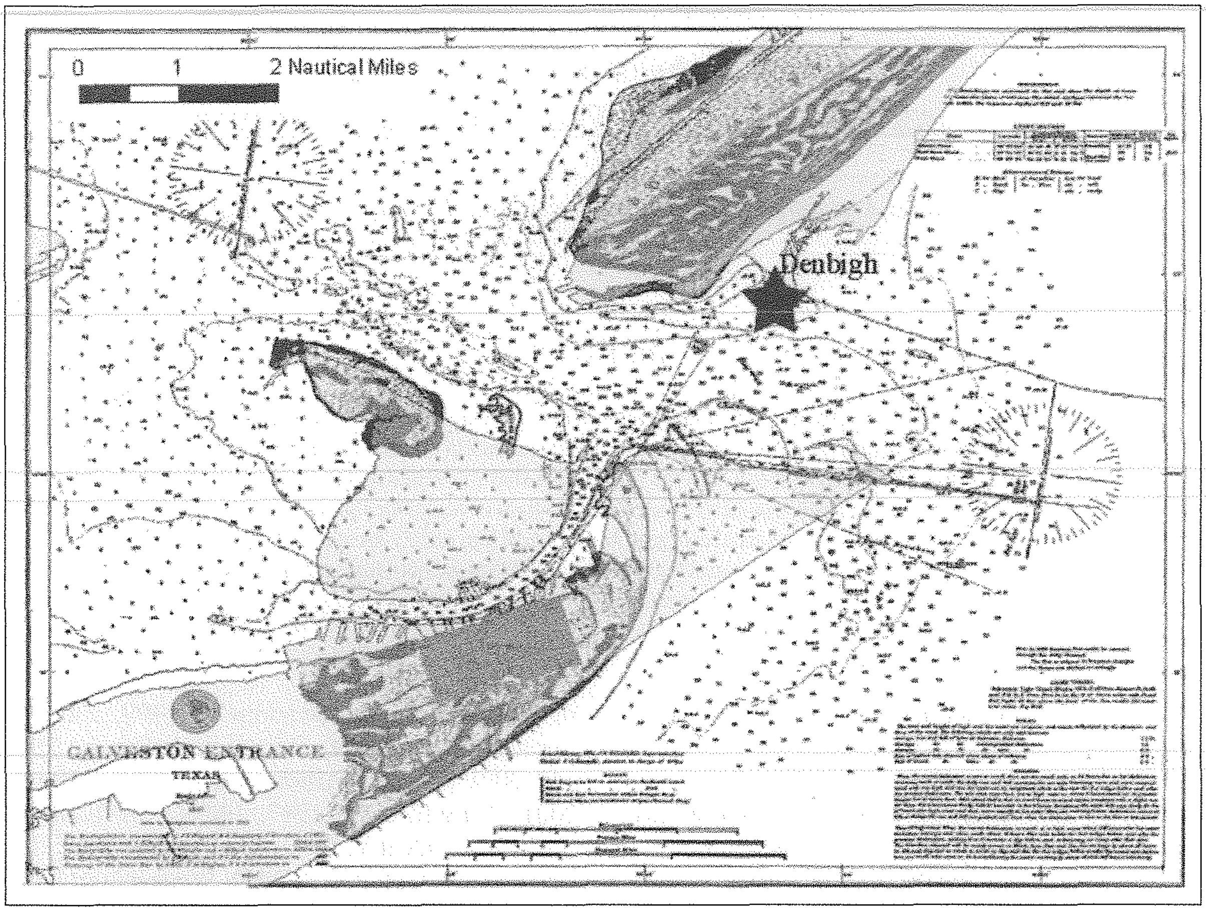


Figure 1. The *Denbigh* wreck area. The GIS map shows the pre-jetties entrance overlain by the modern shoreline. Illustration by Robert Edwards.

**Table 1. The *Denbigh* at a glance**

| | |
|---|---|
| Launched: | August 1860 |
| Builder: | Laird, Son & Co., Birkenhead |
| Length: | 182 feet (55.5 m) between perpendiculars., about 195 feet over all |
| Beam: | 22 feet (6.7 m), excluding paddlewheels |
| Depth of Hold: | 8.7 feet (2.65 m) |
| Register Tons: | 162.69 |
| Sustained Speed: | 13.7 knots (15.75 mph) |
| Cost to Build: | £10,250 (approx. $1 million today) |
| Port of Registry: | Liverpool, England |
| Trips as Runner: | 13 successful round trips |
| Cargo Capacity: | Approx. 500 bales, or 225,000 lbs. Cotton |
| Crew: | 21 |

machinery were often salvaged. The finding was particularly important because the ship's technology was a major aspect of interest for further investigation. The *Denbigh's* type of ship had served as a test bed for constantly evolving innovations in marine engineering for much of the nineteenth century. The test excavation unit in the forward area found the port side of the ship had broken and collapsed outward. The aft test excavation unit found the stern area of the hull intact. Beneath about 10 feet (ca. 1.5 m) of overburden, a few artifacts were found hinting at the presence of cargo and crew possessions. Only the first couple of feet (ca. 60 cm) above the hull's bottom yielded relatively undisturbed archeological deposits, a pattern that seems to be the usual at this site.

Three summers of full-scale excavation during the 2000, 2001, and 2002 field seasons allowed the recording of hull construction, the complex paddlewheel and drive train, and the port engine together with the condenser, air pump, hot well, and boiler. Another excavation unit in the stern half of the hull helped confirm the location of the crew quarters, but excavations were mainly concentrated in the engine room and just outboard of the engine room. Small artifacts were generally scarce, but one remote corner of the engine room contained a storage area for engineering department tools and a private stash of liquor. Some of the bottles were sealed with intact contents; however, the contents have yet to be analyzed and identified.

The present report presents the latest progress and results. Fieldwork in 2002 took place from June 1 to July 31 with headquarters at the campus of Texas A&M—Galveston (TAMUG) as was the case during the prior seasons. Educational aspects are important goals of the *Denbigh* Project, but research is the primary emphasis. This article discusses the 2002 research progress and is presented in two sub-sections, one on historical research and one on the excavation that includes a discussion of a few artifacts recovered during the excavations. The last section describes educational and public outreach activities. Historic shipwrecks with their instant appeal are ideal for building public understanding and appreciation of history, cultural heritage, and archeology.

The *Denbigh* Project benefited extensively this year from our correspondence with John Riley of Australia. Riley is an engineer and avocational archeologist who studies wrecks of the same period and general type as the *Denbigh*. Riley led us to Burgh's book on marine engineering with its plans of a Laird's boiler very like the *Denbigh's* (Burgh 1867).

There were other important Civil War shipwreck projects in 2002 the received widespread publicity: the gun turret of the USS *Monitor* was brought to the surface, representing a successful conclusion to several years of work (Anonymous 2002; Broadwater 2002); the lab work on the CSS *Hunley* submarine continued (Neyland 2002; C. Powell 2002); and the blockade-runner *Pevensey* received attention (Smith 2003). Scholarly interest in the Civil War continues to grow and public interest remains unflagging.

It is interesting, also, to note a few new and current books both scholarly and popular that bear specifically on the Civil War and its last days or on the specific situation in Texas. In the popular category, there is a novel of the Civil War period entitled *Galveston* (Nagle 2002). For understanding the social and cultural setting of the mid-19th century there is *American Scoundrel: the Life of the Notorious Civil War General Dan Sickles* (Keneally 2002). In the scholarly category there is *Look Away! A History of the Confederate States of America* (Davis 2002) in which the author presents a political history of the Confederacy. The chapter on the lack-of-civil-order problem caused by the manpower drain into the army was eye opening. It was a very grave problem not just at the end of the war as defeat loomed, but from much earlier in the war than one might have thought.

Davis has another important chapter about the intrusion of the central Confederate government into the business of the states and private individuals. The discussion in the chapter entitled "Cotton Communism, Whiskey Welfare, and Salt Socialism" is fascinating. It is a great irony that in the face of military necessity (losing the war over several years), the Confederate government violated the most dearly held of liberties in more egregious ways than ever had the old Union. The philosophical and political principals upon which secession was fomented were trampled although not without acrimony with State governors.

## RESEARCH

### Recent Advances in Historical Research— Yellow Fever and Blockade Running

The following section on Galveston's 1864 epidemic of yellow fever presents an important new historical understanding and linkage resulting directly from *Denbigh* research. A reconsideration of events in Galveston during the late summer and fall of 1864 suggests a likely linkage between the first steam blockade runners arriving at Galveston after the Battle of Mobile Bay in August 1864 and the outbreak of a yellow fever epidemic the following month. During the first three years of the war, steam blockade-runners arrived at Galveston only on rare occasions; the Texas coastal city was too far removed from the main theaters of war to be of much use. After the Union admiral Farragut closed the entrance to Mobile Bay, however, Galveston was the only seaport of any significance left in Confederate hands on the Gulf of Mexico. As a result, beginning in late August there was a sudden upsurge in blockade-running activity at Galveston that continued through the end of the war ten months later.

Although an effective vaccine can now prevent yellow fever, in the nineteenth century it was a recurring and serious problem in the southern United States and the Caribbean. Yellow fever is a mosquito-borne viral disease varying widely in severity, exhibiting everything from flu-like symptoms to severe hepatitis and hemorrhagic fever. A large proportion of those infected died. At the time of the American Civil War, the variability of the symptoms made the disease difficult to distinguish from other illnesses, and even today a positive diagnosis is only possible through laboratory testing (WHO 2001).

The threat of yellow fever was taken very seriously in Galveston, and on August 3 the Confederate commander in Texas, General Magruder, ordered a strict 30-day quarantine for all vessels arriving from Mexico, the Caribbean and other areas where the fever was endemic. It seems likely that Magruder's order met with sharp opposition from merchants and others that had an interest in blockade running, because the following day he revised his order to require quarantine only for ships arriving from ports known to be infected with fever, and then only for eight days isolation (Hayes 1974). These watered-down precautions would prove to be woefully inadequate.

The first steam blockade-runners arriving at Galveston after the fall of Mobile were the *Susanna*, arriving about August 24, and the *Denbigh*, which arrived on August 25. No other steam blockade-runner is known to have arrived at Galveston for two weeks following the *Denbigh's* arrival (Wise 1988). In the days following the *Susanna's* and the *Denbigh's* arrival, several cases believed to be yellow fever appeared among civilians and soldiers stationed in the town. On September 14, the first deaths positively attributed to the disease occurred. That same day the military command sent out a call for nurses to care for those afflicted, and two days later the city was quarantined (unsuccessfully) to prevent the spread of the disease inland.

Over the next two months, at least 259 deaths in Galveston were attributed to the disease. This figure represented nearly ten percent of the town's military and civilian population at the time. The majority of the dead were civilians, and over a quarter were children ten years and under. The heaviest toll occurred in September, but deaths were recorded as late as November 20. A heavy frost on the evening of November 22 dissipated the fever and the quarantine was lifted soon thereafter (Hayes 1974).

There was debate at the time about the origin of this particular outbreak of fever. The etiology of the disease, and the role mosquitoes played in transmitting it, would remain unconfirmed for two generations. Some in Galveston argued adamantly that the disease must have come by way of a blockade-running schooner that had sailed from Vera Cruz, Mexico, while others insisted that it sprang from "local causes in the city" (Hayes 1974).

The present authors believe the case to be somewhat unlikely for the schooner from Vera Cruz being the source of the yellow fever outbreak. The length of the voyage from Vera Cruz, typically a week or longer, would probably be enough time for symptoms to begin appearing among the crew and to draw the attention of authorities inspecting the vessel upon arrival. A steamer from Havana, on the other hand, would normally be able to make the run into Galveston in three or four days, making it much easier for infected seamen to pass undetected. It is also possible that the disease arrived at Galveston not in an infected sailor (who was subsequently bitten by a local mosquito), but in an insect brought along from the vessel's point of origin. In that scenario, too, a steamer making a quick passage seems a more likely means of transmission than a relatively slow sailing vessel.

The normal course of the disease suggests its first victims in Galveston were infected very shortly after the arrival of the *Susanna* and the *Denbigh* in late August. There were two interments of victims on September 14—they same day they died—and three more the following day. The disease has a normal incubation period of three to six days, during which time there are no outward symptoms of the illness. After this incubation period, most victims enter what is now termed the "acute phase" of the disease, during which they experience fever, headache, muscle pain, nausea, and vomiting. These symptoms usually subside after three or four days and the patients recover. In some cases, however, within 24 hours the disease enters its "toxic phase," and the patient develops jaundice (from which appearance yellow fever gets its name) and complains of abdominal pain with vomiting. Patients bleed from the mouth, nose, eyes, and stomach. Kidney function drops off and sometimes fails altogether, resulting in a rapid rise in the levels of toxins in the body. About half the patients who enter the toxic phase of the disease die within 10 to 14 days, while the rest usually recover gradually (WHO 2001).

If one takes this as the course of the disease in those patients who died on September 14 and 15, and the disease had its normal incubation period of three to six days, they most likely were infected during the last week of August, immediately after the arrival of the two steamers from Havana. While the connection between the arrival of the *Susanna* and the *Denbigh* in late August and the appearance of yellow fever in Galveston soon after is speculative, the coincidence of these events is striking. Further research on both the prevalence of the disease in Vera Cruz and Havana, as well as on the arrival of other vessels at Galveston during that period, is currently underway and may point to other causes of the outbreak. The authors believe, however, that ultimately they will be able to establish a likely source for the epidemic that swept Galveston during that final autumn of war.

## EXCAVATION

### Unit 3-engine Room Forward Part, Near Boiler

Excavation Unit 3 consists of the port half of the engine room including the boiler. In 2002, we finished the planned work in Unit 3, begun in earlier seasons, digging to the bottom of the ship's interior as far down as possible. In a few small places digging penetrated to the engine room deck. Fallen wreckage obstructed the digging, although the crew moved some of this debris.

The 2002 excavation cleared the area between the engine frames beneath the paddle shaft to the aft, forward to the face of the boiler. In addition the crew excavated nearly the full length of the boiler's side along the ship's port side. Important data recorded included primarily the features of the boiler's working face (the aft face where the stokers shoveled in the coal and the engineers controlled the boiler's functions).

Near the bottom of the muddy sand filling the hull was a prominent feature of stratigraphy we called the crunchy layer. The layer was a foot or two above the bottom of the hull and hard enough to be difficult to break through with hand tools. This season's work revealed a coal bunker in the area between the boiler and the port side of the ship. The bunker extended aft of the working boiler face for several feet. On its inboard side there was a thin iron bulkhead to contain the coal. The fire set by the Union boarding party had clearly melted this lightweight bulkhead. This led to speculation that the thin crunchy layer is in fact a melt layer resulting from the fire.

### Unit 5-port Side Sponson and Paddlewheel

Excavation Unit 5 contained the port paddlewheel and sponson. The sponson was the structure outboard of the hull proper that supported and housed the paddlewheel. Features recorded in 2002 include the paddlewheel bearing attached to the hull-side outboard (between the ship's side and the paddlewheel hub), the structural members of the sponson, details of the float mounting brackets, and the hub of the feathering mechanism. The feathering paddlewheel was an advanced feature of the *Denbigh* that greatly increased speed and efficiency. It operated to move the paddle blades (floats) keeping them nearly vertical to the water surface.

Using a hack saw, the crew cut the iron rods leading from the feathering hub to the pivoting brackets of the floats. Then, with lift bags, we moved the hub away from the ship and recovered it using a small spud barge and crane. Deconcreting revealed fascinating construction details including a hollow-cast axel that served as a reservoir for lubrication (Figures 2-6). There was collision damage to the iron sponson supports and evidence of ad hock repair. During the *Denbigh's* excavation, the project recovered two important mechanical parts for detailed study and for later exhibit: in 2001, the nearly 8-ft.-long (c. 2.5 m) connecting rod of the port engine and in 2002, the feathering hub. The impressively large connecting rod gives a nice impression of the engine's scale and has already been conserved and placed in a *Denbigh* exhibit.

Figure 2. The project immediately transported the feathering hub to the Conservation Research Lab, TAMU, where, at the time of writing (June 2003), it was in conservation. Photo by Barto Arnold.

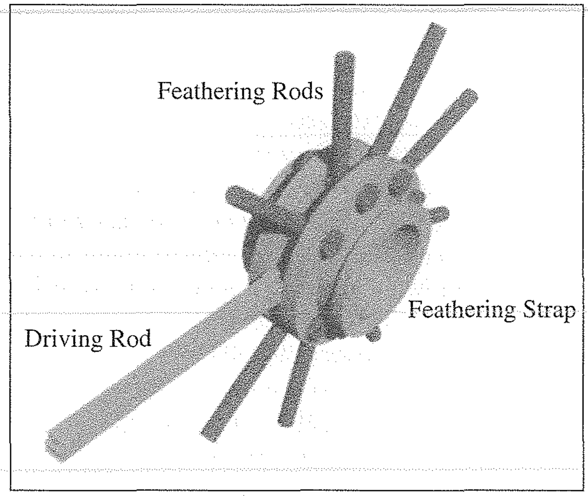


Figure 3. Reconstructed view of the feathering mechanism's central structure, the feathering strap. Illustration by Andy Hall.

## EDUCATION AND PUBLIC OUTREACH

The field crew consisted about ten varying over the summer as additional short-term members came and went. On the 2002 *Denbigh* crew were two graduate students from Texas A&M University

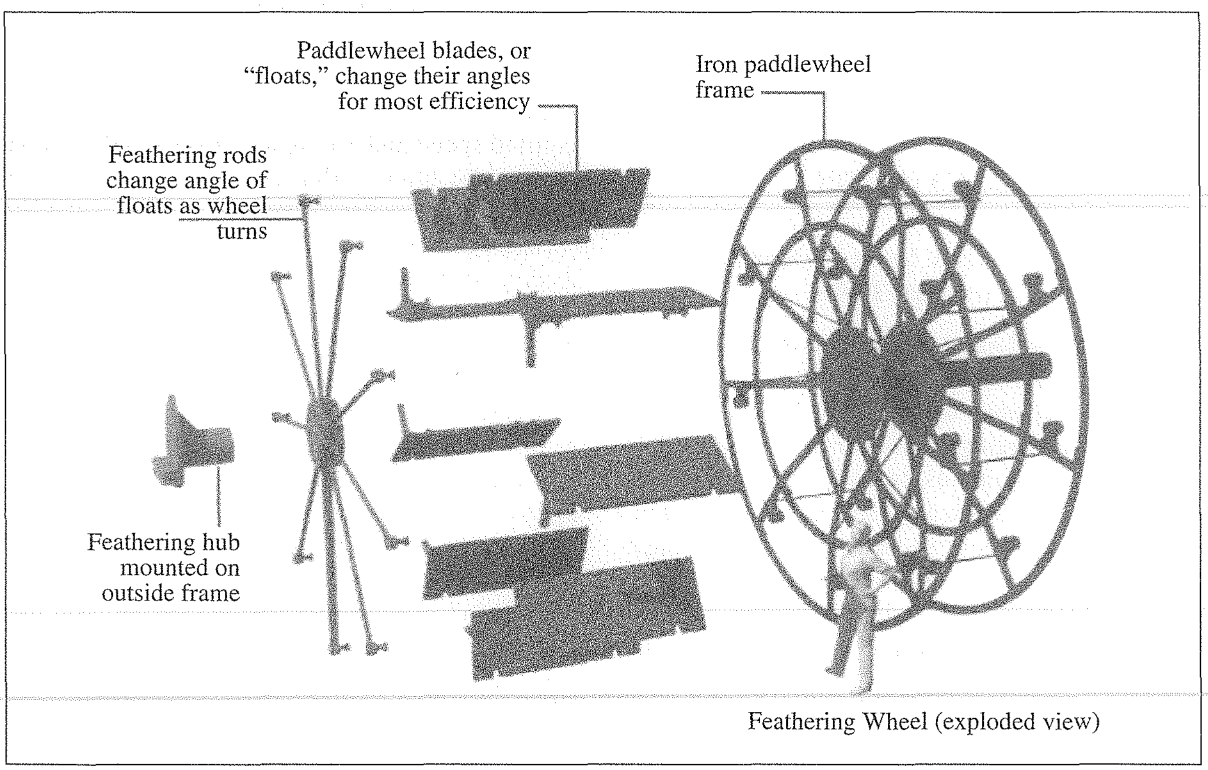


Figure 4. Exploded view of the *Denbigh's* paddlewheel and feathering mechanism. Illustration by Andy Hall.

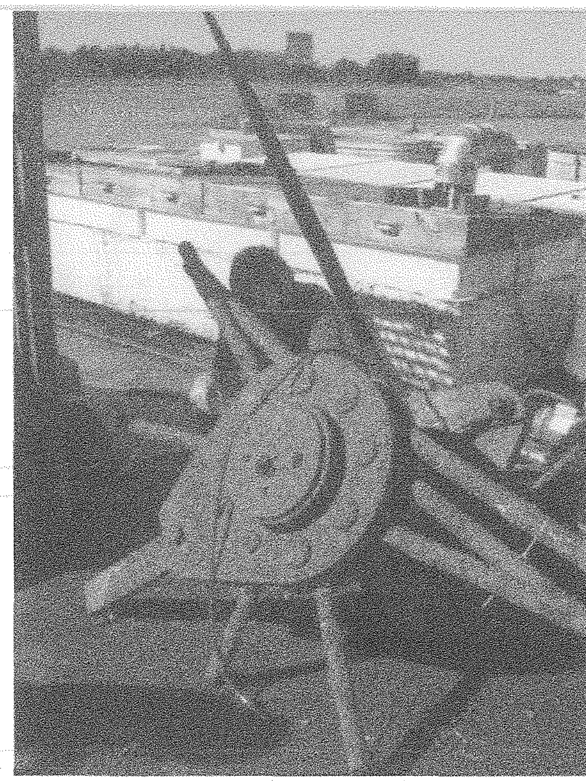

Figure 5. Inboard side of the *Denbigh*'s feathering hub after concretion removal. Photo by Barto Arnold.

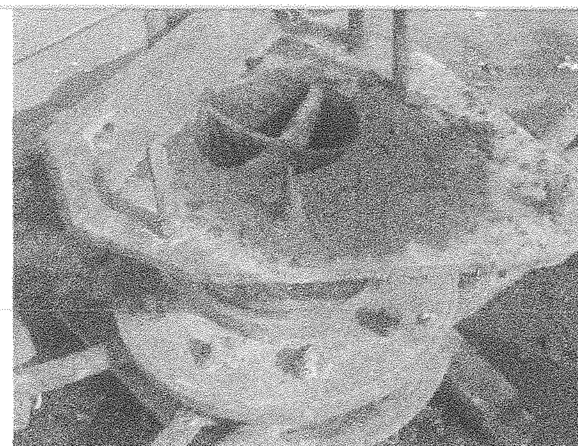

Figure 6. Feathering hub with outboard side up. Wooden pieces lining the mounting bracket have been removed revealing the hollow cast axel with cross braces. The hollow inside of the axel acted as a reservoir for lubricant for the rotating bracket for the arms called a feathering strap. Photo by Christoph Bachhuber.

(TAMU), one in nautical archeology and one in marine biology. There were archeology undergraduates including one from TAMUG. Also on the crew were young professionals and avocational volunteers from around the country. All gained valuable practical experience in nautical archeological fieldwork. Some of the students arranged with their professors for independent-study credit hours, and for this assistance by several faculty members, the *Denbigh* Project is most grateful. Two students from the Webb Institute of New York joined the project in the field. Andrew Wiggins and Sam Ernst, the "Webb boys," were a welcome asset, helping with topside support and providing their professional perspective on many structural and technological aspects of the *Denbigh.*

### Exhibit

There was a preliminary exhibit on the *Denbigh* Project at Galveston's Moody Gardens Discovery Museum from August 2001-May 2002. The exhibit, centered on the huge connecting rod of the port engine, was revised, expanded, and displayed at the TAMUG campus in the foyer of the library June-November 2002. It is a very good thing to have an exhibit available to the public during the fieldwork phase of an archeological project while interest runs high.

### Press day

In promoting public appreciation for heritage and archeology, the press is an excellent way to reach large numbers. The project arranged a press outing to the *Denbigh* wreck each summer. This year with the assistance of the TAMU University Relations Dept. and TAMUG, we held another successful event. There was excellent coverage in local and statewide papers. The Associated Press picked up the excellent feature story in the Fort Worth Star Telegram for national and international distribution (Hanna 2002).

## CONCLUSIONS

The project completed the excavation of about half of the engine room, begun in prior years, concentrating during the 2002 season between the paddle shaft and the aft or working face of the boiler. Excavation also focused on the port paddlewheel and sponson. The feathering hub was recovered. Again the work revealed few small finds,

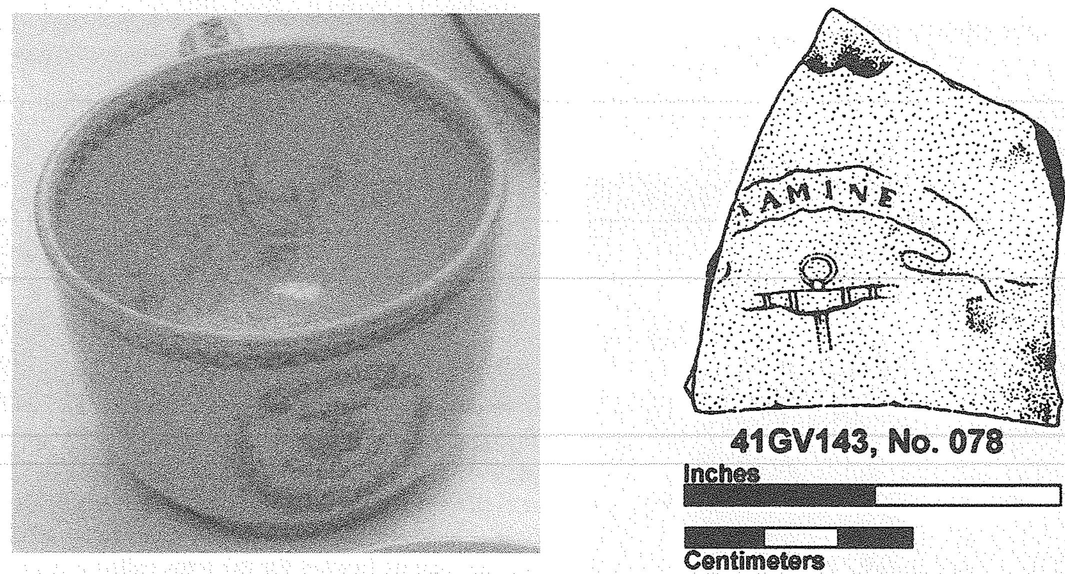


Figure 7. China cup with crown and anchor crest. Exact parallel for decoration of several of the sherds from the *Denbigh*. The cup depicted from the Museum of the Confederacy is shown in a figure by Davis, *Commanders of the Civil War* (Davis 1989: 148).

but those recovered are quite interesting and illuminate the ship and life on board (Figure 7). The project successfully advanced its goals in all areas (Figures 8-9).

The *Denbigh* Project now enters a phase of conservation, analysis, and write-up. We plan at least two more books to join the Watson memoir (Watson 2001) in a series: first, the main excavation

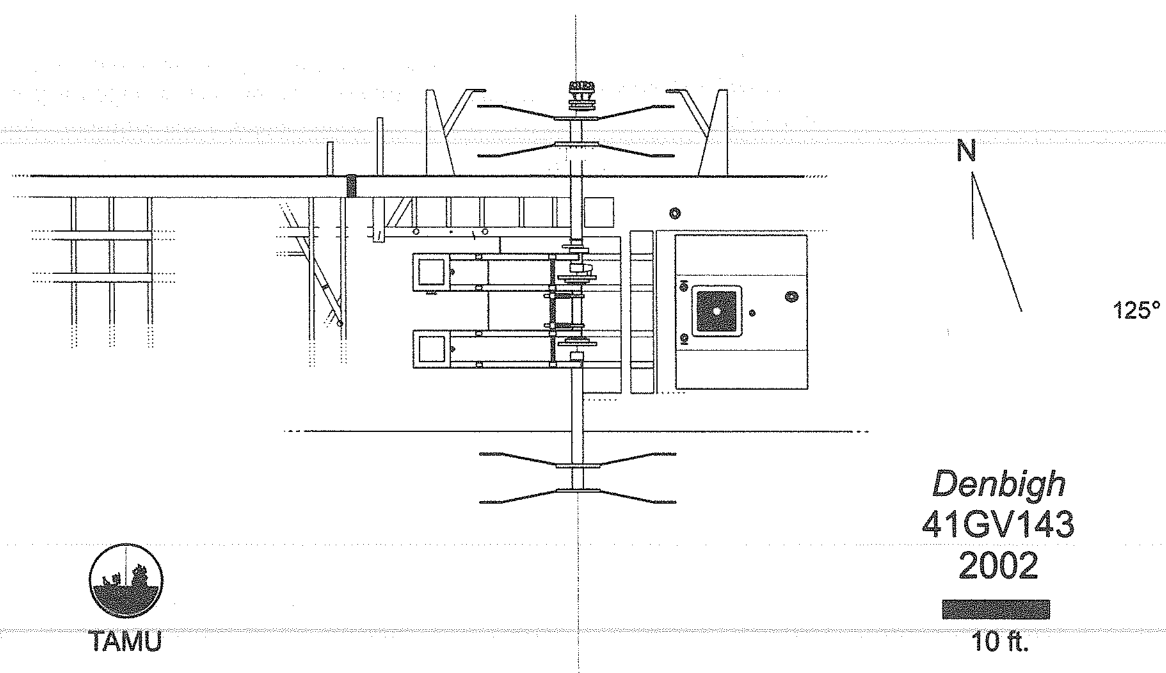


Figure 8. *Denbigh* deck level site plan. Illustration by Barto Arnold.

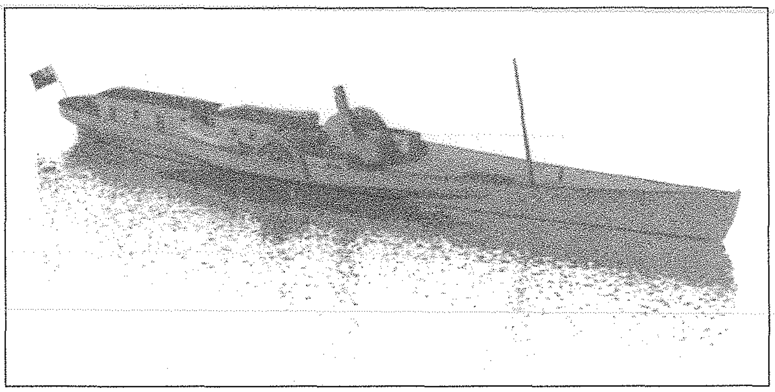

Figure 9. Rendering of the *Denbigh* based on a contemporary portrait. Illustration by Andy Hall.

report and history of the ship and second, a collection of documentary sources about the *Denbigh*. Historical research continues, and the archeological potential of the site is far from exhausted. The bow and the stern need attention as the next areas for digging and study. Very likely there are further areas in the hull where important and intact archeological deposits remain. When the present reporting phase is complete, INA's *Denbigh* Project excavations will continue.

## ACKNOWLEDGMENTS

The *Denbigh* Project works under the aegis of the Institute of Nautical Archaeology, Texas A&M University, a non-profit scientific and educational organization. This season the PI and Co-PIs divided the duties of the project differently from prior years. Arnold, PI, was again project director. Hall,Co-PI, became a certified diver and joined the fieldwork more actively than in the past including underwater. Oertling, Co-PI, due to teaching duties, did not go to the site but rather helped coordinate shore based activities and devoted time to lab duties.

The 2002 work was primarily funded by a major grant from the Ed Rachal Foundation of Corpus Christi. The *Denbigh* Project has also received financial support from (in alphabetical order) the Albert & Ethel Herzstein Charitable Foundation of Houston; the Communities Foundation of Texas; the Brown Foundation, Houston; the Hillcrest Foundation of Dallas, founded by Mrs. W.W. Caruth, Sr.; the Horlock Foundation, Houston; the Houston Endowment, Inc.; the Strake Foundation of Houston; the Summerfield G. Roberts Foundation of Dallas; the Summerlee Foundation of Dallas; the Joseph Ballard Archeology Fund of Texas Historical Foundation of Austin; and the Trull Foundation of Palacios.

Finally, the *Denbigh* Project sincerely thanks Texas A&M University-Galveston for generous assistance throughout the course of the project, and particularly during the 2002 Summer Field Season. Gig 'em, Sea Aggies!

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# Paleopathology at Jamaica Beach (41GV5), in Galveston, Texas

*Jennifer L. Z. Rice*


## ABSTRACT

The goal of this study is to provide an assessment of the health of a Hunter-Gatherer population at the Jamaica Beach site (41GV5) in Galveston, Texas. Skeletal remains of this population were examined for the presence of the following dental and skeletal lesions: dental enamel hypoplasia, caries, abscesses, periostitis, porotic hyperostosis, degenerative joint disease, osteoarthritis, and trauma. Although all individuals are not complete, preservation is good. After reconstruction and analysis of the skeletal remains, results show minimal pathological occurrence within this skeletal population of Jamaica Beach.


## INTRODUCTION

On November 10, 1962, a Native American burial site was discovered on the property of the Jamaica Beach Development Company on Galveston Island. Heavy equipment stripped approximately 500 dump truck loads of topsoil from the site and placed it on a single beach lot. After several heavy rains, artifacts began to surface. The skeletal remains of three individuals were discovered and sent to the Galveston County Sheriff's Office with the suspicion of murder. Upon determination that the remains were Native American, they were eventually turned over to the John Sealy Hospital of the Texas Medical School and ultimately to the Museum of Natural Science in Houston, Texas.

As public speculation rose, so did rumors of the origins of the skeletons. Amateur archeologists noticed the flexed burial positions of the remains and teeth that were characteristic of Native Americans. Within several days, the site was guarded against the public and interested treasure seekers. Unfortunately, people did manage to invade the area and as a result bones, especially skulls, were removed from the site.

Dr. T. E. Pulley, who was the director of the Houston Museum of Natural Science at the time agreed to protect the site and begin an archaeological investigation. Along with Dr. Pulley, the Houston Archeological Society agreed to work on the site. There was also an area of the site that had been badly disturbed by machinery where the public was allowed to dig. Public interest grew and it is believed that over 20,000 people passed through the gates of the site. The site itself known as the Jamaica Beach site (41GV5) is situated on Galveston Island on a ridge between the Gulf of Mexico and Galveston Bay.

By the conclusion of the excavation, seventeen human skeletons had been identified, including fifteen adults and two children. The age range of the adults was estimated to be from 25-30 years to 65-70 years (Ring 1963). In general, the bones were well preserved. Most teeth, regardless of the age of the individual, showed extensive wear probably from chewing sand in association with food (Ring 1963). The remains were oriented on an east-west axis with their heads towards the west. Only one individual was buried directly opposite with the head towards the east. All individuals were buried in a flexed or semi-flexed position on their side or back (Ring 1963). The remains were found in an area of twenty feet square with the entire site having a length of 1,050 feet (Aten 1965). Oyster shells were associated with each grave with one grave having eight *Dosinia* shells placed on the femur along with a *Dinocardium* shell (Aten 1965). This was referred to as Burial K and is not in the present collection. According to the Jamaica Beach map (Aten 1965), one burial contained bone beads, awls, and a bone pendant. Radiocarbon dates have been performed by Dr. E. L. Martin of the Shell Development Co. on the different shells associated with the burials yielding an average date of 450 years B.P. (circa AD 1200 to 1500). There were multiple burials with several having two and three people placed on top of one another. Ray Ring, a member of the Houston Archaeological Society who worked at the site, believes that the burials did not occur simultaneously.

The *Dinocardium* shell, bone awls, beads and pendant in the two graves, are the only burial offerings mentioned in the original documentation. There are a few artifacts such as flint and bone that were recovered from the site, but they were not associated with any particular burial. There were other miscellaneous items found including asphaltum, pumice, and grooved sandstone pieces. Also, according to Ring, a substantial amount of glass, porcelain, and iron pieces were found. A small amount of these items are in with the skeletal collection that is presently housed at the Museum of Natural Science in Houston, Texas. The remains are presumed to be that of Texas Gulf Coast Indians and are assumed to be the same age as the shells dated. Unfortunately, there are no field notes or comprehensive and formal site report available for the Jamaica Beach excavation. The most comprehensive report describing the results of the excavations at the site was written by Ray Ring (1963).

## MATERIALS AND METHODS

Each skeleton was examined to determine incidence of porotic hyperostosis (Stuart-Macadam 1982), dental enamel hypoplasia (Buikstra and Ubelaker 1994), periostitis (Martin et al. 1991; Ortner and Putschar 1981; Steinbock 1976), osteoarthritis (Buikstra and Ubelaker 1994), dental lesions, and trauma. Age and sex of the individuals were mentioned in the initial summary of the excavation, but no specific analysis was performed with the exception of the skulls. In 1965, five crania were examined for anthropometric and morphological data (Aten 1965). The procedures used for taking measurements and reporting morphological observations were taken from Hrdlicka (1952). The only other study performed on these skeletal remains was on Burial I for the purpose of facial reconstruction that was completed by Betty Pat Gatliff. Both age and sex were determined before the facial reconstruction (Few et al. 1990). For this study, all other individuals were sexed and aged using several different methods because of the varying bones present in the skeletal sample. Age and sex assessments were determined as outlined by Bass (1971), Buikstra and Ubelaker (1994), and Lovejoy et al. (1985). Where available, cranial suture closure, dental eruption, epiphyseal closure, and auricular surface of the ilium were examined in order to determine the approximate age of each individual. The development of degenerative joint disease (DJD) and osteoarthritis also suggested age. Sex was determined by examination of the greater sciatic notch, nuchal crest, mastoid process, supra-orbital margin and ridge, the mental eminence, and long bone length and circumference.

## RESULTS AND DISCUSSION

In the original Jamaica Beach archaeological report, 17 burial pits were recorded (Ring 1963). Although there were multiple interments in some instances (more than one individual per grave), only 19 individuals were recorded in the archaeological record. After reconstruction and examination of the skeletal remains during this study, it was determined that the minimum number of individuals (MNI) in the skeletal collection is 27. A category for dental enamel hypoplasia was not included in the analysis as it was not observed in the skeletal remains due to severe attrition present in the dentition. The map of the archaeological site illustrates that a grave contained remains of two individuals, labeled Q and P. The remains are labeled P with two occipitals present in the box. This additional occipital will be called individual Q. Burial F has a MNI of 3 individuals therefore the two additional individuals were given the numbers 16 and 17.

## DESCRIPTION OF ANALYSIS

Table 1 provides a description of each burial including burial number, age and sex of the individual, presence of any lesion, and the presence of specific lesions. If sex or presence of a lesion could not be determined due to a lack of skeletal material, *indeterminable* was entered into the table. *Juvenile, subadult*, and *adult* were entered into the table if a more exact determination of age could not be determined. Original burial letters assigned during the initial excavation were used except when there was more than one individual per grave. Of the 27 individuals studied, 11 (41%) exhibit some type of lesion. Burial I is the only individual in the 18-20 year age range and this individual exhibits healed porotic hyperostosis. The middle aged adult category is represented by six individuals or 22%, with 5 (19%) revealing some type of lesion. Of the complete or semi-complete individuals, adults within the Middle Age category (36 to 49 years of age) are the most highly represented. Being middle aged would allow sufficient time for the skeleton to reveal any chronic illness as well as age dependent conditions. These individuals with some type of lesion include Burials D, EE, P, CC, and BB, all of which are male. The percentage of Young Adults (20 to 35 years of age) with a lesion is 11%, including Burials FF, GG, AA, and one individual of unknown sex and two males. Older Adults (over 50 years of age) have a relatively low percentage of lesions (4%), including Burial DD, a female with signs of arthritis and infection. Burial N represents the only adult of undetermined age having a lesion (arthritis). One individual, an older male (Burial NN), did not have any lesions.

**Table 1. Paleopathology at 41GV5**

| Case # | Burial | Age | Sex | Any Lesion | Infection | PH | Arthritis | Trauma | Carie | Abscess |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | NN | 50+ | M | no | no | no | no | no | no | no |
| 2 | D | 36-49 | M | yes | no | no | yes | no | yes | no |
| 3 | AA | 20-35 | M | yes | — | — | — | — | yes | no |
| 4 | I | 18-20 | F | yes | — | yes | — | — | no | no |
| 5 | EE | 36-49 | M | yes | no | yes | yes | no | no | no |
| 6 | P | 36-49 | M | yes | yes | yes | yes | no | no | no |
| 7 | DD | 50+ | F | yes | yes | — | yes | — | no | no |
| 8 | S | 36-49 | — | — | — | — | no | — | — | — |
| 9 | CC | 36-49 | M | yes | yes | — | yes | yes | — | — |
| 10 | FF | 20-35 | — | yes | no | yes | — | — | — | — |
| 11 | F | 20-35 | — | — | — | — | — | — | — | — |
| 12 | HH | — | M | — | — | — | — | — | no | yes |
| 13 | GG | 20-35 | M | yes | — | — | yes | — | — | — |
| 14 | BB | 36-49 | M | yes | no | — | yes | — | — | — |
| 15 | N | — | M | yes | no | — | yes | — | — | — |
| 16 | Fb | Subadult | — | — | — | — | — | — | — | — |
| 17 | Fc | 20-35 | — | — | — | — | — | — | — | — |
| 18 | Ib | Juvenile | — | — | — | — | — | — | no | no |
| 19 | J | Adult | — | — | — | — | — | — | — | — |
| 20 | M | Adult | — | — | — | — | — | — | — | — |
| 21 | N | Adult | — | — | — | — | — | — | — | — |
| 22 | O | Adult | — | — | — | — | — | — | — | — |
| 23 | Ia | — | — | — | — | — | — | — | — | — |
| 24 | GGa | Juvenile | — | — | — | — | — | — | no | — |
| 25 | B | — | — | — | — | — | — | — | — | — |
| 26 | L | — | — | — | — | — | — | — | — | — |
| 27 | Q | — | — | — | — | — | — | — | — | — |

M= Male, F = Female, — = Indeterminable

## Age and Sex of Sample

Of the 27 individuals in the current collection (Figure 1), five make up the 20-35 year category, the 36-49 year category contains six, and there are ten in the indeterminable category. There are two individuals over the age of 50 and these make up 7% of the sample with the remaining population (4) being less than 20 years of age (15%). Of the individuals in the collection, ten are male (37%), two are female (7%), and 15 (56%) are indeterminable. Of these fifteen, three are sub-adult, and of these three, two are juveniles. Of the complete and semi-complete individuals, sex distribution parallels the statement regarding the Jamaica Beach population made by Ring (1963: 4), "It appears that adult males outnumber adult females."

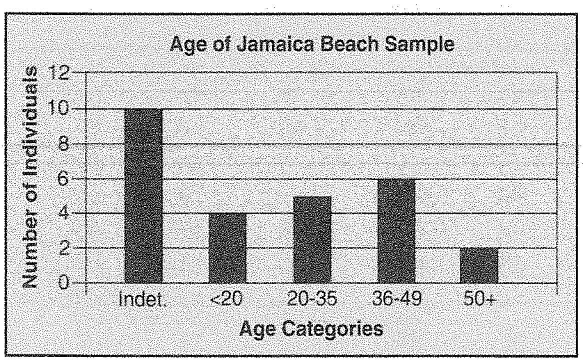


Figure 1. Age distribution at 41GV5

## Infection

Both specific and non-specific infections were observed in this skeletal population. Non-specific infection also known as periosteal reaction can be caused by irritation or trauma to the periosteum. The periosteum is a sheath-like coating around bone that provides nourishment. Some fibers of the periosteum penetrate bone, while others combine with tendons to help anchor muscles to bone (White 1991). Periostitis is an inflammatory response by the periosteum to any infection or trauma and tends to be superficial. Lesions on the bone are characterized by areas of proliferative, hyper-vascular bone that create the appearance of "swelling" (Ortner and Putschar 1981). Bones close to the surface of the skin, such as the skull and tibia, tend to be the most affected. Three individuals (17%) had at least some periosteal reaction present at Jamaica Beach. The tibia was the most common bone affected.

Burial DD, an older adult female (50+), exhibited signs of infection on the right radius. Burial CC, an adult male aged 36-49, had a periosteal reaction on the right tibia. Burial P, also a middle aged male had periosteal reactions on the left clavicle and radius, the right femur, both tibiae, and fibulae. Also present was a cloaca located on the left ulna indicating osteomyelitis. In Burial S, all long bones and bones of the hands and feet appear to have had infection present, but due to erosion on the bone, it is difficult to be certain of the severity. This was a middle aged individual (36-49 years) of undetermined sex.

## Porotic Hyperostosis

Porotic hyperostosis is the resultant lesions of childhood anemia found on the cranial vault. In the condition of anemia, red blood cell production increases which causes the marrow cavity to expand (Huss-Ashmore et al. 1982; Walker 1986). The bones of the skull become thickened, as the diploë or inner table of marrow expands. As this expansion takes place, the outer layer of cortex bone becomes thin which reveals the trabecular bone of the diploë (Huss-Ashmore et al. 1982). The result is a porous, sieve-like appearance and thickened bone with pore-like openings ranging in size from a pinhole up to two millimeters in diameter (Huss-Ashmore et al. 1982; Ortner and Putschar 1981). When cross sections are viewed, different variations of the condition are seen. The exterior vault of the skull may be destroyed, while the diploë, although thicker in appearance, remains intact. Occasionally, new bone is added to the skull vault during the disease process while leaving the inner and/or outer table unaffected (Ortner and Putschar 1981).

Cribra orbitalia refers to similar lesions within the eye orbits and usually occurs together with porotic hyperostosis. The origin of the diseases is believed to be the same (Stuart-Macadam 1985, 1987, 1989a, 1989b). Factors that contribute to anemia may include a maize-dependent diet, poor living conditions that invite parasite exposure and infection, and chronic diarrhea. Maternal health during pregnancy and weaning are also possible etiologies. Anemia actively affects the less mineralized skulls of children and indicates iron deficiency in childhood with the exception of a few cases in adults (Stuart-Macadam 1985). Porotic hyperostosis mainly affects infants and young children even though evidence of the condition may be seen in older sub-adults and adult skeletal remains as healed lesions. Sufficient nutritional intake can aid in the healing of previously active lesions resultant of a previous episode of chronic anemia.

In the Jamaica Beach skeletal population, incidence of porotic hyperostosis was detected from skeletal remains from six individuals. Burial I, an 18-20 year-old female, exhibited healed porotic hyperostosis in the area of the external auditory meatus (EAM). Burial EE, a 36-49 year-old male, had evidence of healed porotic hyperostosis across the supra orbital ridge, above the EAM, and several small areas on the parietals and occipital. Burial P, a middle aged male aged 36-49, exhibited healed porotic hyperostosis on the occipital region and in the eye orbits (cribra orbitalia). Burial FF, a young adult, contained only fragments; however, porotic hyperostosis was evident on one small skull fragment. All porotic hyperostosis observed in these individuals was slight to moderate and was healed. Food resources of hunters and gatherers vary from season to season; therefore, it is reasonable to assume that hunting and gathering societies most likely suffered at least one season of low nutritional intake during their childhood years, which resulted in slight cases of anemia.

## Degenerative Joint Disease

Degenerative Joint Disease (DJD) is the most common form of arthritis. It is basically part of the aging process that occurs mostly in the load-bearing joints. There are two types of joints in the human body: synarthroses and diarthroses. The synarthrosis joints are those in which there is little or no movement such as the pubic symphysis and sutures of the skull (Steinbock 1976). As a result of this limited mobility, arthritis does not affect these joints. Only the diarthroses, also known as synovial joints are vulnerable to osteoarthritis. Examples of these joints include the hips, knees, shoulders, and elbows.

In DJD, the destruction of the articular cartilage occurs in these joints along with subsequent formation of adjacent bone that is seen as lipping and spur formations. A combination of factors contributes to DJD that include age, sex, hormones, mechanical stress, genetics, trauma, and bacteria (White 1991). Usually, arthritis occurs in individuals over the age of fifty, male, and those with large muscles and torsos (Steinbock 1976). Obviously, the extra weight and size of individuals forces the joints to work harder and thus, arthritis becomes more prevalent. As one gets older, the articular cartilage of the diarthrodial joints deteriorates which results in abrasion and the formation of new bone (Steinbock 1976). Along with maturity, the constant wear and overuse of joints during life causes the process of degeneration to accelerate. Heavy lifting, constant positions such as squatting and kneeling also contribute to the degeneration of joints over time. During the process of severe wear on the joint, the cartilaginous tissue is lost and evidence of eburnation is seen. The area of bone that was once covered with cartilage becomes exposed to the opposing bone and this constant rubbing of the two bones produces the polishing affect of eburnation.

Evidence of DJD and osteoarthritis or osteophytosis (arthritis in the vertebral column) in the Jamaica Beach population is fairly high with deterioration, osteophytes, and/or eburnation all present (Figure 2). Most arthritis observed in the skeletal sample is located throughout the vertebral column and bones of the arms. The severity of the arthritis ranges from slight to moderate with some vertebral lipping (osteophytes) seen in the middle aged and older adults. Burial D, a 36-49 year-old male, that is the individual buried in a different position (east to west orientation), had a cleft atlas and subsequent arthritis on the cervical vertebrae C2, C3, C4 and C5. The facets are flattened and appear to have been compressed together (See Developmental Defects below). Burial EE, a middle aged male, had arthritis present on the distal end of the left humerus, semilunar notch of the left ulna, and on the

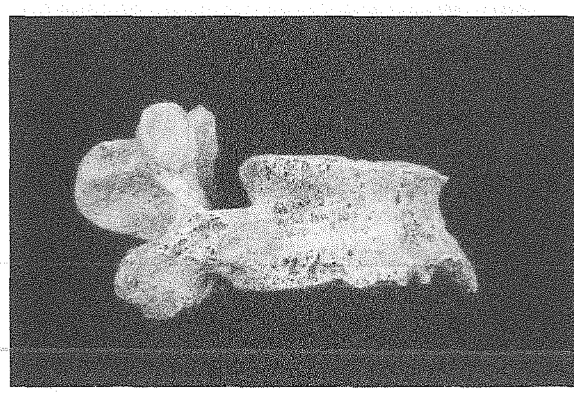

Figure 2. Osteoarthritis with Vertebral Lipping, Skeleton M from 41GV5.

right talus. Burial P, a middle aged male, had arthritis in both feet, the distal ends of both ulnas (eburnation present on both), and the proximal ends of both radii. Burial DD, an older female (50+) and Burial GG, a young male (20-35), had osteoarthritis along their vertebral columns. Burial CC, a middle aged male, exhibited arthritis on the distal end of the left humerus and humeral head, and both semilunar notches. Burial BB, a 36-49 year-old male, had arthritis on the first, left metatarsal and the left semilunar notch of the ulna. Burial N, a male of unknown age, had arthritis present on the distal end of the right humerus and proximal end of the right ulna. Arthritis was also present on several vertebral fragments of this individual.

## Dentition

Information regarding the diet and health of prehistoric populations can be obtained from the analysis of teeth (Goodman 1991; Rose et al. 1985). The presence of dental lesions, although nonspecific, can suggest nutritional stress. Therefore, the study of dental lesions becomes an important aspect of skeletal analyses. The dentition can provide insight to diet and techniques of food preparation and consumption in archaeological populations as well as the age of individuals (Powell 1985). Mechanical, chemical, and pathogenic stresses from diet affect teeth upon their eruption into the oral cavity. The relationship between these factors in combination with general tooth morphology and environmental factors, influence the dental health of populations (Powell 1985).

The loss of the occlusal surface of the tooth and the interproximal surface area between the teeth is generally known as dental wear (Martin et al. 1991). Wear of the teeth has been divided into two different components: dental attrition which is a result of tooth to tooth contact, and dental abrasion, which results from contact of foreign objects on the tooth itself (Scott and Turner 1988). Most degrees of dental wear are not considered pathological since attrition is the result of masticatory stress on the dentition through nutritional and technological activities (Powell 1985). Most wear of the teeth is simply a result of normal chewing processes (Figure 3).

The number of teeth available for analysis in this collection was minimal. Most teeth were extremely worn with shortening of the tooth and

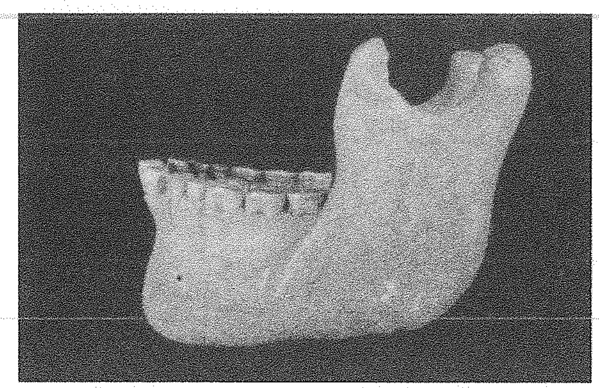

Figure 3. Dental attrition, 41GV5, Skeleton HH.

exposed dentin. Only one individual, a young female (Burial I) had slightly worn teeth compared to other 41GV5 individuals, while the teeth of the juveniles exhibited no wear. Of the ten graves that contained teeth, two had caries and one had an abscess. Burial D, a middle aged male, had one carie present on the upper right second incisor ($RI^2$). Burial AA, a young male, had several caries. Both upper canines had caries as well as the first lower right molar ($RM_1$) and the first and second lower left molars $LM_1$ and $LM_2$. The only abscess in the collection was found in an individual in Burial HH, a male of indeterminable age. The abscess is located just below the lower left incisors.

Burial GG, although fragmentary, contained a mandible with no teeth intact. Resorption was evident around the entire mandible indicating that this young male lost his teeth well before death. Deciduous teeth in the Jamaica Beach collection were found in Burials Ia, F, and GG. There was no evidence of dental enamel hypoplasia (DEH) or dental hypocalcification in this collection. These conditions may have been present in the Jamaica Beach population in life before the dentition became severely worn.

There are two carious individuals in the collection. These make up 7% of the total collection and 20% of the individuals with teeth. The frequency of caries and abscesses at 41GV5 are low, but since there are only ten individuals in the collection with at least one tooth, the true frequency is impossible to know.

## Trauma

There is no clear case of trauma in the Jamaica Beach population. Burial P exhibits the only case of possible trauma in the collection. The left fibula may have a healed fracture but it is difficult to be certain without an x-ray. This was not possible as the collection could not be removed from the museum.

Although not pathological, hyperossification at muscle attachment sites alters the shape of the bone where repetitive use of muscles occurs. This condition is seen in several individuals at Jamaica Beach. Burial GG, a young male, had evidence of muscle development along both arms. Burial BB, a middle aged adult, had a projection on the right humerus at the distal end. This may be the result of large muscle development. An older female, Burial DD, had signs of muscle development on the right and left humeri. Individuals at Jamaica beach exhibited signs of varying degrees of muscle attachment. Bones of the arms (wrists and shoulders) are most affected.

### Developmental Disorders

The only obvious case of a developmental defect in the collection was seen in Burial D. The atlas vertebra had a cleft posterior neural arch that is an opening of the posterior arch (Figure 4). There was also compensatory overgrowth of the left side of the vertebra. The inferior facet of the C2 vertebra and superior facet of C3 were compressed into each other as well as the C4 and C5 vertebrae. Again, this was observed only on the individual that was buried in a different orientation from the remainder of the Jamaica Beach population. Although only one individual exhibits this defect (1/27 = 4%), the frequency of this occurrence equals the expected frequency of cleft atlas for any population (Bailey 1974).

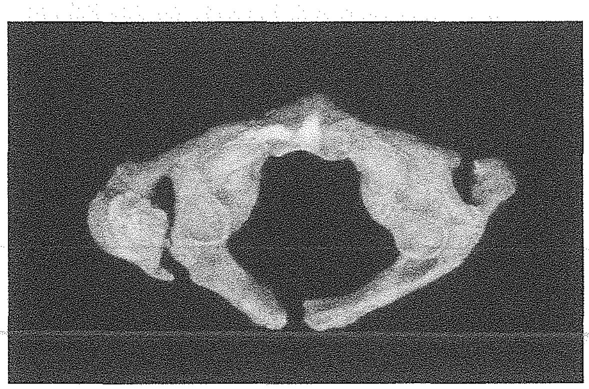

Figure 4. Cleft Atlas Vertebra, Superior View, 41GV5, Skeleton D.

## CONCLUSION

Generally, overall health of the population at Jamaica Beach was good. The skeletal remains in the sample reveal stress markers that would be expected in a hunting and gathering society. Diet plays a major role in the health of an individual, but lifestyle also affects the human body. Most afflictions or evidence of pathological occurrences in the Jamaica Beach population are the result of accidents, such as periosteal reactions, or degenerative processes such as osteoarthritis and dental attrition. Periosteal reactions observed in this skeletal sample are minimal and most were not severe with the exception of one individual. These skeletal remains exhibit a possible case of congenital treponematosis indicative of infectious disease. The majority of the arthritis in the sample is located in the vertebral column, arms and feet and most likely associated with aging and physiological wear. Arthritis of the feet may be the result of the environment. Walking in sand puts extra stress on the muscles of the feet more so than walking on a flat surface. Substantial muscle development was seen in several of the individuals, including females.

The diet of the Jamaica Beach Indians was most likely varied and seasonal which provided a wide range of food. The dentition of the individuals shows severe attrition that is common in hunters and gatherers due to a diet containing foods rough in texture. This rough texture of food along with required vigorous mastication contributed to dental attrition. Also, these coastal Indians must have encountered sand in the diet that can also account for severe attrition (Ring 1963).

The small sample size of the collection and limited documentation of the excavation made for difficult analyses. Several individuals are boxed together and not labeled. Further reconstruction and analysis will be helpful in adding to the number of complete or almost complete individuals.

## ACKNOWLEDGEMENTS

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# Recovery and Interpretation of Fungal Pathogens of Maize from Mimbres-Mogollon Archeological Sites

*Michael W. Pendleton, Dale Newton, and Bonnie B. Pendleton*

ABSTRACT

Common fungal pathogens of modern corn (*Zea maize*) are described with explanations of how these pathogens could be traced through macrobotanical and microbotanical samples from prehistoric Mimbres-Mogollon archeological sites. Problems with interpretation of evidence of prehistoric fungal outbreaks are discussed. Research on fungal activity at a Mimbres-Mogollon archeological site is described. The method may have potential for identifying evidence of agricultural production at sites occupied by agriculturalists in the Caddo and Jornada Mogollon regions of Texas.

## INTRODUCTION

The prehistoric Mogollon people occupied southeastern Arizona, southwestern New Mexico, western Texas, and northern Mexico from A.D. 220 to 1150 (Wheat 1955:3). The Mimbres-Mogollon branch of the Mogollon occupied the Mimbres River and its tributaries, the upper areas of the Gila River, and the lower San Francisco River (LeBlanc 1986:297). Maize (*Zea mays*) was the primary crop of the Mimbres-Mogollon people of the Southwest from the Late Pithouse through Classic phases from approximately A.D. 550 to 1150 (LeBlanc 1983). Fungal pathogens might have influenced yields and stored supplies of maize during the occupation periods of the Mimbres-Mogollon. This study examines how fungal outbreaks may be traced and interpreted in the archeological record.

## DISEASES OF MAIZE

Although diseases of maize may be caused by such agents as bacteria, flowering parasitic plants, fungi, mycoplasmas, nematodes and viruses, this report primarily discusses fungal parasites of maize. The fungi are simple, filamentous organisms that do not have chlorophyll and commonly reproduce by producing spores spread by wind and/or other vectors, such as insects. Many of the fungal diseases of maize are called smuts or rusts (Christensen 1951:31).

*Ustilago zeae* is one of the many fungi that cause smut of maize. Corn smut grows in stems, ears, and tassels of the maize plant and produces galls on the outer surface of the plant. Infestation of 10 percent of plants in a field is considered a moderate infection in modern maize-growing regions of the world (Christensen 1951:31). Other fungal pathogens of maize include *Puccinia sorghi*, a common rust fungus that infected an average of 51 percent of maize plants in Minnesota in 1977 (Kommedahl et al. 1978:692). *Helminthosporium pedicellatum* is a fungal pathogen that causes root rot in maize and caused economic damage in California in the 1960s (Shepherd et al. 1966:52-56). Sorghum downy mildew (*Sclerospora sorghi*) is a fungus that attacks sorghum and maize in the central United States and was reported in areas of New Mexico in 1973 (Frederisksen and Ullstrup 1975:39). These fungal pathogens (mildews, root rots, rusts and smuts) infect present-day fields where tilling is practiced and also fields that are not tilled.

During the 1980s, research was directed to identifying plant pathogens of maize produced without tillage due in part to increasing use by farmers of minimum-tillage agriculture. Infestation by the fungal pathogen *Cercospora zeae-maydis* occurred more frequently in the southern United States because of no-tillage farming (Latterell and Rossi 1983:842). *Cercospora zeae-*

*maydis* infected as much as 69 percent of maize crops in no-tillage fields in Maryland (Smith and Grybauskas 1985:1366). Not only does the use of minimum tillage increase the incidence and severity of fungal diseases (compared to that in fields cultivated by conventional methods), but also continuous planting of maize in the same field causes the disease to spread because of buildup of fungal spores (Shurtleff et al. 1977:2). If the Mimbres-Mogollon grew maize in the same fields for many seasons and presumably did not use a plow to till the fields, accumulations of spores of the fungus in the soil could have caused a decrease in yields of maize over time.

Minnis (1978:360) postulated that as prehistoric Mimbres-Mogollon population increased in the Mimbres Valley, riparian plant species were exploited more extensively, resulting in a lowering of the water table and subsequent increase in soil erosion. A lower water table combined with an increase in erosion may have resulted in warmer soil temperatures and lower humidity during prehistoric times. These dry conditions favor the development of corn smut but hamper the development of most rusts of maize during modern times (Shurtleff et al. 1977:31-34). However, present-day reactions of a specific smut or rust pathogen to specific temperature and humidity levels may have evolved from a reaction that was different during Mimbres-Mogollon times. Therefore, it is difficult to determine which fungal pathogens may have been favored for the environmental conditions postulated to have occurred during the Mimbres-Mogollon occupation.

Following harvest, fungal pathogens that commonly attack stored maize are called storage rots. Storage rots may infest either shelled or whole cobs of maize shortly after harvest or years after being placed in storage, at which time a production of toxins may occur which make the maize inedible. These storage rots include many fungi, one of which is *Aspergillus*. If maize is stored with moisture less than 15% and at temperatures less than 10 degrees Celsius, *Aspergillus* will not thrive, but when grain with more than 15% moisture is stored at temperatures of 21 to 32 degrees Celsius, the fungi may infest entire storage bins with no apparent external symptoms until damage is well advanced (Shurtleff et al. 1977:47).

## USING MACROBOTANICAL EVIDENCE TO TRACE PATHOGENS OF MAIZE

Martin et al. (1952) thought the Mimbres-Mogollon subsistence base shifted from the hunting and gathering of the Cochise Archaic to a horticulture/pottery complex by 2300 B.P. Maize was a critical resource during the horticulture/pottery complex period. Minnis (1981:176) commented that it was clear from an analysis of Mimbres Foundation excavation data that agricultural products, particularly maize, were critical resources for people during the Late Pithouse to Salado phases of the Mimbres-Mogollon.

Minnis (1981:243-246) also noted that maize was one of the most frequent archeological plant remains recovered from flotation samples from Mimbres Foundation excavations in the Mimbres Valley. Flotation recovers such fragile macrobotanical materials as seeds and other plant fragments large enough to see without magnification. However, maize kernels recovered by flotation probably are under-represented because maize usually was ground before eating and would not preserve well (Bohrer 1976:245-250). Minnis (1981:243) also explained that most macrobotanical remains recovered by using flotation were individual charred cupules so that cob characteristics such as kernel row number could not be determined easily. He also noted that most examples of maize recovered by using flotation were so small and incomplete that few features useful to determine the attributes of the yield of a prehistoric maize crop could be determined. Charred cupules of maize, like other carbonized botanical material, may become waterlogged and lose buoyancy during processing by flotation (French 1971:62). Carbonized botanical materials from arid environments may commonly be coated with calcium carbonate and become non-buoyant during flotation (Minnis and LeBlanc 1976:492). Therefore, froth flotation devices, rather than tub-type flotation devices, should be used to recover charred cupules because froth flotation recovers non-buoyant carbonized seed materials (such as maize cupules) more efficiently than does the tub-type flotation method (Pendleton 1983:615).

While carbonized macrobotanical remains of maize are underrepresented in the archeological record, carbonized macrobotanical remains of maize infected with fungus would be even more under-represented because infected cobs would not be taken from the field and therefore would have little chance for preservation at a habitation or firepit. Even if infested cobs were burned for warmth or for cooking, it would be unlikely that fungal mycelium would be recovered after cobs (or kernels) were carbonized. The thin-walled mycelium of most fungi is not adapted to withstand desiccation or the stresses of carbonization (Weier et al. 1974:461). Occasionally, head smut may create spore masses that are black and loose and completely destroy the ear of maize (De Leon 1984:60). Although an infestation of corn smut may render plants barren or may cause them to produce many very small ears (Shurtleff et al. 1977:31), evidence of these conditions may be difficult to detect even in macrobotanical soil samples from fields of maize. If the fortuitous preservation of an intact spore mass were recovered from a Mimbres-Mogollon site, it would be difficult to interpret the importance of such a spore mass to loss of yield. This is because a single spore mass could contain millions of spores and could cause significant crop loss if released under humidity and temperature conditions adequate for germination. Unfavorable temperature and humidity would not usually produce significant fungal damage to crops. Macrobotanical evidence of outbreaks of storage rot fungi occurring during the Mimbres-Mogollon occupation could be based on the recovery of carbonized cobs of maize infested with storage rot from granary bins (if the room was burned). The significance of this evidence would be determined by assessment of the degree of fungal outbreak, the extent of the loss to the stored maize, and the time of the outbreak in relation to the next harvest.

## USING MICROBOTANICAL EVIDENCE TO TRACE PATHOGENS OF MAIZE

It is difficult to use microbotanical analysis (such as spores) from soil samples to trace fungal pathogens of maize. Although extraction and analysis of plant pollen from archeological sites has become common, similar research of fungal spores from archeological sites is not as widespread. Fungal spores generally are more easily destroyed than are pollen grains by the process used to extract pollen and spores from soil samples (Graham 1962:63). Although fungal keys and identification books (for example Duran 1987; Ellis and Ellis 1989; Fischer 1953) are useful for general identification of fungi, Elsik et al. (1990:91) noted that fossil fungal spores are relatively untreated as taxonomic entities in the published literature. Most pollen grains are easier to locate on a slide and identify than are the spores of most taxa of corn smut by using a light microscope because the average size of pollen grains is 20-50 micrometers in diameter (Kapp 1969:3) while, for example, the size range of *Ustilago zeae* (corn smut) spores is 8-12 micrometers in diameter (Christensen 1951:31). However, Graham (1962:60-65) described several positive aspects of the use of all kinds of fungal spores to trace paleoecological changes at an archeological site. He noted that most kinds of fungal spores are often present in pollen samples in greater quantities than are pollen grains, and the morphological characteristics of fungal spores allow many kinds to be positively identified. Graham (1962:60-65) also mentioned that the recovery of spores of host-specific fungi from archeological sites indirectly indicated the presence of the host plant when other paleobotanical evidence such as host plant pollen grains, seeds or plant fragments could not be recovered.

Although Davis and Goodlett (1960) directly attempted to correlate vegetation abundance and patterns with pollen grain taxa recovered from soil samples from plant communities producing these patterns, a similar study would be difficult to complete with a fungal pathogen such as a corn smut or rust. For example, *Puccinia* (one genera of corn smut) produces five distinct kinds of reproductive cells: urediniospores, teliospores, basidiospores, spermatia, and aeciospores (Bold 1973:201). To identify these spores, a reference collection would ideally include all five kinds of cells for each species of *Puccinia*. In contrast, plant species, however, usually produce only one morphologically distinct kind of pollen grain so only examples of this kind would be required for identification. It would be difficult because of the reproductive capability of the fungus to use concentrations of *Puccinia* spores (all five kinds) from a soil sample from a site to determine the infection rate in maize fields surrounding the site. For example, mycelium arising from the germination of just one urediniospore may produce several thousand more urediniospores, and urediniospore cycles may be repeated many times during a single maize-growing season (Bold

1973:200). Because *Puccinia* may have more than one host (Bold 1973:200), spore concentrations in samples of soil from prehistoric farm fields should be considered when estimating the relative abundance of one host in relation to others and levels of infestation of maize by *Puccinia*. Microbotanical evidence of storage rots in maize during the Mimbres-Mogollon occupation could be based on the recovery of storage rot spores from soil samples from Mimbres-Mogollon granary bins.

In an article by Pendleton (1998:41), spores of a fungal pathogen of grasses (*Tilletia*) were recovered from soil samples from site LA 15049 (Nan Ranch), a Mimbres-Mogollon archeological site in southern New Mexico. This site was occupied during the Pithouse to Late Classic Mimbres cultural periods (Shafer 1988:7). Soil was collected from 11 rooms at the site (Pendleton 1993) but spores of *Tilletia* were found only in one sample (Figure 1) from one room occupied at the time the site was abandoned (Pendleton 1998). Although Pendleton's (1998) research presented only limited information about the cultural use of these fungal spores and the possible host species of this fungi (maize is not known to be a host of *Tilletia*), it demonstrated that fungal spores could be recovered from a Mimbres-Mogollon archeological site in significant enough amounts to be analyzed as a feature of a site.

## SUMMARY

Many difficult problems are associated with recovery and interpretation of fungal pathogens of maize or other plants associated with Mimbres-Mogollon archeological sites. While a study by Graham (1962:60-68) highlighted general aspects of interpreting data on fungal spores from soil samples, research is required to define new methods to analyze and understand the impact of quantities of prehistoric fungal pathogens on yields of maize from the Mimbres-Mogollon region and at archeological sites in other regions occupied by agriculturalists.

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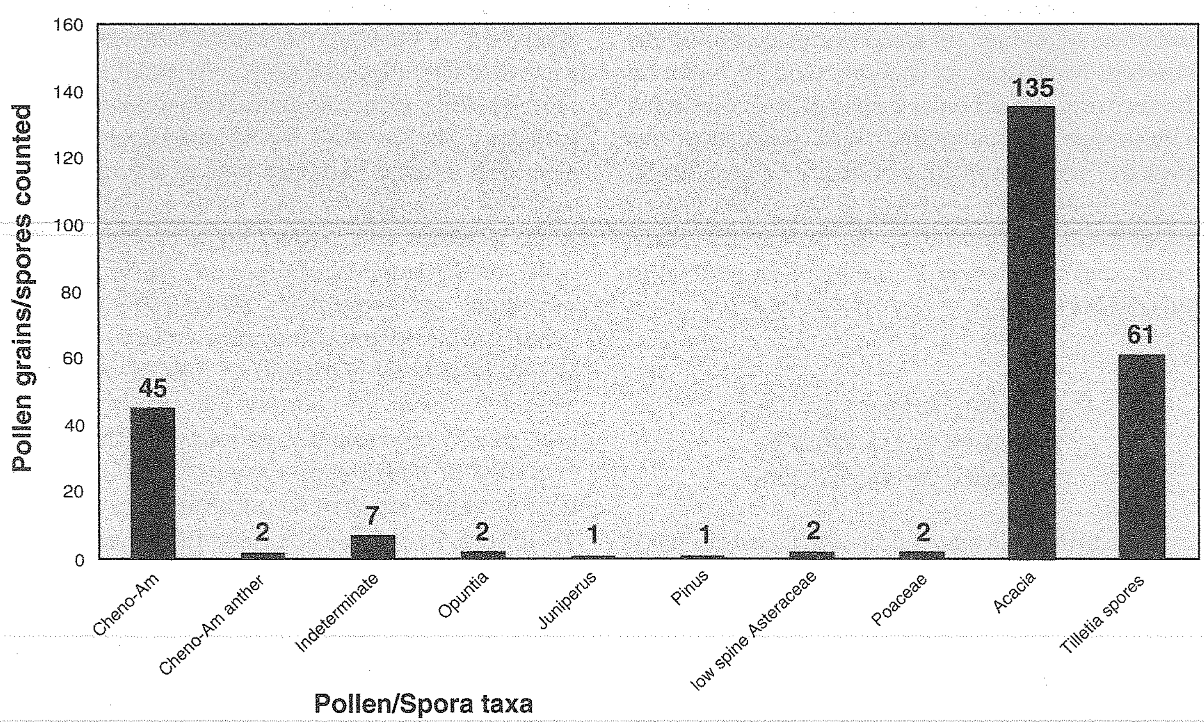


Bar graph of numbers of pollen taxa recovered from Site LA 15049, Room 60, Sample 12 (Pendleton 1993). The Cheno-Am category (Martin 1963:49) includes pollen that cannot be distinguished between the Chenopodiaceae family and the *Amaranthus* genera by using light microscopy.

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